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**GROUND WATER STUDY FOR THE  
CITY OF GARRETSON, SOUTH DAKOTA**

by

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## INTRODUCTION

During the summer of 1982, the South Dakota Geological Survey conducted a study for the city of Garretson, South Dakota. The purpose of this investigation was to determine potential sources of ground water within a radius of approximately 5 miles from the city, excluding the land in Minnesota. Results of the investigation are presented in this report. This study was financed by the city of Garretson, the East Dakota Water Development District, and the South Dakota Geological Survey.

Field work for this study began in May of 1982 and continued through August of 1982. The field work included the drilling of 61 test holes, of which 6 were completed as observation wells, and the collection of 13 water samples for analysis. The locations of the test holes and water sample collection points are shown on figure 1. More than one test hole may have been drilled at the same location. Also shown on figure 1 are test holes and one well (MA-80K) which were drilled for a previous project. The lithologic logs of the test holes and observation wells are on file at the South Dakota Geological Survey, Vermillion, South Dakota.

## RESULTS OF INVESTIGATION

### Geology

The geology of the study area can be divided into bedrock, bedrock derived sand, and glacial deposits. The bedrock consists mainly of Sioux Quartzite which is a very hard, pink, silica cemented quartz sand. The Sioux Quartzite crops out or is very near the land surface in much of the study area. Directly overlying the Sioux Quartzite south of Garretson in the SW $\frac{1}{4}$  sec. 6, T. 102 N., R. 47 W. (fig. 1) are sands which were derived from the Sioux Quartzite. These sands, or quartzite wash, are pink or orange in color and are fine grained. This quartzite wash is not considered to be part of the glacial sediment which directly overlies these sands.

The glacial deposits in the study area consist primarily of till and outwash. Till is the heterogeneous mixture of clay, silt, sand, gravel, and boulders in a predominantly fine grained matrix of clay and silt. Outwash consists of sand and gravel with minor amounts of clay and silt which has been deposited by meltwater from a glacier.

### Hydrogeology

The Sioux Quartzite is used as a drinking water source for many people in eastern South Dakota. The occurrence of ground water in this formation is dictated by the presence or absence of fractures. Where the quartzite is fractured, useable amounts of ground water might be obtained. The city of Garretson had used ground water from the Sioux Quartzite as a drinking water supply. Because of high levels of radionuclides in the water from wells drilled into this formation (table 1), the U.S. Environmental Protection Agency asked the city to obtain its drinking water supply from an alternate source.

The quartzite wash is sometimes used as a source of drinking water. These sands were encountered south of Garretson in the SW $\frac{1}{4}$  sec. 6, T. 102 N., R. 47 W. (fig. 2). One well (R1-82-71)

was completed into this sand and showed 22 feet of saturated sand to be present (table 2). This sand was found to be under confined conditions. Test hole CO-82-82 was drilled just east of well R1-82-71 (fig. 2) and was found to have 66 feet of quartzite wash (table 2). Based on water level data from well R1-82-71, it is believed that the quartzite wash is fully saturated in test hole CO-82-82. The water in well R1-82-71 has good quality as shown in table 3. Although the thickness and water quality of the quartzite wash is good, the deposit appears to be laterally discontinuous as shown on figure 2.

Outwash, which consists primarily of sand and gravel, generally has a high permeability. When these deposits are saturated and areally extensive, they produce water to wells in useable quantities. Outwash was encountered during the drilling for this study in two primary areas. The first of these areas is southwest of Garretson in the vicinity of test hole SFB-32 (observation well MA-80K) in the SE¼ sec. 27, T. 103 N., R. 48 W. (fig. 2). The saturated thickness of the outwash surrounding MA-80K ranges from 11 feet to about 20 feet (table 2). The quality of the water found in wells completed in the outwash is good (table 3). Well CO-82-47 was not sampled for water quality. The outwash does not appear to be very extensive and it appears that the outwash encountered in individual test holes in this area may not be laterally continuous.

The second area is east of Garretson in the SE¼ sec. 15, T. 103 N., R. 47 W. (fig. 1, inset A). Figure 3 shows the names and locations of test holes that encountered more than 8 feet of sand and/or gravel in this area. The data show that the wells completed in this sand and gravel (CO-82-45) and (CO-82-93) had 16 and 10 feet of saturated thickness, respectively (table 2), of shallow sand and gravel. It was also found that this deposit is not very extensive as shown on figure 2. The quality of water from well CO-82-45 is given in table 3. All parameters analyzed were below the maximum contaminant levels set forth by the U.S. Environmental Protection Agency. Although the water quality in this well was generally good, the nitrate values for water in well CO-82-45 were around 8 milligrams per liter. Well number CO-82-93 was not sampled for water quality.

## DISCUSSION AND CONCLUSIONS

The Sioux Quartzite crops out or is very near land surface for the majority of the study area. The Sioux Quartzite has been the source of drinking water for the city. The water contained in the Sioux Quartzite has high levels of radionuclides and, during this study, it was not considered as a future water source.

Quartzite wash was found to be present south of Garretson in the SW¼ sec. 6, T. 102 N., R. 47 W. in test holes R1-82-71 and CO-82-82. The quartzite wash has good water quality and a relatively large saturated thickness at this location. Because of limited areal extent, it requires additional testing.

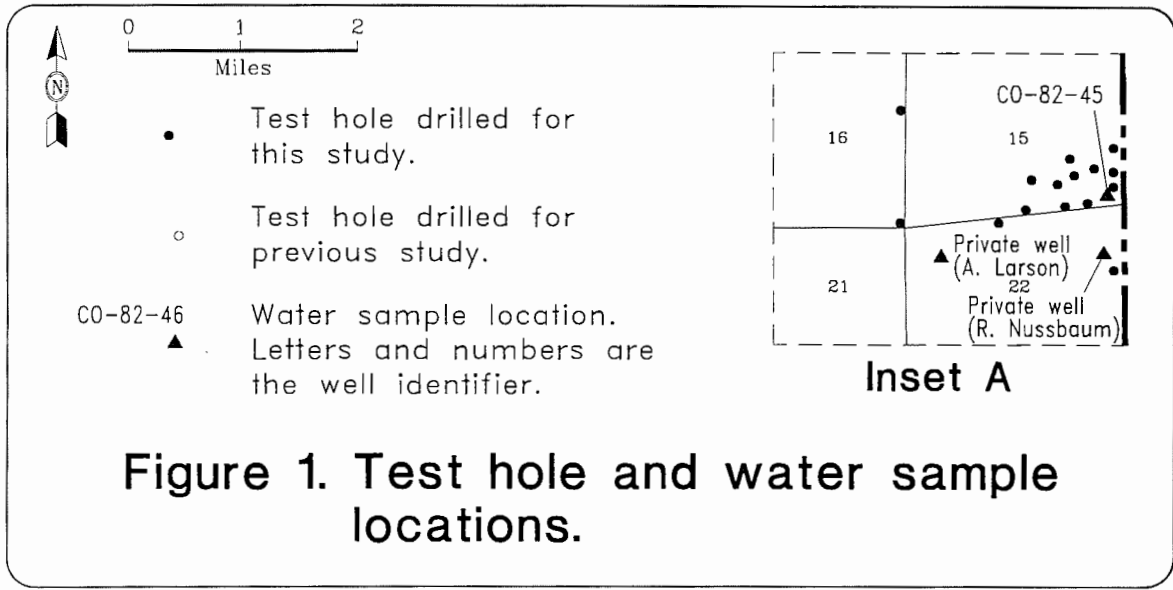
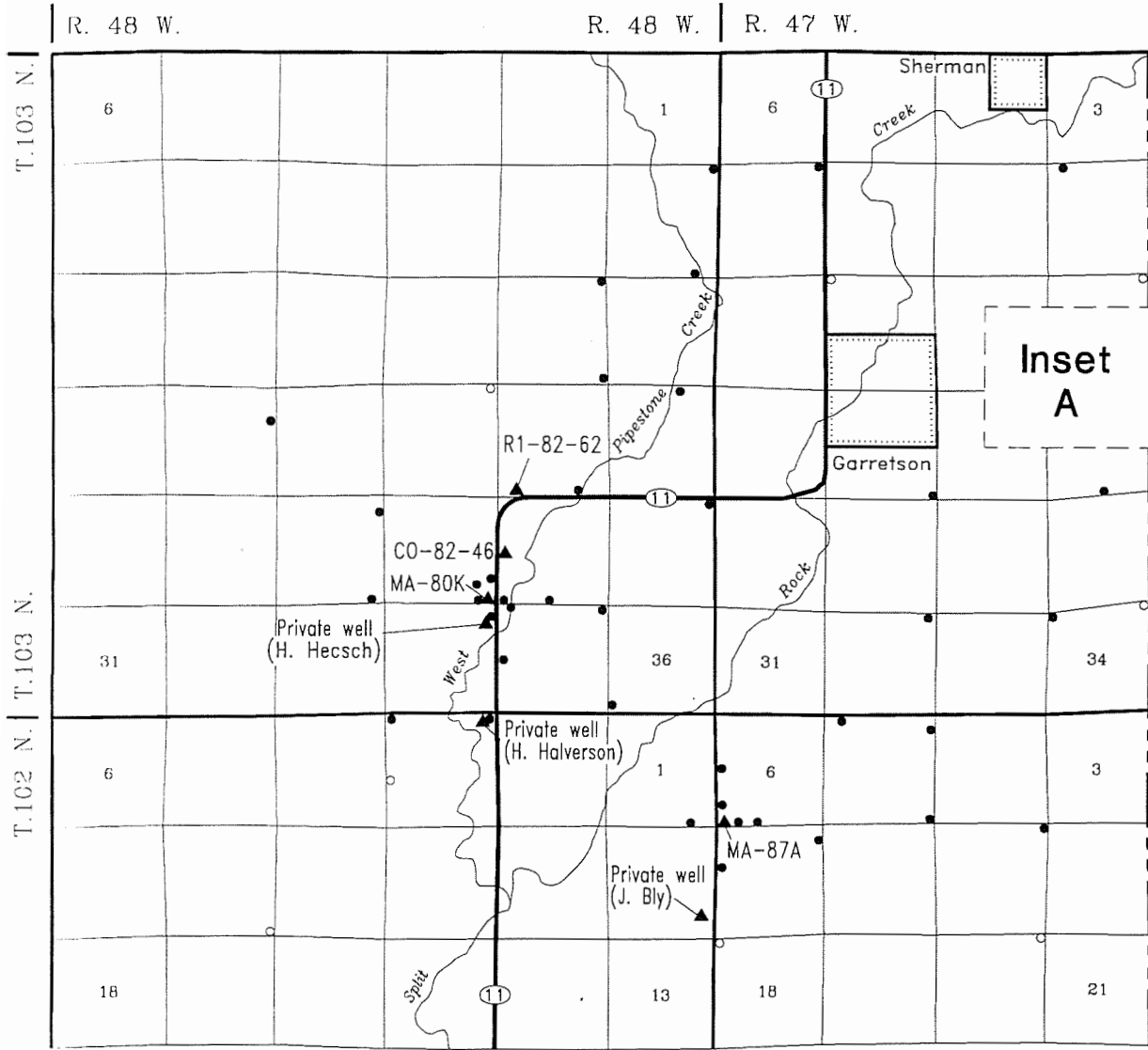
Outwash was encountered in two areas during this investigation. The first is southwest of Garretson in the SE¼ sec. 27, T. 103 N., R. 48 W., and the second is east of Garretson in the SE¼ sec. 15, T. 103 N., R. 47 W. The first area has good water quality, but is limited in areal extent. The second area, east of Garretson, has generally good water quality, and had nitrate values of about 8 milligrams per liter. This second area is also limited in areal extent and saturated thickness and would not be recommended for future development by the city.

Two areas might be considered for further exploration. The first area lies southwest of Garretson in the SE¼ sec. 27, T. 103 N., R. 48 W. around test hole SFB-32 (well MA-80K) (fig. 2). The outwash in this area had saturated thicknesses that ranged from 11 feet to about 20 feet and had good water quality. The second area is south of Garretson in the SW¼ sec. 6, T. 102 N., R. 47 W. (fig. 2). The quartzite wash found in this area had a thickness that ranged from 22 to 66 feet and also had good water quality in well R1-82-71. If the areal extent of the quartzite wash and outwash deposits are limited, as indicated by the data, it would limit the production of water to wells in these areas.

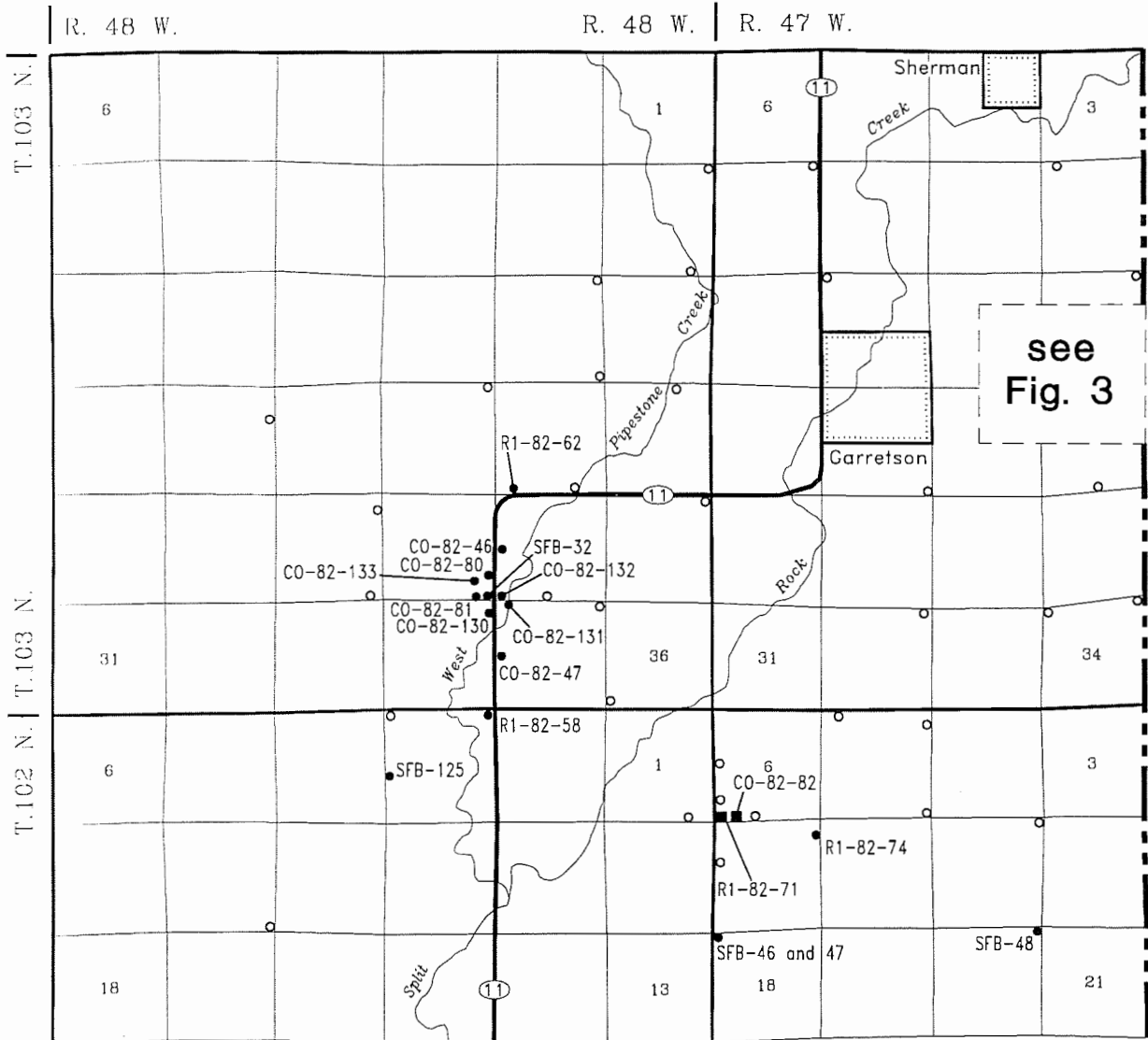
It was recommended that if the city decided to test the potential of one or both of these areas for development, that further drilling be conducted by a private driller to verify the aquifer extent, saturated thickness, and water quality. It was also recommended that prior to the installation of a permanent production well, an aquifer test be conducted to determine the hydraulic characteristics of the aquifer and estimate the quantity of water available for city use.





## REFERENCE

U.S. Environmental Protection Agency, 1994, *Drinking water regulations and health advisories*:  
November 1994



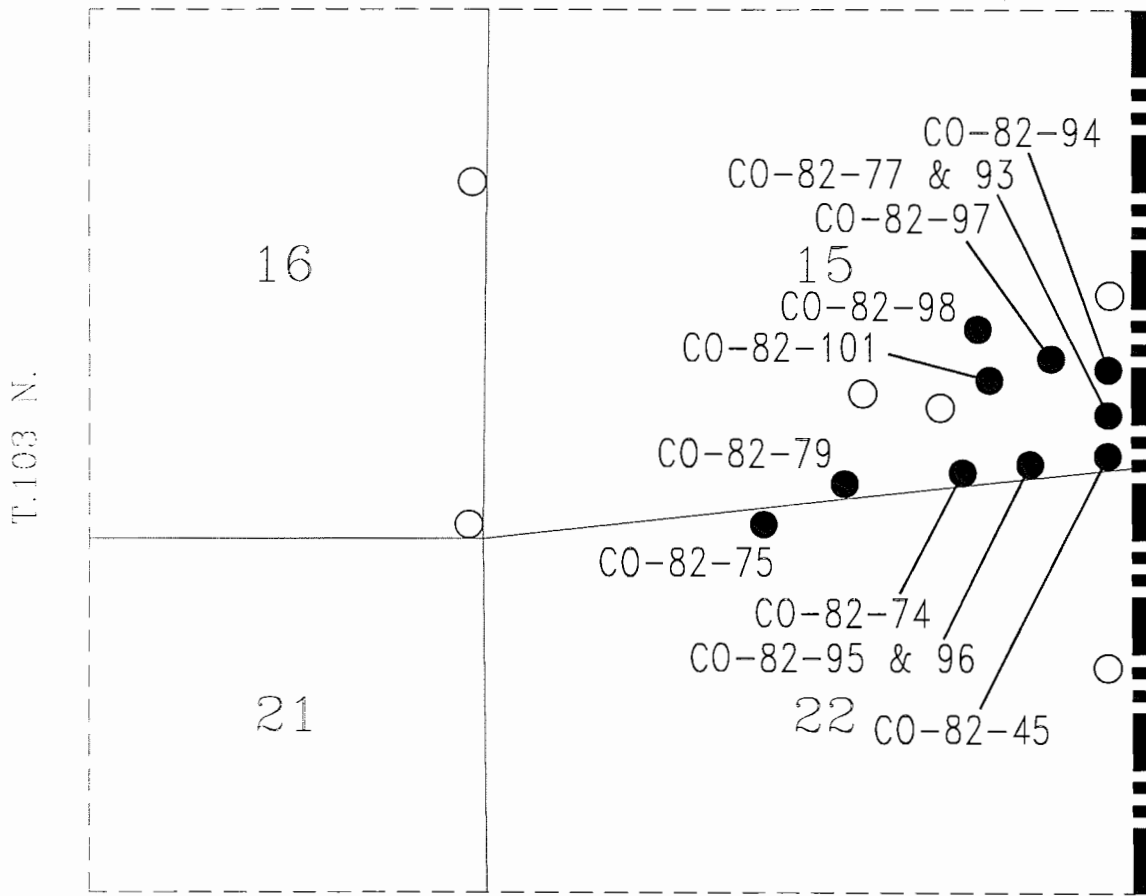
**Figure 1. Test hole and water sample locations.**



- 0 1 2  
Miles
- 
-  R1-82-71 Test hole or well where 8 or more feet of quartzite wash were encountered. The letters and numbers are the test hole identifier. See table 2 for test hole and well data summary.
  -  SFB-48 Test hole or well where 8 or more feet of outwash were encountered. The letters and numbers are the test hole identifier. See table 2 for test hole and well data summary.
  -  Test hole where no sand and/or gravel was encountered, or the thickness of the sand and/or gravel was less than 8 feet.

**Figure 2. Locations of test holes and wells that encountered 8 or more feet of sand and/or gravel.**

R. 47 W.



0 1/2 1 MILE



● Test hole or well where more than 8 feet of outwash was encountered. The letters and numbers are the test hole number. See table 2 for test hole and well data summary.

○ Test hole where no sand and/or gravel was encountered, or the thickness of the sand and/or gravel was less than 8 feet.

**Figure 3. Locations of test holes or wells east of Garretson that encountered 8 or more feet of sand and/or gravel.**



**Table 1. Results of analyses of water for radionuclides**

Well name	Date collected	Parameter			
		Gross Alpha <sup>1</sup>	Radium 226 <sup>1</sup>	Radium 228 <sup>1</sup>	Uranium <sup>2</sup>
Garretson city wells composite samples	10-06-80	19.0 ± 5.5	9.6	-----	9.0 ± 6.0
	01-05-81	14.4 ± 5.2	4.9	<0.1	-----
	04-06-81	19.1 ± 5.7	3.5 ± 0.6	10.4	<1.0
	06-29-81	41.6 ± 7.6	4.4 ± 0.8	8.7	7.0
	10-09-81	-----	5.7 ± 0.9	-----	-----
	02-23-82	19.0	9.6	-----	-----
R1-82-71	07-07-82	11.3 ± 3.3	0.9 ± 0.4	-----	-----
MA-80K	07-08-82	4.0 ± 2.6	0.3 ± 0.2	-----	-----
maximum contaminant levels <sup>3</sup>		15	20	20	20

<sup>1</sup> Numbers are presented in picocuries per liter

<sup>2</sup> Numbers are presented in micrograms per liter

<sup>3</sup> U.S. Environmental Protection Agency (1994). Maximum contaminant levels. Enforceable limit.

Table 2. Test hole and well data summary

Test hole identifier	Well name	Total depth of test hole (feet)	Bottom hole formation	Ground surface elevation (feet)	Depth of sand and/or gravel below land surface (feet)	Elevation (feet)	Thickness (feet)	Saturated thickness (feet) <sup>1</sup>	Ground water elevation (feet)
<b>South of Garrettson</b>									
CO-82-82	-----	179	bedrock	1405	113-179	1292-1226	66	-----	-----
R1-82-71	R1-82-71	110	bedrock	1400	85-107	1315-1293	22	22	1394
R1-82-74	-----	26	bedrock	1430	1- 25	1429-1405	24	-----	-----
SFB-46	-----	183	bedrock	1468	21- 30 42- 64	1447-1438 1426-1404	9 22	-----	-----
SFB-47	-----	206	bedrock	1466	17- 26 36- 47	1449-1440 1430-1419	9 11	-----	-----
SFB-48	-----	87	bedrock	1524	25- 41	1499-1483	16	-----	-----
<b>Southwest of Garrettson</b>									
CO-82-46	CO-82-46	20	bedrock	1390	1- 19	1389-1371	18	12	1384
CO-82-47	CO-82-47	46	till	1370	4- 18	1366-1352	14	9	1361
CO-82-80	-----	50	bedrock	1380	20-49	1360-1331	29	-----	-----
CO-82-81	-----	56	bedrock	1395	9- 55	1386-1340	46	-----	-----
CO-82-130	-----	53	bedrock	1375	7- 17 37-52	1368-1358 1338-1323	10 15	-----	-----
CO-82-131	-----	61	bedrock	1370	5- 20 19-59	1365-1350 1341-1311	15 30	-----	-----
CO-82-132	-----	55	bedrock	1372	12-24 34-52	1360-1348 1338-1320	12 18	-----	-----
CO-82-133	-----	46	bedrock	1400	12-20 25-45	1388-1380 1375-1355	8 20	-----	-----
R1-82-58	-----	36	bedrock	1355	1- 20	1354-1335	19	-----	-----
R1-82-62	R1-82-62	32	bedrock	1412	19-31	1393-1381	12	10	1391
SFB-32	MA-80K	55	bedrock	1380	14-26 33-53	1366-1354 1347-1327	12 20	20	1366
SFB-125	-----	90	bedrock	1425	52-61	1373-1364	9	-----	-----

Table 2 – continued.

Test hole identifier	Well name	Total depth of test hole (feet)	Bottom hole formation	Ground surface elevation (feet)	Depth of sand and/or gravel below land surface (feet)	Elevation (feet)	Thickness (feet)	Saturated thickness (feet) <sup>1</sup>	Ground water elevation (feet)
<b>East of Garretson</b>									
CO-82-45	CO-82-45	128	bedrock	1560	16- 32 105-128	1544-1528 1455-1432	16 23	16	1548
CO-82-74	-----	82	bedrock	1555	70- 81	1485-1474	11	-----	-----
CO-82-75	-----	42	bedrock	1560	23- 41	1537-1519	18	-----	-----
CO-82-77	-----	123	bedrock	1575	20- 39	1555-1536	19	-----	-----
CO-82-79	-----	46	bedrock	1550	10- 30	1540-1520	20	-----	-----
CO-82-93	CO-82-93	46	till	1575	11- 42	1564-1533	31	10	1543
CO-82-94	-----	56	till	1580	11- 43	1569-1537	32	-----	-----
CO-82-95	-----	92	bedrock	1555	12- 16	1543-1539	4	-----	-----
CO-82-96	-----	56	till	1560	14- 30	1546-1530	16	-----	-----
CO-82-97	-----	46	till	1580	14- 29	1566-1551	15	-----	-----
CO-82-98	-----	46	till	1570	15- 24	1555-1546	9	-----	-----
CO-82-101	-----	56	till	1570	22- 34	1548-1536	12	-----	-----

<sup>1</sup> The number for saturated thickness is provided only for those occurrences of sand and/or gravel from which water level information is available.

**Table 3. Chemical analyses of water samples**

Legal location	Well name	Date collected	Aquifer	Well depth <sup>2</sup>	Conductivity <sup>3</sup>	Parameter <sup>1</sup> with concentration in milligrams per liter										
						Ca	Cl	F	Fe	Mg	Mn	Na	NO <sub>2</sub> -N	NO <sub>3</sub> -N + NO <sub>2</sub> -N	TDS	Hardness as CaCO <sub>3</sub>
						250 <sup>4</sup>	2.4 <sup>5</sup>	0.3 <sup>4</sup>	0.05 <sup>4</sup>	0.05 <sup>4</sup>	10 <sup>5</sup>	250 <sup>4</sup>	500 <sup>4</sup>			
SW SW SW SW sec. 06,		06-03-82	quartzite		686	92	5	0.46	0.61	31	0.13	20	0.4	80	330	358
T. 102 N., R. 47 W.	R1-82-71	07-07-82	wash	105	653	68	4	0.40	0.28	28	0.03	18	0.8	55	359	285
NE NE NE NE sec. 03,	Private well															
T. 102 N., R. 48 W.	H. Halverson	06-25-82	unknown	unknown	768	96	7	0.46	0.02	33	0.01	15	14	54	480	365
NE NW SE SE sec. 12,	Private well															
T. 102 N., R. 48 W.	J. Bly	06-25-82	unknown	220	955	117	3	0.45	1.78	33	0.57	42	<0.10	200	650	427
SE SE SE SE sec. 15,		06-17-82			663	77	3	0.62	0.02	35	0.02	14	7.6	29	414	335
T. 103 N., R. 47 W.	CO-82-45	07-12-82	outwash	33	625	78	2	NA	NA	35	NA	11	7.5	NA	NA	336
SE SE NE NE sec. 22,	Private well															
T. 103 N., R. 47 W.	R. Nussbaum	06-17-82	unknown	40	2790	252	350	0.51	0.08	202	0.02	68	92	161	1920	1460
NW NW NW NW sec. 22,	Private well															
T. 103 N., R. 47 W.	A. Larson	06-24-82	unknown	39	1980	215	119	0.25	0.07	113	0.03	45	78	124	1360	1002
SW SE SW SW sec. 23,																
T. 103 N., R. 48 W.	R1-82-62	06-17-82	outwash	30	731	80	4	0.29	0.10	41	0.03	21	5.9	NA	564	369
NW NW NW SW sec 26,																
T. 103 N., R. 48 W.	CO-82-46	06-17-82	outwash	18.5	810	86	22	0.43	0.04	34	0.04	45	2.9	49	486	355
SE SE SE SE sec. 27,		06-30-82			620	80	2	0.07	0.03	24	0.01	17	4.3	25	388	298
T. 103 N., R. 48 W.	MA-80K	07-08-82	outwash	45	612	72	3	0.38	0.13	25	<0.02	19	3.4	24	376	282
NW SE NE NE sec. 34,	Private well															
T. 103 N., R. 48 W.	H. Hecsch	06-25-82	unknown	unknown	701	96	4	0.37	0.02	29	<0.01	12	5	32	426	359

<sup>1</sup> Ca - calcium; Cl - chloride; F - fluoride; Fe - iron; Mg - magnesium; Mn - manganese; Na - sodium; NO<sub>3</sub>-N + NO<sub>2</sub>-N - nitrate plus nitrite as nitrogen; SO<sub>4</sub> - sulfate; TDS - total dissolved solids; Hardness as CaCO<sub>3</sub> - hardness as calcium carbonate.

<sup>2</sup> Well depth is presented in feet below top of casing.

<sup>3</sup> Numbers are presented in micromhos.

<sup>4</sup> U.S. Environmental Protection Agency (1994). Secondary maximum contaminant levels. Recommended limit.

<sup>5</sup> U.S. Environmental Protection Agency (1994). Maximum contaminant levels. Enforceable limit.

NA - not analyzed