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**OPEN-FILE REPORT 84-UR**

**GROUND WATER INVESTIGATION FOR THE  
CITY OF ROSCOE, SOUTH DAKOTA**

by

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# CONTENTS

	Page
<b>INTRODUCTION</b> .....	1
Methods of investigation .....	1
<b>RESULTS OF INVESTIGATION</b> .....	1
Hydrogeology .....	1
Bedrock .....	1
Glacial deposits .....	2
Hydrology .....	2
Grand aquifer .....	2
<b>CONCLUSIONS</b> .....	2
<b>APPLICATION OF THE INITIAL FIELD WORK</b> .....	3
<b>POST INVESTIGATION WATER USE</b> .....	3
<b>REFERENCES</b> .....	3

## FIGURES

1. Locations of test holes, observation wells, and geologic cross sections .....	4
2. Geologic cross section A-A' .....	5
3. Geologic cross section B-B' .....	6
4. Geologic cross section C-C' .....	7
5. Geologic cross section D-D' .....	8
6. Geologic cross section E-E' .....	9
7. Water sample locations and approximate areal extent of the Grand aquifer .....	10

## TABLES

Page

1. Test hole and well summary .....	11
2. Description of geologic units .....	13
3. Static water levels .....	14
4. Chemical analyses of water samples .....	15

## INTRODUCTION

Prior to 1982 the city of Roscoe obtained its drinking water supply from a well that was completed into the Dakota Formation. This well, which was constructed in 1946, was completed at a depth of 1,575 feet below land surface. This well began to fail in January of 1982 and the city decided to construct a new well into the Dakota Formation at the same location. The new well was completed by Huron Drilling Incorporated on January 12, 1982, at a depth of 1,580 feet below land surface. This well, however, only produced 23 gallons of water per minute. The Roscoe City Council concluded that this amount of water was not sufficient to meet demands and that an additional well would be needed.

A buried aquifer, known as the Grand aquifer, had previously been identified in Edmunds County by test drilling for the Edmunds County study (Christensen, 1977). The Grand aquifer was found to be present to the north, south, and east of the city of Roscoe. In February of 1982, the Roscoe City Council requested the South Dakota Geological Survey to investigate the potential of the Grand aquifer as an additional municipal water supply for the city. The results of the investigation are presented in this report. The investigation was financed by the South Dakota Geological Survey, the former Oahe Conservancy Sub-District, and the city of Roscoe.

### Methods of Investigation

Field work for this study began in May of 1982 and continued through July of 1982. The field work included the drilling of 10 test holes, 4 of which were completed as observation wells, and the collection of 19 water samples that were analyzed for general water quality. Figure 1 shows the study area for this investigation. Figure 1 also shows the location of test holes and wells drilled for this investigation and the location of test holes and wells drilled for previous investigations. Each test hole or well was assigned a map location number. Table 1 lists the map location (ML) number and legal location along with a brief summary of test hole and well information. The lithologic logs for the test holes and wells are on file at the South Dakota Geological Survey in Vermillion, South Dakota.

## RESULTS OF INVESTIGATION

### Hydrogeology

The geology of the study area can be divided into bedrock and glacial deposits. Table 2 shows the geologic unit or names, their relative ages, and provides a description of each unit known to be present in the study area. Five cross sections (figs. 2, 3, 4, 5, and 6) show the relative positions of the different units. Cross section locations are shown on figure 1.

#### Bedrock

The Pierre Shale is the first bedrock that was found to be present in the study area. Preglacial streams carved a buried valley on the Pierre Shale surface that is present to the north, south, and east of the city of Roscoe (Hamilton, 1982) (figs. 2 through 6). The lithologic log of the well that was drilled for the city of Roscoe by Huron Drilling Incorporated at map location number 20 (fig. 1 and table 1) showed that the Pierre Shale, Niobrara Formation, Carlile Shale, Greenhorn Limestone, Graneros Shale, and Dakota Formation are

all present beneath the study area. The lower portion of this well, including the Carlile Shale, Greenhorn Limestone, Graneros Shale, and Dakota Formation, is not shown on figures 4 and 5. These geologic units were beyond the scope of this investigation and not used in constructing the cross sections.

### Glacial Deposits

The glacial deposits in the study area consist 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 mainly of sand and gravel with minor amounts of clay and silt. One major outwash body known as the Grand aquifer was found to be present beneath the study area (figs. 2 through 6). This outwash body is composed of gray, fine sand to coarse gravel with some interbedded layers of till and was generally deposited as channel fill in the preexisting valley on top of the Pierre Shale. The Grand aquifer ranges in thickness from 23 to 70 feet across the study area.

### Hydrology

The Dakota Formation and the Grand aquifer were both found to be present below the study area. The Dakota Formation occurs at a depth of approximately 1,580 feet below land surface and was beyond the scope of this investigation. Although the Dakota Formation was present, only the Grand aquifer will be discussed below.

### Grand Aquifer

The Grand aquifer is a buried aquifer that is overlain by 300 to 400 feet of till and lies generally in a preglacial valley on top of the Pierre Shale surface. Portions of the Grand aquifer are separated from the Pierre Shale by till as shown on figures 3 and 6. The approximate areal extent of the Grand aquifer across the study area is shown on figure 7. Static water levels for wells completed in the Grand aquifer are given in table 3 and show that the aquifer is under confined conditions. The quality of water in wells completed in the Grand aquifer is variable but does not violate any of the enforceable limits for drinking water standards set forth by the U.S. Environmental Protection Agency (1994). However, the water quality data show that the values for total dissolved solids, iron, manganese, and sulfate in some wells exceed the secondary maximum contaminant levels set forth by the U.S. Environmental Protection Agency. These secondary drinking water standards are suggested limits and are not enforceable limits for public water supplies. Water sample locations are shown on figure 7. Analytical results of the water samples collected for this study are presented in table 4.

## CONCLUSIONS

The Grand aquifer lies within a buried valley which is present to the north, south, and east of the city of Roscoe. The Grand aquifer generally lies directly on the Pierre Shale surface, but is separated from the Pierre Shale in some areas by till. The thickness of the Grand aquifer ranges from 23 to 70 feet and consists of gray, fine sand to coarse gravel. Water levels for wells completed in the Grand aquifer indicate that the aquifer is under confined conditions. The quality of water in wells that were completed in the Grand aquifer does not

violate any of the enforceable limits for drinking water standards set forth by the U.S. Environmental Protection Agency, although the values for total dissolved solids, iron, manganese, and sulfate in some wells exceed the secondary maximum contaminant levels set forth by the U.S. Environmental Protection Agency.

## APPLICATION OF THE INITIAL FIELD WORK

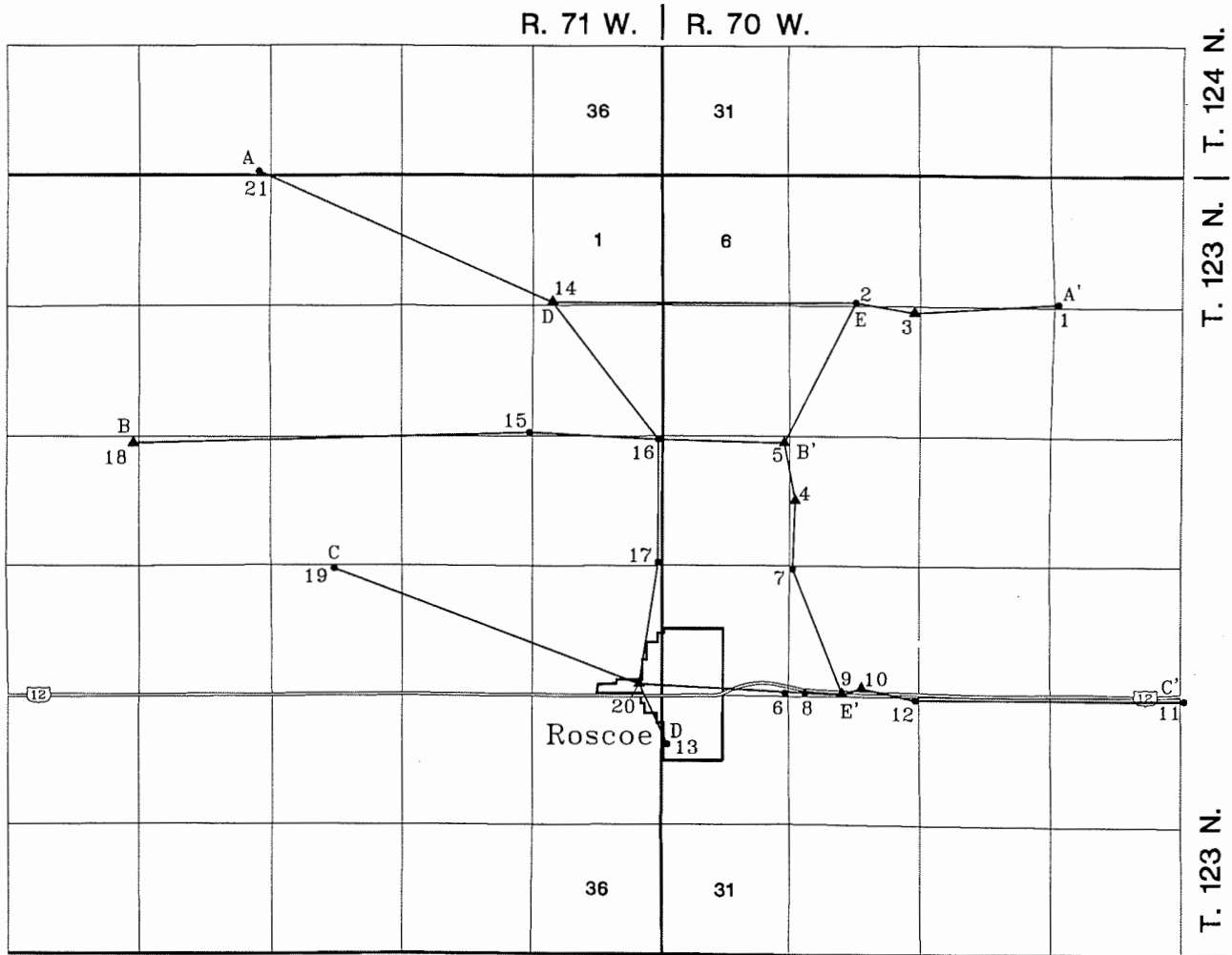
Based on the field work that was conducted from May of 1982 through July of 1982, an area in the southern half of section 20, T. 123 N., R. 70 W. was recommended by the South Dakota Geological Survey for future municipal well development. The Grand aquifer, in this area, is greater than 46 feet thick and the water quality in well ED-82D (fig. 1, map location 9; fig. 7, and table 4) was better than the quality of water from the city wells previously installed in the Dakota Formation. It was also recommended by the South Dakota Geological Survey that an aquifer test be performed to identify the potential yield of the Grand aquifer in this area. At this time the city of Roscoe obtained the services of LTP Enterprises Incorporated which completed the new well in the Grand aquifer on October 18, 1982. This municipal well is located at the SW SW SW SE sec. 20, T. 123 N., R. 70 W. (fig. 1, map location 10) and was completed at 409 feet below land surface. An aquifer test was conducted to determine the potential yield of a production well drilled into the Grand aquifer in this area. It was found that the production well would produce the required amount of water needed for the city of Roscoe.

## POST INVESTIGATION WATER USE

The city of Roscoe is currently using water from the WEB Rural Water Development Association pipeline and from their municipal well completed in the Grand aquifer. The city of Roscoe first joined the WEB Rural Water Development Association in November of 1986 and was a member intermittently until November 22, 1988 when the city became a permanent member of the association (Opal Himerich, city of Roscoe personal communication, 1997). Presently, the majority of the city's drinking water is supplied by their municipal well and is supplemented by the use of the WEB Rural Water Development Association pipeline.

## REFERENCES

- Christensen, C.M., 1977, *Geology and water resources of McPherson, Edmunds, and Faulk Counties, South Dakota; Part I, Geology*: South Dakota Geological Survey Bulletin 26, 58 p.
- Hamilton, L.J., 1982, *Geology and water resources of McPherson, Edmunds, and Faulk Counties, South Dakota; Part II, Water resources*: South Dakota Geological Survey Bulletin 26, 60 p.
- U.S. Environmental Protection Agency, 1994, *Drinking water regulations and health advisories*. November 1994.
- U.S. Geological Survey, 1974, *Surficial topography of the Roscoe, South Dakota quadrangle*: U.S. Geological Survey Topographic Map Series, scale 1:24,000.
- \_\_\_\_\_, 1978, *Surficial topography of the Roscoe NW, South Dakota quadrangle*: U.S. Geological Survey Topographic Map Series, scale 1:24,000.



0 1 2 3 4 5 6 MILES

▲ Test hole drilled for this investigation. Number is the map location number. See table 1 for legal locations.

▲ Observation well drilled for this investigation. Number is the map location number. See table 1 for legal locations.

—▲ E' Line of geologic cross section. See figures 2 through 6.



Figure 1. Locations of test holes, observation wells, and geologic cross sections.

ML 2 Test hole or well. The number is the map location number. See table 1 for legal location and a brief summary of test hole and well information. See figure 1 for geologic cross section location.

Geologic contact. Dashed where approximate.

Vertical exaggeration = 35X

Qt.....till undifferentiated  
 Qo.....undifferentiated outwash  
 Qog...outwash, Grand aquifer  
 Kp.....Pierre Shale

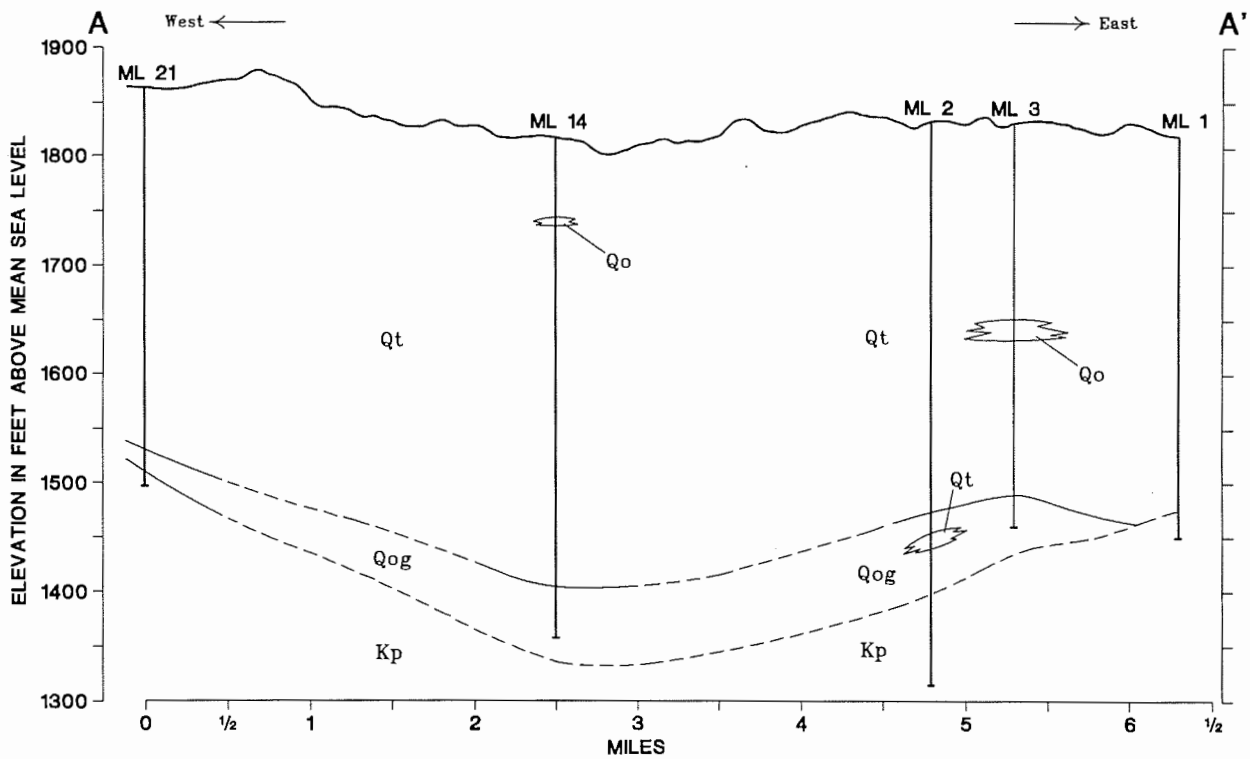


Figure 2. Geologic cross section A-A'.



ML 5 Test hole or well. The number is the map location number. See table 1 for legal location and a brief summary of test hole and well information. See figure 1 for geologic cross section location.

Geologic contact. Dashed where approximate.

Vertical exaggeration = 35X

Qt....till undifferentiated  
 Qo....undifferentiated outwash  
 Qog...outwash, Grand aquifer  
 Kp....Pierre Shale

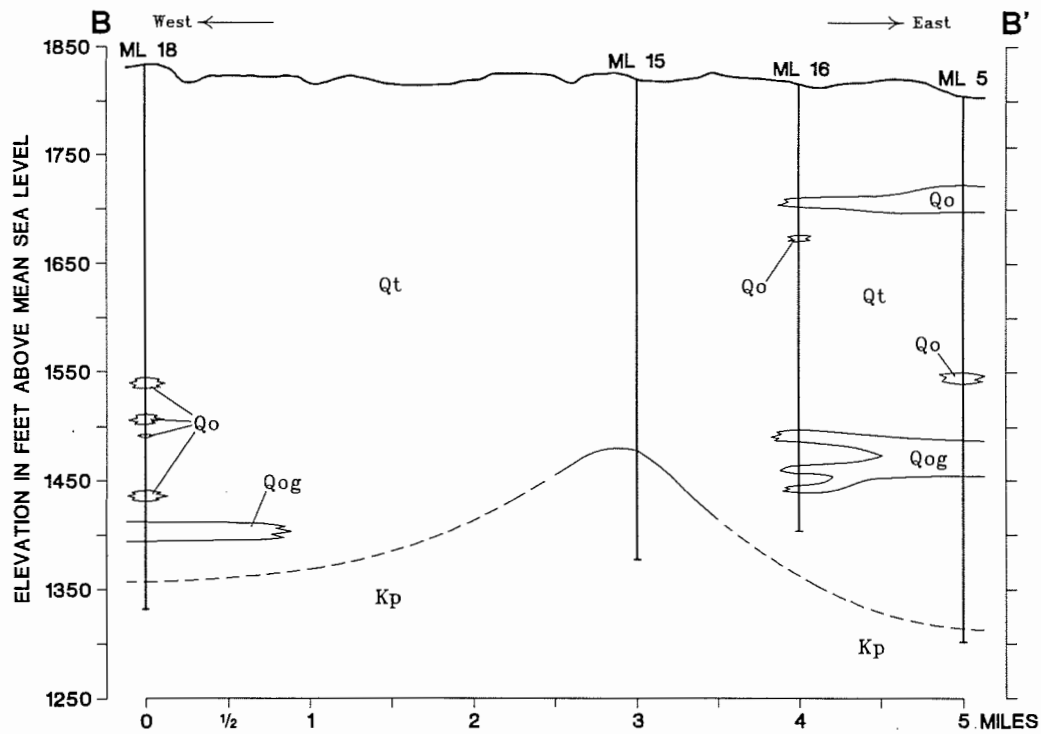


Figure 3. Geologic cross section B-B'.

ML 9 Test hole or well. The number is the map location number. See table 1 for legal location and a brief summary of test hole and well information. See figure 1 for geologic cross section location.

Geologic contact. Dashed where approximate.

Vertical exaggeration = 35X

Qt.....till undifferentiated  
 Qo.....undifferentiated outwash  
 Qog...outwash, Grand aquifer  
 Kp.....Pierre Shale  
 Kn.....Niobrara Formation

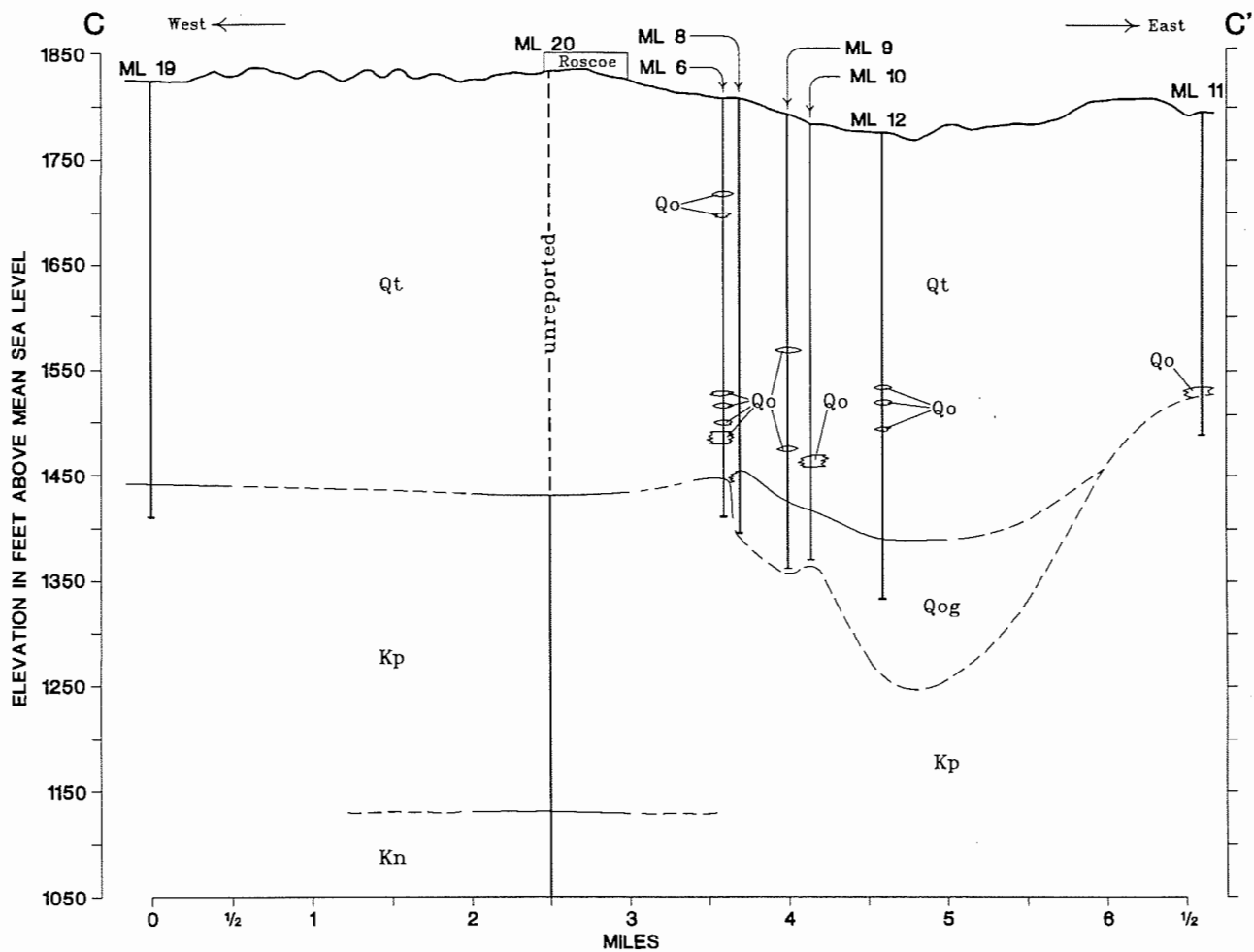


Figure 4. Geologic cross section C-C'.

ML 14 Test hole or well. The number is the map location number. See table 1 for legal location and a brief summary of test hole and well information. See figure 1 for geologic cross section location.

Geologic contact. Dashed where approximate.

Vertical exaggeration = 35X

Qt.....till undifferentiated  
 Qo.....undifferentiated outwash  
 Qog...outwash, Grand aquifer  
 Kp.....Pierre Shale  
 Kn.....Niobrara Formation

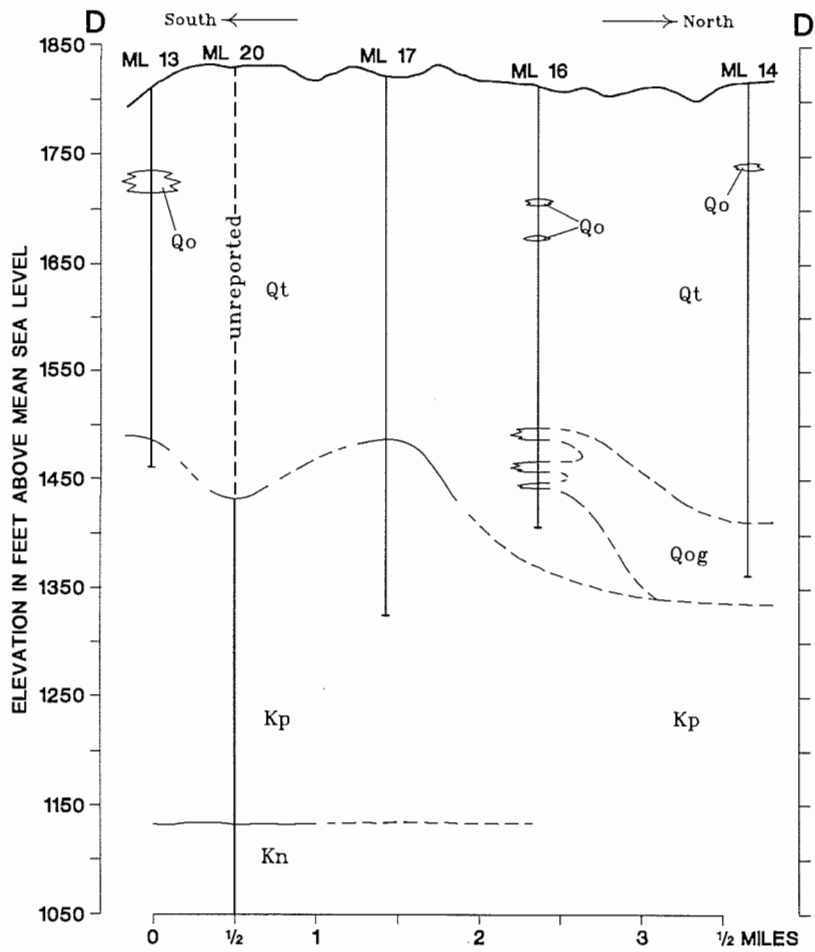


Figure 5. Geologic cross section D-D'.

ML 9 Test hole or well. The number is the map location number. See table 1 for legal location and a brief summary of test hole and well information. See figure 1 for geologic cross section location.

Geologic contact. Dashed where approximate.

Vertical exaggeration = 35X

Qt.....till undifferentiated  
 Qo.....undifferentiated outwash  
 Qog...outwash, Grand aquifer  
 Kp.....Pierre Shale

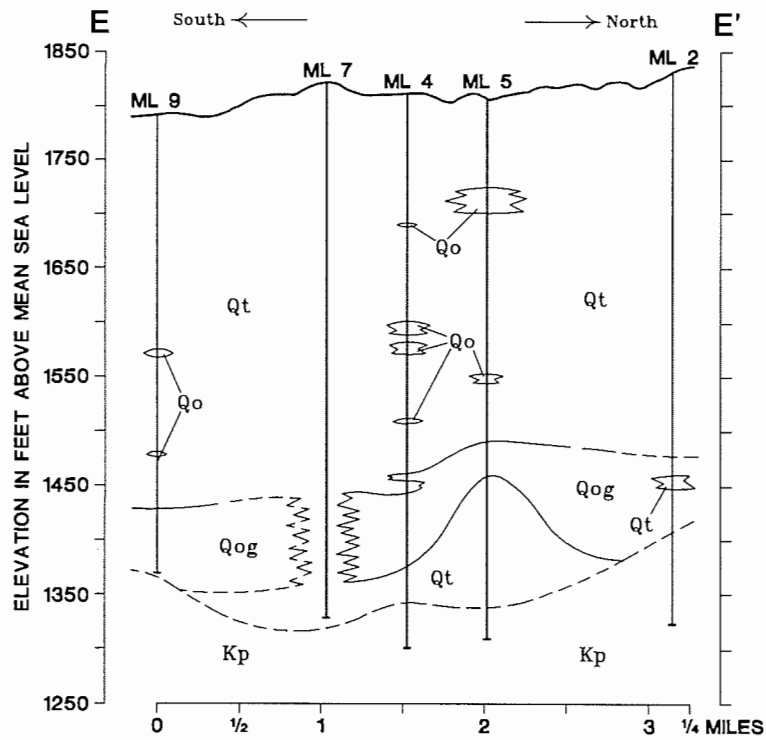
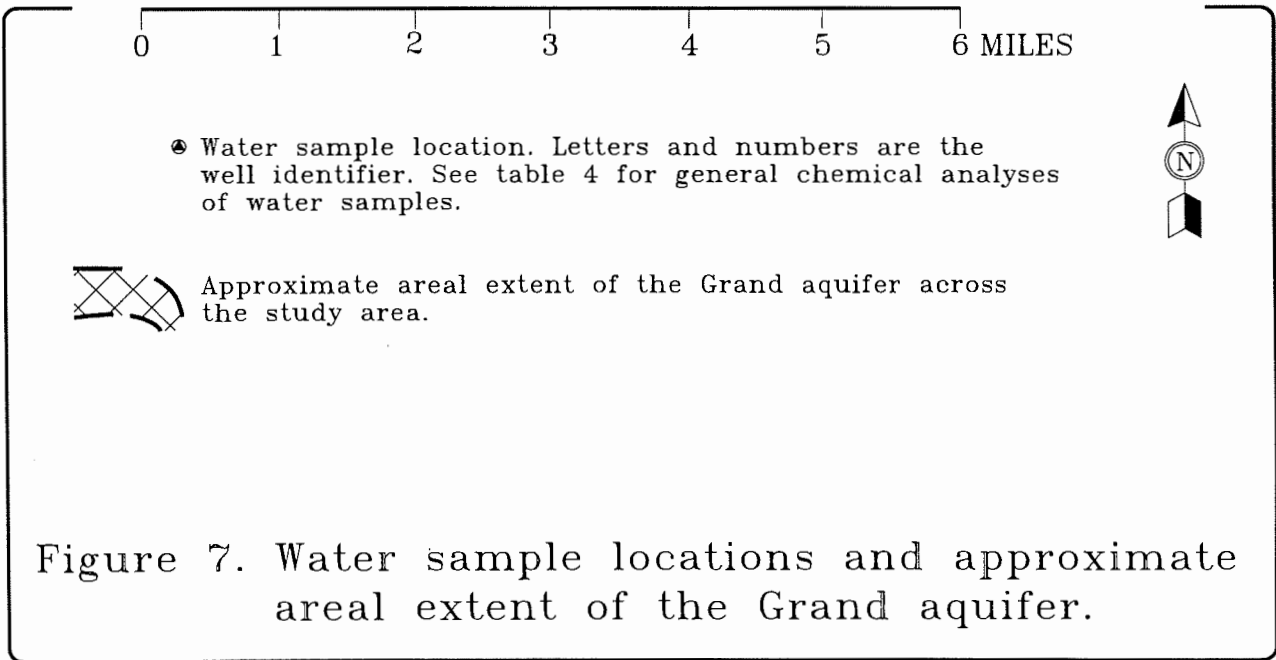
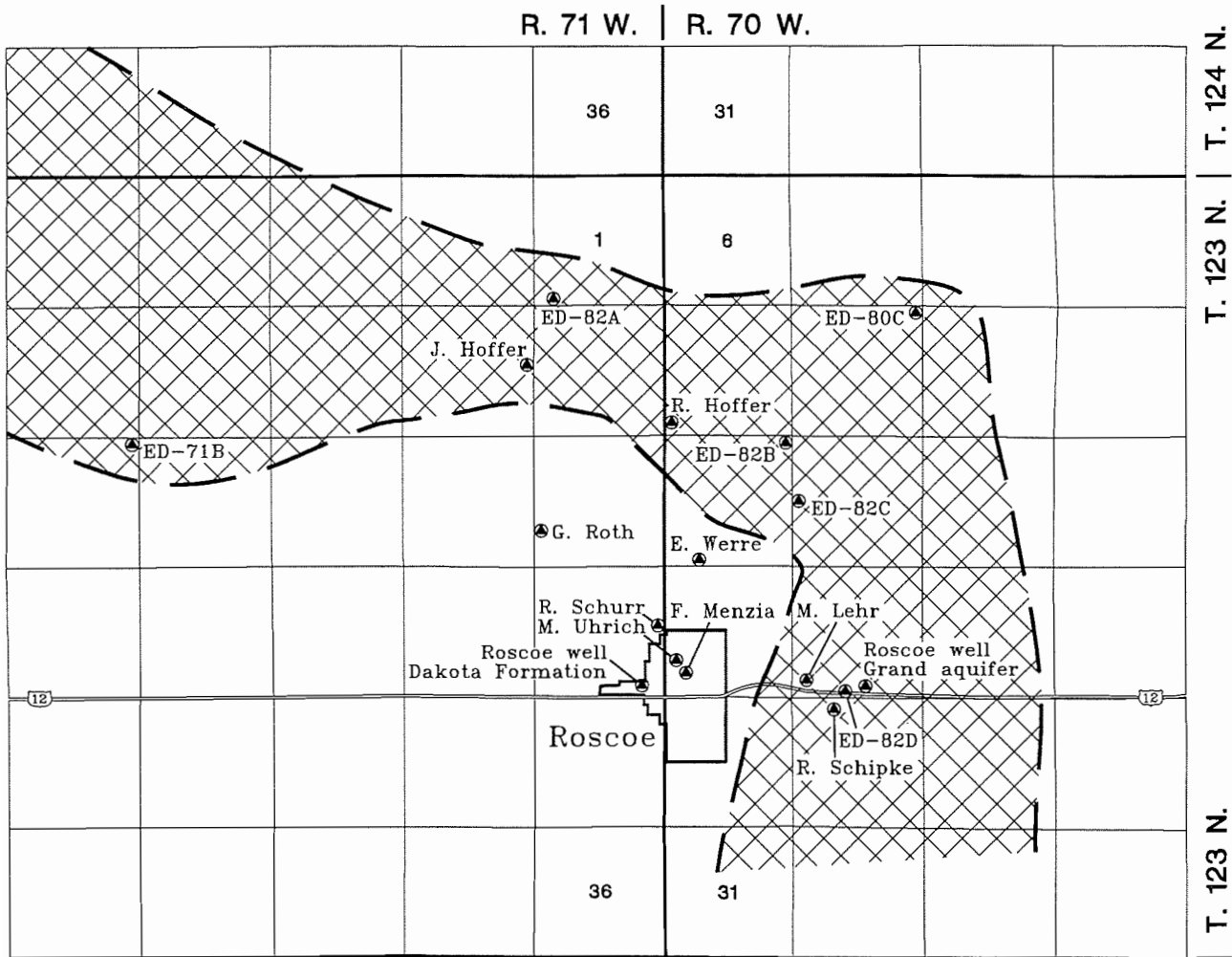


Figure 6. Geologic cross section E-E'.



**Table 1. Test hole and well summary**

Map location number	Legal Location	Test hole number	Well name	Total drill hole depth (ft.)	Total well depth (ft.)	Bottom hole Formation
1	SW SW SW SW sec. 03, T. 123 N., R. 70 W.	R-17	Test hole only	365		Pierre Shale
2	SW SW SW SE sec. 05, T. 123 N., R. 70 W.	R-72-28	Test hole only	516		Pierre Shale
3	NE NE NE NE sec. 08, T. 123 N., R. 70 W.	Not listed	ED-80C	370	372	Outwash - Grand aquifer
4	SW SW SW NW sec. 17, T. 123 N., R. 70 W.	R2-82-26	ED-82C	515	420	Pierre Shale
5	NE NE NE NE sec. 18, T. 123 N., R. 70 W.	R2-82-25	ED-82B	500	344	Pierre Shale
6	SE SE SE SE sec. 19, T. 123 N., R. 70 W.	R2-82-22	Test hole only	395		Pierre Shale
7	NW NW NW NW sec. 20, T. 123 N., R. 70 W.	R2-82-23	Test hole only	500		Pierre Shale ?
8	SE SW SW SW sec. 20, T. 123 N., R. 70 W.	R2-82-30	Test hole only	410		Outwash - Grand aquifer
9	SW SE SE SW sec. 20, T. 123 N., R. 70 W.	R2-82-29	ED-82D	427	408	Outwash - Grand aquifer
10	SW SW SW SE sec 20, T. 123 N., R. 70 W.	Not listed	Roscoe well - Grand aquifer		409	Outwash - Grand aquifer

**Table 1 – continued.**

Map location number	Legal Location	Test hole number	Well name	Total drill hole depth (ft.)	Total well depth (ft.)	Bottom hole Formation
11	NW NW NW sec 26, T. 123 N., R. 70 W.	Not listed	Test hole only	305		Pierre Shale
12	NE NE NE sec. 29, T. 123 N., R. 70 W.	R-72-27	Test hole only	440		Outwash - Grand aquifer
13	SW NW SW NW sec. 30, T. 123 N., R. 70 W.	R-14	Test hole only	350		Pierre Shale
14	SW SE SW SW sec 01, T. 123 N., R. 71 W.	R2-82-28	ED-82A	457	425	Outwash - Grand aquifer
15	SE SE SE SE sec. 11, T. 123 N., R. 71 W.	R2-82-27	Test hole only	440		Pierre Shale
16	NE NE NE sec. 13, T. 123 N., R. 71 W.	R2-82-24	Test hole only	410		Till
17	SE SE SE SE sec. 13, T. 123 N., R. 71 W.	R2-82-21	Test hole only	500		Pierre Shale
18	NE NE NE sec. 17, T. 123 N., R. 71 W.	Not listed	ED-71B	500	425	Pierre Shale
19	NE NE NE NW sec. 22, T. 123 N., R. 71 W.	Not listed	Test hole only	410		Pierre Shale
20	NE SW SE SE sec. 24, T. 123 N., R. 71 W.	Not listed	Roscoe well - Dakota Formation	1580	1580	Dakota Formation
21	SW SE SE SE sec. 33, T. 124 N., R. 71 W.	R-73-4	Test hole only			Pierre Shale

Table 2. Description of geologic units

Geologic age from youngest to oldest	Geologic unit or formation name	Designation used on the cross sections	Description <sup>1</sup>
Quaternary undifferentiated	Till	Qt	Heterogeneous mixture of clay, silt, sand pebbles, and boulders.
	Outwash	Qo or Qog	Mixture of sand and gravel with minor amounts of silt and clay.
Cretaceous	Pierre Shale	Kp	Blue-gray, calcareous to noncalcareous shale which locally contains bentonite beds and marl zones.
	Niobrara Formation	Kn	Light to medium blue gray marl and white to cream colored limestone calcareous, fossiliferous; weathers white to dark yellowish-orange.
	Carlile Shale	Not shown on the cross sections.	Medium-gray noncalcareous, plastic, fissile shale. May be chalky in part and contain some traces of carbonized wood.
	Greenhorn Limestone	Not shown on the cross sections.	Gray to cream colored fossiliferous limestone.
	Graneros Shale	Not shown on the cross sections.	Medium to dark-gray, noncalcareous, silty shale interbedded with thin silt and sand layers.
	Dakota Formation	Not shown on the cross sections.	Varicolored alternating beds of siltstone, sandstone, and shale.

<sup>1</sup> Modified from Christensen (1977)



**Table 3. Static water levels**

Well name	Map location number <sup>1</sup>	Depth to water <sup>2</sup>	Water level elevation <sup>3</sup>	Elevation of the top of the aquifer <sup>3</sup>	Date measured
ED-80C	3	59.95	1772	1490	7-23-82
ED-82C	4	45.75	1764	1438	6-16-82
		46.12	1764		7-23-82
ED-82B	5	43.28	1761	1486	5-25-82
		42.90	1761		6-09-82
		42.62	1761		6-16-82
		40.64	1763		7-23-82
ED-82D	9	26.60	1765	1423	6-08-82
		26.50	1765		6-16-82
		26.60	1765		6-29-82
		26.88	1765		7-23-82
Roscoe well - Grand aquifer	10	25.80	1756	1416	10-28-82
ED-82A	14	57.26	1760	1406	6-16-82
		57.92	1759		7-23-82
ED-71B	18	76.0	1758	1412	6-29-82
		76.3	1758		8-18-82

<sup>1</sup> Map location numbers corresponds to the numbers shown on figure 1 and in table 1.

<sup>2</sup> Depth to water measured in feet below casing top.

<sup>3</sup> Water level elevations and the elevation of the top of the aquifer are in feet above mean sea level and are based on an estimation of land surface elevation from U.S. Geological Survey 7.5 minute topographic maps of the Roscoe South Dakota (1974) and Roscoe NW South Dakota (1978) quadrangles. Elevations are accurate to within plus or minus 10 feet. Where no casing top elevation was given, a stick-up of 2 feet was assumed for calculating water level elevations.

**Table 4. Chemical analyses of water samples**

Legal location	Well name	Date collected	Well depth <sup>2</sup>	Conductivity <sup>3</sup>	Parameter <sup>1</sup> with concentrations in milligrams per liter											
					Ca	Cl	F	Fe	Mg	Mn	Na	NO <sub>2</sub> -N	NO <sub>3</sub> -N +	SO <sub>4</sub>	TDS as CaCO <sub>3</sub>	
					Standards	----	250 <sup>4</sup>	2.4 <sup>5</sup>	0.3 <sup>4</sup>	----	0.05 <sup>4</sup>	----	10 <sup>5</sup>	250 <sup>4</sup>	500 <sup>4</sup>	----
<b>GRAND AQUIFER</b>																
NW SW SW sec. 07, T. 123 N., R. 70 W.	Private well R. Hoffer	5-18-82	387	1760	67	380	0.44	0.57	17.0	0.74	295	0.1	275	1080	237	
NE NE NE sec. 08, T. 123 N., R. 70 W.	ED-80C	7-23-82	372	1541	42	152	0.47	NA <sup>6</sup>	9	NA <sup>6</sup>	NA <sup>6</sup>	<0.1	295	1105	142	
SW SW SW NW sec. 17, T. 123 N., R. 70 W.	ED-82C	5-26-82	420	1675	59	193	0.55	0.02	18	0.51	323	<0.1	254	1185	221	
NE NE NE sec. 18, T. 123 N., R. 70 W.	ED-82B	5-25-82	344	1334	54	74	0.4	0.02	13.9	0.19	229	0.2	231	915	192	
NW SE SW SW sec. 20, T. 123 N., R. 70 W.	Private well M. Lehr	5-27-82	330	1626	45	215	0.49	5.85	13.7	0.37	335	0.4	88	1135	168	
SW SE SE SW sec. 20, T. 123 N., R. 70 W.	ED-82D	5-28-82	408	1595	40	138	0.65	<0.01	12.1	0.34	330	<0.1	288	1130	149	
SW SE SE SW sec. 20, T. 123 N., R. 70 W.	ED-82D	6-29-82	408	1740	35	165	0.18	<0.01	10	0.31	340	<0.1	270	1120	128	
SW SE SE SW sec. 20, T. 123 N., R. 70 W.	ED-82D	6-29-82	408	1490	41.8	141	0.54	0.08	11	0.38	340	0.10	315	1090	150	

Table 4 - continued.

Legal location	Well name	Date collected	Well depth <sup>2</sup>	Conductivity <sup>3</sup>	Parameter <sup>1</sup> with concentrations in milligrams per liter											
					Ca	Cl	F	Fe	Mg	Mn	Na	NO <sub>2</sub> -N	NO <sub>3</sub> -N +	SO <sub>4</sub>	TDS	Hardness as CaCO <sub>3</sub>
			Standards			250 <sup>4</sup>	2.4 <sup>5</sup>	0.3 <sup>4</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>	-----	
<b>GRAND AQUIFER (continued)</b>																
SW SW SW SE sec. 20, T. 123 N., R. 70 W.	Roscoe well Grand aquifer	10-28-82	409	1569	34	131	0.61	0.30	0.34	9	0.34	349	<0.1	340	1075	122
SW NW NE NW sec. 29, T. 123 N., R. 70 W.	Private well R. Schipke	5-25-82	397	2563	59	285	0.45	0.46	19.6	0.39	0.39	342	<0.1	212	1238	227
SW SE SW SW sec. 01, T. 123 N., R. 71 W.	ED-82A	5-28-82	425	1589	81	305	0.46	0.02	28.6	0.64	0.64	260	<0.1	177	1065	319
SE SE SE NE sec. 11, T. 123 N., R. 71 W.	Private well J. Hoffer	5-18-82	350	1790	63	591	0.46	2.19	16.9	0.74	0.74	325	<0.1	149	1140	226
<b>DAKOTA FORMATION</b>																
NE SW SE SE sec. 24, T. 123 N., R. 71 W.	Roscoe well Dakota Fm.	3-17-82	1580	3744	11.8	496	2.76	0.73	5.8	0.02	854	<0.1	430	2213	53.7	
NE SW SE SE sec. 24, T. 123 N., R. 71 W.	Roscoe well Dakota Fm.	07-23-82	1580	3566	10	470	3.05	NA <sup>6</sup>	6	NA <sup>6</sup>	NA <sup>6</sup>	0.4	476	2300	50	
<b>AQUIFER UNKNOWN</b>																
SW SW SE SW sec. 18, T. 123 N., R. 70 W.	Private well E. Werre	5-18-82	350	3640	24	890	0.4	1.03	7.2	0.13	760	<0.1	<10	2070	89	

**Table 4 - continued.**

Legal location	Well name	Date collected	Well depth <sup>2</sup>	Conductivity <sup>3</sup>	Parameter <sup>1</sup> with concentrations in milligrams per liter										
					Ca	Cl	F	Fe	Mg	Mn	Na	NO <sub>2</sub> -N	NO <sub>3</sub> -N	SO <sub>4</sub>	TDS
					-----	250 <sup>4</sup>	2.4 <sup>5</sup>	0.3 <sup>4</sup>	-----	0.05 <sup>4</sup>	-----	10 <sup>5</sup>	250 <sup>4</sup>	500 <sup>4</sup>	-----
<b>AQUIFER UNKNOWN (continued)</b>															
SE SW NW SW sec. 19, T. 123 N., R. 70 W.	Private well M. Uhrich	5-17-82	370	2510	23	670	0.27	0.08	8.5	0.08	525	0.9	96	1430	92
SW NE SW SW sec. 19, T. 123 N., R. 70 W.	Private well M. Menzia	5-18-82	350	2290	51	645	1.03	0.02	13.9	0.74	465	<0.1	165	1130	184
SW SW NW SW sec. 13, T. 123 N., R. 71 W.	Private well G. Roth	5-13-82	380	2460	24	860	0.34	1.33	7.4	0.12	505	<0.1	<10	1410	90
NE NE NE SE sec. 24, T. 123 N., R. 71 W.	Private well R. Schurr	5-26-82	not known	1992	33	580	0.24	0.02	9.8	0.15	470	<0.1	22	1405	122

<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.

<sup>6</sup> NA - Not Analyzed