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DEPARTMENT OF WATER AND NATURAL RESOURCES
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GEOLOGICAL SURVEY
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Open-File Report No. 29-UR

GROUND-WATER STUDY FOR THE BAD RIVER RURAL WATER SYSTEM

by

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Vermillion, South Dakota
1980

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INTRODUCTION

At the request of the West River Conservancy Sub-District and the Bad River Rural Water System, the South Dakota Geological Survey conducted a ground-water study in three small areas along the Bad River west of the city of Philip, South Dakota. The purpose of the study was to locate a source of ground water in the Bad River Valley which would yield an average of 25 gallons per minute to the Rural Water System. The field work was conducted from August 7 through August 18, 1979. The investigation involved the drilling of 57 test holes, the installation of three temporary wells for the collection of water samples and collecting and analyzing 13 water samples.

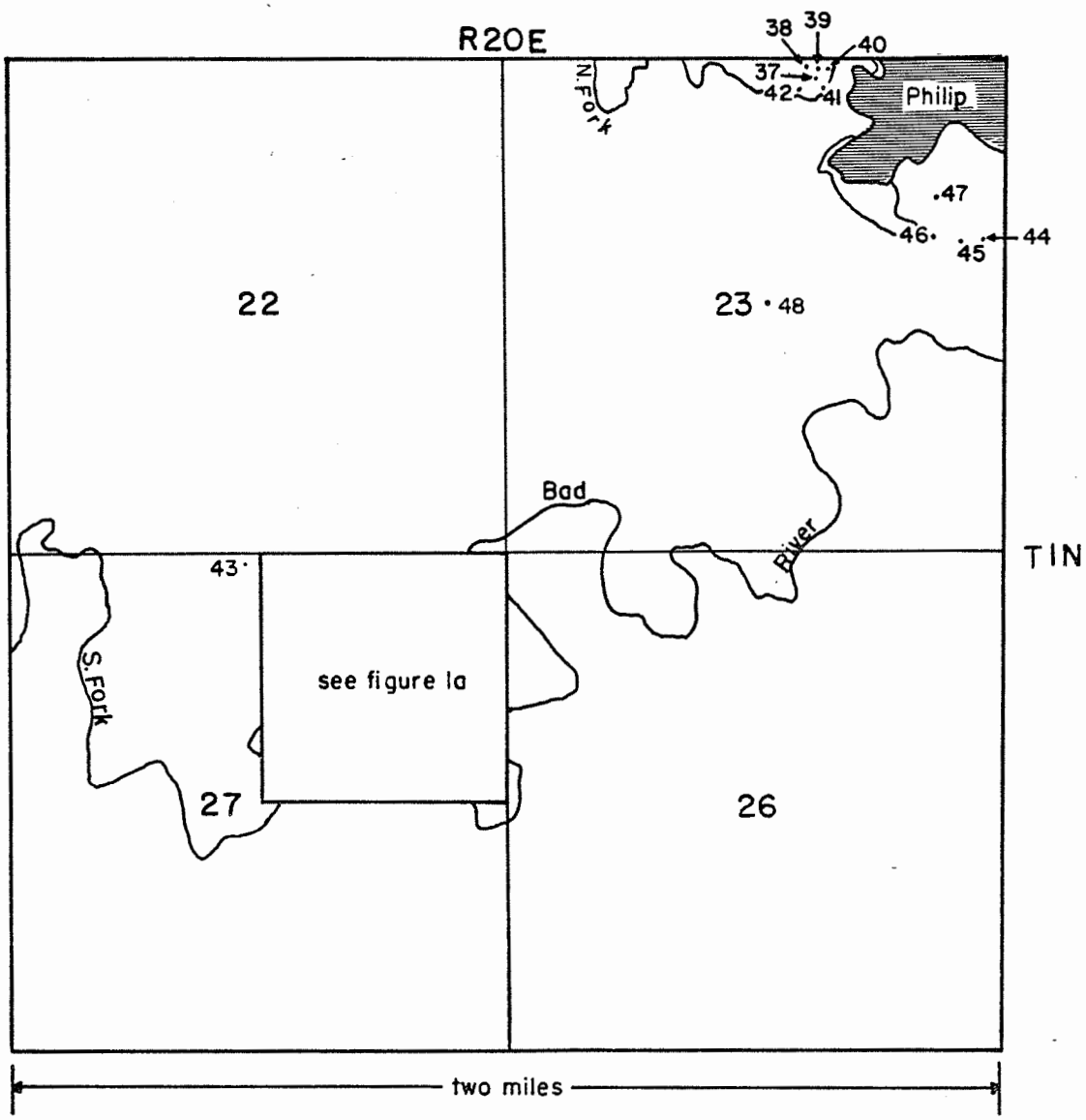
The cooperation of the residents in the area was greatly appreciated.

The study was financed by the South Dakota Geological Survey, the West River Conservancy Sub-District, and the Bad River Rural Water System.

The locations of the test holes are plotted in figures 1 and 1a, and the logs of these holes are in appendix A. As figure 1 illustrates, three small areas, in which the Rural Water System had obtained permission from the owners to drill test holes, were investigated. These areas were: NE¼ of section 27, SE¼NE¼ of section 23, and NW¼NE¼ of section 23, all in Township 1 North, Range 20 East. The best sand in these three areas was penetrated in the NE¼ of section 27. Several test holes were drilled in this area to define the extent of the sand and gravel deposits (fig. 1a).

Figure 1

Map showing location of test holes and observation wells.



• — test hole

o — test hole with observation well

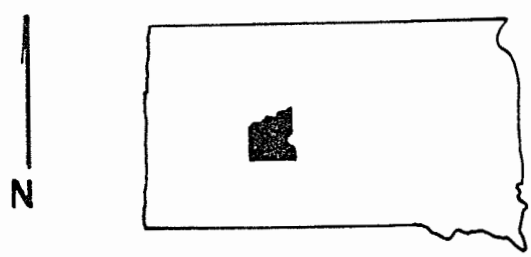


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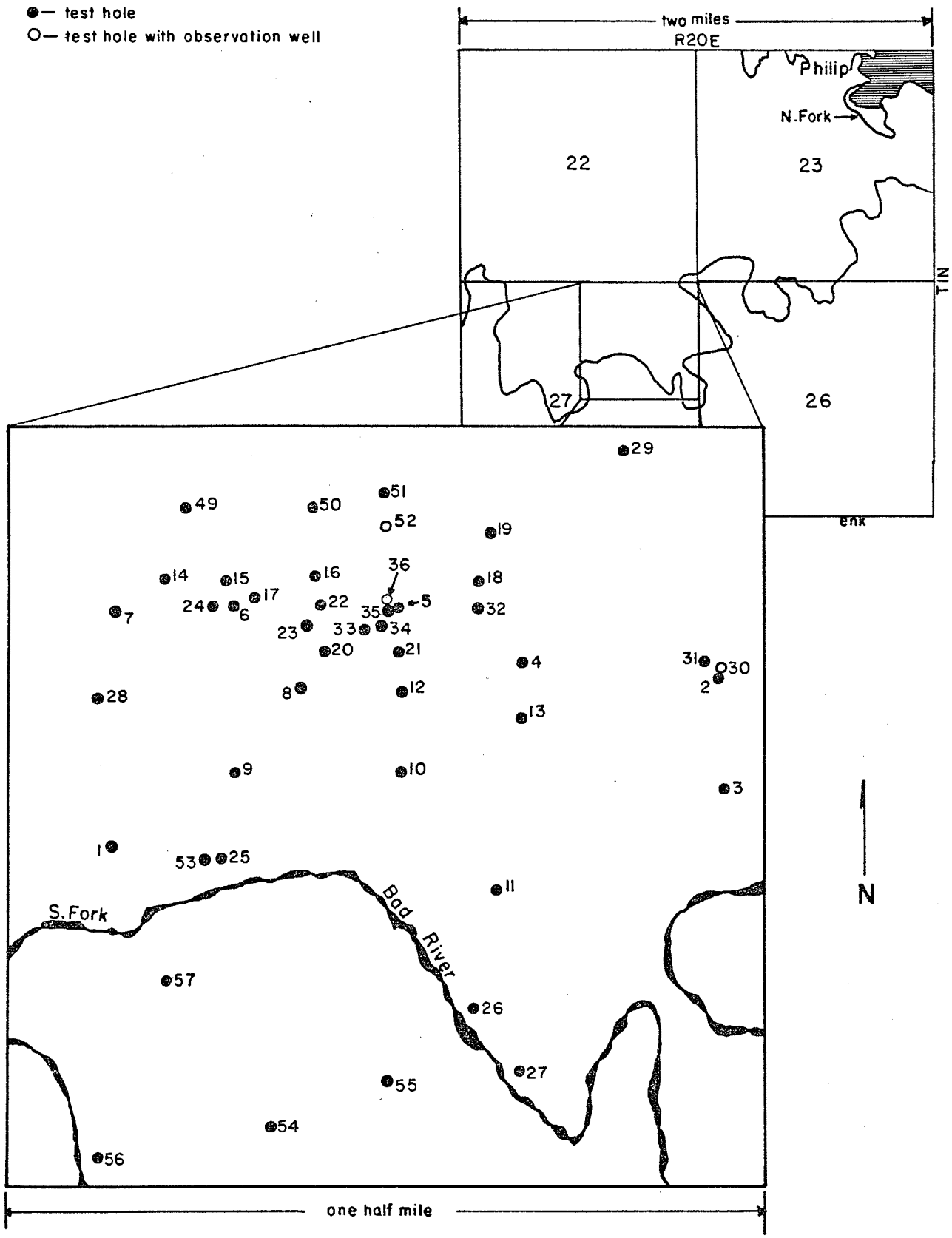
Figure 1a

Map showing location of test holes and observation wells.



Figures 2 and 2a show the thickness of the saturated sand and gravel in the holes in which the water levels were measured. Water levels were not measured in some of the test holes due to the very thin layer of sand, the close proximity of other test holes with measured water levels, or the hole caved in before the water level stabilized.

Three small temporary wells were constructed to collect water samples for chemical analyses. The first well (app. A, test hole 30) was constructed next to test hole 2 with 9.3 feet of saturated sand (fig. 2 and app. A). The first temporary well (test hole 30) was pumped by a centrifugal pump for more than 30 minutes before the collection of the water sample. The water from this well had a high content of dissolved chemicals (table 1, sample W-I; for water sample locations, see fig. 3). The sulfate content of this sample was 1500 parts per million (ppm) and the hardness content was 745 ppm, and the total solids content was 2600 ppm.

A second temporary well was constructed in test hole 36 which was located next to test hole 5 with 6.8 feet of saturated sand and a water level of 19 feet 4 inches below the land surface (fig. 2 and app. A). This well failed to pump water.

A third temporary well was installed in test hole 52. This well was pumped for 2 hours. The analysis of a water sample from this well is in table 1 (sample W-J). This water has less dissolved chemicals than water sample W-I. Sample W-J contained 820 ppm total solids, 185 ppm sulfate, and 154 ppm hardness. Only the value for total solids exceeds the recommended limit

Figure 2

Map showing thickness of saturated sand and gravel.

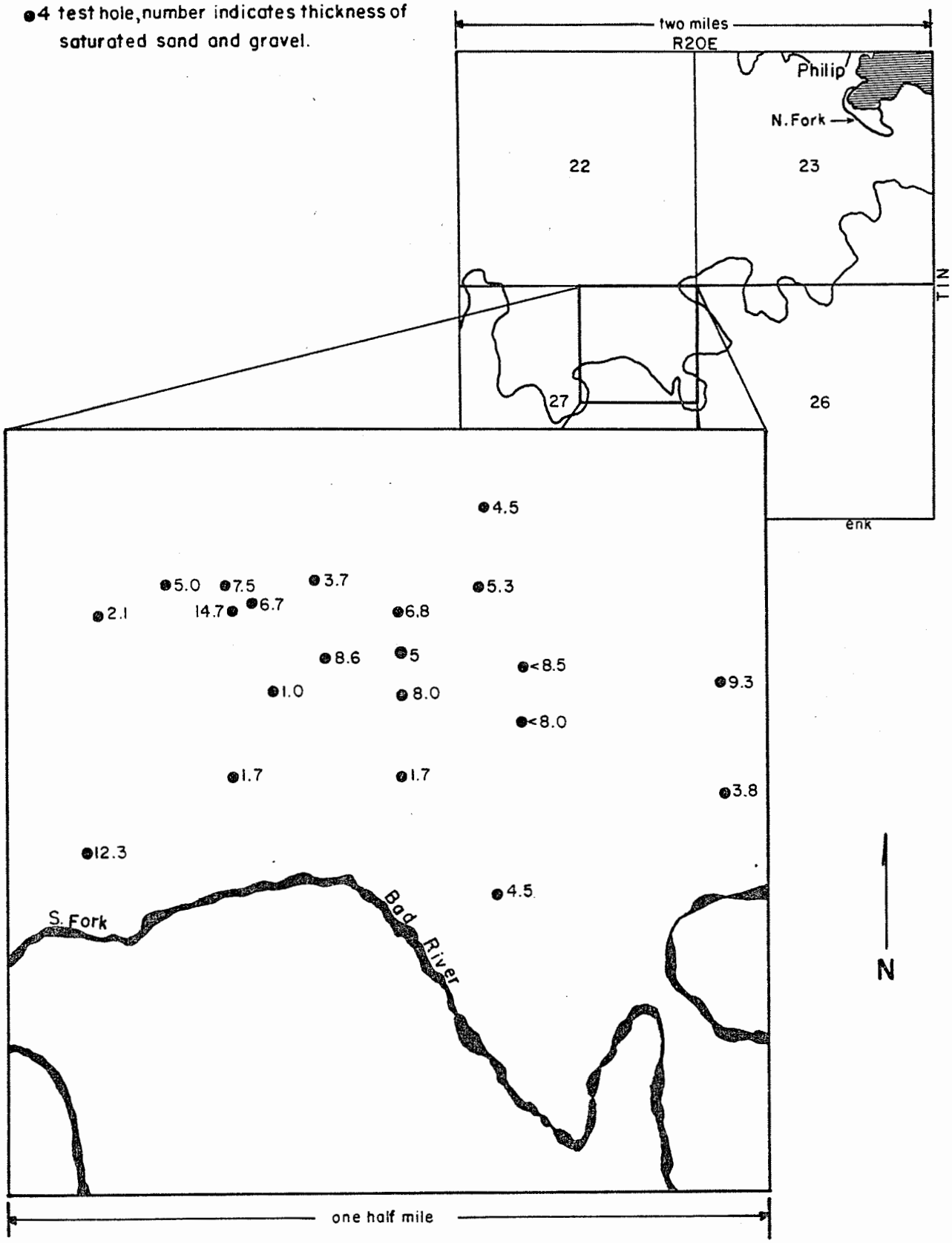
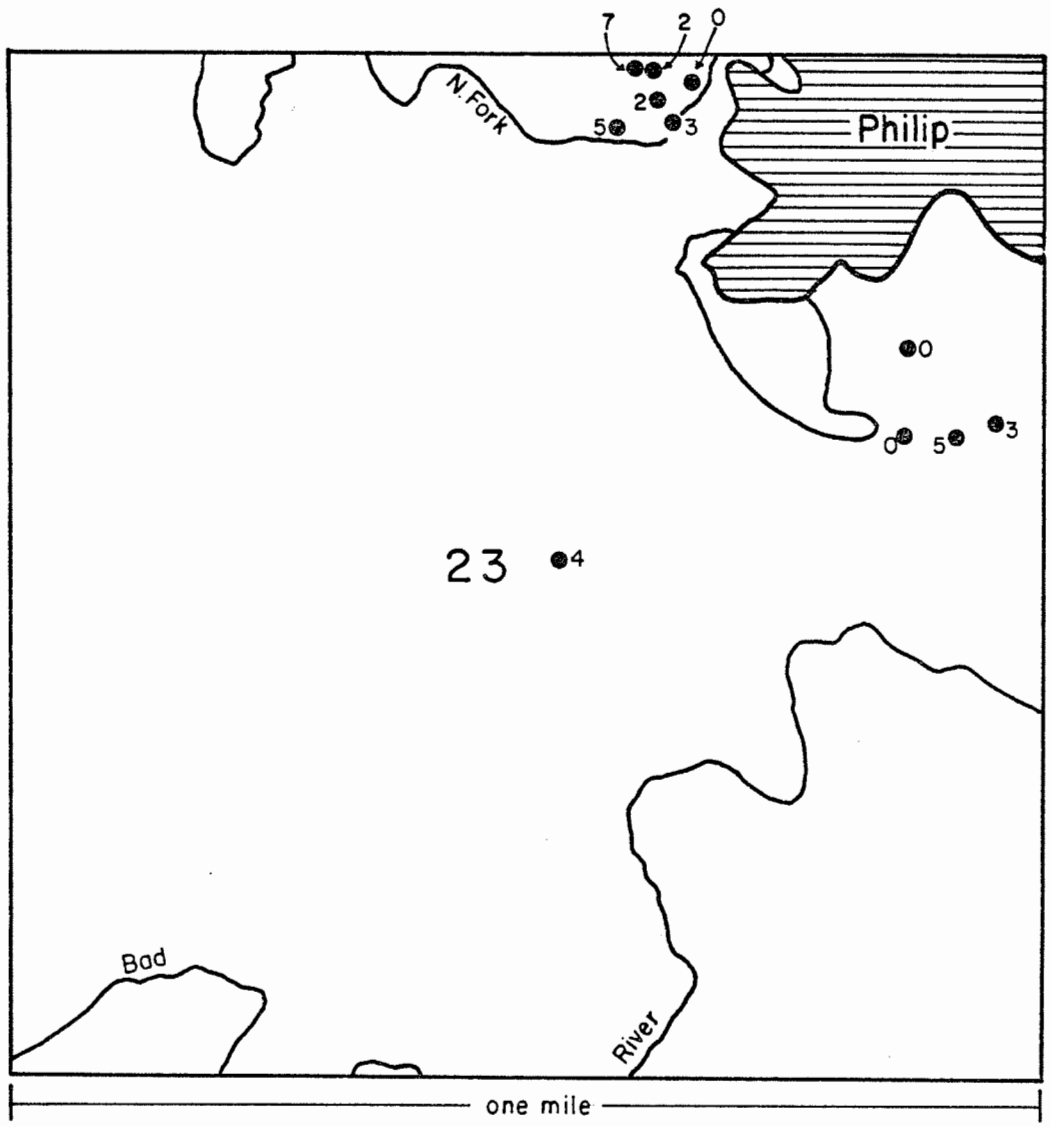


Figure 2a

Map showing thickness of saturated sand and gravel.



●4 test hole, number indicates thickness of saturated sand and gravel.

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TABLE 1. Chemical analyses of water samples from the area

Sample	Parts Per Million												Conductivity micromhos
	Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate Nitrogen	Fluoride	Hardness $CaCO_3$	Selenium	Total Solids	
A	---	---	---	250[2]	250[2]	0.30[2]	0.05[2]	10.0[1]	1.4 2.4[2]	---	0.010[1]	500[2]	----
W-A	120	305	22	20	650	0.19	0.05*	0.7	0.42	389	0.020	1313[3]	1750
W-B	190	260	46	20	820	0.11	0.15	0.5*	0.44	662	0.006	1568[3]	1960
W-C	51	135	10	7	240	0.05*	0.05*	0.5*	0.72	168	0.009	720[3]	960
W-D	165	270	52	72	740	0.05*	0.05*	3.5	0.24	625	0.003*	1568[3]	1960
W-E	230	335	75	80	1100	0.05*	0.05*	2.0	0.28	881	0.007	2125[3]	2500
W-F	200	275	56	130	660	0.09	0.05*	6.5	0.35	728	-----	1780	2050
W-G	8	770	(2)	(200)	670	0.12	0.05*	0.5*	4.5	28	-----	2260	3100
W-H	220	740	94	(320)	1580	0.03	0.05*	3.6	0.55	934	-----	3540	4300
W-I	230	635	42	48	1500	0.36	0.55	0.5*	0.37	745	0.004	2600[3]	3250
W-J	47	178	9	40	185	0.07	0.05*	1.1	0.65	154	-----	820	1020
W-K	12	85	(1)	6	25	0.25	0.05*	1.0	0.65	34	-----	380	440
W-L	235	19	59	18	600	0.08	0.05*	0.1*	2.1	827	-----	1194	1100
W-M	94	81	31	6	150	1.1	0.23	0.5*	0.42	361	-----	508	920

* Less Than

( ) Figure Uncertain

[1]National Interim Primary Drinking Water Regulations, Federal Register, December 24, 1975 (enforceable limits)

Sample A

[2]Proposed National Secondary Drinking Water Regulations, Federal Register, March 31, 1977 (recommended limits)

[3]The value for Total Solids was estimated from the Conductivity value. The ratio between the two varies with differing concentrations of the other constituents.

Samples W-A through W-F and Samples W-H through W-J are collected from wells that draw from shallow alluvial deposits that lie on Pierre Shale.

Sample W-G was collected from well drawing water from Dakota Sandstone approximately 2300 feet below the surface.

Sample W-K was collected from surface water of the Bad River (South Fork).

Sample W-L was collected from a well drawing water from the Madison Limestone 4010 feet below the surface.

Sample W-M was collected from the springs 3.5 miles northeast of Philip.

Location of Water Samples
(for map location, see fig. 3)

W-A NE¼NW¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E., Ted Becker (depth of well - 21? feet, depth to water - 16 feet)

W-B NW¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E., Lester Pearson (depth of well - 25? feet, depth to water - 18 feet)

W-C NW¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E., Rod Knutson (depth of well - 25 feet, depth to water - 18 feet)

W-D SW¼NE¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E., Jay Crouser (depth of well - 23? feet)

W-E SE¼SW¼SW¼SE¼ sec. 14, T. 1 N., R. 20 E., Howard Kennedy (depth of well - ?)

W-F SW¼SE¼SW¼SE¼ sec. 14, T. 1 N., R. 20 E., ? (depth of well - 15.8 feet, depth to water - 13.8 feet)

W-G NE¼NW¼SW¼NW¼ sec. 24, T. 1 N., R. 20 E., Ray Pfiefer (depth of well - 2300? feet, flowing well, 133°F at well head)

W-H SE¼SW¼SE¼SW¼ sec. 22, T. 1 N., R. 20 E., Jerry Rhodes (depth of well - ?)

W-I NE¼SE¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E., S. D. Geological Survey (depth of well - 20 feet, depth to water - 10.7 feet)

W-J SE¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E., S. D. Geological Survey (depth of well - 26 feet)

W-K SE¼NW¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E., Bad River (South Fork)

W-L SE¼SE¼SW¼NE¼ sec. 1, T. 1 N., R. 20 E., City of Philip (depth of well - 4010 feet, flowing well, 400 gpm, 153° at well head)

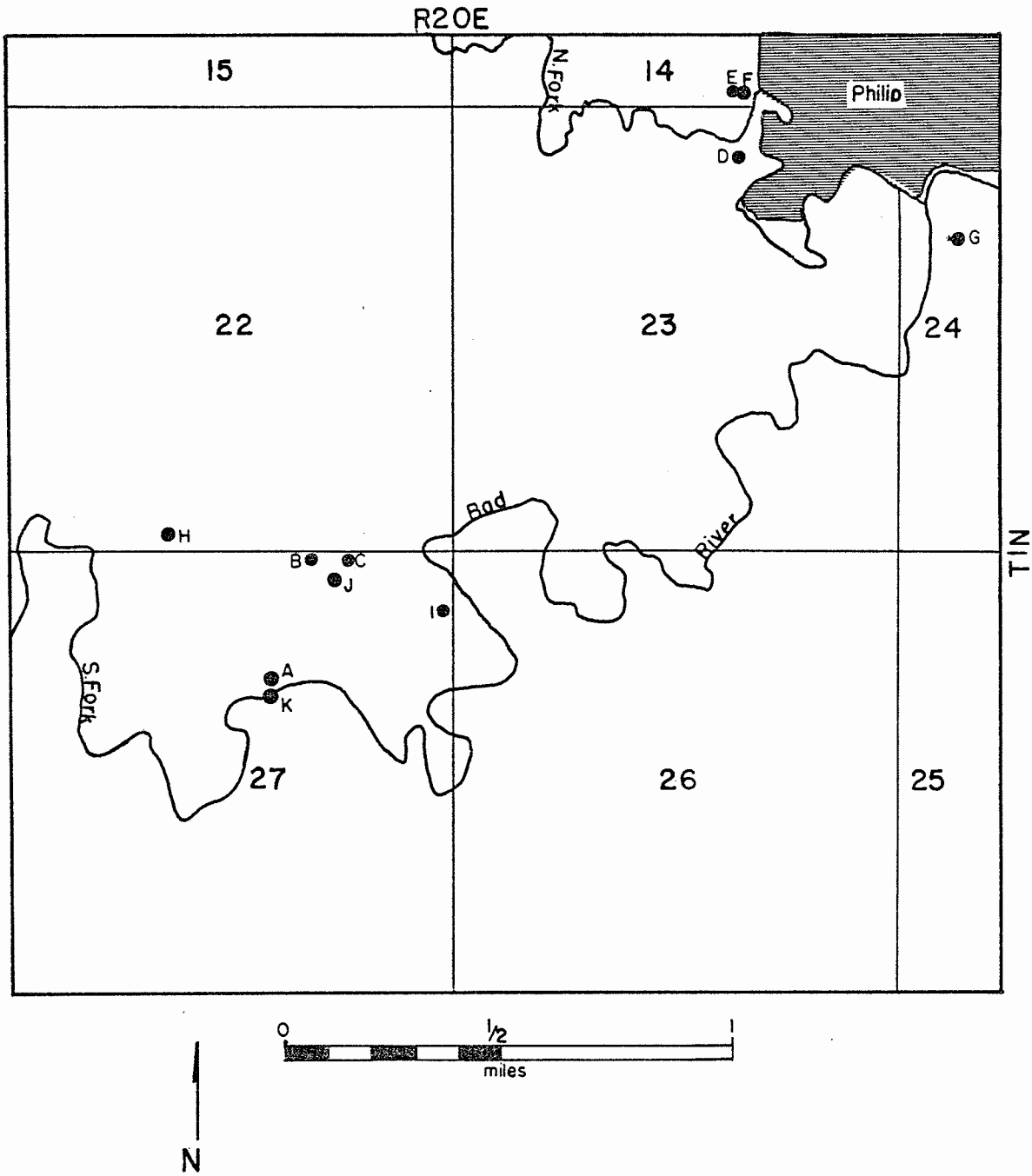
W-M SW¼ sec. 31, T. 2 N., R. 21 E., water from the springs

Figure 3

Map showing water sample locations.

●A— Water sample location

Sample W–L was collected from the city well located approximately 2.5 miles northeast of the city of Philip. Sample W–M was collected from the springs approximately 3.5 miles northeast of the city of Philip.



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in this water. Water was pumped by a hand pump from this well. Extended pumping with a higher rate could change the quality of water. Samples W-A through W-F and W-H through W-J were collected from wells that yield water from shallow alluvial deposits that lie directly over the Pierre Shale.

Sample W-C was collected from a 25-foot private well. This water sample had the best quality of all the shallow ground-water samples in the NE¼ of section 27. The quality of this water is comparable to the water sample W-J which was previously discussed. Sample W-J was located approximately 160 feet south of W-C. Water sample W-C contained 240 ppm sulfate, 168 ppm hardness, and 720 ppm total solids. However, sample W-B, which was collected from another private shallow well located approximately 300 feet to the west of W-C, contained 820 ppm sulfate, 662 ppm hardness, and 1568 ppm total solids.

Another sample collected from the shallow ground water in the NE¼ of section 27 is sample W-A which contained 650 ppm sulfate, 389 ppm hardness, and 1313 ppm total solids. The selenium content in this sample is 0.020 ppm which exceeds the enforceable limit for a municipal or rural water supply.

Sample W-K was collected on August 18 from the Bad River. Philip had received more than 6.5 inches of precipitation during July and the first half of August before the sample was collected. This water is exceptionally good and it is expected that during the normal flow in the river, the water will have a higher dissolved chemical content than sample W-K indicates.

Two samples were collected from deeper aquifers in the

area. Sample W-G was collected from a well approximately 2300 feet deep and yields water from the Dakota Formation. The total solids content in this sample is 2260 ppm. Sample W-L was collected from the Philip city well which is located approximately 2.5 miles northeast of the city of Philip. This well yields hot water from the Madison Formation. The depth of this well is 4010 feet. This is a flowing well and flows approximately 400 gallons per minute. The sulfate content in this sample was 600 ppm, the hardness content was 827 ppm, and the total solids content was 1194 ppm.

Sample W-M was collected from the springs located approximately 3.5 miles northeast of the city of Philip. The iron content in this sample was 1.1 ppm and the manganese content was 0.23 ppm, both of which exceed the recommended limits. The sample also contained 150 ppm sulfate, 361 ppm hardness, and 508 ppm total solids.

SUMMARY AND RECOMMENDATIONS

The thickest shallow saturated sand and gravel in the three areas studied was in the NE¼ of section 27, Township 1 North, Range 21 West. The thickest saturated sand and gravel was found in test hole 6. This hole had 14.7 feet of saturated sand. The saturated thickness of sand varies rapidly in a short distance. Test hole 17, located approximately 100 feet east of test hole 6, had 6.7 feet of saturated sand (fig. 2 and app. A). Based on the thickness, uniformity, and the extent of saturated sand, three locations were chosen for construction of temporary wells.

A well was constructed next to test hole 2 which had 9.3 feet of saturated sand. This well (test hole 30) was pumped by a centrifugal pump. The water had a high content of dissolved chemicals. It contained 1500 ppm sulfate, 745 ppm hardness, and 2600 ppm total solids (see W-I, table 1). The second well (test hole 36) was constructed next to test hole 5. This well failed to pump. The third well was constructed in test hole 52. This well was pumped by a hand pump and the results of the water analysis are shown in table 1 (sample W-J). The water from this well and from a private well (sample W-C, fig. 3), located approximately 160 feet to the north, are comparable. Sample W-C contained 240 ppm sulfate, 168 ppm hardness, and 720 ppm total solids. Sample W-J contained 185 ppm sulfate, 154 ppm hardness, and 820 ppm total solids. Sample W-B which was taken from a private well located approximately 300 feet west of sample W-C had twice as much dissolved chemicals. Sample W-B contained 820 ppm sulfate, 662 ppm hardness, and 1568 ppm total solids. Sample W-A, also collected from the NE¼ of section 27, had a selenium content which was higher than the enforceable limits for municipal or rural water supply. These facts indicate that not only the thickness of saturated sand varies rapidly in this area but the quality of the water changes very rapidly in a short distance.

Considering the thickness of saturated sand, the rapid change in overall sand thickness, and the fact that this study was conducted in an above average precipitation year, this area is marginal for yielding a reliable source of water for the Bad River Rural Water System. As it was discussed previously, the

quality of water changes in a short distance. In the area studied, if a well were drilled, which initially yielded water of good quality, and was pumped at a rate higher than domestic use rate, then a deterioration of the quality of the water might occur. This change in quality could be more noticeable during drought periods. Also, this area would not be able to yield an adequate quantity of water during drought periods for the rural water system.

The rural water system should reconsider obtaining water from the city of Philip or from the city well (sample W-L) which flows approximately 400 gallons per minute or from another well yielding water from the same formation.

APPENDIX A

Logs of test holes for the Bad River Rural Water System

(for map locations, see figs. 1 and 1a)

All elevations have been estimated using a 7½ minute topographic map and are presented in feet above mean sea level.

The depths to water were measured in the uncased test hole two or three days after the hole had been drilled.

Test Hole 1
Location: NE¼NW¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2170
Depth to water: 9 feet

0- 3	Sand, yellow, silty
3-23	Clay, yellow, silty
23-26	Sand, fine to coarse, some shale mixed in
26-35	Shale, gray, oily, sandy, some pebbles

* * * *

Test Hole 2
Location: NE¼SE¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2170
Depth to water: 11 feet 7 inches

0-11	Clay, brown, silty
11-21	Sand, fine to coarse, subangular, and gravel, fine to medium, subangular
21-32	Shale, gray, silty

* * * *

Test Hole 3
Location: SE¼SE¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2170
Depth to water: 17 feet 4 inches

0- 1	Topsoil, black
1-18	Clay, brown, sandy, silty
18-20	Shale, gray, silty

* * * *

Test Hole 4
Location: NE¼SW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2175
Depth to water: hole caved in

0-11	Clay, brown, silty
11-21	Sand, medium to coarse, subangular, and gravel, fine to medium, angular
21-30	Shale, gray, silty

* * * *

Test Hole 5
Location: SW¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2180
Depth to water: 19 feet 4 inches

0- 1	Topsoil, black
1-11	Clay, gray-brown, silty, sandy
11-26	Sand, fine to coarse, and gravel, fine to medium, subrounded
26-28	Shale, gray, silty, very hard

* * * *

Test Hole 6
Location: SW¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2180
Depth to water: 13 feet 3 inches

0-12	Clay, tan, silty, very stiff (shale?)
12-28	Sand, fine to coarse, subangular, and gravel, fine to medium, subangular and angular, with clay
28-40	Clay, gray, silty (shale?)

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Test Hole 7
Location: SE¼NW¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 7, 1979
Elevation: 2180
Depth to water: 12 feet 10½ inches

0-12	Clay, brown, silty
12-15	Sand, fine to coarse, and gravel, fine to medium, angular
15-18	Shale, gray, silty

* * * *

Test Hole 8
Location: NE¼SE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: 17 feet 1 inch

0-18	Clay, gray-brown, silty
18-27	Shale, gray, silty

* * * *

Test Hole 9
Location: SW¼SE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: 16 feet 4 inches

0-18	Clay, gray-brown, silty
18-20	Sand, fine to coarse, and gravel, fine, sub-rounded
20-27	Shale, gray, with gravel, fine to medium, angular

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Test Hole 10
Location: SW¼SW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2175
Depth to water: 14 feet 5½ inches

0-18	Clay, gray-brown, sandy, silty
18-22	Shale, gray, silty

* * * *

Test Hole 11
Location: NE¼NW¼SE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2175
Depth to water: 14 feet 5½ inches

0-19	Clay, brown, sandy, silty
19-22	Shale, gray, silty, pebbly

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Test Hole 12
Location: NW¼SW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: 18 feet 1 inch

0- 4	Clay, gray, silty, sandy

Test Hole 12 -- continued.

4- 6	Clay, brown, silty, sandy
6-26	Sand, fine to coarse, and gravel, fine to medium, angular
26-34	Shale, gray, silty

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Test Hole 13
Location: SE¼SW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: hole caved in

0-12	Clay, gray-brown, silty, sandy
12-24	Sand, fine to coarse, angular
24-35	Shale, gray, silty, pebbly

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Test Hole 14
Location: SE¼NW¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: 11 feet

0- 9	Clay, brown, silty, sandy
9-16	Sand, fine to coarse, and gravel, fine to coarse, subrounded
16-21	Shale, gray, silty, pebbly

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Test Hole 15
Location: SW¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: 19 feet 6 inches

0-23	Clay, gray-brown, silty, sandy
23-27	Sand, very silty, some pieces of shale
27-30	Shale, gray, silty

* * * *

Test Hole 16
Location: SE¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 10, 1979
Elevation: 2180
Depth to water: 19 feet 3 inches

0-11	Clay, gray-brown, silty

Test Hole 16 -- continued.

11-17	Sand, fine, rounded, very silty
17-23	Sand, fine to coarse, subrounded
23-27	Shale, gray, silty

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Test Hole 17
Location: SW¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 11, 1979
Elevation: 2180
Depth to water: 19 feet 4 inches

0-20	Clay, brown, sandy, silty
20-26	Sand, fine to medium, subrounded, very silty
26-30	Shale, gray, silty

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Test Hole 18
Location: SW¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 11, 1979
Elevation: 2180
Depth to water: 16 feet 8 inches

0-13	Clay, gray-brown, silty
13-22	Sand, fine to very coarse, subrounded
22-27	Shale, gray

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Test Hole 19
Location: SE¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 11, 1979
Elevation: 2175
Depth to water: 14 feet 5 inches

0-19	Clay, gray-brown, silty, sandy
19-23	Shale, gray, very hard

* * * *

Test Hole 20
Location: NE¼SE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 11, 1979
Elevation: 2180
Depth to water: 17 feet 4 inches

0-12	Clay, brown-gray, silty, sandy
12-26	Sand, fine to very coarse, and gravel, fine to coarse, subrounded
26-30	Shale, gray, silty

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Test Hole 21
Location: NW¼SW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2180
Depth to water: not measured

0- 5	Clay, brown-gray, silty, sandy
5- 8	Sand, fine to coarse, subrounded
8-17	Clay, yellow, sandy, silty
17-22	Sand, fine to very coarse, subrounded
22-27	Shale, gray

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Test Hole 22
Location: SE¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2180
Depth to water: not measured

0-14	Clay, brown, sandy, silty
14-23	Sand, fine to very coarse, subrounded, some clay mixed in
23-27	Shale, gray

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Test Hole 23
Location: NE¼SE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2180
Depth to water: not measured

0- 7	Clay, gray-brown, sandy, silty
7-16	Clay, yellow, sandy, silty
16-25	Sand, fine to coarse, subrounded, very silty
25-27	Shale, gray

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Test Hole 24
Location: SW¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2180
Depth to water: not measured

0- 8	Clay, gray-brown, silty
8-15	Clay, yellow, sandy, silty
15-25	Sand, fine to very coarse, subrounded
25-30	Shale, gray

* * * *

Test Hole 25
Location: NW¼NE¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2175
Depth to water: not measured

0- 2	Clay, brown, silty
2-15	Sand, fine, silty
15-21	Sand, fine to very coarse, and gravel, fine to very coarse, subrounded
21-27	Shale, gray

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Test Hole 26
Location: NW¼SW¼SE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2170
Depth to water: not measured

0- 1	Clay, brown, silty
1-12	Sand, fine, very silty
12-16	Sand, fine to very coarse, subrounded
16-20	Shale, gray

* * * *

Test Hole 27
Location: NE¼SW¼SE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2170
Depth to water: not measured

0- 1	Clay, brown, silty
1-15	Sand, fine, silty, with brown clay (about 30 percent clay)
15-18	Sand, fine to very coarse, subrounded
18-20	Shale, gray

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Test Hole 28
Location: NW¼SW¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2180
Depth to water: not measured

0-16	Clay, brown, sandy, silty
16-20	Sand, fine to coarse, subrounded
20-23	Shale, gray

* * * *

Test Hole 29
Location: NW¼NE¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 13, 1979
Elevation: 2175
Depth to water: not measured

0- 6	Clay, brown, sandy, silty
6- 8	Sand, fine to medium, rounded, silty
8-12	Clay, yellow, sandy, silty
12-16	Sand, fine to very coarse, and gravel, fine to very coarse, subrounded
16-22	Shale, gray

* * * *

Test Hole 30 (Observation Well)
Location: NE¼SE¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 14, 1979
Elevation: 2170
Depth to water: not measured

0- 5	Clay, brown, silty
5- 7	Sand, fine, silty (50 percent), and clay, silty (50 percent)
7-20	Sand, fine to coarse, rounded, with some bits of clay and shale
20-	Shale, gray

Observation well: Drilled with a 6-inch bit, 10 feet of 4-inch diameter plastic casing and 10 feet of 5-inch diameter stainless steel well screen

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Test Hole 31
Location: NE¼SE¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 14, 1979
Elevation: 2170
Depth to water: not measured

0- 9	Clay, tan, silty
9-18	Sand, medium to fine, subrounded, with bits of gray clay
18-21	Clay (shale?), gray, silty, very stiff

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Test Hole 32
Location: SW¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 14, 1979
Elevation: 2180
Depth to water: not measured

0- 3	Clay, brown, silty
3- 6	Clay, yellow, sandy, silty
6-22	Sand, fine to very coarse, subrounded, very silty, some clay
22-24	Shale, gray

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Test Hole 33
Location: NE¼SE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 14, 1979
Elevation: 2180
Depth to water: not measured

0- 6	Clay, tan and dark brown, silty, sandy
6-24	Sand, fine to coarse, subrounded, silty, becomes less silty at approximately 12 feet
24-26	Clay (shale), gray, silty

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Test Hole 34
Location: NE¼SE¼NW¼NE¼ sec. 27, T. 1 N., R 20 E.
Date Drilled: August 14, 1979
Elevation: 2180
Depth to water: not measured

0- 6	Clay, gray-brown, silty
6-25	Sand, fine to coarse, subrounded, silty
25-	Shale, gray

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Test Hole 35
Location: SW¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 14, 1979
Elevation: 2180
Depth to water: not measured

0- 6	Clay, tan and dark brown, silty
6-26	Sand, medium to coarse, well sorted, subrounded, silty at the top becoming less silty towards the bottom
26-?	Shale, gray, silty

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Test Hole 36 (Observation Well)
Location: SW¼NW¼NE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 14, 1979
Elevation: 2180
Depth to water: not measured

0- 5	Clay, brown, sandy, silty
5-25	Sand, fine to coarse, and gravel, fine to coarse, subrounded
25-26	Shale, gray

Observation well: Drilled with a 6-inch bit, 10 feet of 4-inch diameter plastic casing and 10 feet of 5-inch diameter stainless steel well screen

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Test Hole 37
Location: NE¼NW¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2160
Depth to water: not measured

0- 1	Topsoil, dark brown, silty, sandy
1-12	Sand, fine, silty, clayey
12-21	Clay, brown, sandy, silty
21-23	Gravel, red-brown, poorly sorted, silty, clayey, sandy
23-27	Shale, gray, silty

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Test Hole 38
Location: NE¼NW¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2160
Depth to water: not measured

0-15	Clay, brown, very sandy, silty
15-22	Sand, fine to very coarse, with fine gravel, subrounded
22-25	Shale, gray

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Test Hole 39
Location: NE¼NW¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2160
Depth to water: not measured

Test Hole 39 -- continued.

0- 1	Topsoil, brown, silty
1-19	Clay, brown, silty, sandy
19-21	Sand, medium to coarse, and gravel, fine to coarse, poorly sorted, subangular, silty, clayey
21-23	Shale, gray, silty

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Test Hole 40
Location: NW¼NE¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2160
Depth to water: not measured

0-22	Clay, brown, very sandy, silty
22-25	Shale, gray

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Test Hole 41
Location: NW¼NE¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2160
Depth to water: 16? feet

0- 1	Topsoil, brown, silty
1- 6	Clay, brown, silty, sandy
6-12	Gravel, fine to medium, angular, poorly sorted, and sand, fine to coarse, silty, clayey
12-19	Sand, fine to medium, subrounded, silty, clayey
19-21	Shale, gray, silty

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Test Hole 42
Location: SE¼NW¼NW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2160
Depth to water: 16? feet

0- 6	Clay, brown, sandy, silty
6-18	Sand, fine, very silty, some clay
18-21	Sand, fine to very coarse, subrounded
21-23	Shale, gray

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Test Hole 43
Location: NE¼NE¼NE¼NW¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2180
Depth to water: not measured

0- 3	Topsoil, dark brown, silty, sandy
3- 6	Sand, coarse, and gravel, fine, angular, unsorted, silty, clayey
6-11	Sand, fine to coarse, slightly silty and clayey
11-14	Gravel, fine to medium, and sand, fine to coarse, poorly sorted, angular
14-16	Shale, gray, silty

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Test Hole 44
Location: SE¼NE¼SE¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2155
Depth to water: 15? feet

0-12	Clay, brown, sandy, silty, very soft
12-18	Sand, fine to very coarse, subangular
18-20	Shale, gray

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Test Hole 45
Location: SW¼NE¼SE¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2155
Depth to water: 16? feet

0- 1	Topsoil, dark brown, silty, sandy
1-11	Clay, brown, silty, sandy
11-21	Sand, fine to coarse, subrounded, somewhat silty, clayey
21-23	Shale, gray

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Test Hole 46
Location: SE¼NW¼SE¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2155
Depth to water: not measured

0-21	Clay, brown, sandy, silty
21-23	Shale, gray

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Test Hole 47
Location: NE¼NW¼SE¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 16, 1979
Elevation: 2155
Depth to water: not measured

0-11	Clay, brown, silty, sandy
11-16	Gravel, angular, poorly sorted, sandy, silty, clayey
16-18	Shale, gray

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Test Hole 48
Location: SW¼SW¼SW¼NE¼ sec. 23, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2150
Depth to water: 15? feet

0- 1	Topsoil, black
1-15	Clay, brown, sandy, silty, very soft
15-19	Sand, fine to very coarse, with gravel, fine to medium, subrounded
19-20	Shale, gray

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Test Hole 49
Location: NE¼NW¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2180
Depth to water: not measured

0-12	Clay, brown, sandy, silty
12-15	Sand, fine to coarse, subangular, clean
15-17	Shale, gray

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Test Hole 50
Location: NE¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2180
Depth to water: not measured

0- 6	Clay, gray-brown, sandy, silty
6-22	Clay, light brown, silty
22-26	Sand, fine to coarse, rounded, silty
26-27	Shale, gray

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Test Hole 51
Location: NE¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2180
Depth to water: not measured

0 -24½	Clay, brown, silty, sandy
24½-25	Gravel
25 -27	Shale, gray

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Test Hole 52 (Observation Well)
Location: SE¼NE¼NW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2180
Depth to water: not measured

0-12	Clay, gray-brown, silty
12-16	Clay, light brown, sandy, silty
16-27	Sand, fine to very coarse, with gravel, fine to coarse, subrounded
27-30	Shale, gray

Observation well: bottom of well at 25 feet, screened with 2-inch diameter plastic well screen from 15 to 25 feet

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Test Hole 53
Location: NW¼NE¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2180
Depth to water: not measured

0- 8	Clay, brown, silty, sandy
8-12	Clay, brown, very sandy, silty
12-20	Sand, fine to coarse, and gravel, fine, silty, somewhat clayey
20-23	Shale, gray

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Test Hole 54
Location: SW¼SE¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2170
Depth to water: not measured

0-14	Clay, brown, very sandy, silty

Test Hole 54 -- continued.

14-19	Sand, fine to very coarse, and gravel, fine, subrounded
19-21	Shale, gray

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Test Hole 55
Location: NW¼SW¼SE¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2170
Depth to water: not measured

0-11	Clay, brown, very sandy
11-16	Sand, fine to coarse, and gravel, fine, slightly silty, clayey
16-20	Shale, gray

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Test Hole 56
Location: SW¼SW¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2170
Depth to water: not measured

0-10	Clay, brown, very sandy, silty
10-16	Sand, fine to very coarse, subangular
16-18	Shale, gray

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Test Hole 57
Location: SE¼NW¼SW¼NE¼ sec. 27, T. 1 N., R. 20 E.
Date Drilled: August 17, 1979
Elevation: 2170
Depth to water: not measured

0-12	Clay, brown, sandy, silty
12-17	Sand, fine to coarse, and gravel, fine, slightly silty, and some clay
17-19	Shale, gray

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