

STATE OF SOUTH DAKOTA
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DEPARTMENT OF NATURAL RESOURCE DEVELOPMENT
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GEOLOGICAL SURVEY
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Open-File Report No. 6-UR

GROUND-WATER STUDY FOR THE
CITY OF ISABEL

by

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Vermillion, South Dakota
1976

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GROUND-WATER STUDY FOR THE CITY OF ISABEL

This report contains the results of a special ground-water investigation conducted by the South Dakota Geological Survey around the City of Isabel, Dewey County, South Dakota. The field work was conducted from June 14 to June 25 and August 6 to August 18, 1976. The investigation involved: (1) a review of the geology of the area as mapped by the South Dakota Geological Survey (R. E. Curtiss, 1952), (2) the drilling of 19 rotary test holes, (3) a well inventory, (4) the collection and analysis of 22 water samples, (5) construction of 9 observation wells, and (6) surveying elevation of test hole sites.

The study was financed by the South Dakota Geological Survey, the West River Conservancy Sub-District, and the City of Isabel. The cooperation of the residents of the Isabel area and the South Dakota Department of Highways was greatly appreciated.

At present the City of Isabel obtains its water from Isabel Lake, two miles north of the City. The study was conducted to assist in the location of a future ground-water source to augment the present surface water supply.

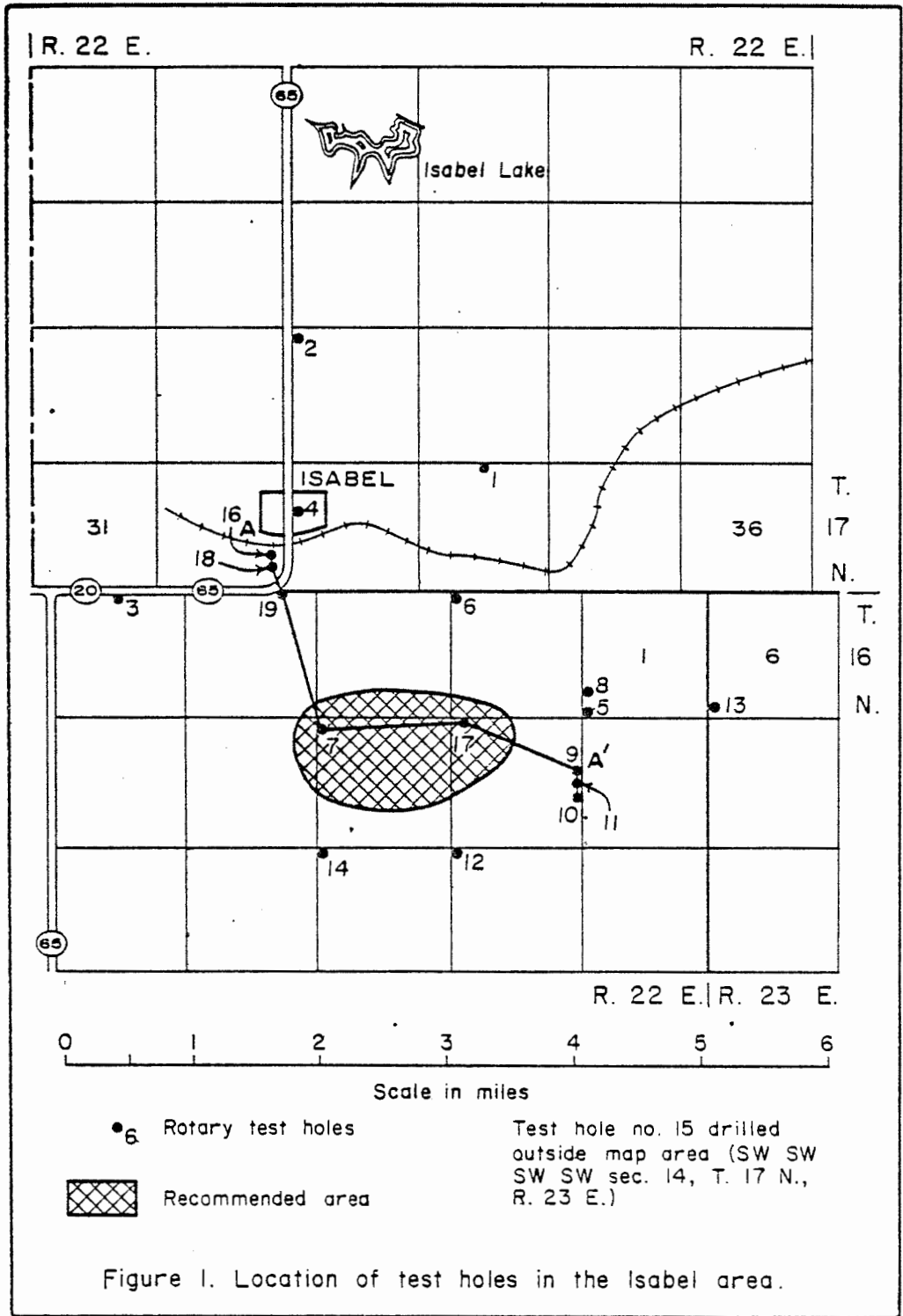
The area of study is underlain by a Cretaceous sequence of shallow marine sediments consisting of the Hell Creek, Fox Hills, and Pierre Formations. Wells in the area yield water primarily from the Fox Hills Formation, with a few shallow wells obtaining water from the Hell Creek Formation. The rotary test holes, drilled for the study, indicate two stratigraphic sequences of very fine to fine grained sand associated with the Colgate and Trail City members of the Fox Hills Formation. The location of the test holes are plotted on figure 1 and figure 2 shows a cross section for A-A' (see fig. 1). The drilling logs are included in appendix A.

The sand layers are important as aquifers in the area and occur at depths varying from 30 to 120 feet for the upper layer, and 150 to 230 feet for the lower. This variation in depth is a function of the variance in surface elevation and the relation to the geologic structure of the area.

The upper sand, however, is limited as a water-producing sequence due to the lack of lateral extent. This is indicated in the varying depth and thickness encountered in test holes 9, 10, and 11; and test holes 16 and 18 (refer to the cross section, fig. 2 and app. A). At the locality of test holes 9, 10, and 11, the upper sand sequence was encountered at depths of 36, 46, and 35 feet respectively. Similarly, the thickness of the layer varied from 10 to 27 feet within a horizontal distance of 125 feet.

In contrast, the lower sand sequence was more consistent in thickness and depth, varying only in grain size and clay content. The most promising area for yielding water is in the vicinity of test holes 7 and 17. In test holes 7 and 17 the lower sand was encountered at a depth of 220 feet and 168 feet respectively (these test holes are approximately one mile apart). The variation in depth is a result of surface elevation differences between the two sites, and minor structural trends. However, in this area, the sand is very fine to fine grained and contains some clay and silt-sized particles. As a result, the aquifer is limited in water yielding capacity.

The quality of the present Isabel water supply is good, as evidenced by the relatively low value for total dissolved solids. However, the levels of iron and particularly manganese are rather high (see table 1). Most wells in the area, in contrast, are much higher in total dissolved solids and the major chemical constituents are sodium, bicarbonate (alkalinity), and sulfate. The primary variations in water quality are a function of differences in the levels of these three constituents. The results of the water samples analyzed by the Survey for the study are listed in table 1 and the locations of the sampling sites are plotted in figure 3.



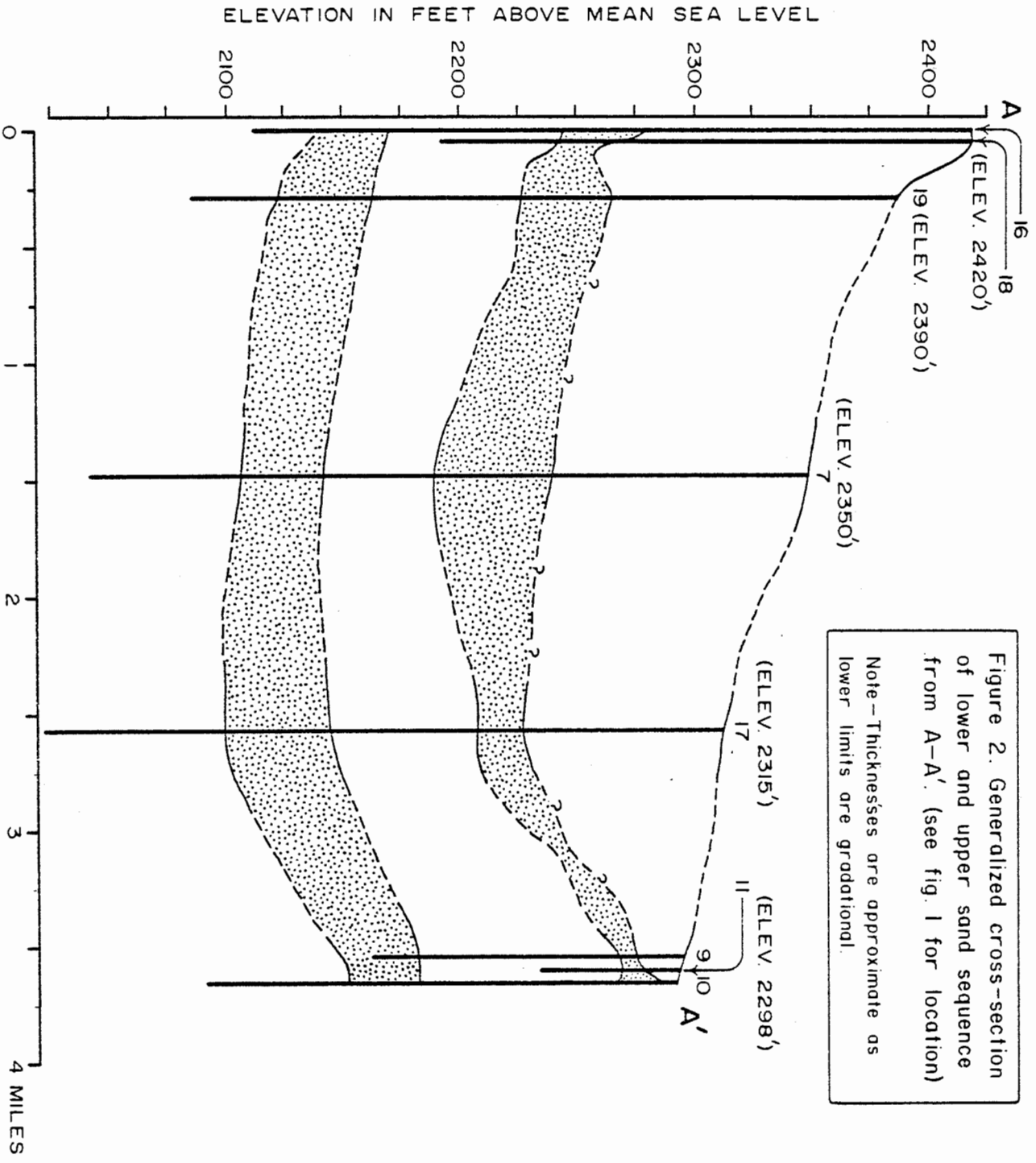
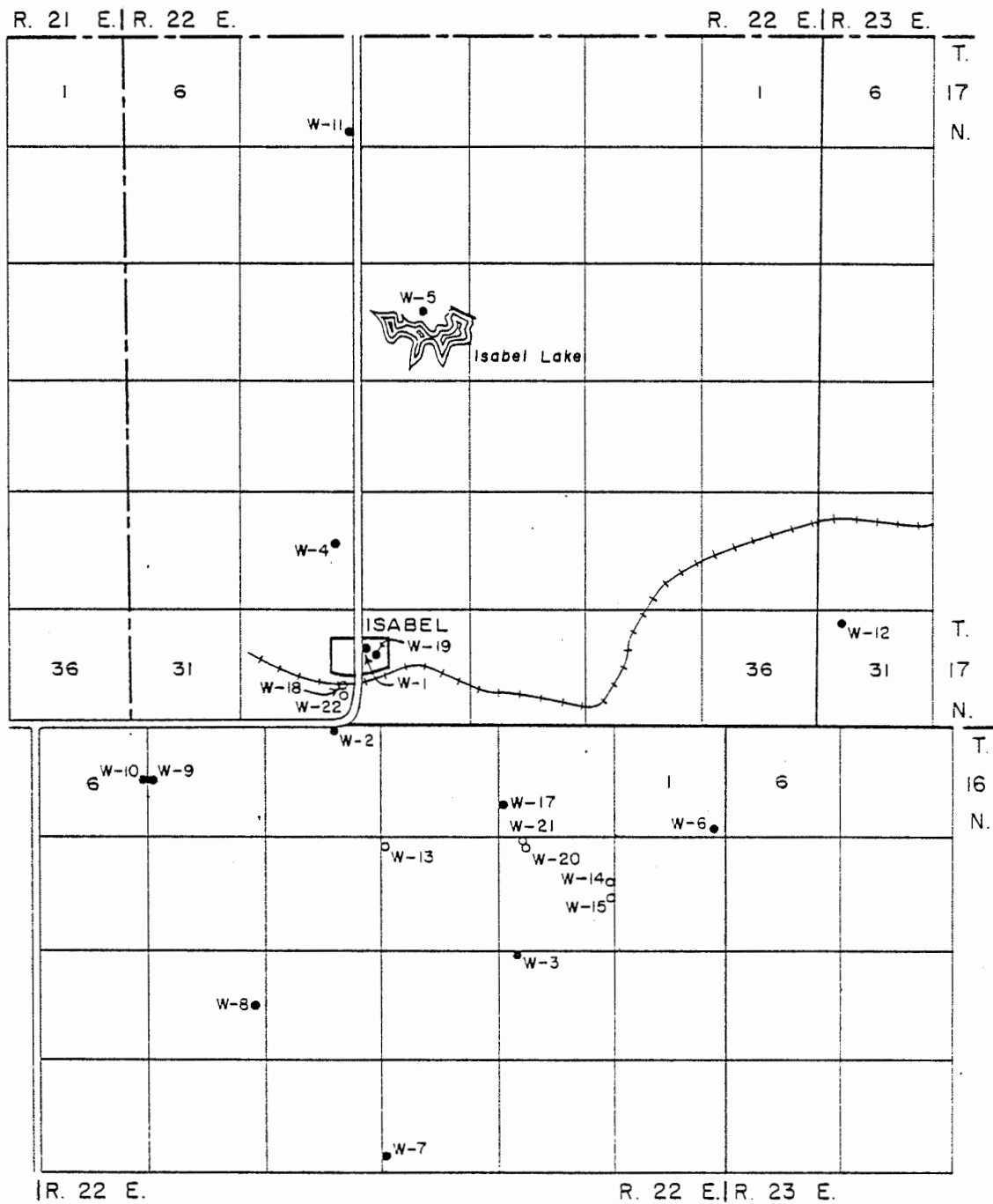


Figure 2. Generalized cross-section of lower and upper sand sequence from A-A'. (see fig. 1 for location)



W-10 ● Water sample from private well.

W-14 ○ Water sample from S. Dak. Geol. Survey observation well.

Water sample W-16 taken from outside map area (SW SW SW SW sec. 14, T. 17 N., R. 23 E.)

Figure 3. Location of water samples in the Isabel area.

Table 1 --- Chemical Analyses of Water Samples from the Isabel Area

Sample	Depth to Water	Calcium	Sodium	Magnesium	Chlorides	Sulfate	Iron	Manganese	Nitrate Nitrogen	Total Hardness	Alkalinity	Total Dissolved Solids	Geologic Source
A					250	500 ¹	0.3	0.05	45			1000 ¹	
Present Supply		26	92	7	14	47	0.3	1.2	0.0	97	276	376	
W-1	200?	2	420	0.0	22	200	2.2	<0.05	<0.5	5	655	1452	KfHL
W-2	220	5	320	3	44	160	0.05	<0.05	2.0	25	480	1124	KfHL
W-3	210	2	420	10	7	160	0.05	<0.05	<0.5	45	790	1570	KfHL
W-4	270	8	420	10	17	150	0.4	0.05	<0.5	60	800	1590	KfHL
W-5		40	370	36	13	420	0.6	10.0+	<0.5	250	600	1943	KLC
W-6	200	8	380	2	33	240	0.10	<0.05	<0.5	28	612	1415	KfL
W-7	73	4	350	1	38	145	<0.05	<0.05	<0.5	14	603	1290	KfL
W-8	193	4	475	1	7	(1440)	0.10	<0.05	<0.5	14	761	1860	KfHL
W-9	200	27	670	4	18	(1050)	1.7	<0.05	<0.5	34	641	2555	KfHL
W-10	200	18	350	5	80	(1324)	0.10	<0.05	<0.5	65	711	1472	KfHL
W-11	220	35	850	4	14	1150	0.60	0.05	<0.5	104	339	3035	
W-12	180	22	560	2	19	(1030)	<0.05	0.05	<0.5	63	651	2433	KfHL
W-13	162	6	330	45	42	130	20+	0.20	<0.5	200	512	1203	KfHL
W-14	125	10	510	2	9	385	20+	0.20	<0.5	33	667	1757	KfHL
W-15	55	30	660	5	8	950	3.6	0.15	<0.5	95	733	2558	KfHU
W-16		5	280	15	9	175	<0.10	<0.05	<0.5	74	301	339	Kfh
W-17	200	3	460	3	3	375	3.0	<0.05	<0.5	20	607	1599	KfHL
W-18	270	4	410	2	340	50	0.2	0.05	3.3		360	1252	KfHL
W-19	260	4	440	2	20	350	2.0	<0.05	<0.5		540	1482	
W-20	130	3.5	330	2	110	50	0.2	<0.05	<0.5		510	1123	KfHL
W-21	180	3	340	2	120	50	0.2	<0.05	<0.5		515	1149	KfHL
W-22	185	2.5	280	1	20	250	1.4	0.05	1.0		345	930	KfHU

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

All samples were analyzed by the South Dakota Geological Survey.

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

²To convert to grains, divide parts per million by 17.

³South Dakota Public Water Supply Data, Department of Health, January, 1971.

Geologic Source: KfHU, Upper Fox Hills Formation
KfHL, Lower Fox Hills Formation
Kfh, Fox Hill Formation
KhC, Hell Creek Formation

The values in parentheses are approximate.

LOCATIONS OF WATER SAMPLES

(for map location see Fig. 3)

- W- 1. SW NE SE NW sec. 33, T17N, R22E, E. Reichart
- W- 2. NE SW NW NE sec. 4, T16N, R22E, S. Tidball
- W- 3. NE SE NW NW sec. 14, T16N, R22E, B. Schuh
- W- 4. NE SW SE NE sec. 29, T17N, R22E, F. Fuhrer
- W- 5. SW SW SW NE sec. 16, T17N, R22E
- W- 6. SE SE SE SE sec. 1, T16N, R22E, R. Brenner
- W- 7. NE SW SW SW sec. 22, T16N, R22E, H. Jones
- W- 8. SW NE NE SE sec. 17, T16N, R22E, K. Kahl
- W- 9. SW NW NW SW sec. 5, T16N, R22E, A. Reichart
- W-10. NE NW NE SE sec. 6, T16N, R22E, A Reichart
- W-11. NE SW SE SE sec. 5, T17N, R22E, G. Waddell
- W-12. SE NE NE NW sec. 31, T17N, R23E, G. Heck
- W-13. NW NW NW NW sec. 10, T16N, R22E
- W-14. NE NE NE SE sec. 11, T16N, R22E
- W-15. NE NE NE SE sec. 11, T16N, R22E
- W-16. SW SW SW SW sec. 14, T17N, R23E, G. Reinboldt
- W-17. SW SW NW NW sec. 2, T16N, R22E
- W-18. NE NE NW SE sec. 32, T17N, R22E
- W-19. NE NE NW SW sec. 33, T17N, R22E, S. Lutz
- W-20. NE NW NW NW sec. 11, T16N, R22E
- W-21. NE NW NW NW sec. 11, T16N, R22E
- W-22. NE NE NW SE sec. 32, T17N, R22E

Appendix A

Logs of test holes drilled in the Isabel area

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Section: 34 T. 17 N. XX R. 22 E. MMWell: _____ Test Hole: Is-1 Land Owner: _____County: Dewey Date: 6-16-76 Elevation: _____ (A, I, T)E-Log: yes Samples: _____ Drilling Company: SDGSSource of Data: Driller - Danzl

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	2	Topsoil	0-2
	10	Sand, fine to very fine, silty	2-12
	5	Clay, brown, slightly silty	12-17
	7	Clay, light gray, shaley	17-24
	9	Clay, medium to dark gray, shaley	24-33
	1	Coal	33-34
	8	Clay, light gray, shaley	34-42
	11	Clay, dark gray to black, shaley	42-53
	13	Clay, Alternating light to dark gray, shaley	53-66
	16	Clay, dark gray, shaley	66-82
	35	Sand, light gray, very fine soft	82-117
	8	Sand, light gray, very very fine, silty, gradates to clay	117-125
	59	Clay, light gray, silty	125-184
	22	Sand, blue-green, fine, glauconitic	184-206
	22	Sand, light gray, very fine, silty (silt content increases with depth)	206-228
	30	Clay, light gray, shaley, slightly silty	228-258
	15	Sand, Greenish gray, very fine, silty	258-273
	1	Sandstone, dark green, cemented	273-274
	26	Sand, green gray, very very fine, silty	274-300

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NW¹/₄NW¹/₄NW¹/₄NW¹/₄ Section: 28 T. 17 N. XX R. 22 E. XX
 Well: _____ Test Hole: Is - 2 Land Owner: _____
 County: Dewey Date: 6-17-76 Elevation: 2335 (X, XX T)
 E-Log: yes Samples: _____ Drilling Company: SDGS
 Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	1	Topsoil, black	0-1
	6	Clay, brown, shaley	1-7
	21	Clay, yellow-brown to dark brown, shaley	7-28
	3	Sand, gray, silt	28-31
	14	Clay, yellow-brown, shaley	31-45
	39	Clay, gray-brown, shaley	45-84
	7	Light gray, (cemented sand?)	84-91
	14	Clay, gray-brown, shaley	91-105
	1	Coal	105-106
	12	Clay, gray-brown, shaley	106-118
	3	Organic Material?, dark brown	118-121
	51	Clay, gray-brown, shaley (layer of light gray sand at 146 feet)	121-172
	14	Sand, light gray	172-186
	49	Clay, gray	186-235
	11	Sand, light gray	235-246
	112	Clay, gray, sandy	246-358
	102	Clay, light gray, slightly silty	358-460
	20	Shale, dark gray, hard	460-480
		T.D. - 480 feet	
		Water level- not measured	

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ Section: 5 T. 16 N. R. 22 E. Well: _____ Test Hole: Is-3 Land Owner: _____County: Dewey Date: 6-17-76 Elevation: 2391 (, ,)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	26	Sand, yellow-brown	0-26
	5	Clay, brown-gray, silty, shaley	26-31
	1	Clay, orange, silty, shaley	31-32
	16	Clay, brown-gray, silty shaley	32-48
	20	Sand, gray, cemented?	48-68
	8	Clay, dark brown, shaley	68-76
	20	Clay, gray-brown, silty, shaley	76-96
	48	Clay, dark brown, shaley(hard spot at 101 feet)	96-144
	1	Coal	144-145
	31	Clay, dark gray and brown, shaley	145-176
	6	Sand, gray, silt	176-182
	24	Clay, brown and gray, shaley	182-206
	27	Sand, gray, silty	206-233
	73	Clay, gray, shaley	233-306
	9	Sand, gray, silty	306-315
	1	Hard, (concretion?)	315-316
	4	Clay, gray, shaley	316-320
	21	Sand, silty, gray	320-341
	54	Clay, gray, silty, shaley	341-395
		T.D. - 395 feet	
		Water Level - 47 feet	

SOUTH DAKOTA GEOLOGICAL SURVEY

Location SW $\frac{1}{2}$ SW $\frac{1}{2}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Section: 33 T. 17 N. XX R. 22 E. XXWell: _____ Test Hole: Is-4 Land Owner: _____County: Dewey Date: 6-18-76 Elevation: 2398 (XX X T)E-Log: Yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	9	Silt, tan, clayey, sandy	0- 9
	19	Sand, brown, fine to medium, clayey	9- 28
	4	Clay, brown-gray, silty, sandy	28- 32
	3	Sand, light gray, fine to medium	32- 35
	3	Clay, greenish-gray	35- 38
	6	Clay, brown, silty	38- 44
	4	Sand, light gray, fine, clayey	44- 48
	14	Clay, brown to light gray, silty	48- 62
	1	Coal	62- 63
	11	Clay, brown to gray, silty	63- 74
	22	Sand, gray-green, very fine, clayey	74- 96
	25	Clay, dark brown, silty	96-121
	37	Sand, fine to medium, some small clayey layers	121-158
	47	Clay, light gray, silty (Gradates to finer and harder material with depth)	158-205
	35	Clay, light gray	205-240
	22	Sand, fine to medium (gets finer with depth)	240-262?
	48	Sand and clay	262?-310
	5	Clay, gray	310-315
	7	Sand, greenish-gray, silty	315-322
	1	Hard spot (concretion?)	322-323

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NW₄NW₄NW₄NW₄ Section: 2 T. 16 N. 88 R. 22 E. XXWell: _____ Test Hole: Is - 6 Land Owner: _____County: Dewey Date: 6-21-76 Elevation: 2350 (XX, XX T)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	4	Clay, yellow-brown, sandy	0-4
	24	Clay, yellow-brown, silty, shaley	4-28
	5	Clay, gray, sandy	28-33
	11	Clay, dark brown, silty, shaley	33-44
	8	Clay, gray, silty, shaley	44-52
	22	Clay, brown to gray, silty, shaley	52-74
	14	Sand, gray	74-88
	6	Clay, light brown	88-94
	24	Sand, gray	94-118
	13	Clay, gray, silty, shaley	118-131
	14	Sand, gray	131-145
	62	Clay, gray, silty, shaley	145-207
	16	Sand, gray	207-223
	71	Clay, gray, sandy, silty	223-294
	1	Hard spot (concretion?)	294-295
	25	Clay, gray, silty, shaley	295-320
		T.D. - 320 feet	
		Water level - 32.5	

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ Section: 10 T. 16 N. X R. 22 E. XXWell: _____ Test Hole: Is-7 Land Owner: _____County: Dewey Date: 6-21-76 Elevation: 2350 (XX, I, X)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	7	Clay, yellow-brown, very sandy	0- 7
	13	Clay, yellow-brown, silty, shaley	7- 20
	6	Clay, dark brown, silty, shaley	20- 26
	30	Clay, gray, silty, shaley	26- 56
	2	Clay, dark brown, organic material, silty	56- 58
	17	Clay, gray, silty, shaley	58- 75
	18	Clay, dark brown, silty, shaley	75- 93
	1	Coal (?)	93- 94
	3	Clay, dark brown, silty, shaley	94- 97
	11	Sand, gray	97-108
	4	Clay, gray, silty, shaley	108-112
	20	Sand, gray	112-132
	2	Clay, light gray	132-134
	7	Sand, gray	134-141
	10	Sandstone, cemented	141-151
	21	Clay, light gray, sandy	151-172
	48	Clay, gray, sandy	172-220
	25	Sand, fine, with clay	220-245
	1	Sandstone, cemented	245-246
	53	Clay, gray, shaley	246-299
	2	Sandstone, cemented	299-301

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ Section: 11 T. 16 N. XX R. 22 E. XXWell: _____ Test Hole: Is - 10 Land Owner: _____County: Dewey Date: 6-22-76 Elevation: 2297 (X, 1, X)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	3	Clay, gray, shaley	0-3
	13	Clay, yellow-brown, shaley	3-16
	18	Clay, gray-brown, silty, shaley	16-34
	11	Clay, blue-gray, shaley, slightly sandy	34-45
	1	Clay, brown, organic material	45-46
	9	Sand, gray, fine to medium, clay, silt	46-55
	61	Clay, gray, shaley, some bentonite	55-116
	12	Sand, green	116-128
	1	Cemented layer	128-129
	13	Sand, green	129-142
	1	Cemented layer	142-143
	2	Sand, green	143-145
	55	Clay, grayish-brown, silty, shaley	145-200
		T.D. - 200 feet	
		Water level - 32.7'	

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NW¹/₄NW²/₄NW³/₄NW⁴/₄ Section: 14 T. 16 N. XX R. 22 E. XXWell: _____ Test Hole: Is - 12 Land Owner: _____County: Dewey Date: 6-23-76 Elevation: 2345 (XX, XX T)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	1	Soil, light brown, sandy	0-1
	15	Clay, light brownish gray, silty, shaley	1-16
	1	Clay, dark brown, silty, shaley	16-17
	9	Clay, light brownish-gray, silty shaley	17-26
	5	Organic material, dark brown	26-31
	6	Clay, gray, silty, shaley	31-37
	1	Coal	37-38
	8	Clay, green, shaley	38-46
	7	Clay, light brown to gray, silty, shaley	46-53
	10	Clay, light to dark brown, silty	53-63
	1	Coal	63-64
	7	Clay, light brown, silty, shaley	64-71
	48	Sand, gray, fine	71-119
	5	Clay, gray, silty, shaley	119-124
	11	Sand, gray, fine	124-135
	61	Clay, gray, silty, shaley	135-196
	32	Sand, green	196-228
	47	Clay, gray, silty, shaley	228-275
		T.D. - 275 feet	
		Water level - 82.0'	

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ Section: 32 T. 17 N. XX R. 22 E. XX
 Well: _____ Test Hole: Is - 16 Land Owner: _____
 County: Dewey Date: 8-6-76 Elevation: 2420 (X, I, X)
 E-Log: yes Samples: _____ Drilling Company: SDGS
 Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	7	Clay, yellow brown, chunky (reworked?)	0-7
	11	Clay, yellow brown, shaley	7-18
	26	Clay, yellow gray, shaley	18-44
	9	Clay, dark brown, organic	44-53
	15	Gray, silty, sandy	53-68
	4	Clay, brown, shaley	68-72
	7	Clay, gray, shaley	72-79
	6	Clay, dark brown (organic?)	79-85
	36	Clay, gray, shaley	85-121
		Coal (6 inches?)	121
	6	Clay, dark brown (organic?)	121-127
	51	Sand, gray, silty	127-178
	77	Clay, light gray, shaley	178-255
	25	Sand, green	255-280
	25	Clay, gray, shale	280-305
		T.D. - 305 feet	
		Water level = 136'	

SOUTH DAKOTA GEOLOGICAL SURVEY

Location NE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ Section: 11 T. 16 N. XX R. 22 E. XXWell: _____ Test Hole: Is - 17 Land Owner: _____County: Dewey Date: 8-9-76 Elevation: 2315 (A, I, T)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	8	Clay, light gray, silty	0- 8
	8	Silt, orange-yellow, clayey	8- 16
	1	Coal, organic, soft	16- 17
	9	Clay, light green, hard	17- 26
	3	Sand, light gray, fine	26- 29
	15	Clay, gray, medium	29- 44
	4	Clay, dark brown, silty, very hard	44- 48
	9	Clay, gray to dark brown, hard	48- 57
	28	Clay, light gray	57- 85
	1	Sand, fine, white-gray, cemented	85- 86
	12	Clay, light gray (shale)	86- 98
	16	Sand, light gray, fine	98-114
	54	Clay, light gray (shale)	114-168
	32	Sand, green, fine	168-200
	26	Sand, fine, with clay	200-226
	24	Clay, light gray, silty (shale?)	226-250
	1	Cemented layer, sand, very hard	250-251
	6	Sand, light green, very very fine, silty	251-257
	8	Clay, light gray, silty	257-265
	8	Sand, silt, clay, green, cemented	266-268
	17	Clay, gray, shale	265-273
			273-290

T.D. - 290 feet

SOUTH DAKOTA GEOLOGICAL SURVEY

Location SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ Section: 32 T. 17 N. XX R. 22 E. XXWell: _____ Test Hole: Is - 19 Land Owner: _____County: Dewey Date: 8-16-76 Elevation: _____ (A, I, T)E-Log: yes Samples: _____ Drilling Company: SDGS

Source of Data: _____

Geologic Unit	Thickness	Lithologic Description	From - to Feet
	17	Silt, light tan	0- 17
	5	Sand, fine, gray-green	17- 22
	1	Chalk, orange	22- 23
	6	Clay, dark gray - dark brown	23- 29
	17	Clay, light gray, shale	29- 46
	1	Clay, very light gray	46- 47
	11	Clay, brown-gray (50% mix-interlayered)	
		2" coal at 56 feet	47- 58
	3	Clay, light gray, shale	58- 61
	3	Clay, green-gray	61- 64
	5	Sand, fine green	64- 69
	20	Clay, brown, shaley	69- 89
	5	Clay, light gray-green, shaley	89- 94
	10	Sand, gray to green, fine	94-104
	1	Hard clay, brown below 6" coal layer	104-105
	5	Clay, light gray, shale	105-110
	8	Sand, gray-green, fine	110-118
	3	Clay, brown, hard, shaley	118-121
	34	Sand, gray-green, fine, with clay	121-155
	6	Sand and clay	155-161
	3	Clay, sandy, light gray	161-164

