STATE OF SOUTH DAKOTA
Richard F. Kneip, Governor

DEPARTMENT OF NATURAL RESOURCE DEVELOPMENT
Vern W. Butler, Secretary

GEOLOGICAL SURVEY
Duncan J. McGregor, State Geologist

Special Report 60

GROUND-WATER INVESTIGATION FOR THE CITY OF EUREKA, SOUTH DAKOTA

by

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and
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Vermillion, South Dakota
1975

This publication was printed at a cost of 75 cents per copy. A total of 250 copies were printed for dissemination of geologic information.

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INTRODUCTION

Present Investigation

This report contains the results of a special ground-water investigation conducted by the South Dakota Geological Survey around the city of Eureka, McPherson County, South Dakota (fig. 1). The field work was conducted from July 16 to July 27, 1973. The investigation involved: (1) mapping the geology of the area, (2) drilling 26 rotary test holes, (3) making a well inventory, (4) collecting and analyzing 14 water samples, and (5) analyzing pump test data. The following report of this work is the 60th in a continuing series of investigations assisting cities in locating their future water supplies.

In 1923 the city drilled a well to a depth of 2,400 feet within the city limits. This well was plugged in 1973. A second well was drilled in 1960 to a depth of 2,085 feet in the vicinity of the first well. The second well yields water from the Fall River Sandstone at a rate of 320 gallons per minute, which is adequate for city use. Waters from deep aquifers contain high amounts of dissolved chemicals. To remove some of these chemicals, a water-treatment plant was built in 1946. The present investigation was performed to find an adequate shallow city water supply with less dissolved chemicals than the present supply.

As a result of the present investigation, two shallow sand and gravel deposits were found 3 miles south of Eureka. This area was the most favorable site for development of a city water supply, and recommendations were made to drill test holes and conduct a pump test in this area.

The city, with the consultation of their engineering firm, J. T. Banner and Associates, Inc., hired a well driller to drill test holes and pump a test well. In June, 1974, a pump test was conducted by the engineering firm. The data from the pump test were analyzed by the South Dakota Geological Survey and a second well was recommended to be drilled in the area before construction of a pipeline to the city. A short pump test was conducted in November, 1974, on the second well. The water quantity and quality from this aquifer were found to be satisfactory.

The cooperation of the residents in and around Eureka, especially the officials, Mayor Alfred Fischer and City Auditor William Wenzel is appreciated. The assistance of the State Chemical Laboratory is also acknowledged. The cooperation of Mr. Hank Williams of J. T. Banner and Associates, Inc., is also appreciated.

The project was financed by the South Dakota Geological Survey, the Oahe Conservancy Sub-District, and the city of Eureka.

Topography and Drainage

Topography in the Eureka area is an undulating surface developed on glacial till (fig. 2). The drainage is poorly integrated with intermittent lakes and sloughs abundant. A few of the lakes are perennial.

GENERAL GEOLOGY

Surficial Deposits

The surficial deposits of the Eureka area are chiefly the results of glaciation late in the Pleistocene Epoch of geologic time. Glacial deposits are collectively termed drift, which is divisible into two broad lithologic groups: till and outwash.

Till, commonly called "boulder clay," "blue clay," or "gumbo" consists of a heterogeneous mixture of boulders, pebbles, and sand in a matrix of clay deposited directly by the ice. Figure 2 is a geologic map of the Eureka area.

Outwash material is a more homogeneous deposit, consisting primarily of sand and gravel with minor amounts of silt and clay which was deposited by melt water streams issuing from a glacier. Figure 2 shows some surface outwash material north of Eureka. Buried outwash is present in the Eureka area. The most extensive distribution of buried outwash is found in the southern part of the study area which will be discussed later in this report.

Subsurface Bedrock

There is no exposed bedrock in the study area, but data obtained from deep test holes in Walworth and Brown Counties and from the Eureka city well reveal the following units in the subsurface. The thicknesses given in parentheses are only approximate. The units are listed in descending order:

Drift (210 feet — till and outwash)
Pierre Shale (540 feet — underlies the glacial drift in the study area)
Niobrara Marl (130 feet)
Carlile Shale (415 feet)
Greenhorn Limestone (30 feet)
Graneros Shale (275 feet)
Dakota Formation (225 feet — alternating beds of sand and shale)
Skull Creek Shale (130 feet)
Fall River Sandstone (100[?] feet — present Eureka city well is finished in this unit)
Paleozoic section (1,000 feet — underlies the Cretaceous sediments)
Pre-Cambrian (? — approximately 3,000 feet below land surface and it underlies the Paleozoic sediments in the study area)

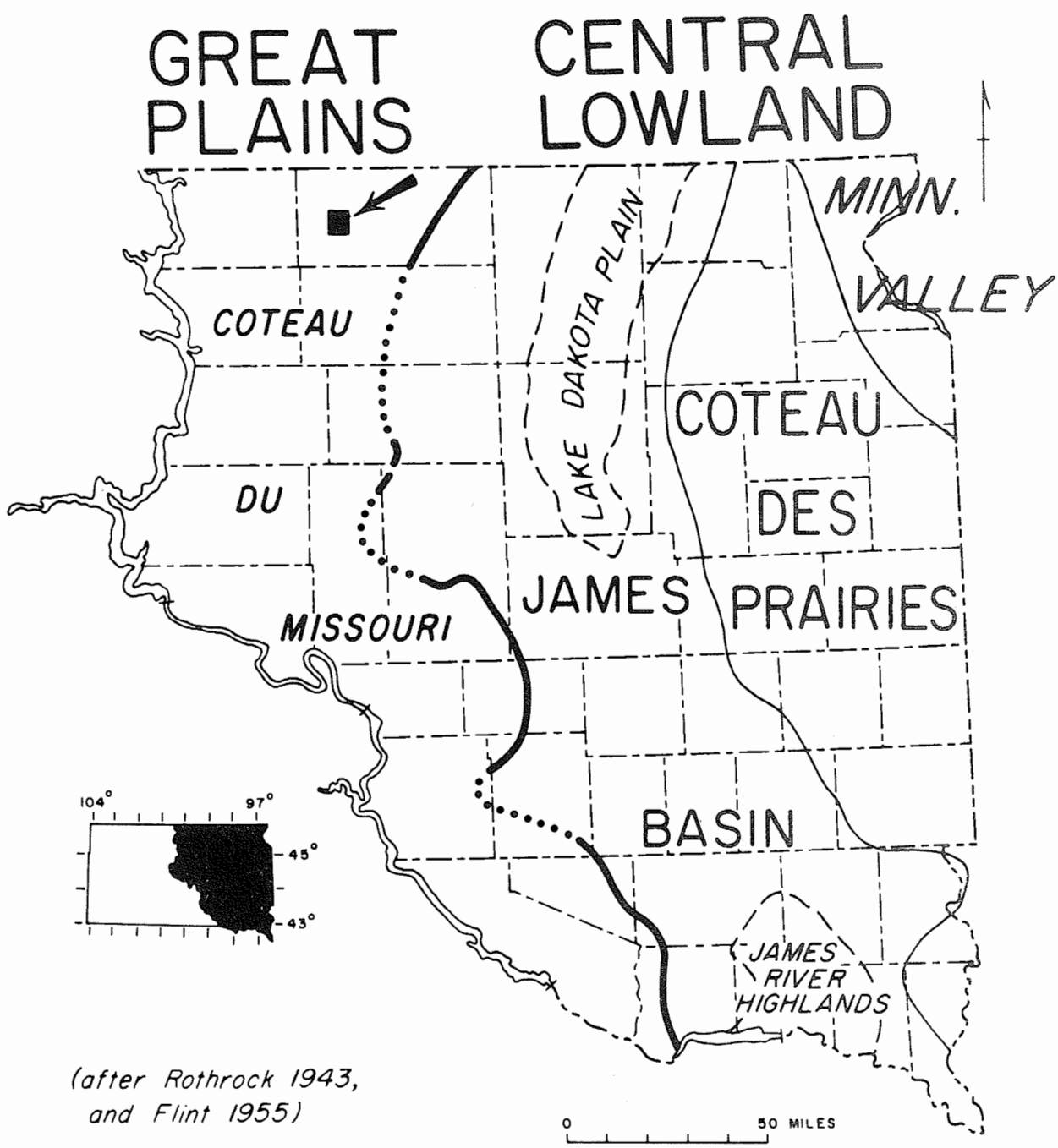

Figure 1. Map of eastern South Dakota showing the major physiographic divisions and location of the Eureka area.

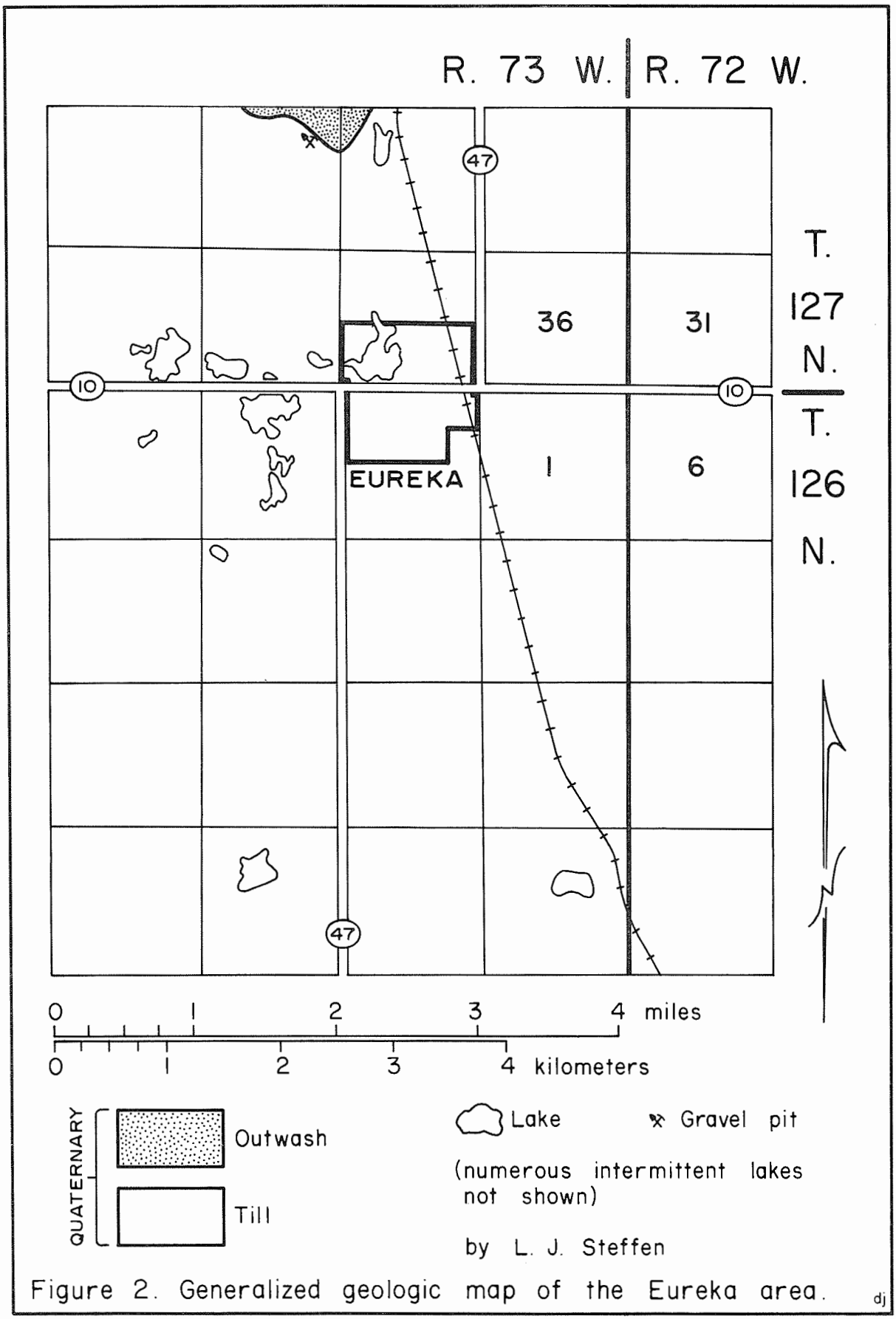

Figure 2. Generalized geologic map of the Eureka area.

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OCCURRENCE OF GROUND WATER

Principles of Occurrence

Ground water is defined as water contained in the voids or openings within rocks or sediments below the water table. Practically all open spaces in the rocks that lie below the water table are filled with water; this is called the zone of saturation. The water table is the upper surface of the zone of saturation and is under atmospheric pressure. Rocks (including the soil) that lie above the water table are in the zone of aeration because only some of the open spaces in this zone are filled with water; the remaining portion contains air. This water is either held by molecular attraction, or is moving downward toward the zone of saturation. Water within the ground above the saturated zone moves downward under the influence of gravity, whereas in the saturated zone, it moves in a direction determined by the hydraulic gradient.

Contrary to popular belief, ground water does not occur in "veins" that crisscross the land at random. Instead it can be shown that water is found nearly everywhere beneath the surface, but at varying depths.

Nearly all ground water is derived from precipitation in the form of rain, snow, or ice. This water either evaporates, 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 into the rocks.

Recharge is the addition of water to an aquifer (a deposit having structures that permit appreciable water to move through it under ordinary field conditions). Recharge to an aquifer is accomplished in four general ways: (1) by downward percolation of precipitation from the ground surface, (2) by downward percolation from surface bodies of water, (3) by lateral movement of ground water into the area, and (4) by artificial recharge, which takes place from excess irrigation seepage from canals, and water purposely applied to augment ground-water supplies.

Discharge of ground water from an aquifer is accomplished in four ways: (1) by evaporation and transpiration by plants, (2) by seepage upward or laterally into surface bodies of water, (3) by lateral movement of ground water out of the area, and (4) by pumping from wells, which constitutes the major artificial discharge of ground water.

The porosity of a rock or soil is a measure of the contained open pore spaces, and is expressed as the percentage of void spaces to the total volume of the rock. Porosity of a sedimentary deposit depends chiefly on (1) the shape and arrangement of its constituent particles, (2) the degree of sorting of its particles, (3) the cementation and compaction to which it has been subjected since its deposition, (4) the removal of mineral matter through solution by percolating waters, and (5) the fracturing of the rocks, resulting in joints and other openings. Thus, the size of the material has little or no effect on porosity if all other factors are equal.

The permeability of a rock is its capacity for transmitting a fluid. 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.

Ground Water in Glacial Deposits

It was stated earlier that glacial deposits are divided into till and outwash. Till does not yield water readily because of its highly unsorted nature and predominance of silt and clay. Locally there may occur some lenses of sand and/or gravel within the till which provide an adequate supply of water for a farm well, but considering the till as a unit, it cannot function as a source of water for municipalities.

Outwash, a highly permeable deposit, may make an aquifer if it is extensive and located below the water table. Results of test hole drilling and well inventory from the area (apps A and B and figs. 3, 4, and 5) indicate that the most extensive and thickest buried outwash is located 3 miles south of the city (test hole 30, app A).

Ground Water in Bedrock

The Dakota Formation and the Fall River Sandstone are the two major bedrock aquifers in the Eureka area. The Dakota Formation is at a depth of approximately 1,650 feet below land surface in the Eureka area. It is composed of alternating layers of sand, sandstone, and shale beds approximately 225 feet in total thickness. The water in this formation is under pressure and should flow from wells in the Eureka area.

The Fall River Sandstone is at a depth of approximately 2,010 feet and is composed of a fine- to medium-grained sand. The water in this unit is under pressure and yields a flow of 320 gallons per minute in the present Eureka city well. There is 63 feet of the sand in the city well but it is unknown whether the well was drilled through the entire unit.

Quality of Ground Water

Ground water always contains dissolved chemicals. These dissolved chemicals are derived from (1) the atmosphere as water vapor condenses and falls, (2)

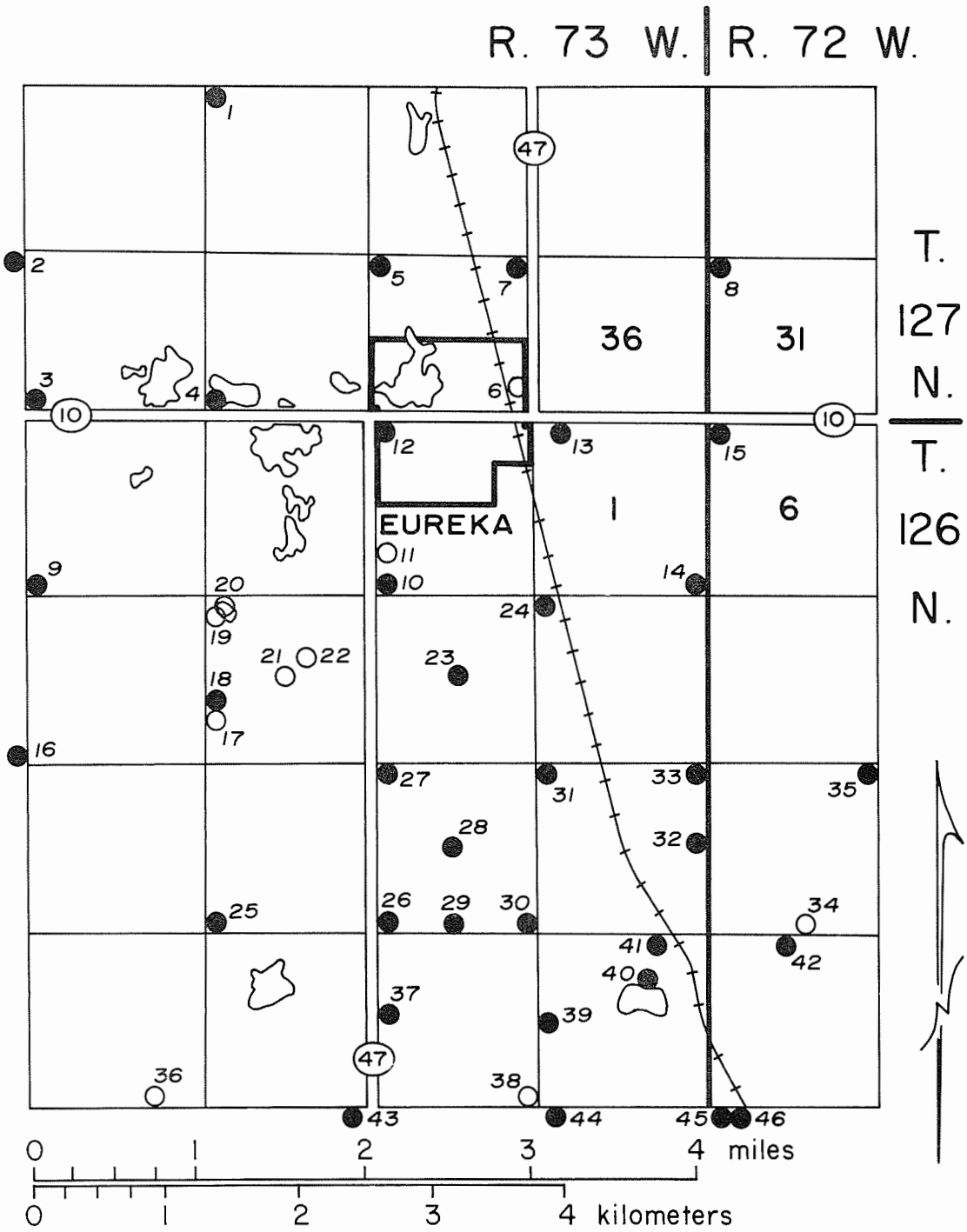

Figure 3. Map showing location of rotary and auger test holes in the Eureka area.

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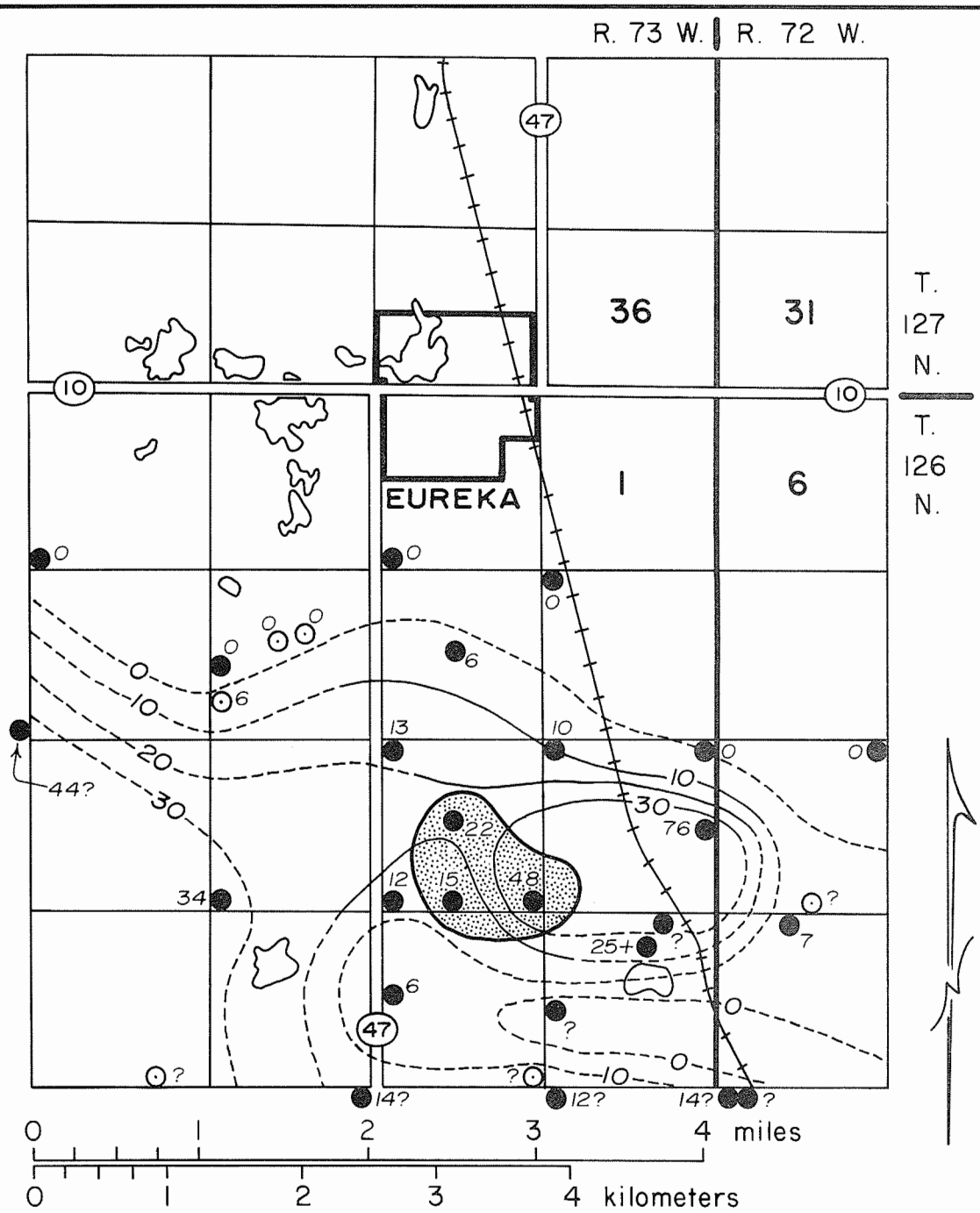

Figure 4. Isopach map showing thickness of first sand in the Eureka area.

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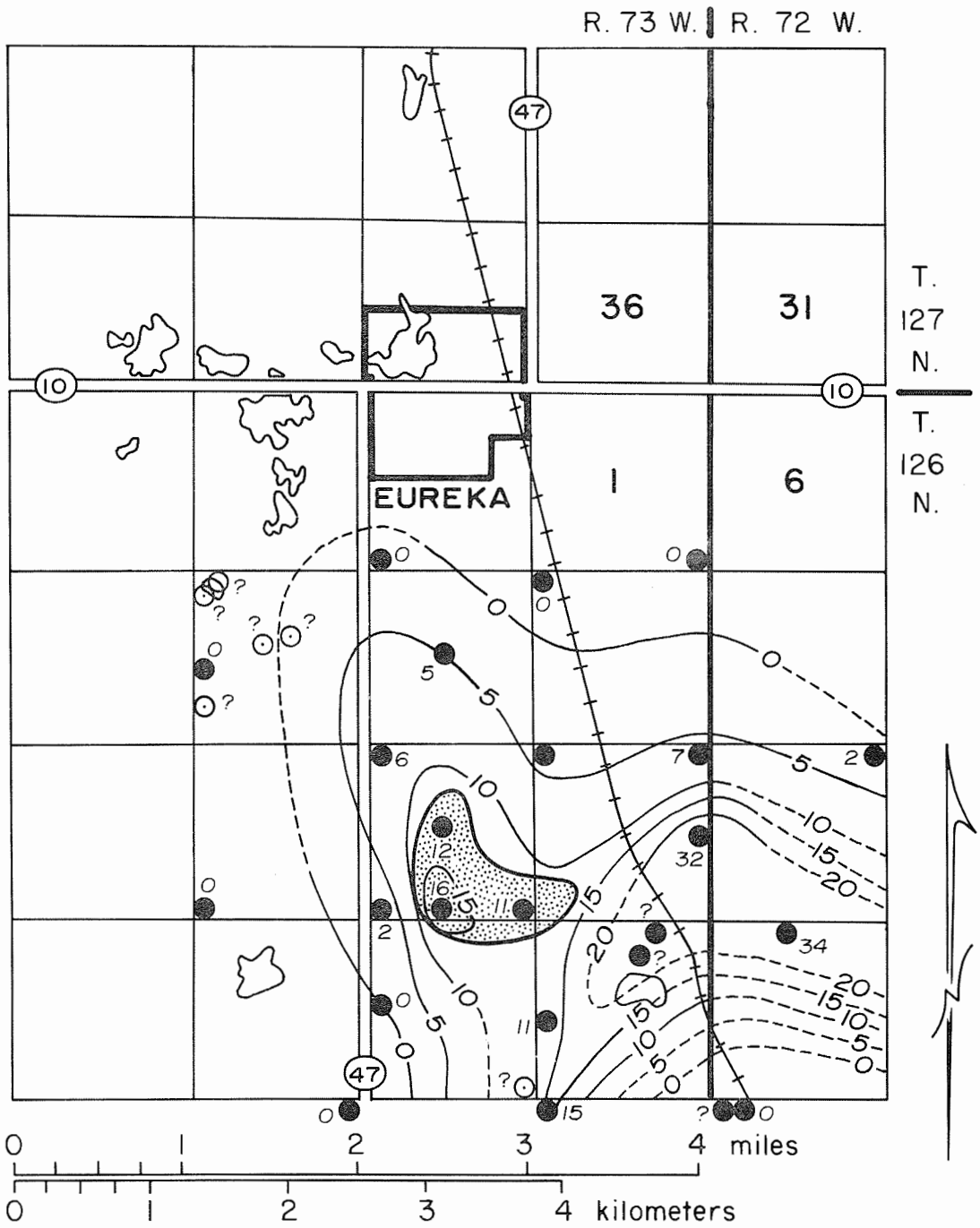

7● Rotary test hole] Number is thickness of sand at approx. 1675' elev. Avg. depth to sand 176 ft.
?⊙ Auger test hole] See Fig. 3 for location in appendix A.

Contour interval=5 feet (dashed where data uncertain or unavailable)

Recommended area by L. J. Steffen

Figure 5. Isopach map showing thickness of second sand in the Eureka area.

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the soil and underlying deposits as the water moves downward to the water table, and (3) the rocks below the water table. In general, the more chemical substances the water contains, the poorer its quality will be.

Table 1 lists the amounts of dissolved chemicals in water samples collected in the Eureka area (for map location, see fig. 6). Table 2 lists the recommended limits of amounts of dissolved chemicals in drinking water in South Dakota. This table also discusses the effects or significance of the dissolved chemicals.

Sample W1, from the present Eureka city well, shows very poor quality water. The water is from the Fall River Sandstone and the total solids, sulfate, and iron are much higher than the recommended limits set by the South Dakota Department of Health. The water is also very hard. Chlorides and nitrate as nitrogen of this water are within the recommended limits.

Samples W2, W3, W4, W7, and W8 are also of very poor quality. These samples are from shallow wells near the city in buried sand and gravel deposits (glacial outwash). The wells range in depth from 42 to 112 feet except for W3. The iron content of these samples is not as high as in W1, but it is still higher than the recommended limits. Total solids are nearly the same as in W1 while the sulfate is within the recommended limit. Chloride and nitrate as nitrogen (with the exception of W8) are within the limits of all five samples. The high nitrogen in sample W8 was probably due to contamination of the well from the surface since the well was located in a chicken yard. The remaining dissolved chemicals were above the recommended limits set by the South Dakota Department of Health.

Samples W5, W6, W9, W10, W12, W13, W14, W15, and W16 are from wells in buried glacial outwash (samples W5 and W10 were from test holes that flowed). All these samples show water of good quality in comparison to the present city water. The manganese levels were higher than the recommended limits but all other remaining dissolved chemicals were within the recommended limits set by the South Dakota Department of Health. The high values of iron in samples W5 and W10 were the only exceptions (these values may be due to analytical error).

Sample W11 was collected from the first city test well after it was pumped for approximately 30 hours. The well was developed in sand and gravel and finished to a depth of 107 feet. Except for manganese, all the dissolved chemicals are well within the recommended limits. This sample was analyzed by the South Dakota Department of Health and the water is much better than the present city water.

CONCLUSIONS AND RECOMMENDATIONS

Two glacial aquifers were located 3 miles south of Eureka. The extent and thicknesses of the aquifers are shown in figures 4 and 5. The two sand and gravel deposits were at average depths of 102 and 176 feet below land surface. The area having the thickest amount and widest extent of the sand was in the southeast corner of Section 14, Township 126 North, Range 73 West. Water quality from the shallow aquifer was determined from farm wells that were drawing water from the aquifer and from two test holes that flowed. This water was shown to be of good quality.

Two bedrock aquifers are also present in the Eureka area. These are the Dakota Formation and the Fall River Sandstone. No recommendation was made to drill another bedrock well since no improvement in water quality would result.

Based on all available information, the recommended area for a new city water supply was in the shallow glacial aquifer located 3 miles south of Eureka (SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W., see fig. 4). Recommendations to drill test holes, a test well, and observation wells, and to have a pump test conducted on the test well, were made December 3, 1973, at a city council meeting. The city contracted J. T. Banner and Associates, Inc., to carry out those recommendations.

A test hole was drilled on the west edge of Eureka to check the extent and thickness of a possible glacial aquifer in that area (see app. C, test hole 1). No significant amounts of sand were found in that area. Two test holes were drilled in the recommended area (see fig. 7 and app. C) to confirm the extent and thickness of the buried outwash in that area. After the distribution and thickness of the sand in that area was found to be satisfactory, a test well and four observation wells (see fig. 7 and app. C) were constructed for a pump test. The pump test was run on the test well for approximately 30 hours in June, 1974. Analysis of the data from that test showed that the glacial aquifer would provide a satisfactory quantity and quality (with the exception of a high manganese content) of water.

A second well was recommended to be drilled before the construction of water mains to the city. In November, 1974, a second test well was drilled and completed in the shallow glacial aquifer. This well was located 930 feet northeast of the first well. A short test was run on this second well using the first well as an observation well.

Analysis of the pump test data showed that this

TABLE 1. Chemical analyses of water samples from the Eureka area

Sample	Source	Parts per million											
		Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	pH	Hardness $CaCO_3$	Total Solids
A		---	---	---	250	500[1]	0.3	0.05	10.0	0.9-1.7[2]	---	---	1000[1]
W 1	C	336	160	97	64	1307	2.4	0.1	0.0	3.6	7.4	1246	2317
W 2	B	329	126	86	63	398			0.9			1174	2078
W 3	B	310	34	101	21	283	6.1		1.3			1188	1724
W 4	B	217	96	57	8	349	0.4		0.9			776	1400
W 5	B	59	76	23	6	74	3.3		0.6			243	596
W 6	B	83		20	10	100	0.1	0.6	0.0		7.40	290	520
W 7	B	402	154	128	64	501	1.2		4.3			1528	2672
W 8	B	307	78	149	204	198	0.5		55.7			1378	2212
W 9	B	66		21	7	50	0.0	0.7	0.0		7.45	250	480
W10	B	62	80	46	6	60	14.5		0.6			250	558
W11	B	54	92.5	12.6	12.3	100	0.13	0.77	< 0.01	0.34	7.54	188	483
W12	B	75		46	12	65	0.0	0.8	0.0		7.60	375	640
W13	B	110		25	20	100	0.0	0.8	0.0		7.60	375	640
W14	B	62		20	7	90	0.0	0.9	0.0		7.50	250	440
W15	B	75		25	7	105	0.0	0.9	0.0		7.45	290	600
W16	B	75		25	20	120	0.0	0.9	0.0		7.55	290	670

A — Drinking water standards, U.S. Public Health Service (1962).

Source: B, buried outwash and sand lenses; C Cretaceous Fall River Sandstone.

Samples W1 and W11 were analyzed by the South Dakota Department of Health (W1 is listed in South Dakota Public Water Supply Data, 1971).

Samples W2, W3, W4, W5, W7, W8, and W10 were analyzed by the State Chemical Laboratory, Vermillion, South Dakota.

All other samples were analyzed by the South Dakota Geological Survey.

[1] Modified for South Dakota by the Department of Health (written communication, Water Sanitation Section, September 24, 1968).

[2] 1.2 is optimum for South Dakota.

Location of Water Samples

W 1. SE¼SE¼NE¼SW¼ sec. 35, T. 127 N., R. 73 W., city well, 2,085 feet deep

W 2. SW¼SW¼SE¼SW¼ sec. 35, T. 127 N., R. 73 W., J. Kary, 50 feet deep

W 3. NW¼NE¼SW¼NW¼ sec. 2, T. 126 N., R. 73 W., W. Roggenkamp, 70 feet deep, water level 55 feet

W 4. SE¼NE¼NW¼SE¼ sec. 2, T. 126 N., R. 73 W., O. Pfeiffle, 42 feet deep, water level 25 feet

W 5. SE¼NE¼SE¼SE¼ sec. 8, T. 126 N., R. 73 W., test hole 16, flowed.

W 6. SE¼SW¼SE¼SE¼ sec. 10, T. 126 N., R. 73 W., J. Opp, Jr., 65 feet deep, water level 3 feet

W 7. SW¼NW¼NW¼NE¼ sec. 11, T. 126 N., R. 73 W., H. Delzer, 112 feet deep, water level 60 feet

W 8. SE¼NW¼SW¼NW¼ sec. 12, T. 126 N., R. 73 W., J. Kary, 65 feet deep, water level 50 feet.

W 9. NW¼SW¼SW¼SW¼ sec. 14, T. 126 N., R. 73 W., H. Melhaff, 70 feet deep, flows

W10. SW¼SW¼SW¼SE¼ sec. 14, T. 126 N., R. 73 W., test hole 29, flowed

W11. SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W., city test well 1, pumped

W12. SW¼SW¼NW¼SW¼ sec. 13, T. 126 N., R. 73 W., O. Knapp

W13. SE¼SW¼SW¼NW¼ sec. 13, T. 126 N., R. 73 W., H. Melhaff, 76 feet deep, water level 37 feet

W14. NW¼NW¼NE¼NE¼ sec. 22, T. 126 N., R. 73 W., M. Rau, 65 feet deep

W15. NW¼NE¼SE¼NE¼ sec. 23, T. 126 N., R. 73 W., A. Stabler, 52 feet deep, flows

W16. SW¼SW¼SW¼NE¼ sec. 24, T. 126 N., R. 73 W., Waterfowl Production Area (USBSFW), 58(?) feet deep, flows

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aquifer would provide the city with an adequate quantity and quality (with the exception of a high manganese content) of water. The two wells will produce enough water for the city's use at the present time. An increased demand for municipal water may require more wells to be constructed in the shallow or deep glacial aquifers. For additional information on the pump tests, the South Dakota Geological Survey should be contacted.

At present, Eureka has plans to use both of the new wells for a city water supply. The recommended pumping rate for Well 1 is 180 gpm and for Well 2, 230 gpm. If the Geological Survey is informed before the city turns on the new water supply, the Survey will monitor the aquifer and make recommendations for any possible future well(s) the city may require.

The city should consult the Division of Water Rights, Department of Natural Resource Development, to obtain water rights and the Environmental Protection Agency to determine the biological and chemical suitability of the water, if it has not done so already.

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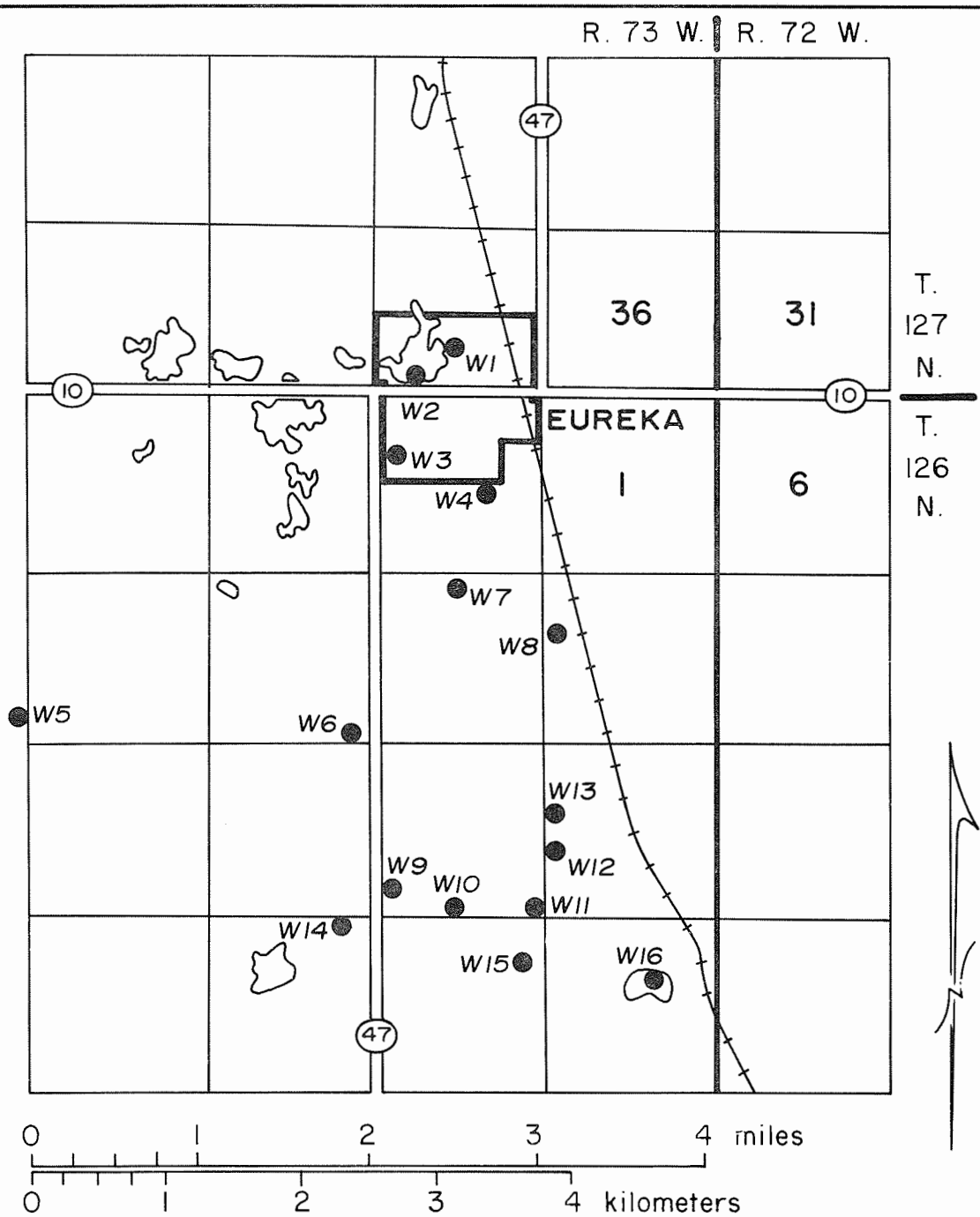

W4● Location of water sample. Number refers to water samples in Table 1.

(numerous intermittent lakes not shown)

by L. J. Steffen

Figure 6. Map showing location of water samples collected in the Eureka area.

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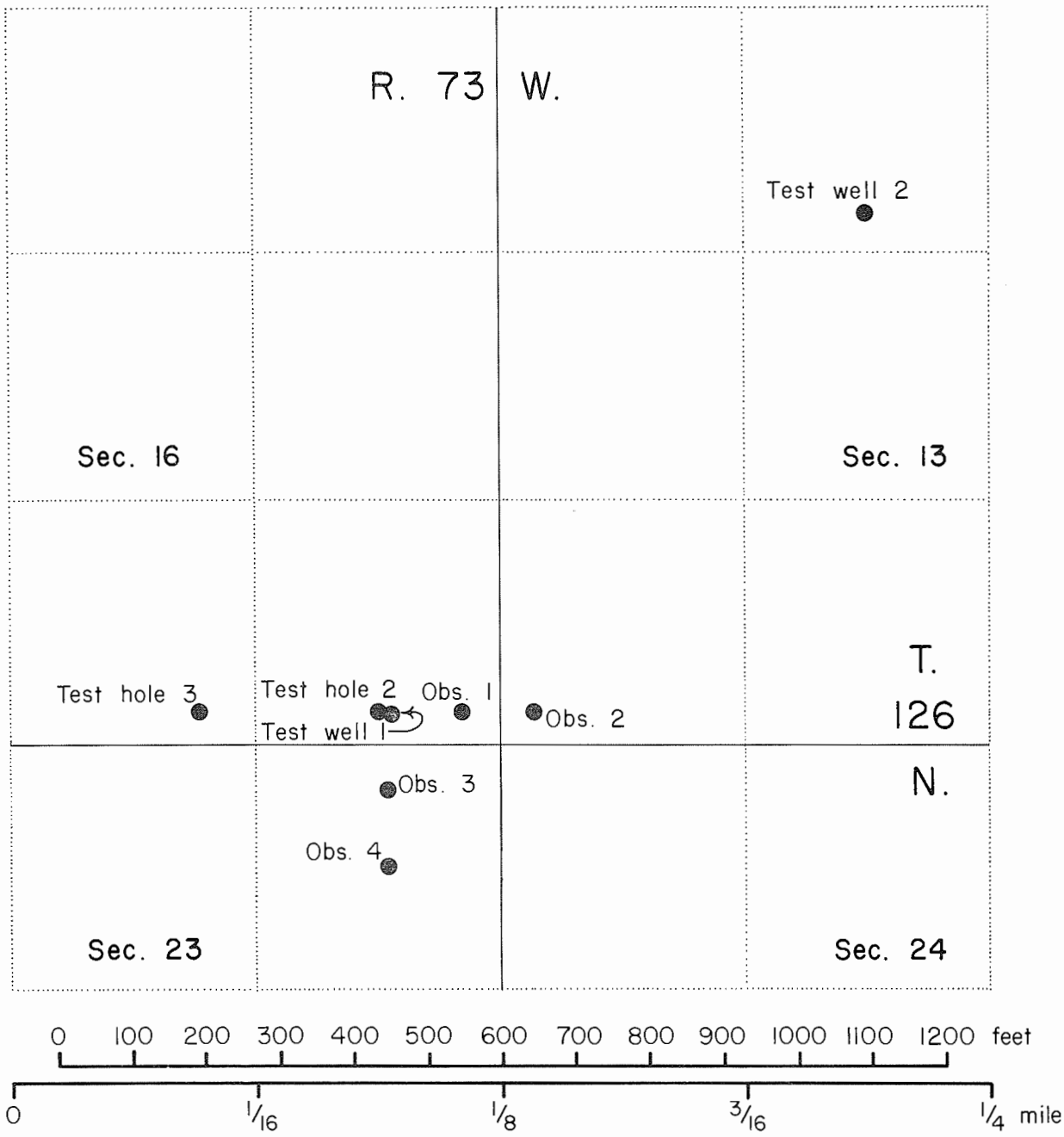
Table 2.--Significance of some chemical and physical properties of drinking water.

Chemical Constituents	Significance	Recommended Limits (ppm)[1]
Calcium (Ca) and Magnesium (Mg)	Cause most of the carbonate hardness and scale-forming properties of water by combining with carbonate and bicarbonate present in the water. Seldom can be tasted except in extreme concentrations.	Ca—None Mg—None
Sodium (Na)	Large amounts in combination with chloride will give water a salty taste. Large amounts will limit water for irrigation and industrial use.	None
Chloride (Cl)	Large amounts in combination with sodium give water a salty taste. Large quantities will also increase corrosiveness of water.	250
Sulfate (SO_4)	Large amounts of sulfate in combination with other ions give a bitter taste to water and may act as a laxative to those not used to drinking it. Sulfates of calcium and magnesium will form hard scale. U. S. Public Health Service recommends 250 ppm maximum concentration.	500[2]
Iron (Fe) and Manganese (Mn)	In excess will stain fabrics, utensils, and fixtures and produce objectionable coloration in the water. Both constituents in excess are particularly objectionable.	Fe—0.3 Mn—0.05
Nitrate Nitrogen (N)	In excess may be injurious when used in infant feeding. The U. S. Public Health Service regards 45 ppm as the safe limit of nitrate (NO_3) or 10 ppm nitrate nitrogen (N).	10
Fluoride (F)	Reduces incidence of tooth decay when optimum fluoride content is present in water consumed by children during period of tooth calcification. Excessive fluoride in water may cause mottling of enamel.	0.9-1.7[3]
pH	A measure of the hydrogen ion concentration; pH of 7.0 indicates a neutral solution, pH values lower than 7.0 indicate acidity, pH values higher than 7.0 indicate alkalinity. Alkalinity tends to aid encrustation and acidity tends to aid corrosion.	None
Hardness	Hardness equivalent to carbonate and bicarbonate is called carbonate hardness. Hardness in excess of this amount is noncarbonate hardness. Hardness in water consumes soap and forms soap curd. Will also cause scale in boilers, water heaters, and pipes. Water containing 0-60 ppm hardness considered soft; 61-120 ppm moderately hard; 121-180 ppm hard, and more than 180 ppm very hard. Good drinking water can be very hard.	None
Total Solids	Total of all dissolved constituents. U. S. Public Health Department recommends 500 ppm maximum concentration. Water containing more than 1000 ppm dissolved solids may have a noticeable taste; it may also be unsuitable for irrigation and certain industrial uses.	1000[2]

Modified from Jorgensen (1966).
[1] (ppm) parts per million.
[2] Modified for South Dakota by the South Dakota Department of Health (written communication, Water Sanitation Section, September 24, 1968).
[3] 1.2 is optimum for South Dakota.



● Location of test holes, test wells, and observation wells drilled in recommended area by J. T. Banner and Associates, Inc. (numbers refer to holes listed in Appendix C.)

by L. J. Steffen

Figure 7. Map showing location of test holes, test wells, and observation wells drilled by private drillers in the recommended area.

APPENDIX A

Logs of test holes in the Eureka area

(For map location, see fig. 3)

(1958 dates are from previous water study; 1973 dates are from present study; other dates with C behind them denote test holes drilled in conjunction with county study)

Test Hole 1 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 27, T. 127 N., R. 73 W.
Surface elevation: 1910 feet
Depth to water: 12.6 feet

0- 1	Soil, black
1- 9	Clay, gray, silty, sandy
9- 18	Gravel, medium to coarse
18- 66	Clay, gray, silty, sandy, pebbly
66- 69	Sand and gravel
69-135	Clay, gray, shaley, sandy, pebbly, gravel in spots
135-175	Clay, brownish gray, very smooth
175-200	Shale

* * * *

Test Hole 2 (1972C)
Location: NE¼NE¼NE¼NE¼ sec. 32, T. 127 N., R. 73 W.
Surface elevation: 1889 feet
Depth to water: Not measured

0- 34	Clay, yellow-brown, silty, pebbly
34- 89	Clay, gray, silty, pebbly, gravel in spots
89- 91	Gravel
91-102	Clay, gray, silty, pebbly
102-118	Gravel, some clay stringers
118-130	Clay, gray, silty, pebbly
130-142	Gravel, some clay stringers
142-170	Shale

* * * *

Test Hole 3 (1973)
Location: SW¼SW¼SW¼SW¼ sec. 33, T. 127 N., R. 73 W.
Surface elevation: 1869 feet
Depth to water: 13.3 feet

0- 1	Soil, black
1- 32	Clay, yellow-brown, silty, gravelly
32- 68	Clay, gray, silty, pebbly
68- 77	Gravel, medium to coarse
77-134	Clay, gray, silty, gravelly
134-135	Gravel
135-155	Shale

* * * *

Test Hole 4 (1973C)
Location: SW¼SW¼SW¼SW¼ sec. 34, T. 127 N., R. 73 W.
Surface elevation: 1818 feet
Depth to water: Not measured

0- 2	Soil, black
2- 13	Clay, yellow-brown, silty, pebbly, gravelly

Test Hole 4 -- continued.

13-130	Clay, gray, silty, pebbly, several thin gravel lenses
130-153	Clay, gray, silty, pebbly
153-188	Shale, brown
188-200	Shale, dark gray to black

* * * *

Test Hole 5 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 35, T. 127 N., R. 73 W.
Surface elevation: 1865 feet
Depth to water: Not measured

0- 1	Soil, black
1- 35	Clay, gray, sandy, silty
35- 39	Gravel, very coarse
39-197	Clay, dark gray, slightly silty, pebbly
197-204	Gravel
204-230	Shale, some bentonite

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Test Hole 6 (1958)
Location: NE¼NE¼SE¼SE¼ sec. 35, T. 127 N., R. 73 W.
Surface elevation: 1880 feet
Depth to water: Not measured

0- 9	Clay, yellow-brown, pebbly
9- 29	Clay, brown, pebbly
29- 37	Gravel, coarse

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Test Hole 7 (1973)
Location: NE¼NE¼NE¼NE¼ sec. 35, T. 127 N., R. 73 W.
Surface elevation: 1882 feet
Depth to water: Not measured

0- 2	Clay, brown, sandy, pebbly
2- 4	Gravel
4- 26	Clay, brown, sandy, pebbly
26- 31	Sand and gravel
31-140	Clay, gray, sandy, pebbly
140-222	Clay, gray, shaley, pebbly
222-245	Shale

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Test Hole 8 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 31, T. 127 N., R. 72 W.
Surface elevation: 1901 feet
Depth to water: Not measured

0- 1	Soil, black
1- 18	Clay, yellow-brown, silty, pebbly
18-103	Clay, gray, silty, pebbly
103-118	Gravel, reworked shale pebbles
118-181	Clay, gray, shaley, pebbly, some bentonite
181-200	Shale

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Test Hole 9 (1973)
Location: SW¼SW¼SW¼SW¼ sec. 4, T. 126 N., R. 73 W.

Test Hole 9 -- continued.

Surface elevation: 1814 feet
Depth to water: Not measured

0- 2	Soil, black
2- 3	Gravel
3- 17	Clay, brown, silty, sandy, pebbly
17- 29	Clay, gray, sandy, pebbly, some thin gravel lenses
29- 30	Sand and gravel
30-100	Clay, gray, sandy, pebbly, gravelly, some thin gravel lenses
100-113	Silt, green-gray, clayey, some pebbles
113-140	Clay, gray, silty, sandy, pebbly
140-150	Silt, green-gray
150-183	Clay, green-gray, very soft, smooth
183-189	Gravel
189-215	Shale

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Test Hole 10 (1973)
Location: SW¼SW¼SW¼SW¼ sec. 2, T. 126 N., R. 73 W.
Surface elevation: 1837 feet
Depth to water: Not measured

0- 22	Clay, yellow, silty, pebbly
22-105	Clay, gray, silty, pebbly
105-109	Gravel, coarse
109-120	Clay, gray, silty, pebbly
120-127	Gravel, coarse, some clay stringers
127-165	Clay, gray, silty, pebbly, thin gravel lenses
165-200	Clay, gray, silty, clayey
200-202	Gravel, coarse
202-230	Shale

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Test Hole 11 (1958)
Location: SW¼SW¼ sec. 2, T. 126 N., R. 73 W.
Surface elevation: 1842 feet
Depth to water: 29 feet

0- 9	Clay, olive-brown, pebbly
9- 29	Clay, brown, pebbly
29- 99	Clay, dark gray, pebbly

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Test Hole 12 (1972C)
Location: NW¼NW¼NW¼NW¼ sec. 2, T. 126 N., R. 73 W.
Surface elevation: 1848 feet
Depth to water: 7.7 feet

0- 23	Clay, yellow-brown, silty, pebbly, gravelly
23- 29	Gravel, coarse, sandy
29- 35	Clay, gray, silty, sandy
35- 61	Gravel, coarse, clay break from 46 to 49 feet
61- 85	Clay, gray, silty, pebbly, gravelly
85- 88	Gravel, very coarse
88-130	Clay, gray, pebbly, gravelly
130-142	Gravel
142-173	Clay, gray, pebbly, shaley, gravelly

Test Hole 12 -- continued.

173-177	Sand and gravel
177-207	Clay, gray
207-214	Gravel
214-263	Clay, gray, shaley, hard
263-281	Clay, light gray-brown, silty, shaley
281-330	Clay, light gray-brown, silty, shaley, gravel lenses
330-349	Gravel, coarse
349-380	Shale

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Test Hole 13 (1973)
Location: NE¼NE¼NW¼NW¼ sec. 1, T. 126 N., R. 73 W.
Surface elevation: 1890 feet
Depth to water: 13.4 feet

0- 1	Soil, black
1- 31	Clay, yellow-brown, silty, pebbly
31- 63	Clay, gray, silty, sandy, gravelly
63- 77	Gravel and sand
77-153	Clay, gray, gravelly, sandy, pebbly
153-154	Gravel
154-198	Clay, gray, sandy, pebbly, gravelly
198-220	Clay, green-gray, very smooth, tough
220-252	Clay, gray, shaley, pebbly
252-271	Clay, gray, very smooth, brittle, drills easy
271-290	Shale

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Test Hole 14 (1973)
Location: SE¼SE¼SE¼SE¼ sec. 1, T. 126 N., R. 73 W.
Surface elevation: 1929 feet
Depth to water: Not measured

0- 2	Soil, black
2- 4	Clay, light-brown, silty
4- 8	Sand and gravel
8- 25	Clay, brown, pebbly
25-180	Clay, gray, pebbly, shaley
180-210	Silt, olive-gray, drills easy
210-255	Clay, gray, very smooth
255-275	Shale

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Test Hole 15 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 6, T. 126 N., R. 72 W.
Surface elevation: 1940 feet
Depth to water: Not measured

0- 2	Clay, brown, sandy, pebbly
2- 8	Sand and gravel
8- 23	Clay, brown, sandy, pebbly
23-121	Clay, gray, sandy, pebbly, gravelly
121-122	Gravel
122-166	Clay, gray, shaley, pebbly, gravelly
166-175	Shale, brown-gray
175-185	Shale, gray

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Test Hole 16 (1973)
Location: NE¼SE¼SE¼SE¼ sec. 8, T. 126 N., R. 73 W.
Surface elevation: 1822 feet
Depth to water: Flowed, 8 gpm

0- 1	Soil, black
1- 10	Sand and gravel
10- 13	Clay, brown, sandy, pebbly
13- 90	Clay, gray, sandy, pebbly, gravelly
90-118	Sand, silty
118-134	Gravel
134-178	Clay, gray, sandy, pebbly
178-181	Gravel
181-213	Clay, gray, silty, pebbly, shaley
213-230	Shale

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Test Hole 17 (1958)
Location: NW¼SW¼ sec. 10, T. 126 N., R. 73 W.
Surface elevation: 1846 feet
Depth to water: Flowed, 1 gpm

0- 4	Clay, tan, pebbly
4- 14	Clay, olive-green, pebbly
14- 19	Clay, olive-brown, pebbly
19- 24	Clay, dark gray, pebbly
24- 29	Clay, gray-green, pebbly
29- 69	Clay, dark gray, pebbly
69- 74	Sand, fine to medium

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Test Hole 18 (1973)
Location: SW¼NW¼NW¼SW¼ sec. 10, T. 126 N., R. 73 W.
Surface elevation: 1845 feet
Depth to water: 4.0 feet

0- 1	Soil, black
1- 25	Clay, brown, very sandy, gravelly
25-106	Clay, gray, very silty, sandy, pebbly, gravelly
106-154	Silt, gray, fine sand
154-170	Gravel, coarse
170-195	Clay, gray, sandy, pebbly, gravelly
195-255	Silt, green-gray, hard
255-385	Clay, green-gray, gravelly
385-396	Gravel, coarse
396-410	Shale

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Test Hole 19 (1958)
Location: NW¼NW¼NW¼NW¼ sec. 10, T. 126 N., R. 73 W.
Surface elevation: 1840 feet
Depth to water: Flowed, 1 gpm

0- 4	Clay, tan, pebbly
4- 9	Clay, olive-brown, pebbly
9- 14	Clay, brownish tan, pebbly
14- 19	Clay, brown, pebbly
19- 24	Clay, brownish gray, pebbly
24- 74	Clay, dark gray, pebbly
74- 79	Sand, fine to medium
79- 99	Clay, brown, pebbly

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Test Hole 20 (1958)
Location: NW¼NW¼ sec. 10, T. 126 N., R. 73 W.
Surface elevation: 1842 feet
Depth to water: Not measured

0- 4	Clay, tan, pebbly
4- 24	Clay, brownish gray, pebbly
24-104	Clay, grayish brown, pebbly

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Test Hole 21 (1958)
Location: Center (?) sec. 10, T. 126 N., R. 73 W.
Surface elevation: 1840 feet
Depth to water: None

0- 4	Soil, black, silty
4- 14	Clay, brown, pebbly
14- 84	Clay, dark gray, pebbly

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Test Hole 22 (1958)
Location: SW¼NE¼ sec. 10, T. 126 N., R. 73 W.
Surface elevation: (?)
Depth to water: Flowed, 1 gpm

0- 24	Clay, brown, pebbly
24- 34	Clay, brownish gray, pebbly
34- 44	Sand, fine to coarse
44- 49	Clay, brown, pebbly

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Test Hole 23 (1973)
Location: SW¼SW¼SW¼NE¼ sec. 11, T. 126 N., R. 73 W.
Surface elevation: 1858 feet
Depth to water: 12.0 feet

0- 1	Soil, black
1- 4	Sand and gravel, yellow
4- 22	Clay, brown, sandy, pebbly
22- 93	Clay, gray, sandy, pebbly, gravelly
93- 99	Sand and gravel, fine
99-124	Silt, green-gray
124-145	Clay, gray, sandy, pebbly, gravelly
145-175	Silt, green-gray
175-184	Clay, gray, sandy, pebbly
184-213	Silt, green-gray, clayey
213-218	Gravel
218-230	Shale

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Test Hole 24 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 12, T. 126 N., R. 73 W.
Surface elevation: 1880 feet
Depth to water: Not measured

0- 30	Clay, brown, pebbly
30- 67	Clay, gray, pebbly
67- 70	Silt, gray-brown, clayey
70- 88	Clay, gray, pebbly, few gravel lenses
88-100	Sand, coarse, some gravel
100-180	Clay, gray, sandy, pebbly

Test Hole 24 -- continued.

180-220	Clay, olive-gray, very smooth
220-267	Clay, gray, very smooth, some calcite
267-290	Shale

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Test Hole 25 (1973)
Location: SW¼SW¼SW¼SW¼ sec. 15, T. 126 N., R. 73 W.
Surface elevation: 1846 feet
Depth to water: Not measured

0- 5	Clay, yellow, pebbly
5- 8	Gravel
8- 22	Clay, yellow, pebbly, gravelly
22- 81	Clay, gray, silty, pebbly
81-115	Sand and gravel, some clay breaks
115-218	Clay, gray, silty, pebbly, gravelly
218-295	Silt, gray
295-327	Clay, gray, shaley, pebbly
327-348	Silt, gray
348-426	Clay, gray, shaley, pebbly, some green-gray marl
426-435	Gravel
435-455	Shale

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Test Hole 26 (1973)
Location: SW¼SW¼SW¼SW¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1838 feet
Depth to water: 11.9 feet

0- 18	Clay, yellow-brown, silty, sandy
18- 78	Clay, gray, silty, pebbly
78- 90	Gravel, medium to coarse, some sand
90-183	Clay, gray, silty, gravelly
183-215	Shale

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Test Hole 27 (1973C)
Location: NW¼NW¼NW¼NW¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1844 feet
Depth to water: Not measured

0- 6	Gravel, medium to coarse, clayey
6- 20	Clay, silty
20- 22	Gravel, medium to coarse
22- 91	Clay, gray, pebbly, sandy
91-104	Gravel, medium to coarse, well sorted
104-182	Clay, gray, silty, pebbly, sandy, some thin gravel lenses
182-204	Clay, gray, silty, pebbly
204-210	Gravel, medium to coarse, sandy
210-230	Shale

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Test Hole 28 (1973)
Location: SW¼SW¼SW¼NE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1874 feet
Depth to water: 9.6 feet

0- 3	Soil, black

Test Hole 28 -- continued.

3- 16	Sand and gravel
16-110	Clay, gray, silty, gravelly
110-132	Gravel, medium to coarse
132-165	Clay, gray, very gravelly, some gravel lenses
165-204	Clay, gray, sandy, pebbly
204-216	Gravel, medium to coarse
216-245	Shale, some bentonite

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Test Hole 29 (1973)
Location: SW¼SW¼SW¼SE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1832 feet
Depth to water: Flowed, 5 gpm

0- 17	Clay, brown, sandy, pebbly
17- 78	Clay, gray, sandy, pebbly, some thin gravel lenses
78- 93	Sand and gravel
93-164	Clay, gray, sandy, pebbly, gravelly
164-180	Sand and gravel
180-200	Shale

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Test Hole 30 (1973)
Location: SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1846 feet
Depth to water: Not measured

0- 23	Clay, brown, sandy, pebbly
23- 53	Clay, gray, pebbly
53- 55	Sand and gravel
55- 60	Clay, gray, pebbly
60-108	Sand and gravel, some clay breaks
108-164	Clay, gray, sandy, pebbly, shaley
164-175	Sand and gravel
175-200	Shale

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Test Hole 31 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 13, T. 126 N., R. 73 W.
Surface elevation: 1880 feet
Depth to water: 6.4 feet

0- 2	Soil, black
2- 15	Clay, yellow, silty
15- 25	Clay, brown, pebbly
25- 85	Clay, gray, silty, pebbly
85-102	Silt, fine, sandy, gravelly
102-112	Sand and gravel, medium to coarse
112-125	Clay, gray, silty, sandy, gravelly
125-135	Gravel, very coarse
135-200	Clay, gray, silty, pebbly
200-204	Gravel
204-230	Shale

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Test Hole 32 (1973)
Location: NE¼NE¼NE¼SE¼ sec. 13, T. 126 N., R. 73 W.
Surface elevation: 1902 feet
Depth to water: Not measured

Test Hole 32 -- continued.

0- 5	Clay, yellow, silty, pebbly
5- 20	Clay, gray, silty
20- 31	Clay, yellow, pebbly
31- 62	Clay, gray, silty, pebbly, some thin gravel lenses
62- 70	Gravel, some clay breaks
70- 80	Clay, gray, silty, pebbly, some thin gravel lenses
80- 87	Gravel, coarse
87-100	Clay, gray, silty, pebbly
100-176	Sand and gravel, fine to medium to coarse
176-210	Clay, gray, gravelly
210-225	Gravel, coarse
225-237	Clay, yellow
237-255	Gravel, coarse
255-267	Clay, gray
267-281	Gravel, coarse
281-305	Shale

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Test Hole 33 (1972C)
Location: NE¼NE¼NE¼NE¼ sec. 13, T. 126 N., R. 73 W.
Surface elevation: 1882 feet
Depth to water: Not measured

0- 1	Soil, black
1- 47	Clay, brown, rocky, gravelly, sandy
47- 64	Clay, gray, gravelly, sandy
64-102	Clay, brown-gray, silty, sandy
102-199	Clay, gray, silty, sandy, gravelly
199-206	Gravel, fine
206-275	Shale, some bentonite

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Test Hole 34 (1971C)
Location: SW¼SW¼SW¼SE¼ sec. 18, T. 126 N., R. 72 W.
Surface elevation: (?)
Depth to water: None

0- 2	Clay, yellow, pebbly
2- 30	Clay, brown, pebbly
30- 34	Clay, gray, pebbly

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Test Hole 35 (1973)
Location: NE¼NE¼NE¼NE¼ sec. 18, T. 126 N., R. 72 W.
Surface elevation: 1889 feet
Depth to water: Not measured

0- 1	Soil, black
1- 17	Sand and gravel, yellow
17- 28	Silt, gray
28-101	Clay, gray, sandy, pebbly, gravelly
101-104	Sand and gravel
104-159	Clay, gray, sandy, pebbly, gravelly
159-196	Sand and gravel, some clay breaks
196-215	Silt, green-gray, clayey
215-217	Gravel
217-245	Shale

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Test Hole 36 (1958)
Location: SW¼SE¼ sec. 21, T. 126 N., R. 73 W.
Surface elevation: 1835 feet
Depth to water: Not measured

0- 14	Clay, brown, pebbly
14- 24	Clay, olive-green, pebbly
24- 94	Clay, dark gray, pebbly

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Test Hole 37 (1973)
Location: NW¼NW¼NW¼SW¼ sec. 23, T. 126 N., R. 73 W.
Surface elevation: 1838 feet
Depth to water: Not measured

0- 28	Clay, brown-gray, silty, pebbly
28- 97	Clay, gray, silty, pebbly, some thin gravel lenses
97-155	Clay, gray, silty, pebbly, gravelly
155-157	Gravel
157-170	Clay, gray, silty, pebbly
170-174	Gravel
174-222	Clay, gray, silty
222-245	Shale

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Test Hole 38 (1958)
Location: SE¼SE¼ sec. 23, T. 126 N., R. 73 W.
Surface elevation: 1835 feet
Depth to water: Not measured

0- 19	Clay, brown, pebbly
19- 84	Clay, gray, pebbly

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Test Hole 39 (1973)
Location: SW¼NW¼NW¼SW¼ sec. 24, T. 126 N., R. 73 W.
Surface elevation: 1853 feet
Depth to water: Not measured

0- 32	Clay, yellow, silty, pebbly
32- 55	Clay, gray, silty, pebbly
55- 62	Silt, black, clayey
62-189	Clay, gray, silty, sandy, shaley, some gravel lenses
189-200	Gravel
200-215	Shale

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Test Hole 40 (1971C)
Location: SE¼SE¼NW¼NE¼ sec. 24, T. 126 N., R. 73 W.
Surface elevation: 1822 feet
Depth to water: 46 feet

0- 1	Soil, brown
1- 9	Silt, yellow-brown, few pebbles
9- 16	Clay, brown, pebbly
16- 46	Clay, gray, pebbly
46- 70	Sand, coarse, some clay

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Test Hole 41 (1971C)
Location: NE¼NE¼NW¼NE¼ sec. 24, T. 126 N., R. 73 W.
Surface elevation: 1825 feet
Depth to water: 3 7 feet

0- 1	Soil, brown, pebbly
1- 15	Clay, yellow-brown, pebbly
15- 47	Clay, gray, pebbly
47- 48	Gravel
48- 73	Clay, gray, sandy, some gravel lenses
73-149	Clay, gray, sandy, some gravel lenses, hard to drill

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Test Hole 42 (1973)
Location: NE¼NE¼NE¼NW¼ sec. 19, T. 126 N., R. 72 W.
Surface elevation: 1846 feet
Depth to water: 7.6 feet

0- 22	Clay, brown, sandy, pebbly, gravelly
22- 90	Clay, gray, sandy, pebbly, gravelly
90- 97	Sand and gravel
97-160	Clay, gray, sandy, shaley, pebbly, gravelly
160-194	Gravel, some clay breaks
194-215	Shale

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Test Hole 43 (1972C)
Location: NE¼NE¼NE¼NE¼ sec. 27, T. 126 N., R. 73 W.
Surface elevation: 1807 feet
Depth to water: Not measured

0- 4	Soil, black
4- 12	Clay, light gray
12- 73	Clay, gray, silty, pebbly, gravelly
73- 87	Sand and gravel, medium to coarse
87- 95	Clay, gray, silty, pebbly, shaley
95-104	Sand, coarse
104-170	Clay, gray, silty, pebbly, shaley
170-177	Sand and gravel, coarse
177-264	Silt, brown-gray, bedded, silts, clays, some sand
264-315	Clay, gray, silty, gravelly
315-375	Clay, medium gray, silty, sandy
375-410	Shale

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Test Hole 44 (1973)
Location: NW¼NW¼NW¼NW¼ sec. 25, T. 126 N., R. 73 W.
Surface elevation: 1846 feet
Depth to water: Not measured

0- 28	Clay, yellow, silty, pebbly
28-105	Clay, gray, silty, pebbly
105-115	Gravel, medium to coarse
115-122	Clay, gray, very silty
122-124	Gravel
124-186	Clay, gray, silty, pebbly, gravelly
186-198	Gravel, medium to coarse
198-230	Shale

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Test Hole 45 (1971C)
Location: NW¼NW¼NW¼NW¼ sec. 30, T. 126 N., R. 72 W.
Surface elevation: 1850 feet
Depth to water: 62 feet

0- 13	Clay, yellow-brown, silty, pebbly
13- 84	Clay, gray, sandy, pebbly
84- 98	Sand, coarse, some clay
98-111	Clay, sandy, pebbly
111-120	Gravel, coarse, some clay
120-149	Clay, gray, sandy, pebbly

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Test Hole 46 (1972C)
Location: NE¼NW¼NW¼NW¼ sec. 30, T. 126 N., R. 72 W.
Surface elevation: 1866 feet
Depth to water: Not measured

0- 1	Soil, black
1- 32	Clay, brown, sandy, pebbly
32- 92	Clay, gray, sandy, pebbly
92- 99	Sand and gravel
99-144	Clay, gray, pebbly
144-148	Sand and gravel
148-176	Clay, gray, very silty
176-239	Clay, gray, sandy, pebbly, shaley
239-242	Gravel
242-275	Shale

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APPENDIX B

Well Records In The Eureka Area

Source: O, outwash and sand lenses
Use: D, domestic; S, stock

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Ritter, W	NW¼SE¼NE¼NE¼ sec. 1, T. 127 N., R. 73 W.	40	28		D,S
Bertsch, T.	SW¼NE¼NE¼SE¼ sec. 3, T. 127 N., R. 73 W.	68	6		S
Brenneise, G.	SW¼SW¼NE¼NW¼ sec. 6, T. 127 N., R. 73 W.	50	35		
Brenneise, G.	NW¼SE¼SW¼SE¼ sec. 7, T. 127 N., R. 73 W.	50	12		
Fischer, E.	SE¼SE¼SW¼SW¼ sec. 11, T. 127 N., R. 73 W.	230	1	O	S
Grenz, M.	NE¼SE¼SW¼NW¼ sec. 13, T. 127 N., R. 73 W.	25	10		
Fischer, E.	NW¼SW¼NE¼NW¼ sec. 14, T. 127 N., R. 73 W.	20	12		
Brenneise, G.	NW¼NE¼NW¼NE¼ sec. 18, T 127 N., R. 73 W.	55	38		
Haidle, W.	SW¼SW¼NW¼ sec. 21, T. 127 N., R. 73 W.	15	7		D
Schott, J.	NE¼SW¼SW¼SW¼ sec. 25, T. 127 N., R. 73 W.	43	25		D,S
Raile, L.	SW¼SE¼SE¼NE¼ sec. 34, T. 127 N., R. 73 W.	40	18		D,S
Kary J.	NW¼SW¼SE¼SW¼ sec. 35, T. 127 N., R. 73 W.	50		O	D
Kurle, E.	NE¼NE¼SE¼SE¼ sec. 10, T. 127 N., R. 72 W.	54	32		D,S
Heuharth, A.	NW¼NE¼NW¼NE¼ sec. 27, T. 127 N., R. 72 W.	58	15		D
Heuharth, A.	NW¼NE¼NW¼NE¼ sec. 27, T. 127 N., R. 72 W.	77	10		
Stabler, S.	NE¼NE¼SE¼SE¼ sec. 33, T. 127 N., R. 72 W.	64	8		
Stabler, S.	NW¼SW¼NW¼SE¼ sec. 33, T. 127 N., R. 72 W.	102	42		D,S
Opp, J.	SE¼SW¼NW¼ sec. 35, T. 127 N., R. 72 W.	62	9		S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Koerner, A.	SW¼NE¼SE¼SE¼ sec. 4, T. 127 N., R. 71 W.	60	13		D,S
Opp, E.	NW¼SE¼NW¼SE¼ sec. 5, T. 127 N., R. 71 W.	50	14	O	D,S
Schnabel, E.	NW¼SW¼SE¼SE¼ sec. 20, T. 127 N., R. 71 W.	32	17		D,S
Schnabel, E.	SW¼NW¼NW¼NW¼ sec. 28, T. 127 N., R. 71 W.	9	6	O	
Burrer, D.	NE¼NW¼NE¼SW¼ sec. 33, T. 127 N., R. 71 W.	93	21		
Burrer, D.	NW¼NW¼NE¼SW¼ sec. 33, T. 127 N., R. 71 W.	12	6		
Pfeiffle, O.	SE¼NE¼NW¼SE¼ sec. 2, T. 126 N., R. 73 W.	42	25	O	D,S
Roggenkamp, W.	NW¼NE¼SW¼NW¼ sec. 2, T. 126 N., R. 73 W.	70	55	O	S
Wanner, M.	SW¼NE¼SE¼NE¼ sec. 4, T. 126 N., R. 73 W.	134	40	O	S
Wanner, M.	SW¼NE¼SE¼NE¼ sec. 4, T. 126 N., R. 73 W.	130	0		
Pfeifer, H.	NE¼SW¼NW¼NW¼ sec. 6, T. 126 N., R. 73 W.	63	27	O	D,S
Scherbenske, E.	SE¼NW¼SE¼SW¼ sec. 8, T. 126 N., R. 73 W.	133	0	O	D,S
Opp, J.	SE¼SW¼SE¼SE¼ sec. 10, T. 126 N., R. 73 W.	65	3	O	D
Delzer, H.	SW¼NW¼NW¼NE¼ sec. 11, T. 126 N., R. 73 W.	112	60	O	D,S
Kary, J.	SE¼NW¼SW¼NW¼ sec. 12, T. 126 N., R. 73 W.	65	50		D,S
Melhaff, H.	SE¼SW¼SW¼NW¼ sec. 13, T. 126 N., R. 73 W.	80	20		S
Melhaff, H.	SE¼SW¼SW¼NW¼ sec. 13, T. 126 N., R. 73 W.	76	37		S
Knapp, O.	SW¼SW¼NW¼SW¼ sec. 13, T. 126 N., R. 73 W.	?	?	?	D
Melhaff, H.	NW¼SW¼SW¼SW¼ sec. 14, T. 126 N., R. 73 W.	70	0		D
Melhaff, H.	NW¼SW¼SW¼SW¼ sec. 14, T. 126 N., R. 73 W.	26	0		D,S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Wanner, E.	SW¼SE¼ sec. 14, T. 126 N., R. 73 W.	21	3	O	S
Kramlich, O.	NW¼SE¼NE¼SW¼ sec. 17, T. 126 N., R. 73 W.	30	3		D,S
Kramlich, J.	SW¼SW¼SE¼NE¼ sec. 18, T. 126 N , R. 73 W.	30	13		S
Otterbach, H.	SW¼NW¼NE¼NW¼ sec. 18, T. 126 N., R. 73 W.	130	0		D,S
Kramlich, J.	SW¼SW¼SE¼NE¼ sec. 18, T. 126 N., R. 73 W.	100	0	O	D,S
Nehlich	SW¼NW¼ sec. 21, T. 126 N., R. 73 W.	30	15		D
Rau, M.	NE¼NE¼NW¼SE¼ sec. 22, T. 126 N., R. 73 W.	65		O	D
Melhaff, W.	NE¼NE¼NE¼NE¼ sec. 22, T. 126 N., R. 73 W.	70	0		D,S
Nehlich, O.	NW¼SW¼SW¼SW¼ sec. 22, T. 126 N., R. 73 W.	36	5	O	D,S
Stabler, A.	NW¼NE¼SE¼NE¼ sec. 23, T. 126 N., R. 73 W.	52	0	O	D,S
USBSFW	SW¼SW¼NW¼NE¼ sec. 24, T. 126 N., R. 73 W.	58?	0		D,S
Wanner, E.	NE¼SE¼SW¼NW¼ sec. 26, T. 126 N., R. 73 W.	45	27	O	D,S
Wanner, E.	SE¼NW¼SW¼SW¼ sec. 26, T. 126 N., R. 73 W.	130	60	O	D,S
Weller, H.	NE¼SW¼SW¼NE¼ sec. 27, T. 126 N., R. 73 W.	90	38		D,S
Weller, W.	NW¼SW¼SE¼SW¼ sec. 27, T. 126 N., R. 73 W.	110	60	O	D,S
Nehlich, E.	NE¼SW¼NW¼NW¼ sec. 27, T. 126 N., R. 73 W.	70	0	O	S
Nehlich, E.	NE¼SW¼NW¼NW¼ sec. 27, T. 126 N., R. 73 W.	100	7		D,S
Weller, H.	NE¼SW¼SW¼SW¼ sec. 27, T. 126 N., R. 73 W.	50	25		S
Fischer, E. G.	SW¼NE¼SW¼SW¼ sec. 29, T. 126 N., R. 73 W.	105	59		D,S
Otterbach, H.	NE¼NE¼NE¼NE¼ sec. 29, T. 126 N., R. 73 W.	60	47	O	S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Balliet, O.	SE¼SW¼SW¼SE¼ sec. 34, T. 126 N., R. 73 W.	18	11	O	D,S
Fauth, E.	NW¼NE¼SW¼NE¼ sec. 5, T. 126 N., R. 72 W.	70	25	O	D
Melhaff, H.	SE¼NW¼SE¼SW¼ sec. 7, T. 126 N., R. 72 W.	111	75	O	D,S
Thurn, J.	NW¼NE¼SW¼SE¼ sec. 10, T. 126 N., R. 72 W.	32	13		S
Thurn, J.	NW¼NE¼SW¼SE¼ sec. 10, T. 126 N., R. 72 W.	60	31		D
Thurn, J.	NW¼NE¼SW¼SE¼ sec. 10, T. 126 N., R. 72 W.	18	8		S
Maher, E.	SE¼SW¼SE¼SW¼ sec. 11, T. 126 N., R. 72 W.	100	0	O	S
Maher, E.	SE¼SW¼NW¼NE¼ sec. 11, T. 126 N., R. 72 W.	58	0		S
Maher, E.	SE¼SW¼NW¼NE¼ sec. 11, T. 126 N., R. 72 W.	54	35		D,S
Fischer, E.	SW¼NW¼NE¼NE¼ sec. 12, T. 126 N., R. 72 W.	27	17	O	S
Meidinger, E.	SW¼NE¼SW¼NW¼ sec. 13, T. 126 N., R. 72 W.	42	22	O	S
Melhaff, A.	SE¼NW¼NE¼NW¼ sec. 16, T. 126 N., R. 72 W.	138	35		D,S
Metzger, E.	NW¼NE¼NE¼SW¼ sec. 17, T. 126 N., R. 72 W.	25	11		S
Metzger, E.	NW¼NE¼NE¼SW¼ sec. 17, T. 126 N., R. 72 W.	10	5	O	S
Metzger, E.	NW¼NE¼NE¼SW¼ sec. 17, T. 126 N., R. 72 W.	10	7	O	S
Metzger, E.	NW¼NE¼NE¼SW¼ sec. 17, T. 126 N., R. 72 W.	20	16	O	D
Krein, E.	NE¼NE¼NE¼SE¼ sec. 24, T. 126 N., R. 72 W.	80	12		D,S
Krein, E.	SE¼SE¼NE¼ sec. 25, T. 126 N., R. 72 W.	330	40		D,S
Waelhaff, R.	SW¼SE¼NE¼SE¼ sec. 27, T. 126 N., R. 72 W.	155	40	O	D,S
Waelhaff, R.	SW¼SE¼NE¼SE¼ sec. 27, T. 126 N., R. 72 W.	90	60		S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Neuharth, H.	SE¼NW¼SE¼NW¼ sec. 28, T. 126 N., R. 72 W.	190	100	O	D,S
Neuharth, H.	SE¼NW¼SE¼NW¼ sec. 28, T. 126 N., R. 72 W.	50	33		S
Mettler, H.	SW¼NW¼NW¼NW¼ sec. 4, T. 126 N., R. 71 W.	100	16		D,S
Kirschemann, A.	SE¼SW¼NW¼SW¼ sec. 5, T. 126 N., R. 71 W.	50	0		S
Martel, E. E.	SW¼SE¼SW¼SE¼ sec. 7, T. 126 N., R. 71 W.	60	9		S
Bertsch, H.	NW¼SE¼NE¼NE¼ sec. 8, T. 126 N., R. 71 W.	38	18	O	D,S
Hiff, R.	NW¼SE¼NW¼NE¼ sec. 9, T. 126 N., R. 71 W.	30	27	O	S
Fischer, E.	SW¼SW¼SE¼NW¼ sec. 18, T. 126 N., R. 71 W.	145	35	O	D,S
Martel, E. E.	NE¼SE¼NW¼NE¼ sec. 19, T. 126 N., R. 71 W.	214	100	O	D,S
Martel, E. E.	NE¼SE¼NW¼NE¼ sec. 19, T. 126 N., R. 71 W.	110	74		S
Martel, E. E.	NE¼SE¼NW¼NE¼ sec. 19, T. 126 N., R. 71 W.	120	95		D
Kirschemann, A.	SE¼SW¼SE¼SW¼ sec. 28, T. 126 N., R. 71 W.	40	30	O	S
Kirschemann, A.	SE¼SW¼SE¼SW¼ sec. 28, T. 126 N., R. 71 W.	60	54	O	D,S
Kirschemann, E.	SW¼SW¼SE¼SE¼ sec. 29, T. 126 N., R. 71 W.	20	15	O	
Preszler, E.	SE¼SE¼SW¼NE¼ sec. 30, T. 126 N., R. 71 W.	55	32		S
Preszler, E.	SE¼SE¼SW¼NE¼ sec. 30, T. 126 N., R. 71 W.	59	36		S
Delbert, A.	NE¼SE¼SW¼SW¼ sec. 1, T. 125 N., R. 73 W.	23	0		D,S
Hauck, B.	NW¼SE¼SE¼SW¼ sec. 3, T. 125 N., R. 73 W.	18	11		D,S
Weller, A.	NE¼SW¼SW¼NW¼ sec. 5, T. 125 N., R. 73 W.	30	10		D,S
Heupel, A.	SW¼NE¼NE¼SW¼ sec. 6, T. 125 N., R. 73 W.	440	0	O	S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Schutz, R.	NE¼SW¼NE¼SE¼ sec. 9, T. 125 N., R. 73 W.	11	5		D,S
Metzger, F.	NE¼SE¼SE¼NE¼ sec. 10, T. 125 N., R. 73 W.	29	25	O	D,S
Aman, E.	SW¼NE¼NE¼NE¼ sec. 11, T. 125 N., R. 73 W.	30	15		
Boschee, V.	NE¼NE¼NW¼NE¼ sec. 12, T. 125 N., R. 73 W.	30	28		D,S
Grosz, W.	SW¼SE¼SW¼SW¼ sec. 14, T. 125 N., R. 73 W.	20	0		D
Aman, E.	SE¼SE¼NE¼NW¼ sec. 17, T. 125 N., R. 73 W.	400	75		S
Stoebher, W.	NW¼NW¼NW¼NW¼ sec. 18, T. 125 N., R. 73 W.	425	25		D,S
Knoepfle, C.	NE¼SW¼SW¼NW¼ sec. 20, T. 125 N., R. 73 W.	400	0		D,S
Eberhert, R.	NE¼NE¼NE¼ sec. 22, T. 125 N., R. 73 W.	9	5		
Grosz, E.	SE¼SE¼NE¼SW¼ sec. 27, T. 125 N., R. 73 W.	13	8		S
Gab, G.	NW¼NW¼NW¼NW¼ sec. 28, T. 125 N., R. 73 W.	385	0		D,S
Gab, G.	SE¼SW¼SE¼SE¼ sec. 29, T. 125 N., R. 73 W.	280	35		D,S
Schilling, W.	SE¼NE¼SW¼NE¼ sec. 30, T. 125 N., R. 73 W.	320	28		D,S
Schilling, J.	NE¼NW¼SE¼NW¼ sec. 30, T. 125 N., R. 73 W.	350	35		D,S
Gab, R.	SW¼NE¼NE¼NE¼ sec. 31, T. 125 N., R. 73 W.	11	4		S
Gab, R.	SE¼NE¼NE¼NE¼ sec. 31, T. 125 N., R. 73 W.	14	5		D,S
Gab, J.	NW¼SW¼NW¼SW¼ sec. 32, T. 125 N., R. 73 W.	20	0		D
Gab, A.	SE¼NE¼NE¼SE¼ sec. 34, T. 125 N., R. 73 W.	47	31		D,S
Kaul, D.	NW¼NW¼NW¼SE¼ sec. 35, T. 125 N., R. 73 W.	90	35		D,S
Kaul, D.	NW¼NW¼NW¼SE¼ sec. 35, T. 125 N., R. 73 W.	214	0		

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Rieger, L.	SE¼SW¼NW¼NW¼ sec. 1, T. 125 N., R. 72 W.	197	0		D,S
Rieger, H.	SW¼SW¼NW¼SE¼ sec. 1, T. 125 N., R. 72 W.	169	51		D,S
Rieger, L.	NW¼NW¼NE¼NW¼ sec. 1, T. 125 N., R. 72 W.	300	0		
Kramlich, A.	NW¼NW¼NW¼SW¼ sec. 4, T. 125 N., R. 72 W.	73	30		D,S
Imberd, J.	SE¼NW¼SW¼SE¼ sec. 5, T. 125 N., R. 72 W.	14	9		D
Malsom, M.	NW¼SW¼NE¼NE¼ sec. 8, T. 125 N., R. 72 W.	231	111	O	S
Malsom, M.	NW¼SW¼NE¼NE¼ sec. 8, T. 125 N., R. 72 W.	24	0		
Malsom, M.	NE¼NE¼SE¼NE¼ sec. 8, T. 125 N., R. 72 W.	355	111		S
Aman, P.	SW¼NE¼SW¼SE¼ sec. 11, T. 125 N., R. 72 W.	138	4		
Hieb, A.	NE¼NW¼SE¼SE¼ sec. 13, T. 125 N., R. 72 W.	11	3		S
Hieb, A.	NW¼NW¼SE¼SE¼ sec. 13, T. 125 N., R. 72 W.	22	6		D
Aman, E.	SE¼SW¼NE¼SE¼ sec. 14, T. 125 N., R. 72 W.	170	111		D,S
Aman, C.	SW¼SW¼NW¼NW¼ sec. 15, T. 125 N., R. 72 W.	14	6		D,S
Aman, E.	SE¼SE¼SE¼SW¼ sec. 19, T. 125 N., R. 72 W.	15	11		D
Kappenman, W.	SW¼NE¼NW¼NE¼ sec. 20, T. 125 N., R. 72 W.	300	20		
Kappenman, W.	NW¼NW¼NE¼NE¼ sec. 21, T. 125 N., R. 72 W.	300	111		D,S
Aman, W.	SW¼NE¼NW¼SW¼ sec. 23, T. 125 N., R. 72 W.	10	7		D,S
Will, E.	SE¼NW¼SW¼NE¼ sec. 26, T. 125 N., R. 72 W.	390	69		D,S
Imbert, I.	NW¼NW¼SE¼NW¼ sec. 30, T. 125 N., R. 72 W.	14	5		S
Maische, E.	NW¼NE¼SW¼NW¼ sec. 5, T. 125 N., R. 71 W.	248	150		D,S

Name	Location	Depth of Well (feet)	Depth to Water (feet)	Source	Use
Deutenhoffer, M.	SW¼SW¼NW¼SW¼ sec. 5, T. 125 N., R. 71 W.	96	12		D,S
Dockter, E.	SW¼NE¼SE¼NE¼ sec. 7, T. 125 N., R. 71 W.	286	50		D,S
Deutenhoffer, M.	SE¼SE¼NW¼NE¼ sec. 8, T. 125 N., R. 71 W.	15	3		
Schilling, A.	SW¼SW¼SW¼SW¼ sec. 8, T. 125 N., R. 71 W.	100	65		D,S
Lang, A.	SW¼SE¼NW¼NE¼ sec. 9, T. 125 N., R. 71 W.	60	0		S
Aman, E.	NE¼NE¼SW¼SE¼ sec. 17, T. 125 N., R. 71 W.	382	0		
Aman, J.	SW¼SE¼NE¼NE¼ sec. 17, T. 125 N., R. 71 W.	363	0		D,S
Aman, E.	NE¼NE¼SW¼SE¼ sec. 17, T. 125 N., R. 71 W.	336	20		D,S
Eberhardt, V.	SE¼NW¼NW¼NE¼ sec. 19, T. 125 N., R. 71 W.	13	0		
Gramm, E.	SW¼SE¼SE¼SW¼ sec. 19, T. 125 N., R. 71 W.	90	80		D,S
Eberhardt, V.	SE¼NW¼NW¼NE¼ sec. 19, T. 125 N., R. 71 W.	271	8		D,S
Martel, W.	NW¼NW¼SE¼NE¼ sec. 29, T. 125 N., R. 71 W.	80	75		D,S
Jung, E.	NW¼NE¼SW¼SE¼ sec. 29, T. 125 N., R. 71 W.	137	50		S
Gramm, W.	SE¼SE¼SW¼NW¼ sec. 30, T. 125 N., R. 71 W.	100	85		D,S
Jung, E.	SE¼SW¼NW¼NE¼ sec. 32, T. 125 N., R. 71 W.	375	100		D,S

APPENDIX C

Logs of test holes, test wells, and observation wells drilled and constructed by private drillers in the recommended area.

(For map location — except Test Hole 1, see fig. 7)

Test Hole 1 (1974)
Location: NW¼NW¼NW¼NW¼ sec. 2, T. 126 N., R. 73 W.
Surface elevation: 1850 (approximate)
Depth to water: Not measured

0- 28	Clay, yellow, pebbly
28- 50	Clay, blue, pebbly
50- 52	Sand, fine
52- 59	Clay, blue, pebbly
59- 65	Sand and gravel, coarse to very coarse
65- 84	Clay, gray, pebbly
84- 92	Sand and gravel, coarse to very coarse
92-140	Clay, gray, pebbly, rocky
140-214	Clay, gray, pebbly
214-218	Sand and gravel, medium to coarse
218-295	Clay, gray, pebbly
295-308	Clay, gray, pebbly, some sand and gravel
308-312	Clay, gray, pebbly
312-340	Shale

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Test Hole 2 (1974)
Location: SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1846 feet
Depth to water: 6 feet

0- 28	Clay, yellow, pebbly
28- 40	Clay, blue, pebbly
40- 69	Clay, gray, pebbly
69- 75	Clay, gray, pebbly, some sand
75-111	Sand and gravel, coarse
111-120	Clay, gray, pebbly

* * * *

Test Hole 3 (1974)
Location: SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: ?
Depth to water: Flowed, 5 to 10 gpm

0- 31	Clay, yellow, pebbly
31- 40	Clay, blue, pebbly
40- 66	Clay, gray, pebbly
66- 76	Sand and gravel, coarse
76- 79	Clay, gray, pebbly
79- 87	Sand and gravel, coarse
87- 90	Clay, gray, pebbly
90-107	Sand and gravel, coarse
107-166	Clay, gray, pebbly
166-172	Sand and gravel, fine to medium
172-173	Clay, gray, pebbly
173-178	Sand and gravel, fine to medium
178-180	Shale

* * * *

Well 1 (1974 — test well)
Location: SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: 1846 feet
Depth to water: 2.0 feet
6-inch steel casing — 0-80 feet
Johnson No. 60 screen — 80-86 feet
Johnson No. 40 screen — 86-107 feet

0- 28	Clay, yellow, pebbly
28- 72	Clay, gray, pebbly
72- 79	Clay, gray, pebbly, some sand layers
79- 88	Sand and gravel, coarse
88- 90	Clay, gray, pebbly
90-107	Sand and gravel, coarse
107-110	Clay, gray, pebbly

* * * *

Observation Well 1 (1974)
Location: SE¼SE¼SE¼SE¼ sec. 14, T. 126 N., R. 73 W.
Surface elevation: Unknown
Depth to water: 4.92 feet
Sand point set at 90 feet

69- 75	Clay, gray, pebbly, some sand layers
75-111	Sand and gravel, coarse

* * * *

Observation Well 2 (1974)
Location: SW¼SW¼SW¼SW¼ sec. 13, T. 126 N., R. 73 W.
Surface elevation: Unknown
Depth to water: 1.85 feet
Sand point set at 100 feet

70-100	Sand and gravel, coarse

* * * *

Observation Well 3 (1974)
Location: NE¼NE¼NE¼NE¼ sec. 23, T. 126 N., R. 73 W.
Surface elevation: Unknown
Depth to water: 3.58 feet
Sand point set at 100 feet

80-104	Sand and gravel, coarse, some clay at 90 feet

* * * *

Observation Well 4 (1974)
Location: NE¼NE¼NE¼NE¼ sec. 23, T. 126 N., R. 73 W.
Surface elevation: Unknown
Depth to water: 1.68 feet
Sand point set at 100 feet

78-104	Sand and gravel, coarse, some clay at 90 feet

* * * *

Well 2 (1974 — test well)
Location: NE¼SW¼SW¼SW¼ sec. 13, T. 126 N., R. 73 W.
Surface elevation: Not measured
Depth to water: 3.08 feet

0- 5	Yellow clay
5- 10	Yellow clay
10- 15	Yellow clay
15- 20	Yellow clay
20- 80	Blue clay - streak sand between 55-60
80- 84	Blue clay with some sand

Well 2 (1974 — test well) -- continued

84- 87	Coarse to very coarse sand and gravel
87- 95	Fine to medium sand
95-100	Coarse to very coarse sand and gravel
100-105	Fine to medium sand
105-110	Coarse to very coarse sand and gravel
110-117	Coarse to very coarse sand and gravel
117-132	Blue clay

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