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GROUND-WATER STUDY FOR THE  
CITY OF HURON

by

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1979

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UR 24

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This report contains the results of a special ground-water investigation conducted by the South Dakota Geological Survey for the city of Huron, South Dakota. The investigation included the drilling of 64 test holes (fig. 1 and app. A), the installation of 5 observation wells (fig. 1), collecting and analyzing 26 water samples (fig. 2, app. B, and table 1), and making a well inventory (app. C).

The project was financed by the South Dakota Geological Survey and the city of Huron.

The investigation began by obtaining water quality information for Beadle County from existing observation well records. Using these records, two areas were chosen for further investigation--just southeast of Lake Byron and the Pearl Creek Colony vicinity.

After some drilling and sampling of newly installed and already existing observation wells, it was noted that the Pearl Creek Colony vicinity had better quality water than the area southeast of Lake Byron (compare W1, W6, W7, W8, W13, W14, and W15 with W2, W3, W4, and W5; table 1). The Pearl Creek Colony vicinity also contains a shallower and, in places, coarser grained aquifer which means that recharge to the aquifer could possibly be more rapid and the yield to a well would probably be greater than in the area southeast of Lake Byron.

More detailed drilling in the Pearl Creek Colony vicinity showed that a narrow bedrock valley exists roughly 1 mile west of Pearl Creek Colony and has a north-south trend. From the results of the drilling, a bedrock contour map was made which illustrates this trend (fig. 3). The aquifer lies within the bedrock valley and consequently exhibits the same trend. The results of drilling show the aquifer to be greater than 60 feet thick in places. Figure 4 shows the areal distribution and thickness of the aquifer and as is shown on the map, the aquifer, although narrow, has a thickness of greater than 40 feet for about 6 miles of its length. The aquifer also appears to be completely saturated to the south of Highway 14.

There are some data points used in figures 3 and 4 that are not shown as test holes in figure 1. These additional data points are holes that were drilled in and near the recommended area between 1961 and 1976. The logs of these holes are presented in appendix D.

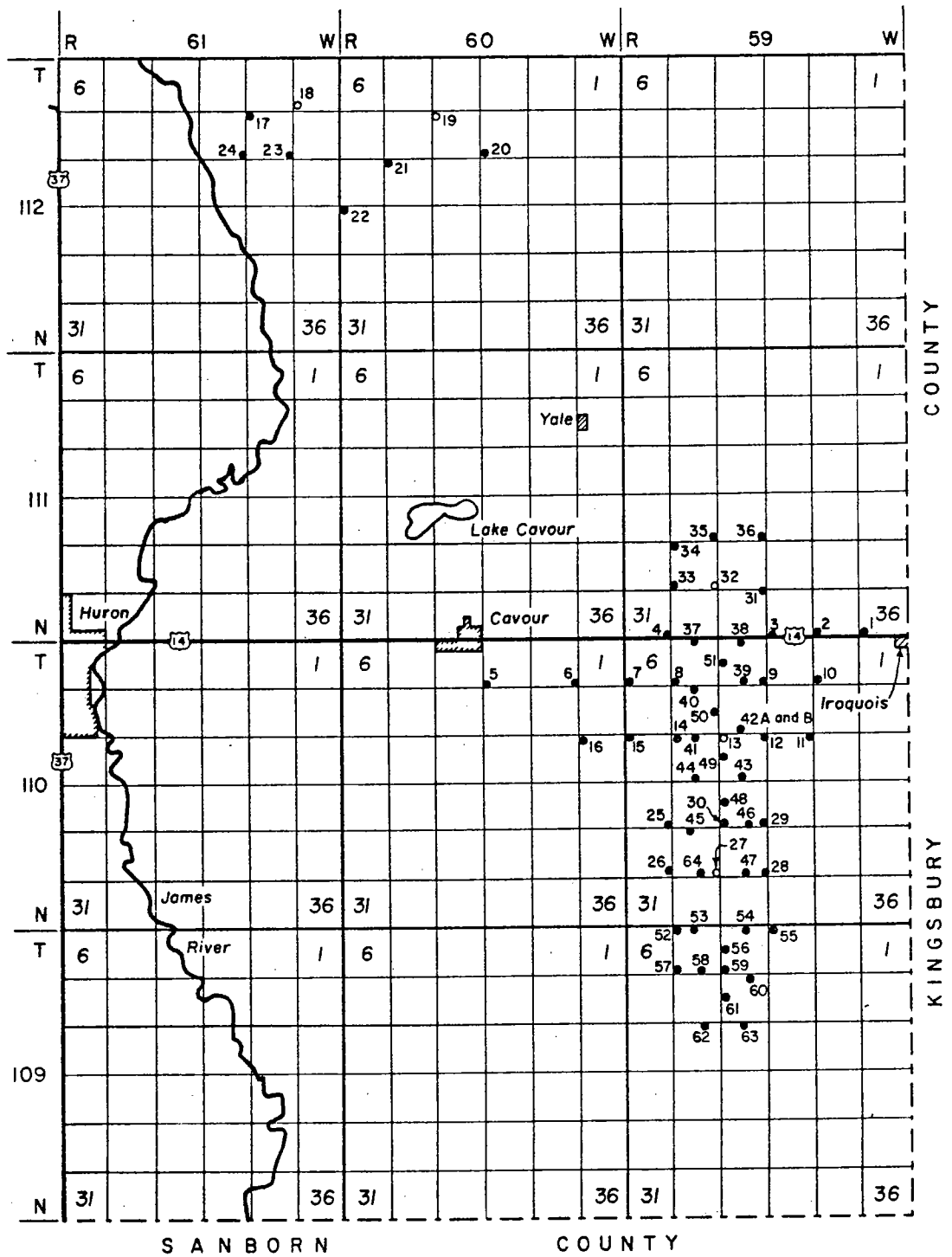
There are seven water samples which came from three observation wells which are in the aquifer in the Pearl Creek Colony vicinity. These samples are W1, W6, W7, W8, W13, W14, and W15 (table 1). Averaging the results from the analyses of these water samples and comparing them with the analysis of the raw water for the city of Huron shows that the raw city water is of poorer quality (table 2). Table 2 shows that except for calcium and manganese the average concentrations of all constituents analyzed for in the water from the observation wells are less than the raw city water. The values

for the raw city water were obtained from a 1974 analysis of James River water which is presented in a March 1976 publication prepared by the South Dakota Department of Environmental Protection entitled "South Dakota Public Water Supply Chemical Data."

A more accurate representation of the water quality in the Pearl Creek Colony vicinity would be from irrigation wells in the area. Four water samples were taken from irrigation wells (W19, W20, W21, and W22; table 1) and the results of the analyses of these samples were averaged. These averages are listed along with the values for raw city water in table 3. A comparison of these two water sources shows that water from the irrigation wells has lower concentrations of all constituents analyzed for except iron and manganese.

If the city of Huron should decide to develop a water supply from this area, it is recommended that a test site be chosen and a pump test be conducted.

Before a permanent well is drilled, the city officials should contact the Division of Water Rights, Department of Natural Resource Development, to obtain water rights and a permit to drill the well. Also, the South Dakota Department of Environmental Protection should be contacted to determine the biological and chemical suitability of the water.



21 ● Test hole, number indicates test hole number.  
 93 ○ Test hole with observation well, number indicates test hole number.

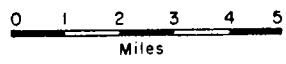
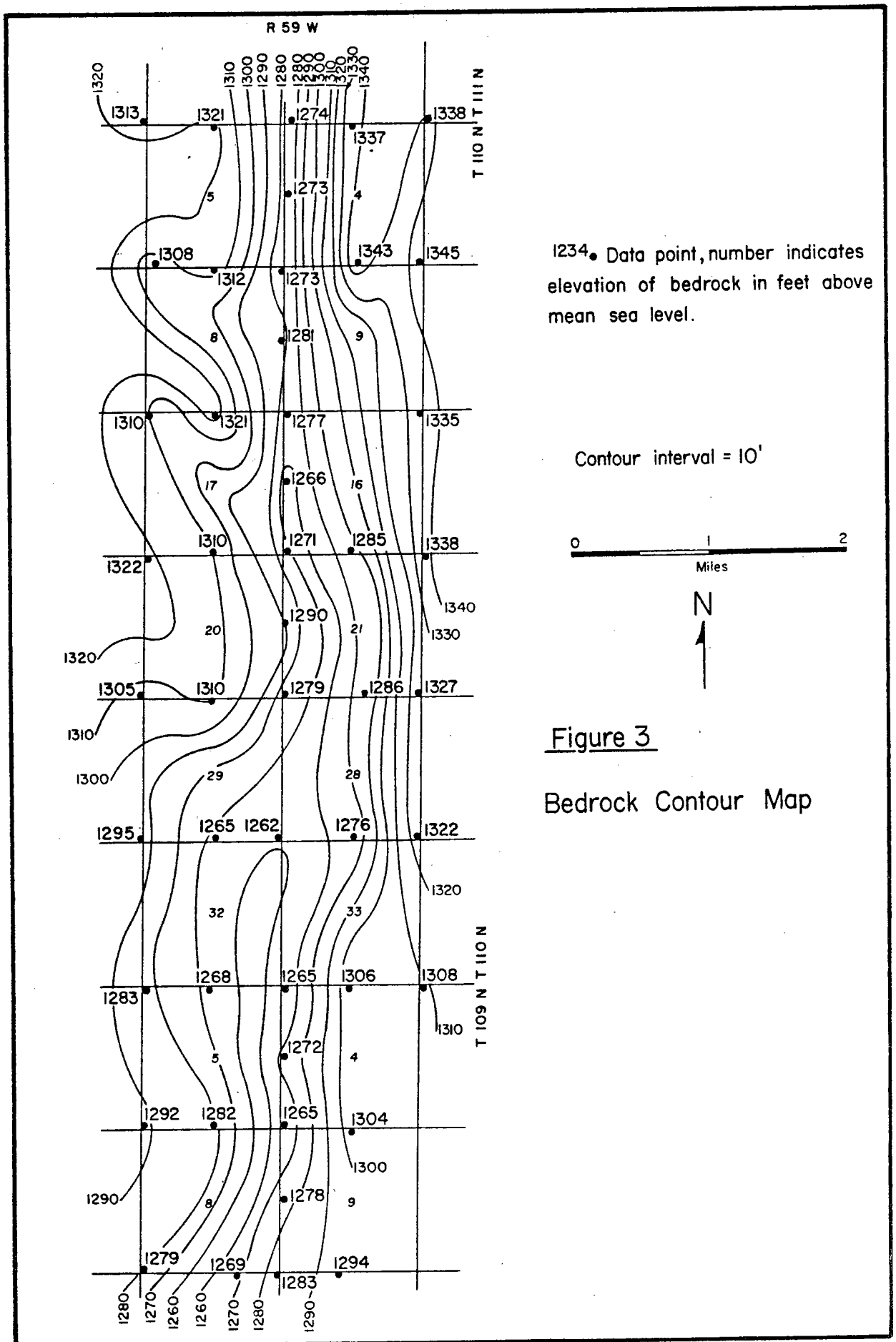


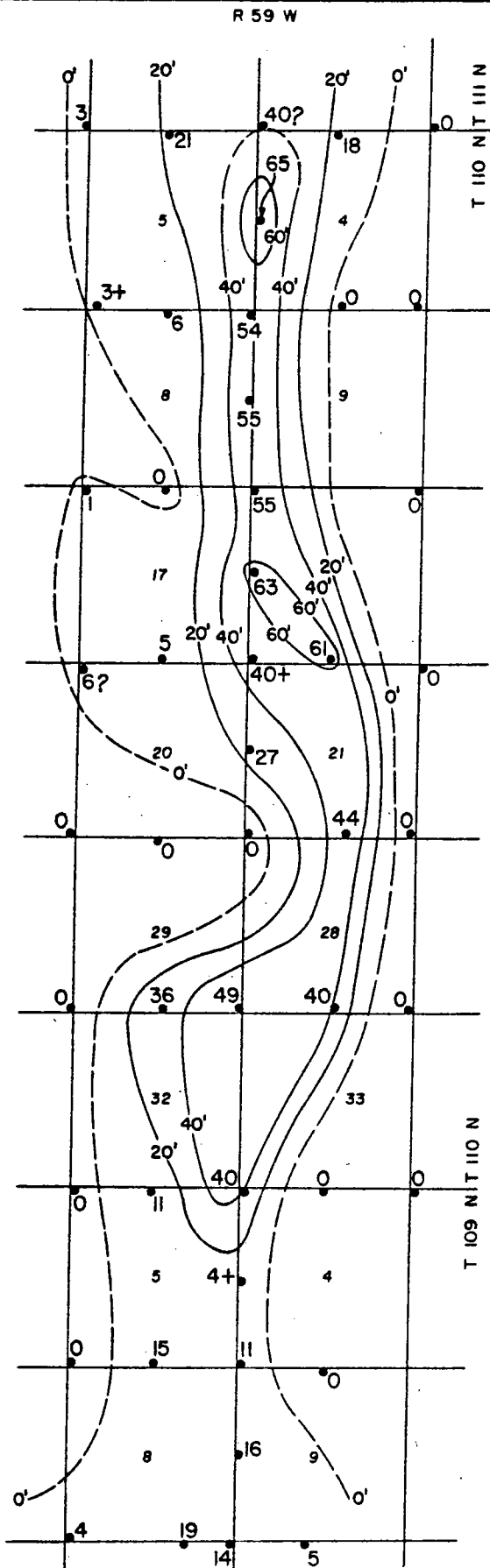
Figure 1

Test hole and observation well locations









— Aquifer boundary (approximate)

23. Data point, number indicates thickness in feet of continuous layers of sand and gravel; a + indicates additional layers of sand and gravel separated by clay layers; a ? indicates an unclear drillers log.

Contour interval = 20'

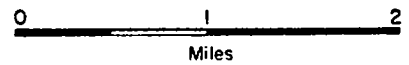


Figure 4

Map showing thickness of sand and gravel.

TABLE 1. Water analyses

Sample	Source	Parts Per Million											ppb <sup>1</sup>
		Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate Nitrogen	Hardness CaCO <sub>3</sub>	Conductivity	Total Solids	Selenium
A	---	---	---	---	250 <sup>2</sup>	250 <sup>2</sup>	0.3 <sup>2</sup>	0.05 <sup>2</sup>	10 <sup>3</sup>	---	---	500 <sup>2</sup>	10 <sup>3</sup>
W 1	OW 13	200	100	37	25	420	0.5	2.1	0.5*	650	---	1310	---
W 2	OW 18	120	340	25	75	500	2.2	1.5	2	402	1950	1700	---
W 3	OW 19	95	210	30	20	240	1.95	0.57	2	360	1320	1220	---
W 4	OW 18	100	325	23	75	770	2.4	1.5	0.5*	344	1900	1520	1.2
W 5	OW 19	75	190	25	10	190	1.8	0.5	0.5*	290	1250	1050	0.7
W 6	OW BD76R	65	68	12	10*	70	0.1	0.75	0.5*	211	620	530	1.8
W 7	OW 13	185	70	39	10	340	0.2	2.3	0.5*	621	1120	1130	0.2
W 8	OW 27	75	132	13	10	120	0.35	0.95	0.5*	240	810	850	0.2
W 9	OW B68C	160	14	37	10	100	0.7	4.1	0.5*	551	780	880	1.9
W10	OW B68B	210	40	55	20	400	0.5	2.05	0.5*	749	1180	1250	0.7
W11	OW 32	570	540	95	35	2200	4.4	6.75	0.5*	1810	3400	4300	7.9
W12	OW 32	510	500	100	37	1948	6.2	10+	0.5*	1681	3800	3244	6.5
W13	OW BD76R	45	71	11	1	45	0.05*	0.6	0.5*	157	650	332	0.4
W14	OW 13	140	55	35	3	412	0.21	2.3	0.5*	492	1175	812	0.0
W15	OW 27	53	113	12	3	108	0.8	2.1	0.5*	181	810	484	0.0
W16	P	6	700	3	118	1380	0.1	0.05*	0.5*	27	2750	2056	0.0
W17	P	6	700	2	119	1260	0.27	0.05*	0.5*	23	3000	2084	0.0
W18	P	6	700	3	120	1260	0.4	0.05*	0.5*	27	2750	2072	0.2
W19	P	80	65	21	5	150	2.1	0.9	0.5*	286	760	444	1.1
W20	P	75	83	23	7	210	5	1.2	0.5*	281	850	524	0.0
W21	P	70	95	22	12	200	1	1.1	0.5*	265	840	512	0.9
W22	P	96	89	27	15	310	0.6	1.3	0.5*	350	1010	680	0.3
W23	P	60	130	18	6	230	0.06	0.9	0.9	223	960	600	0.2
W24	P	60	93	15	7	120	2.7	1	0.5*	211	690	436	0.0
W25	P	4	700	2	112	1388	0.2	0.05*	0.8	18	3000	2000	---
W26	P	37	540	8	525	10	1	0.05*	0.5*	125	2750	1488	0.4

\* Less than

<sup>1</sup>ppb = parts per billion

Sample A:

<sup>2</sup>Proposed National Secondary Drinking Water Regulations, March 31, 1977 (recommended limits)<sup>3</sup>National Interim Primary Drinking Water Regulations, December 24, 1975 (enforceable limits)

Source: OW 48, observation well number 48; P, private well

TABLE 2. Comparison of water quality between water from observation wells in the recommended area and raw city water.

Source	Parts Per Million										
	Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate	Nitrogen	Hardness CaCO <sub>3</sub>	Total Solids
Observation Well Water1	109	87	22.7	8.9	216	0.32	1.59	0.5*	0.5*	365	778
Raw City Water	84	133	50	67	287	0.5*	0.7	1*	1*	419	912

\* Less Than

lvalues for observation well water were obtained by averaging the values listed in table 1 for water samples W1, W6, W7, W8, W13, W14, and W15.

TABLE 3. Comparison of water quality between water from irrigation wells in the recommended area and raw city water.

Source	Parts Per Million										
	Calcium	Sodium	Magnesium	Chloride	Sulfate	Iron	Manganese	Nitrate Nitrogen	Hardness CaCO <sub>3</sub>	Total Solids	
Irrigation Well Water <sup>1</sup>	80.3	83	23.3	9.8	218	2.18	1.13	0.5*	296	540	
Raw City Water	84	133	50	67	287	0.5	0.7	1*	419	912	

\* Less Than

<sup>1</sup>The values for irrigation well water were obtained by averaging the values listed in table 1 for water samples W19, W20, W21, and W22.

APPENDIX A

Test Hole Logs

(T) = Topographic map

Test Hole BD-1-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 36, T. 111 N., R. 59 W.

Date Drilled: September 27, 1977

Elevation: 1391 feet (T)

0- 2	Topsoil, black, silty
2- 16	Clay, yellow, silty, pebbly (till)
16- 19	Clay, brown, silty, pebbly (till)
19- 27	Gravel, yellow, medium to coarse
27- 32	Clay, gray, shaley, pebbly (till)
32- 34	Gravel, medium to coarse
34- 36	Clay, gray, gravelly (till)
36- 37	Gravel, medium to coarse
37- 50	Shale, dark-gray

\* \* \* \*

Test Hole BD-2-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 35, T. 111 N., R. 59 W.

Date Drilled: September 27, 1977

Elevation: 1369 feet (T)

0- 1	Topsoil, dark-brown, silty
1- 18	Clay, olive-brown, silty, pebbly (till)
18- 25	Clay, gray, silty, pebbly (till)
25- 40	Shale, dark-gray to black

\* \* \* \*

Test Hole BD-3-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 34, T. 111 N., R. 59 W.

Date Drilled: September 27, 1977

Elevation: 1363 feet (T)

0- 1	Topsoil, dark-gray, silty
1- 18	Clay, yellow, silty, pebbly (till)
18- 25	Clay, gray, silty, pebbly (till)
25- 40	Shale, dark-gray to black

\* \* \* \*

Test Hole BD-4-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 31, T. 111 N., R. 59 W.

Date Drilled: September 27, 1977

Elevation: 1339 feet (T)

0- 1	Topsoil, gray, sandy
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Test Hole BD-4-77 -- continued.

1- 3	Gravel, fine to medium
3- 12	Clay, yellow, silty, pebbly (till)
12- 26	Clay, yellow, with interbedded gravel, medium to coarse (till)
26- 29	Shale, dark-gray, sandy
29- 40	Shale, dark-gray to black

\* \* \* \*

Test Hole BD-5-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 3, T. 110 N., R. 60 W.

Date Drilled: September 27, 1977

Elevation: 1300 feet (T)

0- 1	Topsoil, gray, silty
1- 19	Clay, yellow, silty, pebbly (till)
19- 31	Clay, gray, silty, pebbly (till)
31- 32	Gravel, fine
32- 63	Clay, dark-gray, shaley, pebbly (till)
63- 64	Gravel, medium
64- 87	Clay, gray, silty, pebbly (till)
87- 88	Sand, coarse, and gravel, fine
88-100	Clay, gray, shaley, pebbly (till)
100-105	Gravel, fine to medium, shaley
105-137	Clay, gray, silty, pebbly, shaley (till)
137-140	Sand, fine
140-166	Clay, gray, silty, gravelly (till)
166-167	Gravel, medium to coarse
167-176	Clay, gray, silty, gravelly (till)
176-194	Gravel, fine to medium
194-210	Chalk, light-gray to white, calcareous

\* \* \* \*

Test Hole BD-6-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 2, T. 110 N., R. 60 W.

Date Drilled: September 28, 1977

Elevation: 1332 feet (T)

0- 1	Topsoil, gray, silty
1- 14	Clay, yellow, silty, pebbly (till)
14- 15	Gravel, medium
15- 28	Sand, coarse, and gravel, fine
28- 61	Clay, gray, silty, pebbly (till)
61- 63	Sand, coarse, and gravel, fine, shaley (till)
63- 69	Shale, dark-gray to black, brittle
69- 80	Shale, dark-gray to black, bentonitic

\* \* \* \*

Test Hole BD-33-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 29, T. 111 N., R. 59 W.

Date Drilled: October 14, 1977

Elevation: 1345 feet (T)

0- 2	Topsoil, dark-gray, silty
2- 12	Clay, yellow, silty, pebbly (till)
12- 22	Gravel, medium to coarse
22- 29	Clay, gray, silty, sandy (till)
29- 43	Sand, fine to medium
43- 45	Shale, gray, brittle
45- 60	Shale, dark-gray to black

\* \* \* \*

Test Hole BD-34-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 29, T. 111 N., R. 59 W.

Date Drilled: October 14, 1977

Elevation: 1352 feet (T)

0- 2	Topsoil, dark-gray, silty
2- 19	Clay, yellow, silty, pebbly (till)
19- 28	Clay, gray, silty, sandy (till)
28- 31	Shale, dark-gray, brittle
31- 40	Shale, dark-gray, bentonitic

\* \* \* \*

Test Hole BD-35-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 20, T. 111 N., R. 59 W.

Date Drilled: October 14, 1977

Elevation: 1354 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 16	Clay, yellow, silty, pebbly (till)
16- 18	Shale, gray, brittle
18- 30	Shale, dark-gray, bentonitic

\* \* \* \*

Test Hole BD-36-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 21, T. 111 N., R. 59 W.

Date Drilled: October 14, 1977

Elevation: 1371 feet (T)

0- 2	Topsoil, dark-gray, silty
2- 14	Clay, brown, silty, pebbly (till)
14- 18	Shale, yellow-gray
18- 30	Shale, dark-gray to black

\* \* \* \*

Test Hole BD-37-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 5, T. 110 N., R. 59 W.

Date Drilled: May 15, 1978

Elevation: 1349 feet (T)

0- 3	Topsoil, black, sandy
3- 24	Sand, black to brown, medium, silty, some gravel, fine
24- 28	Silt, gray, very soft
28- 40	Shale, black, hard

\* \* \* \*

Test Hole BD-38-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 4, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1359 feet (T)

0- 4	Topsoil, black, sandy
4- 22	Sand, coarse to fine, well rounded
22- 30	Shale, black, hard

\* \* \* \*

Test Hole BD-39-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 4, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1360 feet (T)

0- 2	Topsoil, black, clayey
2- 14	Clay, brown, sandy, pebbly (till)
14- 17	Clay, gray, sandy, pebbly (till)
17- 30	Shale, black, hard

\* \* \* \*

Test Hole BD-40-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 8, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1348 feet (T)

0- 2	Topsoil, black, clayey
2- 17	Clay, brown, sandy, pebbly (till)
17- 30	Clay, gray, sandy, very gravelly (till)
30- 36	Sand, coarse, and gravel, fine to medium
36- 50	Shale, black, hard

\* \* \* \*



Test Hole BD-41-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 17, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1346 feet (T)

0- 2	Topsoil, black, sandy
2- 18	Clay, brown, sandy, pebbly, with gravel stringers approximately $\frac{1}{2}$ foot to 1 foot thick (till)
18- 25	Clay, gray, sandy, pebbly (till)
25- 30	Shale, gray, hard

\* \* \* \*

Test Hole BD-42A-78

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 9, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1360 feet (T)

0- 2	Topsoil, black
2- 21	Clay, brown, very very sandy and gravelly (till)
21- 25	Clay, gray, not so sandy (till)
25-	Rock - abandoned hole

\* \* \* \*

Test Hole BD-42B-78

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 9, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1360 feet (T)

0- 2	Topsoil, black
2- 21	Clay, brown, very sandy and gravelly (till)
21- 27	Clay, black to gray, sandy, gravelly (till)
27-	Rock - abandoned hole

\* \* \* \*

Test Hole BD-43-78

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 16, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1358 feet (T)

0- 2	Topsoil, black, sandy
2- 12	Clay, brown, very sandy (till)
12- 21	Sand, fine, grading to gravel, fine, very silty
21- 35	Gravel, fine to medium, very silty
35- 73	Gravel, fine to coarse
73- 90	Shale, black, hard

\* \* \* \*

Test Hole BD-44-78

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 17, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1343 feet (T)

0- 1	Topsoil, black, sandy
1- 21	Clay, brown, sandy, pebbly (till)
21- 26	Gravel, fine to medium, and sand, coarse
26- 33	Clay, gray, sandy, pebbly (till)
33- 40	Shale, gray, hard

\* \* \* \*

Test Hole BD-45-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 29, T. 110 N., R. 59 W.

Date Drilled: May 16, 1978

Elevation: 1343 feet (T)

0- 1	Topsoil, black, clayey
1- 21	Clay, brown, very sandy (till)
21- 33	Clay, gray, very sandy and gravelly (till)
33- 40	Shale, black, hard

\* \* \* \*

Test Hole BD-46-78

Location: SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 21, T. 110 N., R. 59 W.

Date Drilled: May 17, 1978

Elevation: 1361 feet (T)

0- 1	Topsoil, black, sandy
1- 18	Clay, brown, sandy, pebbly (till)
18- 22	Gravel, medium to fine
22- 31	Clay, gray, sandy, pebbly (till)
31- 75	Sand, coarse, grading to gravel, fine, with some silt and shale pebbles
75- 80	Shale, black, hard

\* \* \* \*

Test Hole BD-47-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 28, T. 110 N., R. 59 W.

Date Drilled: May 17, 1978

Elevation: 1351 feet (T)

0- 2	Topsoil, black, clayey
2- 25	Clay, brown, sandy, pebbly (till)
25- 35	Clay, gray, sandy, pebbly (till)
35- 50	Sand, fine to medium
50- 75	Gravel, fine to medium, with some sand
75- 80	Shale, black, hard

\* \* \* \*

Test Hole BD-48-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 21, T. 110 N., R. 59 W.

Date Drilled: May 17, 1978

Elevation: 1351 feet (T)

0- 2	Topsoil, black, clayey
2- 26	Clay, brown, sandy, pebbly (till)
26- 33	Sand, fine to medium, silty
33- 41	Clay, gray, sandy, pebbly (till)
41- 61	Gravel, fine, and sand, medium to coarse, with shale pebbles
61- 70	Shale, black, hard

\* \* \* \*

Test Hole BD-49-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 16, T. 110 N., R. 59 W.

Date Drilled: May 17, 1978

Elevation: 1350 feet (T)

0- 2	Topsoil, black, clayey
2- 21	Clay, brown, sandy, pebbly (till)
21- 48	Sand, medium to coarse, with some gravel, fine
48- 84	Gravel, fine to coarse, some sand
84- 90	Shale, black, hard

\* \* \* \*

Test Hole BD-50-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 8, T. 110 N., R. 59 W.

Date Drilled: May 18, 1978

Elevation: 1351 feet (T)

0- 2	Topsoil, black, clayey
2- 15	Clay, brown, sandy, pebbly (till)
15- 48	Sand, fine to coarse, some gravel, fine
48- 70	Gravel, medium to coarse, some sand
70- 80	Shale, black, hard

\* \* \* \*

Test Hole BD-51-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 4, T. 110 N., R. 59 W.

Date Drilled: May 18, 1978

Elevation: 1351 feet (T)

0- 2	Topsoil, black, clayey
2- 13	Clay, brown, sandy, pebbly (till)
13- 45	Sand, brown, fine to medium
45- 78	Gravel, fine to coarse, some sand
78- 90	Shale, black, hard

\* \* \* \*

Test Hole BD-52-78

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 5, T. 109 N., R. 59 W.

Date Drilled: June 27, 1978

Elevation: 1341 feet (T)

0- 1	Topsoil, black
1- 24	Clay, brown, sandy, pebbly (till)
24- 58	Clay, gray, sandy, silty, pebbly (till)
58- 65	Clay, gray to black, compact (weathered shale?)

\* \* \* \*

Test Hole BD-53-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 5, T. 109 N., R. 59 W.

Date Drilled: June 27, 1978

Elevation: 1337 feet (T)

0- 2	Topsoil, black
2- 14	Clay, brown, sandy, silty, pebbly (till)
14- 58	Clay, gray, sandy, silty, pebbly, very silty from 47 feet to 58 feet (till)
58- 69	Gravel, fine to medium, and sand, medium to coarse, some weathered shale pebbles
69- 80	Shale, black, hard

\* \* \* \*

Test Hole BD-54-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 4, T. 109 N., R. 59 W.

Date Drilled: June 27, 1978

Elevation: 1335 feet (T)

0- 2	Topsoil, black
2- 15	Clay, brown, sandy, silty, pebbly (till)
15- 29	Clay, gray, sandy, silty, pebbly (till)
29- 50	Shale, black, hard

\* \* \* \*

Test Hole BD-55-78

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 3, T. 109 N., R. 59 W.

Date Drilled: June 27, 1978

Elevation: 1346 feet (T)

0- 2	Topsoil, black
2- 19	Clay, brown, sandy, silty, pebbly (till)
19- 38	Clay, gray, sandy, silty, pebbly (till)
38- 50	Shale, black, hard

\* \* \* \*

Test Hole BD-56-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 4, T. 109 N., R. 59 W.

Date Drilled: June 28, 1978

Elevation: 1339 feet (T)

0- 1	Topsoil, black
1- 13	Clay, brown, sandy, silty, pebbly (till)
13- 25	Clay, gray, sandy, silty, pebbly (till)
25- 31	Gravel, fine to medium
31- 38	Clay, gray, sandy, silty, pebbly (till)
38- 52	Gravel, fine to medium, and sand, coarse
52- 63	Clay, gray, gravelly with some shale pebbles
63- 67	Gravel, fine to medium
67- 80	Shale, black, hard

\* \* \* \*

Test Hole BD-57-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 5, T. 109 N., R. 59 W.

Date Drilled: June 28, 1978

Elevation: 1331 feet (T)

0- 2	Topsoil, black, sandy
2- 14	Clay, brown, sandy, silty, pebbly (till)
14- 39	Clay, gray, sandy, silty, pebbly (till)
39- 50	Shale, black, hard

\* \* \* \*

Test Hole BD-58-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 5, T. 109 N., R. 59 W.

Date Drilled: June 28, 1978

Elevation: 1331 feet (T)

0- 2	Topsoil, black
2- 14	Clay, brown, sandy, silty, pebbly (till)
14- 34	Clay, gray, sandy, silty, pebbly (till)
34- 49	Gravel, fine to coarse, and sand, coarse
49- 60	Shale, black, hard

\* \* \* \*

Test Hole BD-59-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 4, T. 109 N., R. 59 W.

Date Drilled: June 28, 1978

Elevation: 1330 feet (T)

0- 2	Topsoil, black
2- 19	Clay, brown, sandy, silty, pebbly (till)
19- 25	Clay, gray, sandy, silty, pebbly (till)
25- 30	Gravel, fine to medium, and sand, medium to coarse

Test Hole BD-59-78 -- continued.

30- 54 Clay, gray, sandy, silty, pebbly (till)  
54- 65 Gravel, medium to coarse, very clayey  
65- 70 Shale, black, hard

\* \* \* \*

Test Hole BD-60-78

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 9, T. 109 N., R. 59 W.

Date Drilled: June 28, 1978

Elevation: 1343 feet (T)

0- 2 Topsoil, black  
2- 20 Clay, brown, sandy, silty, pebbly (till)  
20- 39 Clay, gray, sandy, silty, very hard (till)  
39- 50 Shale, black, hard, bentonitic

\* \* \* \*

Test Hole BD-61-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 9, T. 109 N., R. 59 W.

Date Drilled: June 28, 1978

Elevation: 1327 feet (T)

0- 1 Topsoil, black  
1- 11 Sand, brown, fine to medium  
11- 13 Clay, brown, sandy (till)  
13- 33 Clay, gray, sandy, silty, pebbly (till)  
33- 49 Gravel, fine to medium, and sand, fine to coarse  
49- 60 Shale, black, hard

\* \* \* \*

Test Hole BD-62-78

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 17, T. 109 N., R. 59 W.

Date Drilled: June 29, 1978

Elevation: 1318 feet (T)

0- 1 Topsoil, black  
1- 9 Clay, brown, sandy, silty, pebbly (till)  
9- 30 Clay, gray, sandy, pebbly (till)  
30- 49 Sand, fine to coarse, some fine gravel, some  
shale pebbles in the lower part  
49- 60 Shale, black, hard

\* \* \* \*

Test Hole BD-63-78

Location: NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 16, T. 109 N., R. 59 W.

Date Drilled: June 29, 1978

Elevation: 1341 feet (T)

0- 1 Topsoil

Test Hole BD-63-78 -- continued.

1- 25	Clay, brown, sandy, pebbly, hard (till)
25- 42	Clay, gray, sandy, pebbly, hard (till)
42- 47	Sand, brown, fine to medium
47- 60	Shale, black, hard, bentonitic

\* \* \* \*

Test Hole BD-64-78

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 29, T. 110 N., R. 59 W.

Date Drilled: June 29, 1978

Elevation: 1324 feet (T)

0- 1	Topsoil, black to brown, sandy
1- 9	Clay, brown, sandy (till?)
9- 45	Gravel, fine to coarse, and sand, coarse
45- 59	Clay, gray, sandy, silty, pebbly (till)
59- 80	Shale, black, hard, bentonitic

\* \* \* \*

APPENDIX B. Water samples: well controller and well location

Well controller: SDGS - South Dakota Geological Survey

Water Rights - Division of Water Rights, Department of Natural Resource Development

Numbers and letters inside parenthesis indicate observation well denotation.

Water Sample Number	Well Controller	Location
W 1	SDGS (13)	NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.
W 2	SDGS (18)	SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 1, T. 112 N., R. 61 W.
W 3	SDGS (19)	NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 112 N., R. 60 W.
W 4	SDGS (18)	SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 1, T. 112 N., R. 61 W.
W 5	SDGS (19)	NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 9, T. 112 N., R. 60 W.
W 6	Water Rights (BD-76-R)	NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 8, T. 110 N., R. 59 W.
W 7	SDGS (13)	NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.
W 8	SDGS (27)	SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 110 N., R. 59 W.
W 9	Water Rights (B-68-C)	SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 110 N., R. 60 W.
W10	Water Rights (B-68-B)	SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 110 N., R. 60 W.
W11	SDGS (32)	SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 111 N., R. 59 W.
W12	SDGS (32)	SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 111 N., R. 59 W.
W13	Water Rights (BD-76-R)	NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 8, T. 110 N., R. 59 W.
W14	SDGS (13)	NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.
W15	SDGS (27)	SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 110 N., R. 59 W.
W16	----	NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.
W17	----	SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.
W18	----	NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 15, T. 110 N., R. 59 W.



Appendix B - continued.

Water Sample Number	Well Controller	Location
W19	----	NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 110 N., R. 59 W.
W20	Pearl Creek Colony	SW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 110 N., R. 59 W.
W21	----	SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 110 N., R. 59 W.
W22	----	NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.
W23	Henaber	NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 110 N., R. 59 W.
W24	Henaber	SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 110 N., R. 59 W.
W25	----	SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 9, T. 109 N., R. 59 W.
W26	Debro	NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 109 N., R. 59 W.

APPENDIX C. Well inventory

Well Controller	Location	Depth of Well (ft)	Depth to Water (ft)	Geologic Source	Use	Field Conductivity	Water Sample No.
Lynch	SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 111 N., R. 59 W.	32	20	G	S	4200	
Lynch	SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 111 N., R. 59 W.	960?	--	--	D	2800	
Pearl Creek Colony	SW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 110 N., R. 59 W.	80	--	S	--	--	W20
Kleinsasser	SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 5, T. 110 N., R. 59 W.	--	--	--	D	3000	
----	NE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 15, T. 110 N., R. 59 W.	--	--	--	--	3000	W18
----	NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.	800-900	--	--	D	2900	W16
----	SW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.	900	--	S	D	1900	W17
----	NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 110 N., R. 59 W.	72	--	G	I	--	W22
----	SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 110 N., R. 59 W.	80	--	S&G	I	--	W21
----	NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 110 N., R. 59 W.	90	--	--	I	--	W19
Henaber	SE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 110 N., R. 59 W.	70	--	G	--	--	W24
Henaber	NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 110 N., R. 59 W.	68	--	S&G	D	825	W23
----	SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, T. 110 N., R. 59 W.	800	--	--	D&S	3000	
Fritz	SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 9, T. 109 N., R. 59 W.	180	29	Ch(?)	D&S	3100	

Appendix C - continued.

Well Controller	Location	Depth of Well (ft)	Depth to Water (ft)	Geologic Source	Use	Field Conductivity	Water Sample No.
----	SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 9, T. 109 N., R. 59 W.	--	--	G	D&S	2900	W25
Fenner	SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 109 N., R. 59 W.	890	--	--	D&S	2950	
Fenner	SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 109 N., R. 59 W.	250	--	Ch(?)	S	4050	
Fritz	NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 109 N., R. 59 W.	160	40	--	S	--	
Zell	SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 20, T. 109 N., R. 59 W.	--	--	--	--	2900	
Debro	NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 20, T. 109 N., R. 59 W.	--	--	--	--	2800	W26
-----	NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 21, T. 109 N., R. 59 W.	--	--	--	--	2900	
Nutil	SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 28, T. 109 N., R. 59 W.	--	--	--	D&S	3650	
-----	SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 109 N., R. 59 W.	--	--	--	--	2950	
-----	SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 109 N., R. 59 W.	--	--	--	S	--	
Debro	NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 30, T. 109 N., R. 59 W.	1600	--	--	D&S	2925	

APPENDIX D

Logs of holes drilled in and near the  
recommended area between 1961 and 1976

(A) = Altimeter  
(I) = Instrument  
(T) = Topographic map  
(R) = Rotary  
(Au) = Auger  
SDGS = South Dakota Geological Survey  
USGS = United States Geological Survey

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 33, T. 111 N., R. 59 W.  
Date Drilled: August 31, 1962  
Elevation: 1349.3 feet (I)  
Drilled by: USGS (Au)

0- 7	Clay, dark-brown, sandy, contains a few scattered particles of gravel
7- 10	Clay, yellow-brown, very sandy (fine), no gravel
10- 13	Clay, brown, sandy, contains scattered particles of gravel
13- 17	Gravel, very coarse at 13 feet and 16 feet, and fine to coarse sand; probably clayey
17- 20	Clay, brown, sandy, gravelly
20- 22	Sand, coarse to medium, little fine; saturated. Little medium and fine gravel; clean
22- 26	Clay, very sandy and gravelly
26- 29	Gravel, coarse to fine and sand; saturated, clean
29- 35	Clay, sandy, contains scattered particles of gravel
35- 54	Sand, very coarse to medium, little fine. Some gravel at 36 feet; clean. Little coarse below 37 feet. Gravelly streaks below 40 feet. Coarse gravel from 43 feet to 47 feet, contains fine gravel and very coarse sand. May be clayey at bottom. Loose.
54- 65	No sample, drills like finer sand or soft clay
65- 75	Sand, contains streaks of coarse to fine gravel
75- 92	Shale, black, noncalcareous. Much light gray bentonite in streaks (Pierre Shale)

\* \* \* \*

Location: SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 8, T. 110 N., R. 59 W.  
Date Drilled: September 28, 1976  
Elevation: 1344 feet (T)  
Drilled by: SDGS (R)

0- 1	Topsoil, black, silty
1- 15	Clay, yellow, silty, pebbly
15- 17	Clay, dark-gray, silty

SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 8, T. 110 N., R. 59 W. -- continued.

17- 42 Sand, medium to coarse, grading to fine gravel  
42- 54 Sand, very coarse, grading to fine gravel  
54- 61 Gravel, fine to medium, with some coarse  
coal pebbles  
61- 71 Gravel, fine to medium  
71- 90 Shale, bedrock, 71 feet to 73 feet reworked

\* \* \* \*

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 20, T. 110 N., R. 59 W.

Date Drilled: June 5, 1963

Elevation: 1341 feet (A)

Drilled by: USGS (Au)

0- 1 Soil, dark-brown, clayey, sandy, silty  
1- 13 Clay, medium-brown, silty, sandy  
13- 19 Sand, light medium-brown, fine, grading to silt,  
clayey  
19- 27 Shale, blue-black; might be partly oxidized at  
the contact (Pierre Shale)

\* \* \* \*

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 16, T. 110 N., R. 59 W.

Date Drilled: August 30, 1962

Elevation: 1351 feet (A)

Drilled by: USGS (Au)

0- 28 Clay, dark-brown, sandy, contains scattered particles  
of fine gravel; gradually changes to gray-brown  
with depth  
28- 35 Sand, gray, medium to fine  
35- 40 Clay, blue-gray to gray, sandy; some soft, very  
sandy layers; may contain some streaks of sand  
40- 51 Sand, fine to coarse, mostly medium, very lignitic;  
may contain streaks of clay  
51- 68 Gravel, fine to coarse, contains streaks of sand;  
sandier from 59 to 62 feet; much coarse gravel  
from 62 to 67 feet; lignitic in streaks  
68- 72 Sand and gravel, contains streaks of hard clay;  
coarse gravel at 72 feet  
72- 80 Gravel, mostly coarse, contains streaks of sand; may  
be very gravelly clay at bottom  
80-107 Shale, black, noncalcareous, contains gray bentonite  
streaks (Pierre Shale)

\* \* \* \*

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 22, T. 110 N., R. 59 W.  
Date Drilled: June 5, 1963  
Elevation: 1338 feet (A)  
Drilled by: USGS (Au)

0- 7 Shale, brown at surface, brownish-black at 7 feet (Pierre Shale)

\* \* \* \*

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 4, T. 109 N., R. 59 W.  
Date Drilled: July 19, 1961  
Elevation: 1335 feet (T)  
Drilled by: Private (R)

0 - 13 Clay, yellow  
13 - 13.5 Clay, blue  
13.5- 15 Sand, coarse, and fine gravel  
15 - 20 Clay, blue, contains coarse sand  
20 - 30 Clay, blue, some coarse sand; mostly sand below 25 feet  
30 - 60 Sand, medium to coarse; lignite fragments abundant  
60 - 70 Sand, medium, some lignite; layer of sand size shale particles at 60 feet  
70 - 94 Pierre Shale

\* \* \* \*

Location: SW $\frac{1}{4}$  sec. 8, T. 109 N., R. 59 W.  
Date Drilled: May 13, 1965  
Elevation: 1320 feet (T)  
Drilled by: Private (R)

0- 12 Topsoil, sandy  
12- 17 Clay, dark  
17- 19 Sand  
19- 37 Clay, dark  
37- 41 Gravel, sand  
41- 45 Clay, shale  
45-111 Clay, gummy or shale with bentonite and square chunks of brittle clay or shale  
111-125 Chalk, white and black  
125-130 Chalk, black  
130-140 Chalk, brown, white and black

\* \* \* \*

Test Hole BD-7-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 6, T. 110 N., R. 59 W.

Date Drilled: September 28, 1977

Elevation: 1324 feet (T)

0-	1	Topsoil, gray, silty
1-	7	Clay, olive-brown, silty, pebbly (till)
7-	11	Gravel, fine
11-	12	Clay, gray, silty, pebbly (till)
12-	19	Gravel, medium
19-	25	Shale, dark-gray, brittle
25-	40	Shale, dark-gray to black, bentonitic

\* \* \* \*

Test Hole BD-8-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 5, T. 110 N., R. 59 W.

Date Drilled: September 28, 1977

Elevation: 1336 feet (T)

0-	1	Topsoil, dark-brown, silty
1-	10	Clay, yellow, silty, pebbly (till)
10-	13	Sand, coarse
13-	14	Clay, yellow, silty, pebbly (till)
14-	17	Gravel, fine to medium
17-	28	Clay, yellow, silty, pebbly (till)
28-	32	Shale, yellow-black, brittle
32-	37	Shale, black, brittle
37-	50	Shale, black, bentonitic

\* \* \* \*

Test Hole BD-9-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 4, T. 110 N., R. 59 W.

Date Drilled: September 28, 1977

Elevation: 1362 feet (T)

0-	1	Topsoil
1-	17	Clay, yellow-brown, sandy, silty, pebbly (till)
17-	24	Clay, brown (oxidized shale)
24-	40	Shale, black

\* \* \* \*

Test Hole BD-10-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 2, T. 110 N., R. 59 W.

Date Drilled: September 29, 1977

Elevation: 1372 feet (T)

0-	1	Topsoil, black, silty
1-	2	Gravel, medium to coarse
2-	16	Clay, yellow, silty, pebbly (till)

Test Hole BD-10-77 -- continued.

16- 25 Shale, yellow-black, brittle  
25- 40 Shale, black, bentonitic

\* \* \* \*

Test Hole BD-11-77

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 15, T. 110 N., R. 59 W.

Date Drilled: September 29, 1977

Elevation: 1373 feet (T)

0- 2 Topsoil, gray, silty  
2- 8 Clay, yellow, silty, pebbly (till)  
8- 18 Gravel, medium to coarse  
18- 26 Clay, brown, silty, pebbly (till)  
26- 28 Clay, brown-gray, silty, pebbly (till)  
28- 34 Shale, black, brittle  
34- 50 Shale, black, bentonitic

\* \* \* \*

Test Hole BD-12-77

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 16, T. 110 N., R. 59 W.

Date Drilled: September 29, 1977

Elevation: 1363 feet (T)

0- 2 Topsoil, brown-gray, silty  
2- 15 Clay, yellow, silty, pebbly (till)  
15- 28 Clay, yellow-gray, silty, pebbly (till)  
28- 34 Shale, black, brittle  
34- 50 Shale, black, bentonitic

\* \* \* \*

Test Hole BD-13-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 16, T. 110 N., R. 59 W.

Date Drilled: September 30, 1977

Elevation: 1353 feet (T)

0- 1 Topsoil, dark-brown, silty  
1- 19 Clay, yellow, silty, pebbly (till)  
19- 21 Clay, brown  
21- 57 Sand, medium to coarse  
57- 76 Gravel, fine to medium, grades to very coarse at  
bottom  
76- 81 Shale, dark-gray to black, brittle  
81- 90 Shale, black, bentonitic

Observation well: bottom of well at 62 feet;  
sandpoint from 57 feet to 62 feet.

\* \* \* \*



Test Hole BD-14-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 17, T. 110 N., R. 59 W.

Date Drilled: September 30, 1977

Elevation: 1331 feet (T)

0- 1	Topsoil, dark-brown, silty
1- 2	Sand, coarse
2- 15	Clay, yellow, silty, pebbly (till)
15- 20	Clay, gray, silty, pebbly (till)
20- 21	Gravel, fine to medium
21- 27	Shale, black, brittle
27- 40	Shale, black, bentonitic

\* \* \* \*

Test Hole BD-15-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 18, T. 110 N., R. 59 W.

Date Drilled: September 30, 1977

Elevation: 1325 feet (T)

0- 2	Topsoil, gray, silty
2- 26	Clay, yellow, silty, pebbly (till)
26- 29	Clay, yellow-gray, shaley, pebbly (till)
29- 31	Shale, dark-gray, brittle
31- 40	Shale, black, bentonitic

\* \* \* \*

Test Hole BD-16-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 13, T. 110 N., R. 60 W.

Date Drilled: October 3, 1977

Elevation: 1318 feet (T)

0- 2	Topsoil, dark-gray, silty
2- 15	Clay, yellow, silty, pebbly (till)
15- 32	Clay, gray, silty, pebbly, sandy (till)
32- 36	Sand, coarse, and gravel, fine
36- 38	Clay, gray, silty, pebbly (till)
38- 39	Gravel, fine to medium
39- 54	Clay, gray, silty, pebbly, interbedded gravel, medium (till)
54- 57	Shale, black, brittle
57- 70	Shale, black, bentonitic

\* \* \* \*

Test Hole BD-17-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 11, T. 112 N., R. 61 W.

Date Drilled: October 4, 1977

Elevation: 1284 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 19	Clay, yellow, silty, pebbly (till)

Test Hole BD-17-77 -- continued.

19- 53	Clay, gray, silty, pebbly (till)
53- 54	Sand, coarse, and gravel, fine
54- 73	Clay, gray, silty, pebbly (till)
73- 77	Gravel, fine
77-109	Clay, gray, silty, very gravelly (till)
109-112	Shale, dark-gray
112-130	Shale, dark-gray, bentonitic

\* \* \* \*

Test Hole BD-18-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 1, T. 112 N., R. 61 W.

Date Drilled: October 4, 1977

Elevation: 1295 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 19	Clay, yellow, silty, pebbly (till)
19- 44	Clay, gray, silty, pebbly (till)
44- 46	Gravel, fine and sand, coarse
46- 55	Clay, gray, silty, pebbly (till)
55- 57	Gravel, medium to coarse
57- 94	Clay, gray, silty, pebbly (till)
94- 97	Gravel, fine to medium, shaley
97-116	Clay, gray, silty, shaley (till)
116-139	Gravel, fine, with fine to medium sand
139-146	Clay, gray, silty, shaley (till)
146-160	Chalk, light-gray, calcareous

Observation well: bottom of well at 122 feet;  
sandpoint from 117 feet to 122 feet.

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Test Hole BD-19-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 9, T. 112 N., R. 60 W.

Date Drilled: October 4, 1977

Elevation: 1320 feet (T)

0- 1	Topsoil, brown, silty
1- 6	Clay, yellow, silty, pebbly (till)
6- 13	Gravel, fine and sand, coarse
13- 45	Clay, gray, silty, sandy, brittle (till)
45- 51	Clay, gray, silty, pebbly (till)
51- 65	Sand, coarse
65- 66	Clay, gray, silty, sandy (till)
66- 91	Gravel, fine and sand, coarse
91-110	Shale, dark-gray to black

Observation well: bottom of well at 82 feet;  
sandpoint from 77 feet to 82 feet.

\* \* \* \*

Test Hole BD-20-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 10, T. 112 N., R. 60 W.

Date Drilled: October 4, 1977

Elevation: 1337 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 28	Clay, brown, silty, pebbly (till)
28- 52	Clay, gray, silty, pebbly (till)
52- 81	Sand, coarse
81- 82	Clay, gray, silty, pebbly (till)
82- 91	Sand, coarse
91- 96	Shale, dark-gray, brittle
96-110	Shale, black, bentonitic

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Test Hole BD-21-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 17, T. 112 N., R. 60 W.

Date Drilled: October 4, 1977

Elevation: 1314 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 17	Clay, yellow, silty, pebbly (till)
17- 30	Clay, gray, silty, pebbly, brittle (till)
30- 33	Gravel, medium to coarse
33- 52	Clay, gray, silty, pebbly (till)
52- 54	Gravel, fine, and sand, coarse
54- 84	Clay, gray, silty, pebbly (till)
84- 86	Gravel, fine to medium, shaley
86- 94	Clay, gray, silty, pebbly (till)
94-134	Gravel, medium
134-141	Shale, gray, brittle
141-150	Shale, gray, bentonitic

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Test Hole BD-22-77

Location: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 19, T. 112 N., R. 60 W.

Date Drilled: October 5, 1977

Elevation: 1302 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 18	Clay, yellow, silty, pebbly (till)
18- 38	Clay, gray, silty, pebbly (till)
38- 39	Gravel, fine
39- 58	Clay, gray, sandy, pebbly, brittle (till)
58- 69	Clay, gray, silty, pebbly (till)
69-100	Clay, gray, silty, shaley, pebbly (till)
100-146	Clay, gray, very sandy (till)
146-149	Gravel, fine
149-151	Shale, black, brittle
151-168	Clay, gray, sandy (till)
168-190	Gravel, fine, clayey

Test Hole BD-22-77 -- continued.

190-194 Clay, yellow, silty, pebbly (till)  
194-208 Gravel, fine to medium  
208-220 Chalk, white

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Test Hole BD-23-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 11, T. 112 N., R. 61 W.

Date Drilled: October 5, 1977

Elevation: 1301 feet (T)

0- 2 Topsoil, dark-brown, silty  
2- 18 Clay, yellow, silty, pebbly (till)  
18-102 Clay, gray, silty, pebbly (till)  
102-112 Clay, gray, shaley, pebbly (till)  
112-116 Gravel, fine, with shale pebbles  
116-139 Clay, gray, sandy, shaley in spots (till)  
139-150 Shale, dark-gray to black

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Test Hole BD-24-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 10, T. 112 N., R. 61 W.

Date Drilled: October 5, 1977

Elevation: 1278 feet (T)

0- 2 Topsoil, dark-brown, silty  
2- 19 Clay, yellow, silty, pebbly (till)  
19- 55 Clay, gray, silty, pebbly (till)  
55- 58 Gravel, fine to medium  
58- 86 Clay, gray, silty, gravelly (till)  
86-100 Shale, gray, bentonitic

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Test Hole BD-25-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 19, T. 110 N., R. 59 W.

Date Drilled: October 12, 1977

Elevation: 1330 feet (T)

0- 1 Topsoil, gray, silty  
1- 18 Clay, yellow-brown, silty, pebbly (till)  
18- 25 Clay, gray, silty, pebbly (till)  
25- 26 Shale, dark-gray, brittle  
26- 40 Shale, dark-gray

\* \* \* \*

Test Hole BD-26-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 30, T. 110 N., R. 59 W.

Date Drilled: October 12, 1977

Elevation: 1324 feet (T)

0- 1	Topsoil
1- 3	Gravel, fine to medium
3- 17	Clay, yellow-brown, silty, pebbly (till)
17- 29	Clay, gray, silty, pebbly (till)
29- 31	Shale, gray, brittle
31- 40	Shale, gray

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Test Hole BD-27-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 29, T. 110 N., R. 59 W.

Date Drilled: October 12, 1977

Elevation: 1343 feet (T)

0- 2	Topsoil, gray, silty
2- 23	Clay, yellow, silty, pebbly (till)
23- 32	Clay, gray, silty, pebbly (till)
32- 44	Sand, fine to medium
44- 60	Sand, coarse, and gravel, fine
60- 81	Gravel, medium to coarse
81- 82	Shale, gray, brittle
82-100	Shale, dark-gray, bentonitic

Observation well: bottom of well at 79 feet;  
sandpoint from 74 feet to 79 feet.

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Test Hole BD-28-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 28, T. 110 N., R. 59 W.

Date Drilled: October 13, 1977

Elevation: 1349 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 19	Clay, yellow, silty, pebbly (till)
19- 22	Clay, yellow-gray, silty, pebbly (till)
22- 27	Clay, gray, silty, pebbly (till)
27- 29	Shale, gray, brittle
29- 40	Shale, dark-gray, bentonitic

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Test Hole BD-29-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 21, T. 110 N., R. 59 W.

Date Drilled: October 13, 1977

Elevation: 1360 feet (T)

0- 2	Topsoil, dark-brown, silty
2- 18	Clay, yellow, silty, pebbly (till)

Test Hole BD-29-77 -- continued.

18- 24 Clay, yellow-gray, silty, pebbly (till)  
24- 33 Clay, gray, silty, pebbly (till)  
33- 35 Shale, gray, brittle  
35- 43 Shale, dark-gray, bentonitic

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Test Hole BD-30-77

Location: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 21, T. 110 N., R. 59 W.  
Date Drilled: October 13, 1977  
Elevation: 1346 feet (T)

0- 2 Topsoil, dark-brown, silty  
2- 19 Clay, yellow, silty, pebbly (till)  
19- 23 Clay, yellow to gray, silty, pebbly (till)  
23- 38 Clay, gray, silty, pebbly (till)  
38- 45 Clay, gray, silty, gravelly (till)  
45- 61 Clay, gray, very silty, sandy (till)  
61- 67 Clay, gray, silty, pebbly (till)  
67- 71 Shale, gray, brittle  
71- 80 Shale, dark-gray, bentonitic

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Test Hole BD-31-77

Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 33, T. 111 N., R. 59 W.  
Date Drilled: October 13, 1977  
Elevation: 1363 feet (T)

0- 2 Topsoil, dark-brown, silty  
2- 14 Clay, yellow, silty, pebbly (till)  
14- 16 Shale, gray to yellow  
16- 30 Shale, dark-gray

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Test Hole BD-32-77

Location: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 29, T. 111 N., R. 59 W.  
Date Drilled: October 13, 1977  
Elevation: 1358 feet (T)

0- 2 Topsoil, dark-brown, silty  
2- 5 Clay, brown, silty, pebbly (till)  
5- 15 Sand, coarse, and gravel, fine  
15- 33 Gravel, medium to coarse  
33- 40 Clay, gray, very gravelly (till)  
40- 43 Gravel, very coarse  
43- 45 Shale, gray, brittle  
45- 60 Shale, dark-gray

Observation well: bottom of well at 33 feet;  
sandpoint from 28 feet to 33 feet.

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Location: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 17, T. 109 N., R. 59 W.

Date Drilled: September 6, 1963

Elevation: 1329 feet (T)

Drilled by: USGS (Au)

- 0- 32 Clay, medium to yellow-brown 0 to 10 feet, medium brown 10 to 17 feet, gray-brown 17 to 20 feet, and medium gray below 20 feet, silty, slightly sandy
- 32- 46 Sand, medium brown, very coarse to medium, some finer sand and silt, contains gravelly zones and thin streaks of sandy clay
- 46- 52 Shale, dark-gray, bentonitic (Pierre Shale)

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