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**HYDROGEOLOGIC INVESTIGATION OF THE
DAKOTA FORMATION TO IDENTIFY
ADDITIONAL MUNICIPAL WELL SITES
FOR THE CITY OF CANTON, SOUTH DAKOTA**

by

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INTRODUCTION

During the summers of 1986 and 1987, Canton's municipal water supply was inadequate to meet the city's needs. This inadequacy was due to the decline, over the years, in pumping rates in the municipal wells. In 1987, the city of Canton asked the South Dakota Geological Survey to determine if the Dakota Formation in the vicinity of the city could accommodate additional production wells. By late May of 1988, the water demand outpaced the supply and the city required water rationing.

The study was financed by the city of Canton and the state of South Dakota. This report contains the results of the study which was conducted in and near the city of Canton, South Dakota (fig. 1).

Acknowledgments

Special thanks is given to Palmer Ericksen, Superintendent of Public Works; Dominic Jones and Don Ulrikson, Water and Sewer Department; and Jeff Fossum, Street Department for their invaluable assistance in completing this study.

METHODS AND PROCEDURES

Drilling and Well Installation

Drilling began in November of 1987, but the only test hole drilled in 1987 was at map location (ML) 17, (fig. 2), which was abandoned because the drill hole began to collapse. Neither a geophysical log nor a monitoring well was completed in the hole. In April of 1988, drilling resumed and six test holes (ML 4, 5, 7, 10, 11 and 16, fig. 2) were subsequently drilled and completed as monitoring wells. Geophysical logs are available at the South Dakota Geological Survey for (1) these six test holes, (2) for the pilot holes for municipal wells 9, 10 and 11 and (3) for municipal wells 9, 10 and 11. The pilot holes for the municipal wells and holes for the municipal wells themselves (which are near the pilot holes) were drilled by Huron Drilling, Inc. The geophysical logs include the parameters of natural gamma and/or single-point resistivity (app. A).

Monitoring wells were constructed using 2-inch diameter, schedule 80, threaded, polyvinyl chloride (PVC) casing and screen. Data on screen length and well depth are presented in appendix A.

Filter pack consisting of washed medium to coarse gravel which was obtained from Tri-State Ready Mix plant in Canton was placed around the outside of the monitoring-well screen. The filter pack was placed at least 15 feet above the top of the screen using a tremie pipe to ensure proper positioning of the filter pack.

*Index map of South Dakota
showing location of Lincoln
County.*

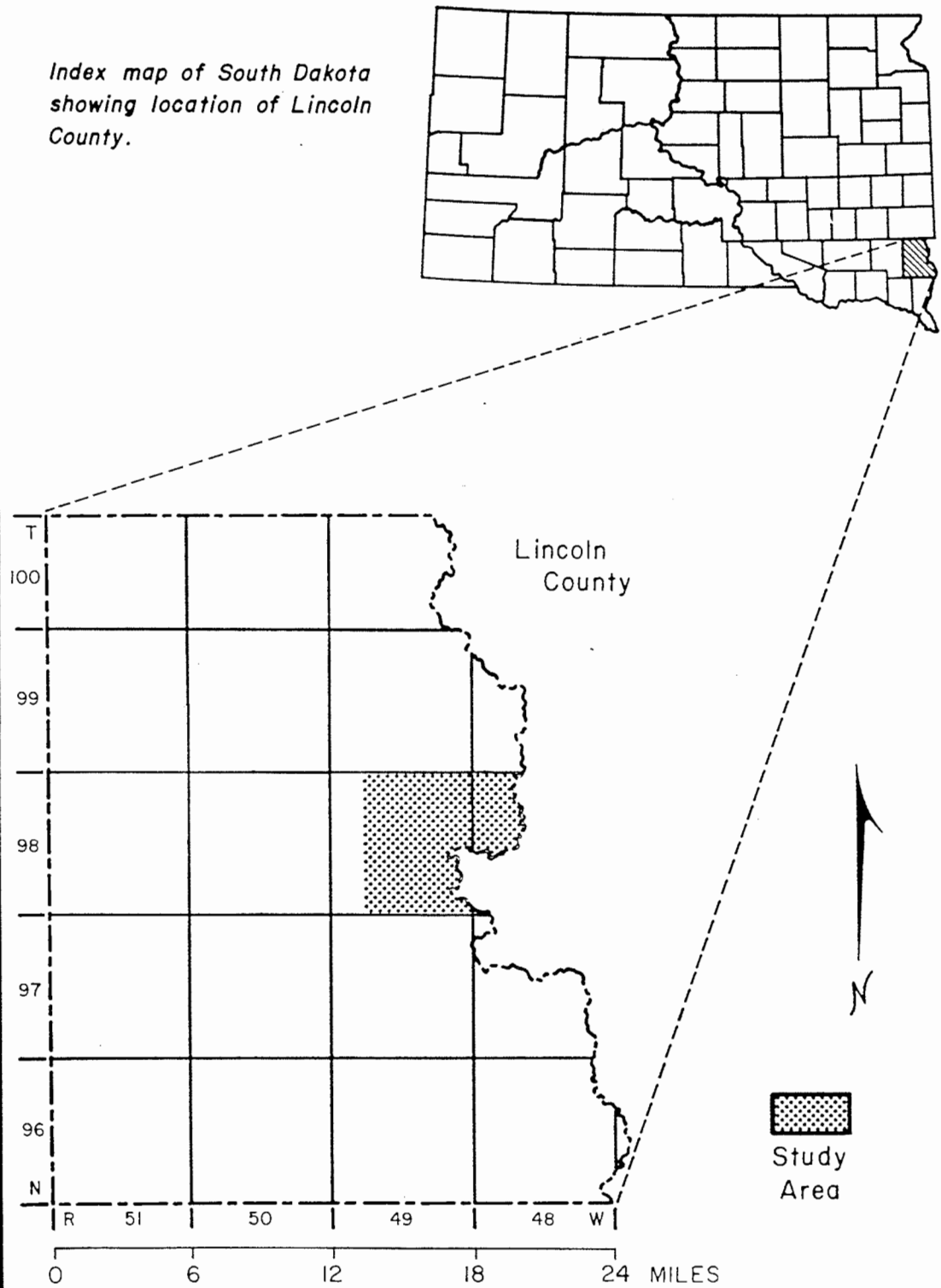


Figure 1. Location of the study area.

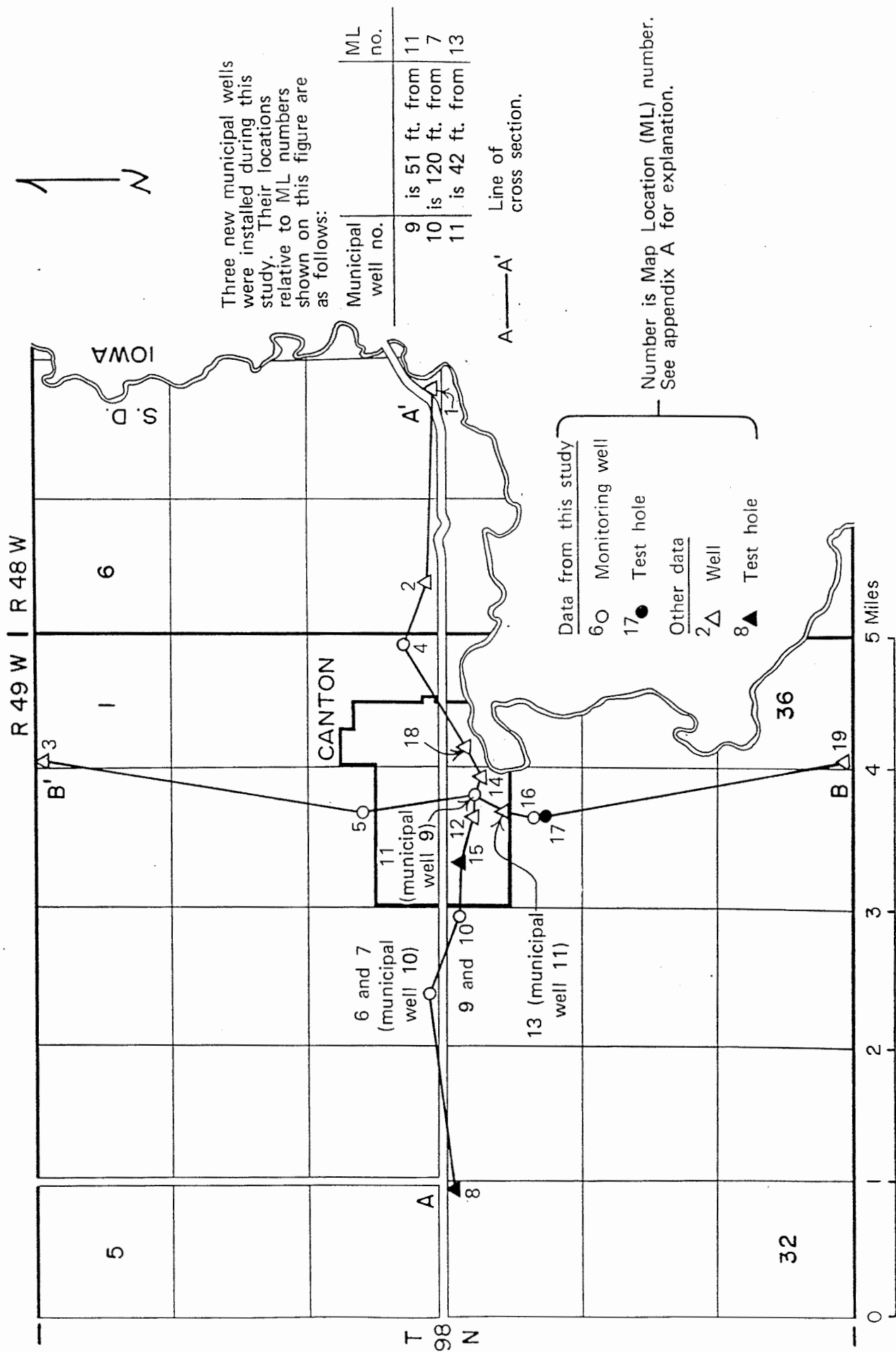


Figure 2. Locations of test holes and monitoring wells used in this study and locations of geologic cross sections.

A bentonite grout was then pumped through the tremie pipe into the remaining annular space (from the bottom up) around the outside of the casing to land surface. At a later date an upper portion of the annular space was finished off with cement grout and finally topped with soil.

Surveying

The casing-top elevations of the monitoring wells were surveyed to the nearest 0.01 foot. Two U.S. Coast and Geodetic Survey bench marks and a city fire hydrant were used as datum points for the surveying. The bench mark which was used as the datum point for all but two wells is located on the west side of Canton at the "Y" junction of the railroad tracks (SW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 23, T. 98 N., R. 49 W.) and was stamped "B 327 1949." The other bench mark is located west of Canton at the corner of sections 15, 16, 21 and 22, T. 98 N., R. 49 W. and was stamped "11 SAN 1961." For the well located near the municipal airport, a fire hydrant near the oil road adjacent to the airport was used as the datum. The elevation of the fire hydrant had been previously surveyed by the city.

Water-Level Measurements

The depths to water in all the monitoring wells were measured to the nearest 0.01 foot. Measurements were made using a metal tape measure with a concave-shaped device on the end which makes an audible sound upon impact with the water. The water-level measurements are presented in appendix B.

Well Development and Water Sampling

All monitoring wells in the Dakota Formation were developed by pumping with compressed air until the water cleared.

Water samples from monitoring wells were collected with a bladder pump or, when that was not possible, with a bailer. Water samples from private wells were collected with the pumps that were in the wells. A minimum of 3 well volumes of water were evacuated from a well before a sample was collected. Water samples were collected from monitoring wells, private wells and Canton municipal wells. Results of water analyses are presented in appendices C, D and E.

PREINVESTIGATION CANTON WATER SUPPLY

The Canton water supply, before this study began, was obtained from five wells completed in the Dakota Formation and one well completed in the Big Sioux aquifer. All of the wells completed in the Dakota Formation, except for municipal well 1, have shown a decline in water yield since installation (table 1).

Table 1. Pumping rates of Canton municipal wells completed in the Dakota Formation.

Municipal well number	Date installed	Depth (feet)	Original pumping rate (gallons per minute)	1989 pumping rate (gallons per minute)
1	1974	450	80	90
3	1965	403	110	40
4	1950	443	80	15
6	1965	443	140	100
8	1977	480	200	180

The Big Sioux aquifer well (municipal well 7) is used as a backup well in case the water demand is too great for the Dakota Formation wells to accommodate. Municipal well 7 was installed in 1918. It has a large diameter (27 feet) and is shallow in depth (28 feet). The yield from this well varies from 100 to 250 gallons per minute (gpm) depending upon the saturated thickness of the aquifer. Even with such a high yield this well is not pumped extensively due to the poor quality water it produces (Water Sample Location 12; app. C).

HYDROGEOLOGIC SETTING

The surficial deposits in the study area are chiefly drift which is the result of glaciation during the Pleistocene Epoch (McMeen, 1965). The drift is directly underlain by Cretaceous age sediments.

Drift is composed of till and outwash, both of which are present in the study area. Till consists of a heterogeneous mixture of boulders, gravel, sand, silt and clay. Outwash consists primarily of sand and gravel that has been washed, sorted and deposited by flowing glacial meltwater. Varying amounts of less permeable materials, silt and clay, may be found dispersed throughout the outwash matrix. Till is present everywhere at the surface except along the Big Sioux River and its tributaries where outwash and alluvium are present. Alluvium is a recent deposit in the present day Big Sioux River valley and its tributaries.

If all commonly encountered bedrock units in the study area were present at one location, they would be encountered in descending order (from youngest to oldest) as follows: Cretaceous age Niobrara Formation, Carlile Shale, Greenhorn Limestone, Graneros Shale and Dakota Formation followed by Paleozoic age sandstone and finally Precambrian age Sioux Quartzite.

The Niobrara Formation, Carlile Shale, Greenhorn Limestone and Graneros Shale are not considered aquifers and will not be discussed in detail. The Dakota Formation will be discussed in detail in the next section of the report. The Dakota Formation, which consists of interbedded sand, sandstone, clay and shale, is the major aquifer used for the Canton municipal water supply and underlies the entire study area.

RESULTS OF THE INVESTIGATION

General Geology

The spatial distribution of sediments in the study area is illustrated on two cross sections (figs. 3 and 4) whose locations are shown in figure 2. Carlile Shale was encountered in all test holes in the study area except at ML 4 and ML 18 where it was discovered that a buried valley had cut through the Upper Cretaceous sediments and into the Dakota Formation (fig. 3).

The following values characterize the thicknesses of some of the bedrock units encountered in drilling. A test hole located at ML 8 was the only test hole which encountered the Niobrara Formation. The thickness of the Niobrara at this site is 24 feet. The Carlile Shale ranges in thickness from 49 feet (ML 1) to 230 feet (ML 8). The Greenhorn Limestone thickness varies from 11 feet (ML 3) to 49 feet (ML 19). The Graneros Shale ranges from 30 feet (ML 19) to 69 feet (ML 5) in thickness.

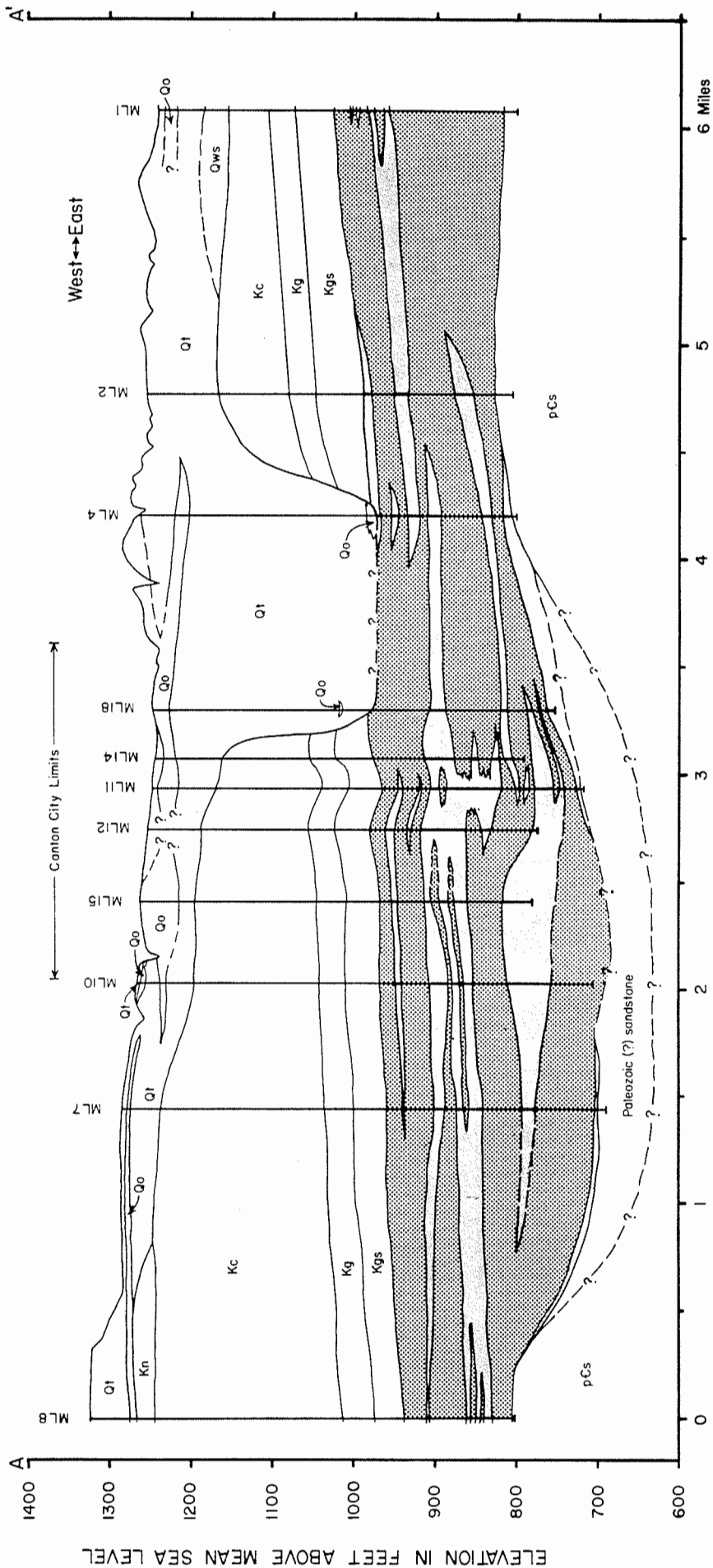
A sandstone was discovered below the Dakota Formation and overlying the Sioux Quartzite (figs. 3 and 4; ML 5, 7, 11, 13, 16 and 17). This sandstone is white to brownish-white in color and is fairly hard. At ML 17 the thickness of the sandstone was found to be at least 84 feet, however, the total thickness of the sandstone was not penetrated and a maximum thickness cannot be determined.

A 5-foot interval of the sandstone below the Dakota Formation was cored at ML 7. Part of the core was sent to Twin City Testing Corporation in Sioux Falls, South Dakota, for permeability testing to determine if this sandstone had the potential to yield water. The results of the testing showed a permeability of less than 1.0×10^{-9} feet per minute (5.1×10^{-10} centimeters per second) (app. F) indicating that the sandstone was unsuitable as an aquifer. Another section of the core was sent to the Iowa Geological Survey, Iowa City, Iowa, for an opinion on its age. The Iowa Geological Survey indicated it was probably of the Paleozoic Era (Richard Hammond, South Dakota Geological Survey, personal communication, 1989).

Dakota Formation

Geology

In the study area, the Dakota Formation varies from 216 (ML 1) to 387 (ML 8) feet below land surface and has a thickness ranging from 126 (ML 1) to 288 (ML 8) feet (app. A). The



Vertical exaggeration = 20X

Geologic contact Dashed where approximate

See Figure 2 for cross section location.

Q1... Glacial till
 Qo... Glacial outwash (sand and gravel)
 Qws... Western-derived sand
 Kn... Niobrara Formation
 Kc... Carlie Shale
 Kg... Greenhorn Limestone
 Kgs... Graneros Shale
 Kd... Dakota Formation

QUATERNARY

CRETACEOUS

PRECAMBRIAN

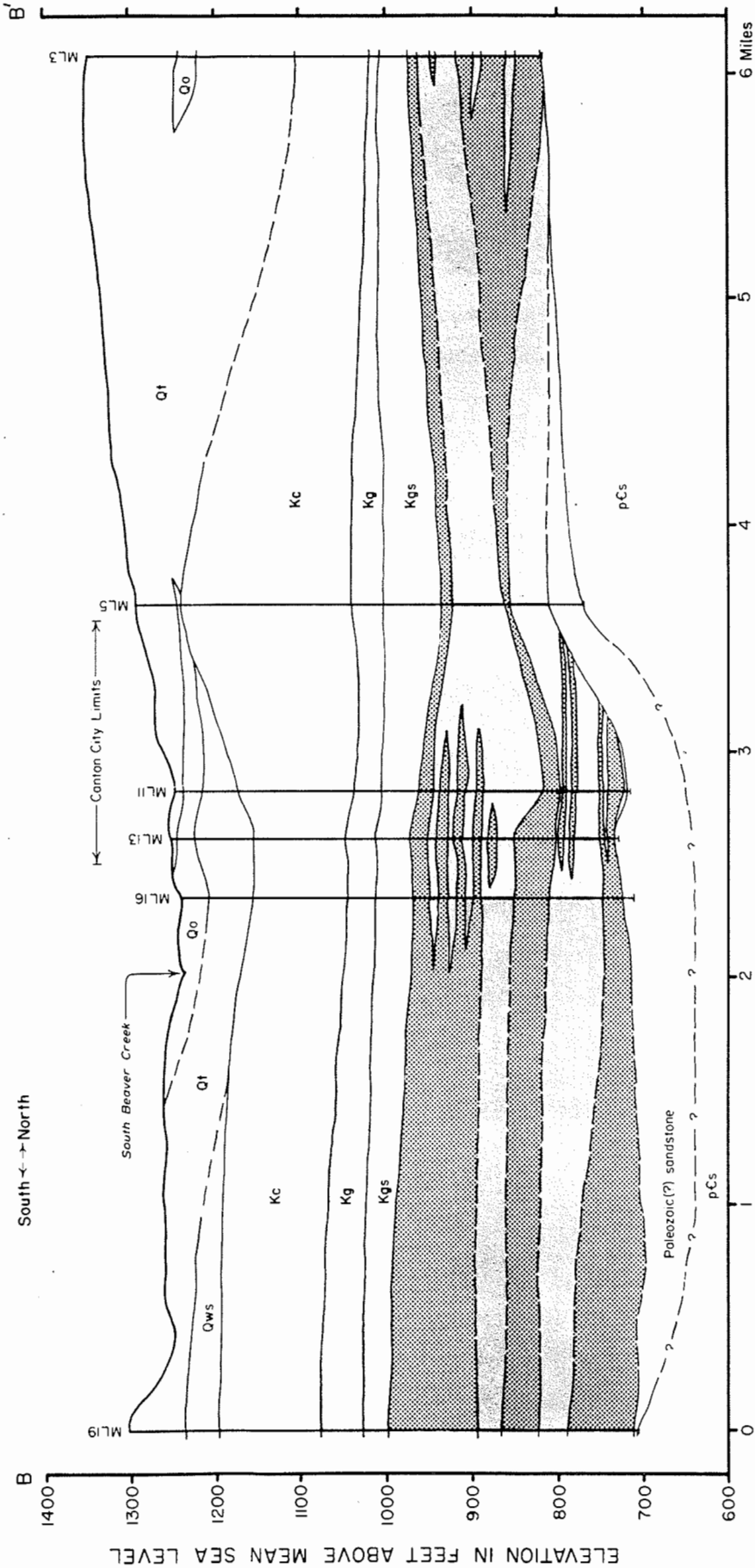
May include 1 to 3 feet of topsoil

primarily sand/sandstone

primarily clay/shale

pCs... Sioux Quartzite

Figure 3. Geologic cross section A-A'.



QUATERNARY { Q1... Glacial till
 Qo... Glacial outwash (sand and gravel) } *May include 1 to 3 feet of topsoil*

Qws... Western-derived sand
 Kn... Niobrara Formation
 Kc... Carlile Shale
 Kg... Greenhorn Limestone
 Kgs... Graneros Shale

CRETACEOUS { Kd... Dakota Formation
 primarily sand/sandstone
 primarily clay/shale

PRECAMBRIAN { pCs... Sioux Quartzite

Dakota Formation lies directly above the Paleozoic sandstone or the Sioux Quartzite and lies under glacial drift or Graneros Shale (figs. 3 and 4).

The Dakota Formation consists of interbedded sand, sandstone, clay and shale (figs. 3 and 4). This interbedded nature makes it difficult to predict a good location for a municipal well or the amount of water available.

Drilling for this project identified a portion of a sand layer at the base of the Dakota Formation which had not previously been utilized by the city of Canton for its water supply. The occurrence of this sand layer is illustrated in figures 3 and 4 in the test holes at ML 7, 10, 11, 13, 16 and 18.

Municipal-Well Installation

Prior to completion of this investigation, the city of Canton requested recommendations from the South Dakota Geological Survey regarding suitable locations for new municipal wells to be completed in the Dakota Formation. The city's request was prompted by increased water demand due to dry conditions during the summer of 1988. Three locations were subsequently recommended during this investigation. The first new municipal well was drilled and completed in July, 1988, near ML 11 in figure 2. This well was installed to pump water from the lowermost sand layer and the next thick sand layer above the lowermost layer in the Dakota Formation under the city of Canton. Two other municipal wells, near ML 7 and 13 (fig. 2), were installed in the spring of 1989 and also utilized the same two layers of sand as the first new municipal well.

Pumping Tests

Pumping tests have been conducted on two of the three new municipal wells (municipal wells 9 and 10, fig. 2). The results of the pumping tests (app. G) show a transmissivity of about 2,800 gallons per day per foot (gpd/ft) and storativity of 0.00022 near municipal well 9 (drawdown data from well R2-88-02) and a transmissivity of about 10,000 to 12,000 gpd/ft and storativity of 0.00083 near municipal well 10 (drawdown and recovery data from well R2-88-09). Values for these aquifer parameters were calculated using the Jacob straight line method.

Water Chemistry

Water-chemistry analyses were performed on 23 water samples whose locations are shown on figure 5. Seventeen of the samples were analyzed for "common" ions at the South Dakota Geological Survey laboratory in Vermillion (app. C). Of these 17 samples, 12 were from the Dakota Formation and 5 were from the Big Sioux aquifer. Four samples were analyzed for selected inorganic parameters, gross alpha and radium at the State Health Laboratory in Pierre (app. D).

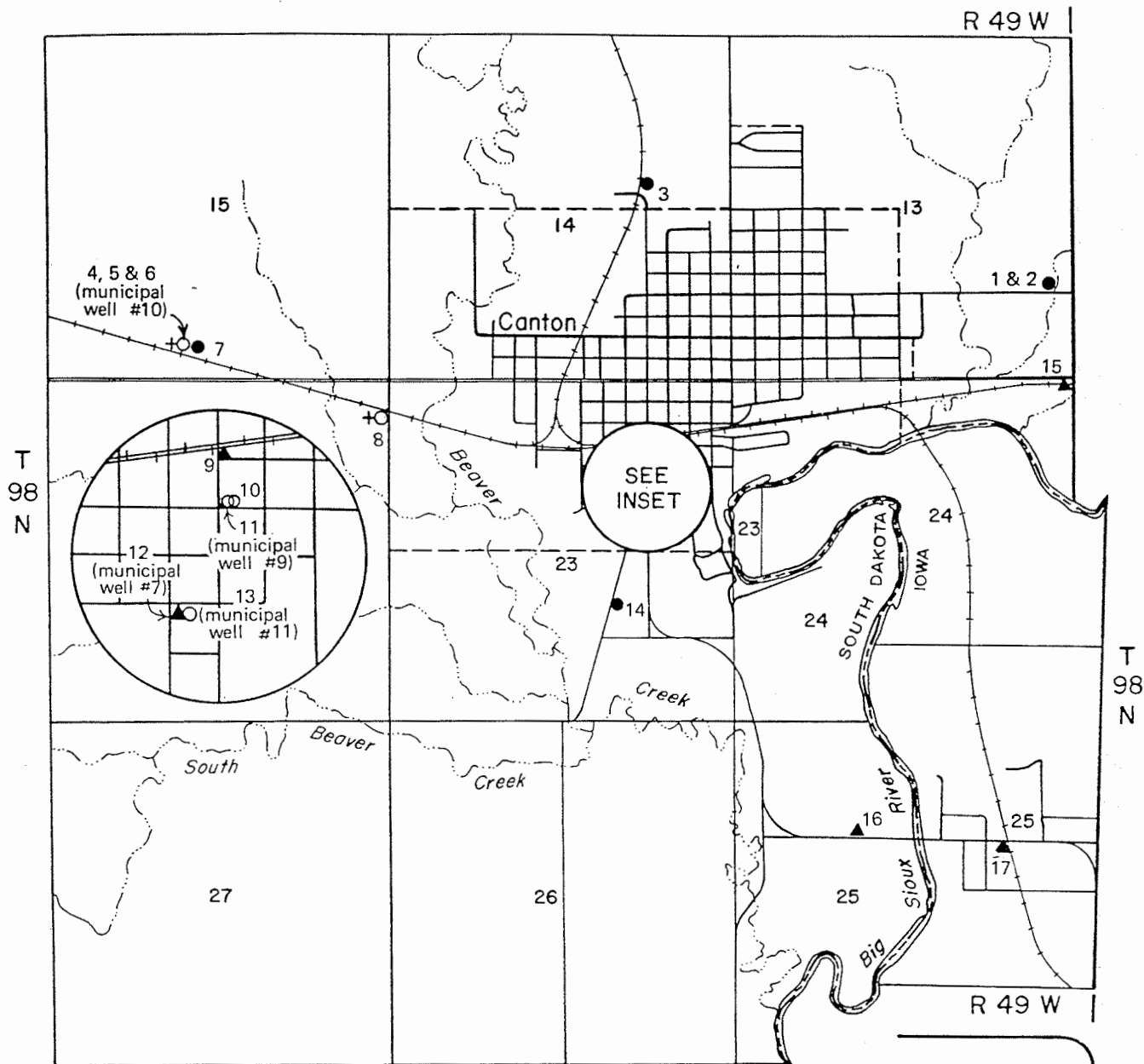


Figure 5. Locations of water samples.

- | | | | | |
|-------------------|---|----|--------------------------------------------------------------------|---------------------------------------------------------------------|
| BIG SIOUX AQUIFER | { | 9▲ | Analytical results presented in appendix C. | } Number is Water Sample Location (WSL) as explained in appendix C. |
| DAKOTA FORMATION | { | 3● | Analytical results presented in appendix C. | |
| | | 7○ | Analytical results presented in appendices C and D and in table 3. | |
| TILL | { | + | Analytical results presented in appendix E. | |

Base maps: Canton, S. Dak.-Iowa and Canton SW, S. Dak. Quadrangles, 7.5 minute series (topographic).

0 1 Mile
SCALE



Two samples were analyzed for trichloroethylene at Pace Laboratories, Inc. in Minneapolis, Minnesota (app. E).

The analyses from the South Dakota Geological Survey laboratory (app. C) showed the Dakota Formation water to be of better quality than the water from the Big Sioux aquifer. Table 2 shows that the average concentrations for calcium, magnesium, sulfate, nitrate-nitrogen, dissolved solids and hardness are higher in the Big Sioux aquifer than in the Dakota Formation. These results compare favorably with those of McMeen (1965).

Table 2. Comparison of averages for some of the water-chemistry parameters from the Big Sioux aquifer and Dakota Formation.

Parameter	Aquifer ¹	
	Big Sioux ²	Dakota Formation ³
Calcium	151	90
Magnesium	59	30
Sodium	43	128
Sulfate	364	258
Chloride	20	68
Iron ⁴	0.025	0.19
Nitrate-Nitrogen	2.75	<0.04
Dissolved Solids	863	756
Hardness	619	347

¹ Numbers represent average concentrations, in milligrams per liter, for the listed parameters.

² Averages are based on five analyses. Water sample location numbers 9, 12, 15, 16 and 17 (app. C).

³ Averages are based on seven analyses. Water sample location numbers 2, 3, 6, 8, 11, 13 and 14 (app. C). If there is more than one water sample from a well, the most recent analysis is used.

⁴ If the concentration of iron was below the detection limit of 0.05 milligrams per liter, then one-half of the value of the detection limit was used to calculate the average.

Two shallow monitoring wells were installed in till, one each at ML 6 and ML 10 (fig. 2). These wells were installed to check the shallow ground water near potential municipal well sites for possible contamination by trichloroethylene. This was done as a precaution because trichloroethylene had been found in the shallow ground water on the property of an industry near

ML 6. The possibility existed, even though remote, that during the installation and subsequent pumping of municipal wells near ML 6 and ML 10, the Dakota Formation might become contaminated with trichloroethylene. The test results of water samples from these two wells showed no detection of trichloroethylene at either well (app. E).

The State Health Laboratory analyzed water samples from new municipal wells 9 and 10 and from the monitoring wells (ML 7 and 11) at these same locations (figs. 2 and 5). The monitoring well at ML 7 is near municipal well 10 and the monitoring well at ML 11 is near municipal well 9. These samples were analyzed for selected inorganic parameters, radium 226 and 228, and gross alpha (table 3).

Table 3. Results of analyses of Dakota Formation water by the South Dakota State Health Laboratory for selected inorganic parameters and radionuclides.

Parameter	Maximum Limit ¹	Units ²	Well identification and sample-collection date			
			Well at ML 7 (R2-88-09)	Well at ML 11 (R2-88-02)	Muni- cipal well 9	Muni- cipal well 10
			07-05-88	07-05-88	08-22-88	04-13-89
Arsenic	50	ug/L	8.7	6.1	5.8	<1.0
Barium	1000	ug/L	175	132	26	13
Cadmium	10	ug/L	1.2	<1.0	<1.0	<1.0
Chromium	50	ug/L	11.0	6.7	2.0	<1.0
Lead	50	ug/L	11.7	9.2	9.4	3.6
Mercury	2	ug/L	<0.2	<0.2	<0.2	<0.2
Selenium	10	ug/L	1.2	3.4	5.1	<1.0
Silver	50	ug/L	4.6	<1.0	<1.0	<1.0
Fluoride	2.4	mg/L	1.04	0.71	1.14	0.76
Gross Alpha	15	pCi/L	---	---	---	10.5±4.5
Radium 226	---	pCi/L	2.3±0.5	3.0±0.5	4.5±0.9	1.8±0.3
Radium 228	---	pCi/L	2.9±0.5	2.5±0.8	1.3±0.7	---
Combined Total Radium 226 + 228	5	pCi/L	5.2	5.5	5.8	---

¹ U.S. Environmental Protection Agency maximum contaminant level (U.S. Environmental Protection Agency, 1985).

² ug/L = micrograms per liter, mg/L = milligrams per liter, pCi/L = picocuries per liter

See appendix D for additional information.

The only parameter over the maximum contaminant level is the combined total of radium 226 and 228 in three of the wells. Gross alpha may be right at the limit in municipal well 10 if the possible error of 4.5 picocuries per liter (pCi/L) is added to the result of 10.5 pCi/L. These samples, however, do not represent the final water distributed to Canton. The final water results from blending water from the various municipal wells. Gross alpha results for final water distributed to Canton on September 9, 1983, and October 10, 1987, were 1.0 ± 0.4 pCi/L on both dates (Dominic Jones, Canton Water and Sewer Department, personal communication, 1989). The gross alpha content on both of these dates was well below the maximum contaminant level.

Municipal wells in use prior to this study were not deep enough to draw water from the lowermost sand layer of the Dakota Formation discovered during this study. However, wells listed in table 3 do draw water from this lowermost layer. This fact and the chemistry data indicate that the high levels of radium are coming from the lowermost layer of sand in the Dakota Formation. Maintaining one or two wells in the upper layers of the Dakota Formation for blending purposes may keep the radionuclide level below the required 5 pCi/L.

CONCLUSIONS AND RECOMMENDATIONS

The Dakota Formation was found to contain enough layers of sand and sandstone in the vicinity of Canton to satisfy the city's demand for more water. During the course of the investigation three sites were recommended for construction of new municipal wells. The city of Canton drilled and completed municipal wells 9, 10 and 11 at the recommended locations. Water throughout the formation was found to be of good quality, except for the possibility of excess levels of radium.

Elevated radium levels are found in water from the lowermost layer of sand of the Dakota Formation under the city of Canton. Comparison of test results from the wells tapping the lowermost layer with the municipal wells not completed in the lowermost layer bear this out. Because the lowermost layer is higher in radium, the city is advised to have at least one or two wells completed in the upper layers only. The waters can then be mixed to keep the combined radium 226 and 228 levels within the maximum contaminant limit for municipal use.

It is also recommended the city test for the combined total of radium 226 and 228 as new wells are connected to the water-supply system. This is to ensure that the final water distributed to Canton stays below the maximum contaminant limit of 5 pCi/L.

To help determine the optimum pumping rate of the city wells, the city should measure water levels monthly. The measurements should be taken at the monitoring wells installed by the South Dakota Geological Survey to monitor the potentiometric surface of the Dakota Formation. This will help determine mutual interference among municipal wells. If there is too much interference among wells, water levels may be lowered to a point where pumping rates will decline. If the interference among municipal wells is too great, it is recommended that older wells should not be replaced with new wells at the same location. Rather, new wells should be placed at some distance from the existing municipal wells to limit interference among wells to an acceptable amount. In

order to space the wells farther apart, the city may have to look outside of its municipal boundaries for additional well sites.

The recommended areas for possible future well sites are located south, southwest or west of the city in sections 22, 24, 25, 26, 27, 34, 35, 36 and S½ section 23 in Township 98 North, Range 49 West. The layers of sand and sandstone appear to be thickest in these areas, as inferred from figures 3 and 4. More drilling and testing in these areas would be necessary, however, to delineate thickness of the layers, quality of water and availability of water prior to installation of any new municipal well.

Due to the decline in pumping rates in the past, it is recommended that the city establish a good maintenance program for the municipal wells. Such a program would minimize the effects of formation and well-screen plugging caused by minerals precipitating from the water (Gass and others, 1980).

REFERENCES

- Gass, T. E., Bennett, T. W., Miller, J., Miller, R., and the National Water Well Association, 1980, *Manual of water well maintenance and rehabilitation technology*: Ada, Oklahoma, Robert S. Kerr Environmental Research Laboratory, National Environmental Research Center, U.S. Environmental Protection Agency.
- McMeen, James A., 1965, *Ground water supply for the city of Canton, South Dakota*: South Dakota Geological Survey Special Report 31.
- U.S. Environmental Protection Agency, 1985, *National interim primary drinking water regulations - maximum contaminant levels for inorganic chemicals*: Code of Federal Regulations, Title 40, Part 141, Section 141.11.

APPENDIX A

Logs of Test Holes and Monitoring Wells

MAP LOCATION (ML)

A number arbitrarily assigned to the log according to the order in which it is listed (see **LEGAL LOCATION** and **LOCATION**). This number corresponds to the numbers listed on figure 2.

LEGAL LOCATION and LOCATION

The logs are listed by smallest township number, then the smallest range number, the smallest section number and then by quarter section: NE = A; NW = B; SW = C; SE = D. A comparison of **LEGAL LOCATION** and **LOCATION** is as follows. A **LEGAL LOCATION** of NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 99 N., R. 64 W. is the same as a **LOCATION** of 099N-64W-30CADB. In several **LOCATIONS**, the smallest quarter section is followed by the number 1 or 2 which indicates that more than one log may exist for that particular location.

LATITUDE and LONGITUDE

The format is DD.MMSS where D is degrees, M is minutes and S is seconds.

DRILLING COMPANY

SDGS is an abbreviation for South Dakota Geological Survey.

TOTAL DRILL HOLE DEPTH, SCREEN LENGTH, TOTAL CASING AND SCREEN and CASING STICK-UP

The numbers are presented in feet.

SCREEN TYPE and CASING TYPE

PVC is an abbreviation for polyvinyl chloride. MFG. is an abbreviation for manufactured and indicates a product that is commercially available. **SLOT SIZE** is the size, in inches, of the openings on the screen. SCH. is an abbreviation for schedule and refers to casing thickness.

CASING TOP ELEVATION and GROUND SURFACE ELEVATION

The numbers are presented in feet above mean sea level. I - the elevation was determined using a surveying instrument. T - the elevation was estimated from a 7.5 minute series topographic map.

CASING DIAMETER

The numbers are presented in inches.

County: LINCOLN
 Map Location: 1
 Legal Location: NW SW SE SE sec. 17, T. 098 N., R. 48 W.
 Latitude: 43.1808
 Land Owner:
 Project: SIOUX FALLS-BRANDON STUDY
 Drilling Company: SDGS
 Driller: E. KOGLIN/M. KOFFLER
 Geologist: D. ILES
 Date Drilled: 08-12-1980
 Ground Surface Elevation: 1241.00 T
 Total Drill Hole Depth: 440
 Water Rights Well: LN-80M
 Other Well Name:
 Basin: BIG SIOUX
 Management Unit:
 Screen Type: PVC, MFG.
 Casing Type: PVC
 Casing Top Elevation: 1244.10 I
 Casing Stick-up:
 Well Maintenance Date:
 USGS Hydrological Unit Code: 10170203
 Electric Log Information:
 Spontaneous Potential: X
 Natural Gamma: X
 Samples:

Location: 098N-48W-17DDCB 1

Longitude: 96.3203

Driller's Log:
 Geologist's Log: X
 Drilling Method: ROTARY

Test Hole Number: SFB-185
 SDGS Well Name:

Aquifer: DAKOTA

Screen Length: 12.0
 Casing Diameter: 2.0

Total Casing and Screen:

Single Point Resistivity: X
 Extra:

Bottom of well at 389 feet. Two 6-foot sandpoints glued together.

0 - 3	Topsoil
3 - 10	Clay, tan, silty (till?)
10 - 22	Sand and gravel, fine sand to medium gravel
22 - 58	Clay, light-gray, silty, sandy (till?)
58 - 87	Sand, fine to medium; with some gravel near the bottom of the interval, the sand is composed of quartz and some green mineral (western-derived sand)
87 - 136	Clay, dark-gray-brown, slightly sandy; slightly calcareous (Carlisle Shale)
136 - 169	Clay, medium-brown, silty; very calcareous (Greenhorn Limestone)
169 - 216	Clay, medium-gray, silty (Graneros Shale)
216 - 236	Sand, very fine; partially cemented (Dakota Formation)
236 - 238	Clay, gray (Dakota Formation)
238 - 242	Sand, very fine (Dakota Formation)
242 - 246	Clay, gray; some sand (Dakota Formation)
246 - 257	Sand, very fine (Dakota Formation)
257 - 264	Clay, gray, sandy (Dakota Formation)
264 - 270	Sand, very fine (Dakota Formation)
270 - 276	Sand, very fine, clayey (Dakota Formation)
276 - 283	Clay, gray (Dakota Formation)
283 - 289	Sand, very fine, clayey (Dakota Formation)
289 - 314	Sand, very fine (Dakota Formation)
314 - 328	Sand, very fine, clayey (Dakota Formation)
328 - 368	Sand, very fine (Dakota Formation)
368 - 424	Sand, very fine; some white clay in the samples, the electric log shows this sand to be different in character from the sandstone in interval from 328 to 368 feet (Dakota Formation)
424 - 440	Quartzite, white to pink; weathered, with some white clay, the quartzite chips

appeared to be getting fresher with depth (Sioux Quartzite)

* * * * *

County: LINCOLN
Map Location: 2
Legal Location: NE SE SE SW sec. 18, T. 098 N., R. 48 W.
Latitude: 43.1807
Land Owner: CANTON HOSPITAL
Project:
Drilling Company: MCCARTHY WELL COMPANY
Driller:
Geologist:
Date Drilled: 10-27-1964
Ground Surface Elevation: 1255.00 T
Total Drill Hole Depth: 450
Water Rights Well:
Other Well Name: WELL 2
Basin: BIG SIOUX
Management Unit:
Screen Type:
Casing Type:
Casing Top Elevation:
Casing Stick-up:
Well Maintenance Date:
USGS Hydrological Unit Code: 10170203
Electric Log Information:
Spontaneous Potential: X
Natural Gamma:
Samples:

Location: 098N-48W-18CDDA

Longitude: 96.3334

Driller's Log:
Geologist's Log:
Drilling Method: ROTARY

Test Hole Number:
SDGS Well Name:

Aquifer: DAKOTA

Screen Length:
Casing Diameter:

Total Casing and Screen:

Single Point Resistivity: X
Extra:

This well is not used anymore.

0	-	90	Clay (till)
90	-	177	Shale (Carlile Shale)
177	-	211	Limestone (Greenhorn Limestone)
211	-	269	Shale (Graneros Shale)
269	-	280	Shale, very sandy (Dakota Formation)
280	-	305	Sand (Dakota Formation)
305	-	323	Shale (Dakota Formation)
323	-	376	Sand, shaley from 352 feet (Dakota Formation)
376	-	402	Shale (Dakota Formation)
402	-	427	Sandstone (Dakota Formation)
427	-	450	Quartzite; weathered (Sioux Quartzite?)

No driller's log was available for this hole. Lithologic interpretations are by L. Frykman (05-08-1989) and are based on the electric log and other nearby test hole data.

* * * * *

County: LINCOLN
Map Location: 3
Legal Location: NW NW NW NW sec. 01, T. 098 N., R. 49 W.
Latitude: 43.2038
Land Owner:

Location: 098N-49W-01BBBB

Longitude: 96.3517

Project: SIOUX FALLS-BRANDON STUDY

Drilling Company: SDGS
Driller: M. KOFFLER/E. KOGLIN
Geologist: D. ILES
Date Drilled: 07-11-1980
Ground Surface Elevation: 1345.00 T
Total Drill Hole Depth: 528
Water Rights Well: LN-80K
Other Well Name:
Basin: BIG SIOUX
Management Unit:
Screen Type: PVC, MFG.
Casing Type: PVC
Casing Top Elevation: 1348.03 I
Casing Stick-up:
Well Maintenance Date:
USGS Hydrological Unit Code: 10170203
Electric Log Information:
Spontaneous Potential: X
Natural Gamma:
Samples:

Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY

Test Hole Number: SFB-170
SDGS Well Name:

Aquifer: DAKOTA

Screen Length: 10.0
Casing Diameter: 2.0

Total Casing and Screen:

Single Point Resistivity: X
Extra:

Bottom of well at 517 feet. Two 5-foot sandpoints glued together.

0	-	2	Topsoil
2	-	23	Clay, tan, silty, sandy, pebbly (till)
23	-	35	Clay, medium-gray, silty, sandy, pebbly (till)
35	-	45	Clay, gray; sandier than interval from 23 to 35 feet (till)
45	-	52	Clay, gray, sandy, pebbly (till)
52	-	104	Clay, gray, very sandy and pebbly (till)
104	-	125	Sand and gravel, fine sand to fine gravel; with a rock from 118 to 119 feet
125	-	240	Clay, gray, very sandy and gravelly (till)
240	-	328	Clay, gray; some sand and pebbles (Carlile Shale)
328	-	339	Clay, brown; calcareous, platy, with white flecks (Greenhorn Limestone)
339	-	370	Clay, dark-gray; slightly calcareous (Graneros Shale)
370	-	382	Sand, fine to medium (Dakota Formation)
382	-	396	Clay, gray; interbedded with sand (Dakota Formation)
396	-	404	Sand (Dakota Formation)
404	-	419	Clay, gray; interbedded with sand, with a hard cemented layer from 416 to 417 feet (Dakota Formation)
419	-	436	Clay, gray; with some sand (Dakota Formation)
436	-	447	Sand; hard cemented layer at 443 feet (Dakota Formation)
447	-	456	Clay, gray; some sand (Dakota Formation)
456	-	488	Sand; hard layers from 456 to 458 feet and from 484 to 485 feet (Dakota Formation)
488	-	496	Clay, gray; with some sand (Dakota Formation)
496	-	527	Sand; slightly cemented, harder from 517 to 527 feet (Dakota Formation)
527	-	528	Quartzite; hard, there was actually no penetration in this interval and no sample was obtained (Sioux Quartzite)

* * * *

County: LINCOLN
Map Location: 4
Legal Location: SE SE NE SE sec. 13, T. 098 N., R. 49 W.

Location: 098N-49W-13DADD

Latitude: 43.1817
 Land Owner:
 Project: CANTON CITY STUDY-1988
 Drilling Company: SDGS
 Driller: T. MCCUE
 Geologist: L. FRYKMAN
 Date Drilled: 05-04-1988
 Ground Surface Elevation: 1263.98 I
 Total Drill Hole Depth: 464
 Water Rights Well:
 Other Well Name:
 Basin: BIG SIOUX
 Management Unit:
 Screen Type: PVC, MFG., SLOT SIZE 0.025 IN.
 Casing Type: PVC, SCH. 80
 Casing Top Elevation: 1266.66 I
 Casing Stick-up: 2.68
 Well Maintenance Date:
 USGS Hydrological Unit Code: 10170203
 Electric Log Information:
 Spontaneous Potential: X
 Natural Gamma: X
 Samples:

Longitude: 96.3414

 Driller's Log:
 Geologist's Log: X
 Drilling Method: ROTARY

 Test Hole Number: R2-88-03
 SDGS Well Name: R2-88-03

 Aquifer: DAKOTA

 Screen Length: 10.0
 Casing Diameter: 2.0

 Total Casing and Screen: 462.7

 Single Point Resistivity: X
 Extra:

43 feet of blank casing placed on bottom, not open to screen, screened from 417 to 407 feet.
 Filter pack from 461 to 395 feet.

0	-	1	Clay, black, silty (topsoil)
1	-	17	Clay, yellowish-brown, silty, sandy, pebbly, cobbly; cobbles are chalk; very sandy from 15 to 17 feet (till)
17	-	44	Clay, gray, silty, sandy, pebbly; sand layer from 24 to 26 feet; unoxidized (till)
44	-	61	Sand and gravel, brown, medium to coarse sand, fine to coarse gravel
61	-	281	Clay, gray to dark-gray, silty, sandy, pebbly; unoxidized (till)
281	-	290	Cobbles, small to large
290	-	297	Silt, light-gray, sandy (Dakota Formation)
297	-	301	Sand, light-gray, fine, silty (Dakota Formation)
301	-	310	Sand, gray-tan, fine, clayey (Dakota Formation)
310	-	318	Clay, gray (Dakota Formation)
318	-	330	Sand, gray, fine; organic rich from 328 to 330 feet (Dakota Formation)
330	-	344	Clay, gray, sandy (Dakota Formation)
344	-	353	Sand, gray-brown, fine (Dakota Formation)
353	-	358	Clay, brown-gray, silty (Dakota Formation)
358	-	371	Clay, gray, sandy (Dakota Formation)
371	-	393	Sand, gray-brown, fine (Dakota Formation)
393	-	402	Sand, gray, clayey (Dakota Formation)
402	-	421	Sand, gray-brown, fine (Dakota Formation)
421	-	426	Clay, gray, silty; hard (Dakota Formation)
426	-	434	Clay, gray, sandy (Dakota Formation)
434	-	446	Sand, gray-brown, fine (Dakota Formation)
446	-	459	Clay, brown-gray, sandy; decreasing sand content toward bottom of interval (Dakota Formation)
459	-	464	Quartzite; weathered

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County: LINCOLN
 Map Location: 5
 Legal Location: NE SE SW NE sec. 14, T. 098 N., R. 49 W.
 Latitude: 43.1833
 Land Owner:
 Project: CANTON CITY STUDY-1988
 Drilling Company: SDGS
 Driller: T. MCCUE
 Geologist: L. FRYKMAN
 Date Drilled: 04-21-1988
 Ground Surface Elevation: 1292.71 I
 Total Drill Hole Depth: 525.1
 Water Rights Well:
 Other Well Name:
 Basin: BIG SIOUX
 Management Unit:
 Screen Type: PVC, MFG., SLOT SIZE 0.020 IN.
 Casing Type: PVC, SCH. 80
 Casing Top Elevation: 1295.28 I
 Casing Stick-up: 2.57
 Well Maintenance Date:
 USGS Hydrological Unit Code: 10170203
 Electric Log Information:
 Spontaneous Potential:
 Natural Gamma: X
 Samples:

Location: 098N-49W-14ACDA

Longitude: 96.3538

Driller's Log:
 Geologist's Log: X
 Drilling Method: ROTARY

Test Hole Number: R2-88-01
 SDGS Well Name: R2-88-01

Aquifer: DAKOTA

Screen Length: 5.0
 Casing Diameter: 2.0

Total Casing and Screen: 518.6

Single Point Resistivity: X
 Extra:

23 feet of blank casing, closed to the screen, was placed from 516 to 493 feet, screen placed from 493 to 488 feet.

0	-	3	Silt, black (topsoil)
3	-	10	Clay, light-brown, silty (loess?)
10	-	21	Clay, brown, silty, sandy, pebbly; oxidized (till)
21	-	48	Clay, gray, silty, sandy, pebbly; unoxidized (till)
48	-	51	Sand, gray-brown, medium to coarse
51	-	251	Shale, gray to dark-gray (Carlile Shale)
251	-	287	Limestone, brown to gray-brown; calcareous (Greenhorn Limestone)
287	-	356	Shale, dark-gray-brown (Graneros Shale)
356	-	370	Sand, light-gray, fine (Dakota Formation)
370	-	430	Clay, gray, silty (Dakota Formation)
430	-	436	Sand, light-gray, fine (Dakota Formation)
436	-	455	Clay, gray, silty (Dakota Formation)
455	-	482	Clay, white (Dakota Formation?)
482	-	525	Sandstone, whitish-brown, fine; cemented (Paleozoic?)
525	-	525.1	Quartzite; no penetration was made

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County: LINCOLN
 Map Location: 6
 Legal Location: NW SE SE SW sec. 15, T. 098 N., R. 49 W.
 Latitude: 43.1807
 Land Owner:
 Project: CANTON CITY STUDY-1988
 Drilling Company: SDGS

Location: 098N-49W-15CDDDB

Longitude: 96.3713

Driller: D. GRAU
Geologist: L. FRYKMAN
Date Drilled: 07-13-1988
Ground Surface Elevation: 1284.20 I
Total Drill Hole Depth: 15
Water Rights Well:
Other Well Name:
Basin: BIG SIOUX
Management Unit:
Screen Type: PVC, MFG., SLOT SIZE 0.016 IN.
Casing Type: PVC, SCH. 80
Casing Top Elevation: 1287.14 I
Casing Stick-up: 2.94
Well Maintenance Date:
USGS Hydrological Unit Code: 10170203
Electric Log Information:
Spontaneous Potential:
Natural Gamma:
Samples:

0	-	3	Clay, black, silty; organic (topsoil)
3	-	5	Clay, yellowish-green-light-brown, very silty, slightly pebbly
5	-	9	Clay, yellowish-light-brown, silty, sandy, pebbly; saturated at 5.5 feet
9	-	15	Clay, reddish-light-brown, silty, slightly sandy, very pebbly; much oxidized iron; quite layered

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County: LINCOLN
Map Location: 7
Legal Location: NW SE SE SW sec. 15, T. 098 N., R. 49 W.
Latitude: 43.1808
Land Owner:
Project: CANTON CITY STUDY-1988
Drilling Company: SDGS
Driller: T. MCCUE
Geologist: L. FRYKMAN
Date Drilled: 06-16-1988
Ground Surface Elevation: 1284.01 I
Total Drill Hole Depth: 595
Water Rights Well:
Other Well Name:
Basin: BIG SIOUX
Management Unit:
Screen Type: PVC, MFG., SLOT SIZE 0.20 IN.
Casing Type: PVC, SCH. 80
Casing Top Elevation: 1286.03 I
Casing Stick-up: 2.02
Well Maintenance Date:
USGS Hydrological Unit Code: 10170203
Electric Log Information:
Spontaneous Potential:
Natural Gamma: X
Samples:

Driller's Log:
Geologist's Log: X
Drilling Method: AUGER
Test Hole Number: A2-88-177
SDGS Well Name: A2-88-177
Aquifer: TILL
Screen Length: 10.0
Casing Diameter: 2.0
Total Casing and Screen: 18.0
Single Point Resistivity:
Extra:

Location: 098N-49W-15CDDDB 1

Longitude: 96.3712

Driller's Log:
Geologist's Log: X
Drilling Method: ROTARY
Test Hole Number: R2-88-09
SDGS Well Name: R2-88-09
Aquifer: DAKOTA
Screen Length: 10.0
Casing Diameter: 2.0
Total Casing and Screen: 577.0
Single Point Resistivity: X
Extra:

20 feet of blank casing placed on bottom, not open to screen, screened from 555 to 545 feet.
Filter pack from 588 to 514 feet.

0	-	3	Clay, black, silty (topsoil)
3	-	5	Clay, light-yellowish-brown, sandy, pebbly, cobbly; cobbles are chalk
5	-	8	Sand, brown, fine to medium
8	-	26	Clay, yellowish-brown, silty, sandy, pebbly; oxidized (till)
26	-	48	Clay, gray, silty, sandy, pebbly; unoxidized (till)
48	-	250	Clay, dark-gray; greasy (Carlile Shale)
250	-	286	Limestone, dark-gray to light-gray; abundant shell fragments; very calcareous (Greenhorn Limestone)
286	-	326	Shale, light-gray (Graneros Shale)
326	-	332	Sand, light-gray-brown (Dakota Formation)
332	-	338	Sand, clayey (Dakota Formation)
338	-	343	Sand, light-gray-brown (Dakota Formation)
343	-	350	Clay and sand interbedded (Dakota Formation)
350	-	360	Sand, light-gray-brown (Dakota Formation)
360	-	384	Sand, clayey (Dakota Formation)
384	-	396	Clay, brown-gray, silty (Dakota Formation)
396	-	412	Sand, gray-brown; silty layers toward bottom (Dakota Formation)
412	-	419	Clay, brown-gray, silty (Dakota Formation)
419	-	423	Sand, clayey (Dakota Formation)
423	-	444	Clay, brown-gray, silty (Dakota Formation)
444	-	493	Sand, gray-brown to pinkish-brown, fine to coarse; cemented from 471 to 490 feet (Dakota Formation)
493	-	503	Clay, white (Dakota Formation)
503	-	513	Clay, dark-gray; hard (Dakota Formation)
513	-	584	Sand, pinkish-white, fine to medium (Dakota Formation)
584	-	586	Clay, white; hard (Dakota Formation)
586	-	595	Sandstone, pinkish-white to greenish-white, fine-grained (Paleozoic?)

Cored sample from 590 to 595 feet.

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County: LINCOLN

Map Location: 8

Legal Location: NE NE NE NE sec. 20, T. 098 N., R. 49 W.

Latitude: 43.1801

Land Owner:

Project: SIOUX FALLS-BRANDON STUDY

Drilling Company: SDGS

Driller: E. KOGLIN/M. KOFFLER

Geologist: D. ILES

Date Drilled: 08-11-1980

Ground Surface Elevation: 1324.00 T

Total Drill Hole Depth: 521

USGS Hydrological Unit Code: 10170203

Electric Log Information:

Spontaneous Potential: X

Natural Gamma: X

Samples:

0	-	3	Topsoil
3	-	27	Clay, tan, silty, sandy, pebbly (till)

Location: 098N-49W-20AAAA

Longitude: 96.3855

Driller's Log:

Geologist's Log: X

Drilling Method: ROTARY

Test Hole Number: SFB-184

Single Point Resistivity: X

Extra:

27 - 50 Clay, medium-gray, silty, sandy, pebbly, very shaley (till)
 50 - 58 Sand; probably clayey
 58 - 63 Chalk, white; hard, very calcareous (Niobrara Formation)
 63 - 82 Clay, dark-brown, silty; very calcareous (Niobrara Formation)
 82 - 312 Clay, light- to medium-gray, silty; hard (Carlile Shale)
 312 - 350 Clay, medium-gray-brown; very calcareous (Greenhorn Limestone)
 350 - 368 Clay, gray (Graneros Shale)
 368 - 387 Clay, gray, sandy; hard layer from 368 to 369 feet (Graneros Shale)
 387 - 408 Sand; interbedded with gray clay (Dakota Formation)
 408 - 414 Sand, white; cemented, hard (Dakota Formation)
 414 - 416 Clay, gray (Dakota Formation)
 416 - 418 Sand, white; cemented, hard (Dakota Formation)
 418 - 464 Sand, white, very fine to fine; some clay and coal (Dakota Formation)
 464 - 468 Clay, gray (Dakota Formation)
 468 - 474 Sand, fine (Dakota Formation)
 474 - 480 Clay, gray (Dakota Formation)
 480 - 484 Sand, fine (Dakota Formation)
 484 - 491 Clay, gray, sandy (Dakota Formation)
 491 - 493 Clay, gray (Dakota Formation)
 493 - 495 Clay, gray, sandy (Dakota Formation)
 495 - 520 Sand, fine (Dakota Formation)
 520 - 521 Quartzite; hard, there was actually no penetration in this interval and no sample was obtained (Sioux Quartzite)

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County: LINCOLN	Location: 098N-49W-22AAAD
Map Location: 9	
Legal Location: SE NE NE NE sec. 22, T. 098 N., R. 49 W.	
Latitude: 43.1758	Longitude: 96.3632
Land Owner:	
Project: CANTON CITY STUDY-1988	
Drilling Company: SDGS	
Driller: S. PENCE	Driller's Log:
Geologist: L. FRYKMAN	Geologist's Log: X
Date Drilled: 07-13-1988	Drilling Method: AUGER
Ground Surface Elevation: 1265.00 T	
Total Drill Hole Depth: 17	Test Hole Number: A2-88-178
Water Rights Well:	SDGS Well Name: A2-88-178
Other Well Name:	
Basin: BIG SIOUX	Aquifer: TILL
Management Unit:	
Screen Type: PVC, MFG., SLOT SIZE 0.016 IN.	Screen Length: 10.0
Casing Type: PVC, SCH. 80	Casing Diameter: 2.0
Casing Top Elevation: 1266.00 T	
Casing Stick-up: 1.20	Total Casing and Screen: 18.0
Well Maintenance Date:	
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity:
Natural Gamma:	Extra:
Samples:	

0 - 3 Silt, orange-brown, very clayey, slightly pebbly; oxidized; dry and powdery (alluvium)

3 - 5 Sand, orange-light-brown, fine to coarse, very silty, very clayey; oxidized
 5 - 7 Sand and gravel, dark-brown, fine to coarse sand, fine to medium gravel, silty, clayey; oxidized
 7 - 9 Gravel, brown, coarse; poor return
 9 - 14 Clay, gray, silty, pebbly; unoxidized
 14 - 16.5 Clay, gray, silty, slightly pebbly; moist; unoxidized

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County: LINCOLN	Location: 098N-49W-22AAAD 1
Map Location: 10	
Legal Location: SE NE NE NE sec. 22, T. 098 N., R. 49 W.	
Latitude: 43.1808	Longitude: 96.3532
Land Owner:	
Project: CANTON CITY STUDY-1988	
Drilling Company: SDGS	
Driller: T. MCCUE/D. IVERSON	Driller's Log:
Geologist: L. FRYKMAN	Geologist's Log: X
Date Drilled: 08-15-1988	Drilling Method: ROTARY
Ground Surface Elevation: 1266.60 I	
Total Drill Hole Depth: 565	Test Hole Number: R2-88-22
Water Rights Well:	SDGS Well Name: R2-88-22
Other Well Name:	
Basin: BIG SIOUX	Aquifer: DAKOTA
Management Unit:	
Screen Type: PVC, MFG., SLOT SIZE 0.016 IN.	Screen Length: 20.0
Casing Type: PVC, SCH. 80	Casing Diameter: 2.0
Casing Top Elevation: 1269.24 I	
Casing Stick-up: 2.64	Total Casing and Screen: 450.6
Well Maintenance Date:	
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity: X
Natural Gamma: X	Extra:
Samples:	

10 feet of blank casing on bottom, not open to screen, screened from 438 to 418 feet.
 Filter pack from 444 to 280 feet.

0 - 3 Clay, black, silty (topsoil)
 3 - 4 Clay, gray, silty, sandy
 4 - 11 Sand and gravel, brown, fine to coarse sand, fine to medium gravel
 11 - 14 Clay, light-gray, silty, sandy, pebbly; unoxidized (till)
 14 - 30 Clay, dark-gray, silty, sandy, pebbly; unoxidized (till)
 30 - 36 Sand and gravel, grayish-brown, fine to coarse sand, fine to medium gravel
 36 - 70 Clay, gray to dark-gray, silty, sandy, pebbly; unoxidized (till)
 70 - 222 Shale, dark-gray; greasy (Carlisle Shale)
 222 - 257 Limestone, brownish-gray, silty; abundant shells (Greenhorn Limestone)
 257 - 299 Shale, gray to light-gray (Graneros Shale)
 299 - 319 Sand, light-gray, fine (Dakota Formation)
 319 - 327 Clay, gray, sandy (Dakota Formation)
 327 - 360 Sand, silty, fine (Dakota Formation)
 360 - 385 Clay, light-gray, sandy (Dakota Formation)
 385 - 389 Sand, light-gray, fine (Dakota Formation)
 389 - 397 Clay, light-gray (Dakota Formation)

397 - 399 Sand, fine (Dakota Formation)
 399 - 415 Clay, light-gray (Dakota Formation)
 415 - 456 Sand, grayish-brown, fine; hard layer from 437 to 439 feet (Dakota Formation)
 456 - 466 Clay, black; organic rich (Dakota Formation)
 466 - 512 Clay, brownish-gray; with some interbedded sand layers (Dakota Formation)
 512 - 520 Sand, grayish-brown, fine (Dakota Formation)
 520 - 522 Clay, white, silty (Dakota Formation)
 522 - 565 Sandstone (Dakota Formation)

* * * *

County: LINCOLN	Location: 098N-49W-23AACD
Map Location: 11	
Legal Location: SE SW NE NE sec. 23, T. 098 N., R. 49 W.	
Latitude: 43.1751	Longitude: 96.3533
Land Owner:	
Project: CANTON CITY STUDY-1988	
Drilling Company: SDGS	
Driller: T. MCCUE	Driller's Log:
Geologist: L. FRYKMAN	Geologist's Log: X
Date Drilled: 04-28-1988	Drilling Method: ROTARY
Ground Surface Elevation: 1247.24 I	
Total Drill Hole Depth: 530	Test Hole Number: R2-88-02
Water Rights Well:	SDGS Well Name: R2-88-02
Other Well Name:	
Basin: BIG SIOUX	Aquifer: DAKOTA
Management Unit:	
Screen Type: PVC, MFG., SLOT SIZE 0.025 IN.	Screen Length: 10.0
Casing Type: PVC, SCH. 80	Casing Diameter: 2.0
Casing Top Elevation: 1249.57 I	
Casing Stick-up: 2.33	Total Casing and Screen: 526.7
Well Maintenance Date:	
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity: X
Natural Gamma: X	Extra:
Samples:	

6.4 feet of blank casing on bottom, not open to screen. Screened from 518 to 508 feet.

0 - 2 Clay, black, silty (topsoil)
 2 - 8 Clay, yellowish-brown, silty
 8 - 15 Sand, brown, fine to medium
 15 - 35 Sand and gravel, brown, fine to coarse sand, fine to coarse gravel
 35 - 73 Clay, gray, silty, sandy, pebbly; unoxidized (till)
 73 - 209 Shale, gray to dark-gray; greasy (Carlile Shale)
 209 - 239 Limestone, dark-gray to gray-brown; hard (Greenhorn Limestone)
 239 - 283 Shale, gray to blue-gray (Graneros Shale)
 283 - 302 Sand, brown-gray, fine (Dakota Formation)
 302 - 308 Clay, brown-gray, silty (Dakota Formation)
 308 - 318 Sand, gray-brown, fine (Dakota Formation)
 318 - 331 Clay, brown-gray, silty (Dakota Formation)
 331 - 340 Sand, gray-brown, fine (Dakota Formation)
 340 - 354 Clay, black, silty (Dakota Formation)
 354 - 360 Sand, gray-brown, fine (Dakota Formation)

360	-	429	Clay, gray-brown, silty (Dakota Formation)
429	-	448	Sand, gray-brown, fine (Dakota Formation)
448	-	451	Clay, white; hard (Dakota Formation)
451	-	456	Sand, gray-brown, fine (Dakota Formation)
456	-	463	Clay (Dakota Formation)
463	-	468	Sand, gray-brown, fine (Dakota Formation)
468	-	496	Clay, gray-brown, silty (Dakota Formation)
496	-	498	Sand (Dakota Formation)
498	-	504	Clay, gray-brown, silty (Dakota Formation)
504	-	522	Sand, gray-brown, fine (Dakota Formation)
522	-	526	Clay, white, silty (Dakota Formation)
526	-	530	Sandstone, whitish-brown, fine (Paleozoic?)

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County: LINCOLN

Location: 098N-49W-23ABDC

Map Location: 12

Legal Location: SW SE NW NE sec. 23, T. 098 N., R. 49 W.

Latitude: 43.1752

Longitude: 96.3545

Land Owner:

Project:

Drilling Company: HURON DRILLING

Driller: L. PETERSON JR.

Driller's Log:

Geologist:

Geologist's Log: X

Date Drilled: 04-26-1977

Drilling Method: ROTARY

Ground Surface Elevation: 1253.22 I

Total Drill Hole Depth: 480

Test Hole Number:

Water Rights Well:

SDGS Well Name:

Other Well Name: CITY 8

Basin: BIG SIOUX

Aquifer: DAKOTA

Management Unit:

Screen Type: STAINLESS STEEL, 5-IN. I.D.

Screen Length: 45.0

Casing Type: STEEL

Casing Diameter: 10.0

Casing Top Elevation: 1253.72 I

Casing Stick-up: 0.50

Total Casing and Screen: 475.5

Well Maintenance Date:

USGS Hydrological Unit Code: 10170203

Electric Log Information:

Spontaneous Potential: X

Single Point Resistivity: X

Natural Gamma: X

Extra:

Samples:

Huron Drilling, Canton City Test #2 - 1977; completed as City Well 8.

0	-	1	Clay, black, silty (topsoil)
1	-	18	Clay, yellowish-brown, silty, sandy, pebbly; oxidized (till)
18	-	67	Clay, gray, silty, sandy, pebbly; unoxidized (till)
67	-	199	Shale; greasy (Carlile Shale)
199	-	232	Limestone (Greenhorn Limestone)
232	-	275	Shale (Graneros Shale)
275	-	293	Sand, fine (Dakota Formation)
293	-	304	Shale (Dakota Formation)
304	-	318	Sand (Dakota Formation)
318	-	323	Shale (Dakota Formation)
323	-	334	Sand (Dakota Formation)

334 - 341 Shale (Dakota Formation)
 341 - 391 Shale, sandy near top and interbedded; sands near bottom of this interval
 391 - 410 Sand (Dakota Formation)
 410 - 421 Shale (Dakota Formation)
 421 - 473 Sand; some shaley layers from 427 to 431 feet and from 460 to 462 feet
 (Dakota Formation)
 473 - 480 Shale, brown-gray, silty (Dakota Formation)

Lithologic interpretations (11-01-1989) modified from original driller's log using the electric log.

* * * *

County: LINCOLN	Location: 098N-49W-23ACDD
Map Location: 13	
Legal Location: SE SE SW NE sec. 23, T. 098 N., R. 49 W.	
Latitude: 43.1739	Longitude: 96.3540
Land Owner: CITY OF CANTON	
Project:	
Drilling Company: HURON DRILLING	
Driller: D. DUVALL	Driller's Log:
Geologist:	Geologist's Log: X
Date Drilled: 03-02-1989	Drilling Method: ROTARY
Ground Surface Elevation: 1252.00 T	
Total Drill Hole Depth: 522	Test Hole Number:
Water Rights Well:	SDGS Well Name:
Other Well Name: OBS WELL	
Basin: BIG SIOUX	Aquifer: DAKOTA
Management Unit:	
Screen Type: PVC, MFG.	Screen Length: 100.0
Casing Type: PVC, SCH. 80	Casing Diameter: 2.0
Casing Top Elevation:	
Casing Stick-up:	Total Casing and Screen: 525.0
Well Maintenance Date:	
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity: X
Natural Gamma: X	Extra:
Samples:	

This log is for the observation well that is approximately 42 feet from Canton City Well 11.

0 - 1 Clay, black, silty (topsoil)
 1 - 5 Clay, yellow
 5 - 29 Sand and gravel
 29 - 99 Clay, blue (till)
 99 - 204 Shale (Carlile Shale)
 204 - 238 Limestone (Greenhorn Limestone)
 238 - 280 Shale (Graneros Shale)
 280 - 300 Sand (Dakota Formation)
 300 - 310 Clay, with some interbedded sand (Dakota Formation)
 310 - 324 Sand (Dakota Formation)
 324 - 329 Clay (Dakota Formation)
 329 - 340 Sand (Dakota Formation)
 340 - 354 Clay (Dakota Formation)
 354 - 364 Sand (Dakota Formation)

364 - 370 Clay (Dakota Formation)
 370 - 379 Sand (Dakota Formation)
 379 - 400 Clay (Dakota Formation)
 400 - 449 Sand (Dakota Formation)
 449 - 453 Clay (Dakota Formation)
 453 - 457 SAND (Dakota Formation)
 457 - 465 Clay (Dakota Formation)
 465 - 470 Sand (Dakota Formation)
 470 - 500 Clay (Dakota Formation)
 500 - 505 Sand (Dakota Formation)
 505 - 509 Clay (Dakota Formation)
 509 - 517 Sand (Dakota Formation)
 517 - 522 Sandstone (Paleozoic?)

Lithologic interpretation (11-01-1989) modified from original driller's log using electric log.

* * * *

County: LINCOLN	Location: 098N-49W-23ADAA 1
Map Location: 14	
Legal Location: NE NE SE NE sec. 23, T. 098 N., R. 49 W.	
Latitude: 43.1749	Longitude: 96.3521
Land Owner: CITY OF CANTON	
Project:	
Drilling Company: MINNEHAHA WATERS, INC.	
Driller: K. LUDEN	Driller's Log:
Geologist:	Geologist's Log: X
Date Drilled: 04-27-1974	Drilling Method: ROTARY
Ground Surface Elevation: 1240.45 I	
Total Drill Hole Depth: 450	Test Hole Number:
Water Rights Well:	SDGS Well Name:
Other Well Name: CITY 1	
Basin: BIG SIOUX	Aquifer:
Management Unit:	
Screen Type: STAINLESS STEEL	Screen Length: 40.0
Casing Type: STEEL	Casing Diameter: 10.0
Casing Top Elevation: 1242.93 I	
Casing Stick-up: 2.48	Total Casing and Screen: 417.5
Well Maintenance Date:	
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	Single Point Resistivity: X
Spontaneous Potential: X	Extra:
Natural Gamma: X	
Samples:	

0 - 8 Clay, tan
 8 - 22 Sand and gravel
 22 - 50 Clay, gray
 50 - 53 Sand, coarse
 53 - 78 Clay, gray
 78 - 186 Shale, gray (Carlile Shale)
 186 - 220 Limestone, brownish-gray (Greenhorn Limestone)
 220 - 263 Shale, dark-gray (Graneros Shale)
 263 - 327 Sand (Dakota Formation)
 327 - 364 Shale, gray (Dakota Formation)

364 - 384 Sandstone (Dakota Formation)
 384 - 392 Shale, gray, sandy (Dakota Formation)
 392 - 414 Sandstone (Dakota Formation)
 414 - 419 Shale, gray (Dakota Formation)
 419 - 423 Sandstone (Dakota Formation)
 423 - 434 Shale, gray (Dakota Formation)
 434 - 450 Sand(?) (Dakota Formation)

Lithologic interpretations (11-01-1989) modified from original driller's log using the electric log.

* * * * *

County: LINCOLN
 Map Location: 15
 Legal Location: SE NW NE NW sec. 23, T. 098 N., R. 49 W.
 Latitude: 43.1758
 Land Owner: CITY OF CANTON
 Project:
 Drilling Company: FREDERICKSON'S INC.
 Driller: C. PULKRABEK
 Geologist:
 Date Drilled: 10-00-1965
 Ground Surface Elevation: 1262.00 T
 Total Drill Hole Depth: 482
 Water Rights Well:
 Other Well Name: CITY 6
 Basin: BIG SIOUX
 Management Unit:
 Screen Type: JOHNSON STAINLESS STEEL
 Casing Type: STEEL
 Casing Top Elevation:
 Casing Stick-up: 1.40
 Well Maintenance Date:
 USGS Hydrological Unit Code: 10170203
 Electric Log Information:
 Spontaneous Potential: X
 Natural Gamma: X
 Samples:

Location: 098N-49W-23BABD

Longitude: 96.3606

Driller's Log:
 Geologist's Log: X
 Drilling Method: ROTARY

Test Hole Number:
 SDGS Well Name:

Aquifer:

Screen Length: 147.4
 Casing Diameter: 10.8

Total Casing and Screen: 444.4

Single Point Resistivity:
 Extra:

0 - 1 Topsoil, black
 1 - 22 Sand, brown; dirty
 22 - 50 Sand, blue, fine
 50 - 67 Clay, blue; soft, sticky
 67 - 219 Shale (Carlile Shale)
 219 - 255 Limestone, black; hard (Greenhorn Limestone)
 255 - 296 Shale (Graneros Shale)
 296 - 310 Sandstone, gray (Dakota Formation)
 310 - 319 Shale, gray (Dakota Formation)
 319 - 350 Sandstone, gray (Dakota Formation)
 350 - 361 Shale, gray (Dakota Formation)
 361 - 367 Sandstone, gray (Dakota Formation)
 367 - 381 Shale, gray (Dakota Formation)
 381 - 385 Sandstone, gray (Dakota Formation)
 385 - 402 Shale, gray (Dakota Formation)
 402 - 444 Sandstone, gray (Dakota Formation)

444 - 482 Shale and sandstone interbedded, gray (Dakota Formation)

Lithologic interpretations by L. Frykman (05-10-1989) modified from original driller's log using the electric log.

* * * *

County: LINCOLN	Location: 098N-49W-23DBDB
Map Location: 16	
Legal Location: NW SE NW SE sec. 23, T. 098 N., R. 49 W.	
Latitude: 43.1729	Longitude: 96.3544
Land Owner:	
Project: CANTON CITY STUDY-1988	
Drilling Company: SDGS	
Driller: M. THOMPSON	Driller's Log:
Geologist: L. FRYKMAN	Geologist's Log: X
Date Drilled: 08-31-1988	Drilling Method: ROTARY
Ground Surface Elevation: 1241.82 I	
Total Drill Hole Depth: 530	Test Hole Number: R2-88-24
Water Rights Well:	SDGS Well Name: R2-88-24
Other Well Name:	
Basin: BIG SIOUX	Aquifer: DAKOTA
Management Unit:	
Screen Type: PVC, MFG., SLOT SIZE 0.016 IN.	Screen Length: 15.0
Casing Type: PVC, SCH. 80	Casing Diameter: 2.0
Casing Top Elevation: 1246.23 I	
Casing Stick-up: 4.41	Total Casing and Screen: 521.4
Well Maintenance Date:	
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity:
Natural Gamma: X	Extra:
Samples:	

Screened from 517 to 502 feet. Filter pack from 517 to 486 feet.

0 - 32	Sand and gravel, brown, fine to coarse sand, medium to coarse gravel; clay layer from 18 to 21 feet; Big Sioux River outwash
32 - 88	Clay, gray, silty, sandy, pebbly; unoxidized (till)
88 - 195	Shale, gray; greasy (Carlile Shale)
195 - 228	Limestone, brownish-gray, silty; abundant shells (Greenhorn Limestone)
228 - 271	Shale, brownish-gray to gray, silty (Graneros Shale)
271 - 291	Sand, grayish-brown, fine (Dakota Formation)
291 - 302	Clay, gray (Dakota Formation)
302 - 312	Sand, grayish-brown, fine (Dakota Formation)
312 - 323	Clay, gray (Dakota Formation)
323 - 332	Sand, grayish-brown, fine (Dakota Formation)
332 - 345	Clay, gray (Dakota Formation)
345 - 351	Sand, grayish-brown, fine (Dakota Formation)
351 - 390	Clay, sandy; decreasing sand content toward lower part of interval (Dakota Formation)
390 - 399	Sand, grayish-brown, fine; slightly cemented (Dakota Formation)
399 - 430	Sand, grayish-brown, fine, somewhat clayey (Dakota Formation)
430 - 492	Clay, white, silty, sandy; hard layers from 430 to 437 feet (Dakota Formation)
492 - 516	Sand, pinkish-gray; slightly cemented (Dakota Formation)

516 - 530 Sandstone, brownish-white, fine (Paleozoic?)

* * * *

County: LINCOLN	Location: 098N-49W-23DBDC
Map Location: 17	
Legal Location: SW SE NW SE sec. 23, T. 098 N., R. 49 W.	
Latitude: 43.1725	Longitude: 96.3546
Land Owner:	
Project: CANTON CITY STUDY-1988	
Drilling Company: SDGS	
Driller: L. SCHULZ	Driller's Log:
Geologist: L. FRYKMAN	Geologist's Log: X
Date Drilled: 11-16-1987	Drilling Method: ROTARY
Ground Surface Elevation: 1246.00 T	
Total Drill Hole Depth: 640	Test Hole Number: R2-87-76
USGS Hydrological Unit Code: 10170203	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity:
Natural Gamma:	Extra:
Samples:	

0 - 26	Sand and gravel, brown, fine to coarse sand, fine to coarse gravel; Big Sioux River terrace
26 - 57	Clay, gray, silty
57 - 77	Clay, gray; sand stringers throughout; sand gray in color
77 - 79	Rock; granite
79 - 91	Clay, gray, silty, sandy (till?)
91 - 189	Shale, light-gray; greasy (Carlile Shale)
189 - 231	Clay, dark-brown; gritty; calcareous (Greenhorn Limestone)
231 - 273	Shale, dark-gray; greasy (Graneros Shale)
273 - 318	Sand, very fine; cemented; drill chattered (Dakota Formation)
318 - 344	Clay, light-yellow-brown, silty, sandy (Dakota Formation)
344 - 349	Clay, black; greasy (Dakota Formation)
349 - 404	Clay, light-yellow-brown, silty, sandy; layers of cemented sandstone in clay (Dakota Formation)
404 - 418	Sandstone, medium; composed of quartz (Dakota Formation)
418 - 504	Clay, light-gray, silty; clay has sandstone interbedded (Dakota Formation)
504 - 508	Clay, black; greasy (Dakota Formation)
508 - 521	Sand, coarse; composed of quartz, somewhat cemented (Dakota Formation)
521 - 556	Clay, white, silty (Dakota Formation)
556 - 640	Sandstone, white to light-pink, medium; composed of quartz, cemented; white clay in fractures; drilling got harder the deeper we went (Paleozoic?)

* * * *

County: LINCOLN	Location: 098N-49W-24BBDB
Map Location: 18	
Legal Location: NW SE NW NW sec. 24, T. 098 N., R. 49 W.	
Latitude: 43.1755	Longitude: 96.3507
Land Owner: CITY OF CANTON	
Project:	
Drilling Company: FREDERICKSON'S INC.	
Driller:	Driller's Log:
Geologist:	Geologist's Log: X

Date Drilled: 10-00-1965
 Ground Surface Elevation: 1245.00 T
 Total Drill Hole Depth: 492
 Water Rights Well:
 Other Well Name: CITY 3
 Basin: BIG SIOUX
 Management Unit:
 Screen Type: JOHNSON STAINLESS STEEL
 Casing Type: UNKNOWN
 Casing Top Elevation:
 Casing Stick-up:
 Well Maintenance Date:
 USGS Hydrological Unit Code: 10170203
 Electric Log Information:
 Spontaneous Potential: X
 Natural Gamma: X
 Samples:

Drilling Method: ROTARY
 Test Hole Number:
 SDGS Well Name:
 Aquifer:
 Screen Length: 131.8
 Casing Diameter: 10.8
 Total Casing and Screen: 401.8
 Single Point Resistivity:
 Extra:

Frederickson's Inc. Test Hole #2, October, 1965; completed as City Well 3.

0	-	4	Topsoil, brown
4	-	22	Sand, brown
22	-	73	Clay, blue (till)
73	-	123	Clay, blue; hard (till)
123	-	143	Clay, blue, sandy; soft (till)
143	-	202	Clay, blue; hard (till)
202	-	227	Clay and sand, blue (till)
227	-	232	Sand, blue; dirty
232	-	270	Clay, blue (till)
270	-	339	Sandstone, shaley 313 to 330 feet(?) (Dakota Formation)
339	-	358	Shale, blue (Dakota Formation)
358	-	426	Sandstone (Dakota Formation)
426	-	435	Shale (Dakota Formation)
435	-	459	Sandstone (Dakota Formation)
459	-	467	Shale; hard (Dakota Formation)
467	-	471	Sandstone (Dakota Formation)
471	-	475	Shale (Dakota Formation)
475	-	483	Sandstone; dirty (Dakota Formation)
483	-	492	Shale; very hard (Dakota Formation)

Dakota Formation lithologic interpretations (10-31-1989), modified from original driller's log using the electric log.

* * * *

County: LINCOLN
 Map Location: 19
 Legal Location: SW SW SW SW sec. 36, T. 098 N., R. 49 W.
 Latitude: 43.1527
 Land Owner:
 Project: SE SO. DAK. UNIT STUDY
 Drilling Company: SDGS
 Driller: L. HELSETH
 Geologist: D. ILES
 Date Drilled: 10-29-1981

Location: 098N-49W-36CCCC 3
 Longitude: 96.3517
 Driller's Log:
 Geologist's Log: X
 Drilling Method: ROTARY

Ground Surface Elevation: 1303.00 T
 Total Drill Hole Depth: 594
 Water Rights Well: LN-81L
 Other Well Name:
 Basin: BIG SIOUX
 Management Unit:
 Screen Type: PVC, MFG.
 Casing Type: PVC
 Casing Top Elevation: 1306.44
 Casing Stick-up:
 Well Maintenance Date:
 USGS Hydrological Unit Code: 10170203
 Electric Log Information:
 Spontaneous Potential: X
 Natural Gamma: X
 Samples:

Test Hole Number:
 SDGS Well Name: SESD-21
 Aquifer: DAKOTA
 Screen Length: 10.0
 Casing Diameter: 2.0
 Total Casing and Screen:
 Single Point Resistivity: X
 Extra:

Bottom of well at 584 feet.

0	-	8	Clay, yellow, silty, sandy, pebbly (till)
8	-	28	Clay, light-gray, silty; sticky
28	-	41	Clay, gray, silty; sticky
41	-	65	Clay, gray, silty, sandy (till)
65	-	104	Sand and gravel, medium to coarse sand and fine gravel; composed primarily of quartz (western-derived sand)
104	-	150	Clay, gray (Carlile Shale)
150	-	226	Clay, gray; calcareous (Carlile Shale)
226	-	275	Clay, gray with some brown; calcareous, harder than interval from 150 to 226 feet (Greenhorn Limestone)
275	-	305	Clay, gray (Graneros Shale)
305	-	409	Sand, fine; with some clay and some clay layers (Dakota Formation)
409	-	437	Clay, gray (Dakota Formation)
437	-	481	Sand, fine; hard from 444 to 461 feet (Dakota Formation)
481	-	513	Clay, gray; interbedded with fine sand (Dakota Formation)
513	-	532	Sand, fine; with some clay layers (Dakota Formation)
532	-	593	Sand, fine; hard from 541 to 579 feet (Dakota Formation)
593	-	594	Quartzite, pink; hard, there was actually only a few inches of penetration in this interval (Sioux Quartzite)

* * * *

APPENDIX B. Water Levels in South Dakota Geological Survey Monitoring Wells

Map Location ¹	Location ²	Well	Casing top elevation ³	Date of measurement and depth to water ⁴					
				07-28-88	09-01-88	09-27-88	10-13-88	10-21-88	03-29-89
4	098N-49W-13DADD	R2-88-03	1266.66	142.58	137.93	139.87	137.67	137.60	134.12
5	098N-49W-14ACDA	R2-88-01	1295.28	147.74	148.54	151.88	150.84	151.17	150.61
7	098N-49W-15CDDDB 1	R2-88-09	1286.03	115.39	119.24	126.04	126.58	132.13	127.30
10	098N-49W-22AAAD 1	R2-88-22	1269.24	---	---	130.02	129.43	132.61	128.64
11	098N-49W-23AACD	R2-88-02	1249.57	96.58	163.85	125.47	152.74	116.11	120.77
16	098N-49W-23DBDB	R2-88-24	1246.23	---	---	113.26	110.14	109.28	111.96

¹ Map Location - corresponds to number on figure 2 and appendix A.

² See appendix A for explanation of location format.

³ Elevations are presented in feet above mean sea level. The datum points used for surveying were two U.S. Coast and Geodetic Survey bench marks stamped "B 327 1949" and "11 SAN 1961" and a city fire hydrant along the airport road that had been surveyed.

⁴ All water levels are presented in feet below top of well casing.

APPENDIX C

Water-Quality Analyses Performed by the South Dakota Geological Survey

LEGAL LOCATION and LOCATION

The analyses are listed by smallest township number, then the smallest range number, the smallest section number and then by quarter section: NE = A; NW = B; SW = C; SE = D. A comparison of **LEGAL LOCATION** and **LOCATION** is as follows. A **LEGAL LOCATION** of SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 101 N. R. 50 W. is the same as a **LOCATION** of 101N-50W-23BCAD.

WATER SAMPLE LOCATION (WSL)

A number arbitrarily assigned to the log according to the order in which it is listed (see **LEGAL LOCATION** and **LOCATION**). This number corresponds to the numbers listed on figure 5.

LATITUDE and LONGITUDE

The format is DD.MMSS where D is degrees, M is minutes and S is seconds.

OWNER-CONTROLLER

SDGS is an abbreviation for South Dakota Geological Survey.

LAB

SDGS is an abbreviation for South Dakota Geological Survey Basic and Analytical Studies Laboratory.

CASING TOP ELEVATION and GROUND SURFACE ELEVATION

The numbers are presented in feet above mean sea level. I - the elevation was determined using a surveying instrument. T - the elevation was estimated from 7.5 minute series topographic map.

WATER ELEVATION

Calculated by subtracting **DEPTH TO WATER** from **CASING TOP ELEVATION**.

WELL DEPTH

The numbers are presented in feet.

DEPTH TO WATER

The numbers are presented in feet below casing top.

SCREENED

An "X" indicates the well has a screen.

CASING TYPE

PVC is an abbreviation for polyvinyl chloride. SCH. is an abbreviation for schedule and refers to casing thickness.

PUMP

Type of apparatus used to collect water sample.

FILTERED

An "X" indicates the water was filtered in the field through a glass filter prefilter and a 0.45 μ membrane filter at time of collection.

The water sample collected at each site was split three ways:

1. nitric acid-treated - HNO_3 ,
2. sulfuric acid-treated - H_2SO_4 and
3. UNTREATED.

H_2SO_4 OR FORMALIN TREATED is marked with H for H_2SO_4 .

Concentrations of the listed parameters are presented in one of the following manners:

1. parts per million (ppm),
2. milligrams per liter (mg/L),
3. milliequivalents per liter (me/L),
4. micromhos (μmhos) or
5. not detected (ND).

Names for abbreviations are as follows:

Ca	.....	Calcium
Mg	.....	Magnesium
Na	.....	Sodium
K	.....	Potassium
SO_4	.....	Sulfate
Cl	.....	Chloride
HCO_3	.....	Bicarbonate
CO_3	.....	Carbonate
Fe	.....	Iron
Mn	.....	Manganese
$\text{NO}_3\text{-N}$	.....	Nitrate as Nitrogen
F	.....	Fluoride
DS	.....	Dissolved Solids
HARDNESS	..	as CaCO_3
ALK-P	.....	Alkalinity-Phenolphthalein

Sample: CNC-88-003
Legal Location: SE SE NE SE sec. 13, T. 098 N., R. 49 W.
Water Sample Location: 1
Latitude: 43.1817 Longitude: 96.3414
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1116.88 feet
Ground Surface Elevation: 1263.98 I
Casing Top Elevation: 1266.66 I
Casing Type: PVC
Pump: BAILED
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-13DADD

County: LINCOLN

Collection Date: 05-24-1988

SDGS Well (Or Other): R2-88-03

Well Depth: 417.0 feet

Depth to Water: 149.78 feet

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 87 ppm
Mg: 33 ppm
Na: 102 ppm
K: 21.9 ppm
SO₄: 274 ppm
Cl: 20 ppm
HCO₃: 352 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: 0.16 ppm
NO₃-N: 0.04 ppm
F: 0.88 ppm
TDS: 686 ppm @ 180°C
pH: 8.30
Conductivity: 1108 umhos @ 25°C
Hardness: 353 ppm
Cations: 12.06 me/L
Anions: 12.09 me/L
ALK-P: ND
Field pH: 8.22
Field Temperature: 15°C

Notes: Eh = 283 millivolts (unfiltered) (varies up to 311 millivolts)
Total alkalinity (field) = 280 mg/L as CaCO₃
Total alkalinity (lab) = 289 mg/L as CaCO₃

Sample: CNC-88-004
Legal Location: SE SE NE SE sec. 13, T. 098 N., R. 49 W.
Water Sample Location: 2
Latitude: 43.1817 Longitude: 96.3414
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1116.70 feet
Ground Surface Elevation: 1263.98 I
Casing Top Elevation: 1266.66 I
Casing Type: PVC
Pump: BAILED
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-13DADD

County: LINCOLN

Collection Date: 05-25-1988

SDGS Well (Or Other): R2-88-03
Well Depth: 417.0 feet
Depth to Water: 149.96 feet
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca:	85 ppm
Mg:	30 ppm
Na:	108 ppm
K:	18.3 ppm
SO ₄ :	242 ppm
Cl:	23 ppm
HCO ₃ :	373 ppm
CO ₃ :	ND
Fe:	<0.05 ppm
Mn:	0.16 ppm
NO ₃ -N:	<0.04 ppm
F:	1.04 ppm
TDS:	678 ppm @ 180°C
pH:	7.85
Conductivity:	1092 umhos @ 25°C
Hardness:	336 ppm
Cations:	11.88 me/L
Anions:	11.86 me/L
ALK-P:	ND
Field pH:	7.62
Field Temperature:	16°C

Notes: Eh = 237 millivolts (unfiltered)-variable 200-316 unstable
Total alkalinity (field) = 301 mg/L as CaCO₃
Total alkalinity (lab) = 306 mg/L as CaCO₃

Sample: CNC-88-009
Legal Location: NE SE SW NE sec. 14, T. 098 N., R. 49 W.
Water Sample Location: 3
Latitude: 43.1833 Longitude: 96.3538
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1104.62 feet
Ground Surface Elevation: 1292.71 I
Casing Top Elevation: 1295.28 I
Casing Type: PVC, SCH. 80
Pump: BAILED
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-14ACDA

County: LINCOLN

Collection Date: 06-06-1988

SDGS Well (Or Other): R2-88-01
Well Depth: 493.0 feet
Depth to Water: 150.66 feet
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 88 ppm
Mg: 28 ppm
Na: 145 ppm
K: 17.9 ppm
SO₄: 266 ppm
Cl: 84 ppm
HCO₃: 339 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: 0.07 ppm
NO₃-N: <0.04 ppm
F: 1.14 ppm
TDS: 768 ppm @ 180°C
pH: 7.80
Conductivity: 1281 umhos @ 25°C
Hardness: 335 ppm
Cations: 13.46 me/L
Anions: 13.53 me/L
ALK-P: ND
Field pH: 7.56
Field Temperature: 16°C

Notes: Eh = 156 millivolts (unfiltered)
Total alkalinity (field) = 277 mg/L as CaCO₃
Total alkalinity (lab) = 278 mg/L as CaCO₃

Sample: CNC-89-015
Legal Location: NW SE SE SW sec. 15, T. 098 N., R. 49 W.
Water Sample Location: 4
Latitude: 43.1808 Longitude: 96.3712
Owner-Controller: CITY OF CANTON
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1284.00 T
Casing Top Elevation:
Casing Type: STEEL - 12 INCH DIAMETER
Pump: SUBMERSIBLE
Aquifer: DAKOTA
Management Unit:
Usage: MUNICIPAL
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H

Location: 098N-49W-15CDDDB

County: LINCOLN

Collection Date: 04-10-1989

SDGS Well (Or Other): CITY 10
Well Depth: 580.0 feet
Depth to Water:
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 110 ppm
Mg: 36 ppm
Na: 127 ppm
K: 1.5 ppm
SO₄: 303 ppm
Cl: 84 ppm
HCO₃: 341 ppm
CO₃: ND
Fe: 1.04 ppm
Mn: 0.09 ppm
NO₃-N: <0.04 ppm
F: 1.03 ppm
TDS: 892 ppm @ 180°C
pH: 7.81
Conductivity: 1340 umhos @ 25°C
Hardness: 423 ppm
Cations: 14.05 me/L
Anions: 14.33 me/L
ALK-P: ND
Field pH: 7
Field Temperature: 14°C

Notes: Total alkalinity (field) = 347 mg/L as CaCO₃
Total alkalinity (lab) = 280 mg/L as CaCO₃

Sample: CNC-89-016
Legal Location: NW SE SE SW sec. 15, T. 098 N., R. 49 W.
Water Sample Location: 5
Latitude: 43.1808 Longitude: 96.3712
Owner-Controller: CITY OF CANTON
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1284.00 T
Casing Top Elevation:
Casing Type: STEEL - 12 INCH DIAMETER
Pump: SUMBERSIBLE
Aquifer: DAKOTA
Management Unit:
Usage: MUNICIPAL
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H

Location: 098N-49W-15CDDB

County: LINCOLN

Collection Date: 04-12-1989

SDGS Well (Or Other): CITY 10

Well Depth: 580.0 feet

Depth to Water:

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 111 ppm
Mg: 36 ppm
Na: 125 ppm
K: 1.4 ppm
SO₄: 304 ppm
Cl: 82 ppm
HCO₃: 344 ppm
CO₃: ND
Fe: 1.00 ppm
Mn: 0.10 ppm
NO₃-N: <0.04 ppm
F: 1.01 ppm
TDS: 882 ppm @ 180°C
pH: 7.83
Conductivity: 1350 umhos @ 25°C
Hardness: 425 ppm
Cations: 14.01 me/L
Anions: 14.33 me/L
ALK-P: ND
Field pH: 6.7
Field Temperature: 15°C

Notes: Total alkalinity (field) = 282 mg/L as CaCO₃
Total alkalinity (lab) = 282 mg/L as CaCO₃

Sample: CNC-89-017
Legal Location: NW SE SE SW sec. 15, T. 098 N., R. 49 W.
Water Sample Location: 6
Latitude: 43.1808 Longitude: 96.3712
Owner-Controller: CITY OF CANTON
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1284.00 T
Casing Top Elevation:
Casing Type: STEEL - 12 INCH DIAMETER
Pump: SUBMERSIBLE
Aquifer: DAKOTA
Management Unit:
Usage: MUNICIPAL
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H

Location: 098N-49W-15CDDDB

County: LINCOLN

Collection Date: 04-13-1989

SDGS Well (Or Other): CITY 10

Well Depth: 580.0 feet

Depth to Water:

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 110 ppm
Mg: 36 ppm
Na: 124 ppm
K: 1.5 ppm
SO₄: 302 ppm
Cl: 79 ppm
HCO₃: 343 ppm
CO₃: ND
Fe: 0.66 ppm
Mn: 0.08 ppm
NO₃-N: <0.04 ppm
F: 1.00 ppm
TDS: 880 ppm @ 180°C
pH: 7.84
Conductivity: 1340 umhos @ 25°C
Hardness: 423 ppm
Cations: 13.91 me/L
Anions: 14.18 me/L
ALK-P: ND
Field pH: 7.1
Field Temperature: 14°C

Notes: Total alkalinity (field) = 275 mg/L as CaCO₃
Total alkalinity (lab) = 281 mg/L as CaCO₃

Sample: CNC-88-010
Legal Location: NW SE SE SW sec. 15, T. 098 N., R. 49 W.
Water Sample Location: 7
Latitude: 43.1808 Longitude: 96.3712
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1167.92 feet
Ground Surface Elevation: 1284.01 I
Casing Top Elevation: 1286.03 I
Casing Type: PVC, SCH. 80
Pump:
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-15CDDB 1

County: LINCOLN

Collection Date: 06-24-1988

SDGS Well (Or Other): R2-88-09
Well Depth: 555.0 feet
Depth to Water: 118.11 feet
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 116 ppm
Mg: 37 ppm
Na: 101 ppm
K: 13.8 ppm
SO₄: 323 ppm
Cl: 43 ppm
HCO₃: 358 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: 0.11 ppm
NO₃-N: <0.04 ppm
F: 0.72 ppm
TDS: 774 ppm @ 180°C
pH: 7.66
Conductivity: 1234 umhos @ 25°C
Hardness: 442 ppm
Cations: 13.58 me/L
Anions: 13.85 me/L
ALK-P: ND
Field pH: 7.43
Field Temperature: 21°C

Notes: Total alkalinity (field) = 316 mg/L as CaCO₃
Total alkalinity (lab) = 294 mg/L as CaCO₃

Sample: CNC-88-013
Legal Location: SE NE NE NE sec. 22, T. 098 N., R. 49 W.
Water Sample Location: 8
Latitude: 43.1808 Longitude: 96.3532
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1139.94 feet
Ground Surface Elevation: 1266.60 I
Casing Top Elevation: 1269.24 I
Casing Type: PVC, SCH. 80
Pump: BAILED
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-22AAAD 1

County: LINCOLN

Collection Date: 10-20-1988

SDGS Well (Or Other): R2-88-22

Well Depth: 438.0 feet

Depth to Water: 129.3 feet

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca:	78 ppm
Mg:	26 ppm
Na:	134 ppm
K:	18.4 ppm
SO ₄ :	244 ppm
Cl:	48 ppm
HCO ₃ :	362 ppm
CO ₃ :	ND
Fe:	0.22 ppm
Mn:	0.08 ppm
NO ₃ -N:	<0.04 ppm
F:	1.09 ppm
TDS:	706 ppm @ 180°C
pH:	7.68
Conductivity:	1158 umhos @ 25°C
Hardness:	302 ppm
Cations:	12.34 me/L
Anions:	12.43 me/L
ALK-P:	ND
Field pH:	7.52
Field Temperature:	15°C

Notes: Eh = -56 millivolts (unfiltered)

Total alkalinity (field) = 287 mg/L as CaCO₃

Total alkalinity (lab) = 297 mg/L as CaCO₃

Sample: CNC-88-008
Legal Location: NE SW NE NE sec. 23, T. 098 N., R. 49 W.
Water Sample Location: 9
Latitude: 43.1753 Longitude: 96.3531
Owner-Controller: H. BURGESS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1249.00 T
Casing Top Elevation:
Casing Type: STEEL
Pump: JET PUMP (IMPELLER)
Aquifer: BIG SIOUX
Management Unit: SOUTH
Usage: DOMESTIC
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-23AACA

County: LINCOLN

Collection Date: 06-06-1988

SDGS Well (Or Other): PRIVATE
Well Depth: 22 feet
Depth To Water: 15 feet
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 142 ppm
Mg: 48 ppm
Na: 88 ppm
K: 8.9 ppm
SO₄: 279 ppm
Cl: 67 ppm
HCO₃: 439 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: <0.05 ppm
NO₃-N: 2.93 ppm
F: 0.31 ppm
TDS: 870 ppm @ 180°C
pH: 7.42
Conductivity: 1346 umhos @ 25°C
Hardness: 552 ppm
Cations: 15.09 me/L
Anions: 15.12 me/L
ALK-P: ND
Field pH: 7.29
Field Temperature: 13°C

Notes: Eh = 301 millivolts (unfiltered)
Total alkalinity (field) = 349 mg/L as CaCO₃
Total alkalinity (lab) = 360 mg/L as CaCO₃

Sample: CNC-88-001
Legal Location: SE SW NE NE sec. 23, T. 098 N., R. 49 W.
Water Sample Location: 10
Latitude: 43.1751 Longitude: 96.3533
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1153.91 feet
Ground Surface Elevation: 1247.24 I
Casing Top Elevation: 1249.57 I
Casing Type: PVC
Pump: BAILED
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-23AACD

County: LINCOLN

Collection Date: 05-23-1988

SDGS Well (Or Other): R2-88-02
Well Depth: 518.0 feet
Depth to Water: 95.66 feet
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 87 ppm
Mg: 29 ppm
Na: 138 ppm
K: 18.4 ppm
SO₄: 244 ppm
Cl: 84 ppm
HCO₃: 345 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: 0.12 ppm
NO₃-N: <=0.04 ppm
F: 1.48 ppm
TDS: 768 ppm @ 180°C
pH: 7.80
Conductivity: 1262 umhos @ 25°C
Hardness: 337 ppm
Cations: 13.20 me/L
Anions: 13.19 me/L
ALK-P: ND
Field pH: 7.51
Field Temperature: 18°C

Notes: Eh = 255 millivolts (unfiltered)
Total Alkalinity (field) = 277 mg/L as CaCO₃
Total Alkalinity (lab) = 283 mg/L as CaCO₃

Sample: CNC-88-012
Legal Location: SE SW NE NE sec. 23, T. 098 N., R. 49 W.
Water Sample Location: 11
Latitude: 43.1752 Longitude: 96.3534
Owner-Controller: CITY OF CANTON
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1247.78 I
Casing Top Elevation: 1249.57 I
Casing Type: STEEL
Pump: SUBMERSIBLE
Aquifer: DAKOTA
Management Unit:
Usage: MUNICIPAL
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-23AACD

County: LINCOLN

Collection Date: 07-28-1988

SDGS Well (Or Other): CITY 9

Well Depth: 520 feet

Depth To Water:

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 87 ppm
Mg: 29 ppm
Na: 136 ppm
K: 16.7 ppm
SO₄: 262 ppm
Cl: 84 ppm
HCO₃: 340 ppm
CO₃: ND
Fe: 0.11 ppm
Mn: 0.08 ppm
NO₃-N: <0.04 ppm
F: 1.22 ppm
TDS: 729 ppm @ 180°C
pH: 7.64
Conductivity: 1244 umhos @ 25°C
Hardness: 337 ppm
Cations: 13.08 me/L
Anions: 13.47 me/L
ALK-P: ND
Field pH: 6.70
Field Temperature: 14°C

Notes: Total Alkalinity (field) = 287 mg/L as CaCO₃
Total Alkalinity (lab) = 279 mg/L as CaCO₃

Sample: CNC-88-005
Legal Location: SE SE SW NE sec. 23, T. 098 N., R. 49 W.
Water Sample Location: 12
Latitude: 43.1739 Longitude: 96.3540
Owner-Controller: CITY OF CANTON
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1253.00 T
Casing Top Elevation:
Casing Type: CEMENT
Pump: SUBMERSIBLE
Aquifer: BIG SIOUX
Management Unit: SOUTH
Usage: MUNICIPAL
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-23ACDD

County: LINCOLN

Collection Date: 05-25-1988

SDGS Well (Or Other): CITY 7
Well Depth: 28.0 feet
Depth To Water: 22.5 feet
Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca:	214 ppm
Mg:	85 ppm
Na:	53 ppm
K:	8.2 ppm
SO ₄ :	720 ppm
Cl:	11 ppm
HCO ₃ :	327 ppm
CO ₃ :	ND
Fe:	<0.05 ppm
Mn:	0.82 ppm
NO ₃ -N:	0.45 ppm
F:	0.38 ppm
TDS:	1312 ppm @ 180°C
pH:	7.65
Conductivity:	1614 umhos @ 25°C
Hardness:	884 ppm
Cations:	20.21 me/L
Anions:	20.71 me/L
ALK-P:	ND
Field pH:	7.38
Field Temperature:	13°C

Notes: Eh = 337 millivolts (unfiltered)
Total Alkalinity (field) = 261 mg/L as CaCO₃
Total Alkalinity (lab) = 268 mg/L as CaCO₃

Sample: CNC-89-018
Legal Location: SE SE SW NE sec. 23, T. 098 N., R. 49 W.
Water Sample Location: 13
Latitude: 43.1740 Longitude: 96.3540
Owner-Controller: CITY OF CANTON
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1252.00 T
Casing Top Elevation:
Casing Type: STEEL - 12 INCH DIAMETER
Pump: SUBMERSIBLE
Aquifer: DAKOTA
Management Unit:
Usage: MUNICIPAL
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H

Location: 098N-49W-23ACDD

County: LINCOLN

Collection Date: 04-26-1989

SDGS Well (Or Other): CITY 11

Well Depth: 518.0 feet

Depth To Water:

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 85 ppm
Mg: 28 ppm
Na: 125 ppm
K: 1.7 ppm
SO₄: 248 ppm
Cl: 61 ppm
HCO₃: 351 ppm
CO₃: ND
Fe: 0.26 ppm
Mn: 0.05 ppm
NO₃-N: <0.04 ppm
F: 1.10 ppm
TDS: 745 ppm @ 180°C
pH: 7.71
Conductivity: 1190 umhos @ 25°C
Hardness: 328 ppm
Cations: 12.04 me/L
Anions: 12.70 me/L
ALK-P: ND
Field Temperature: 14°C

Notes: Total Alkalinity (field) = 283 mg/L as CaCO₃
Total Alkalinity (lab) = 288 mg/L as CaCO₃

Sample: CNC-88-014
Legal Location: NW SE NW SE sec. 23, T. 098 N., R. 49 W.
Water Sample Location: 14
Latitude: 43.1729 Longitude: 96.3544
Owner-Controller: SDGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation: 1134.41 feet
Ground Surface Elevation: 1241.82 I
Casing Top Elevation: 1246.23 I
Casing Type: PVC, SCH. 80
Pump: BAILED
Aquifer: DAKOTA
Management Unit:
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-23DBDB
County: LINCOLN
Collection Date: 10-26-1988
SDGS Well (Or Other): R2-88-24
Well Depth: 517.0 feet
Depth to Water: 111.82 feet
Screened: X
Basin: BIG SIOUX
HNO₃: X

Ca: 97 ppm
Mg: 31 ppm
Na: 127 ppm
K: 17.9 ppm
SO₄: 243 ppm
Cl: 94 ppm
HCO₃: 339 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: 0.08 ppm
NO₃-N: <0.04 ppm
F: 1.15 ppm
TDS: 786 ppm @ 180°C
pH: 7.76
Conductivity: 1278 umhos @ 25°C
Hardness: 370 ppm
Cations: 13.37 me/L
Anions: 13.33 me/L
ALK-P: ND
Field pH: 7.37
Field Temperature: 14°C

Notes: Eh = 179 millivolts (unfiltered)
Total Alkalinity (field) = 261 mg/L as CaCO₃
Total Alkalinity (lab) = 278 mg/L as CaCO₃

Sample: CNC-88-006
Legal Location: NE NE NE NE sec. 24, T. 098 N., R. 49 W.
Water Sample Location: 15
Latitude: 43.1803 Longitude: 96.3408
Owner-Controller: USGS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1250.00 T
Casing Top Elevation: 1253.00 T
Casing Type: PVC
Pump: BLADDER
Aquifer: BIG SIOUX
Management Unit: SOUTH
Usage: OBSERVATION
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-24AAAA

County: LINCOLN

Collection Date: 05-25-1988

SDGS Well (Or Other): USGS

Well Depth: 27.74 feet

Depth to Water: 16.71 feet

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 169 ppm
Mg: 76 ppm
Na: 44 ppm
K: 3.4 ppm
SO₄: 540 ppm
Cl: 9 ppm
HCO₃: 274 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: <0.05 ppm
NO₃-N: 8.90 ppm
F: 0.44 ppm
TDS: 1076 ppm @ 180°C
pH: 7.67
Conductivity: 1398 umhos @ 25°C
Hardness: 735 ppm
Cations: 16.68 me/L
Anions: 16.65 me/L
ALK-P: ND
Field pH: 7.41
Field Temperature: 13°C

Notes: Eh = 344 millivolts (unfiltered)
Total Alkalinity (field) = 219 mg/L as CaCO₃
Total Alkalinity (lab) = 225 mg/L as CaCO₃

Sample: CNC-88-007
Legal Location: NE NW SE NW sec. 25, T. 098 N., R. 49 W.
Water Sample Location: 16
Latitude: 43.1655 Longitude: 96.3455
Owner-Controller: G. CORNELIUS
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1230.00 T
Casing Top Elevation:
Casing Type: STEEL
Pump: JET PUMP (IMPELLER)
Aquifer: BIG SIOUX
Management Unit: SOUTH
Usage: DOMESTIC
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-25BDBA
County: LINCOLN
Collection Date: 06-06-1988
SDGS Well (Or Other): PRIVATE
Well Depth: 28 feet
Depth To Water:
Screened: X
Basin: BIG SIOUX
HNO₃: X

Ca: 138 ppm
Mg: 43 ppm
Na: 21 ppm
K: 2.8 ppm
SO₄: 195 ppm
Cl: 8 ppm
HCO₃: 450 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: 0.35 ppm
NO₃-N: 0.33 ppm
F: 0.22 ppm
TDS: 618 ppm @ 180°C
pH: 7.37
Conductivity: 976 umhos @ 25°C
Hardness: 522 ppm
Cations: 11.42 me/L
Anions: 11.69 me/L
ALK-P: ND
Field pH: 7.26
Field Temperature: 18°C

Notes: Eh = 287 millivolts (unfiltered)
Total Alkalinity (field) = 359 mg/L as CaCO₃
Total Alkalinity (lab) = 369 mg/L as CaCO₃

Sample: CNC-88-011
Legal Location: SE NE NW SE sec. 25, T. 098 N., R. 49 W.
Water Sample Location: 17
Latitude: 43.1652 Longitude: 96.3423
Owner-Controller:
Sample Type: GROUND WATER
Lab: SDGS
Project: CANTON CITY STUDY-1988
Water Elevation:
Ground Surface Elevation: 1246.00 T
Casing Top Elevation:
Casing Type: STEEL
Pump: SUBMERSIBLE
Aquifer: BIG SIOUX
Management Unit: SOUTH
Usage: DOMESTIC
Clean Container: X Filtered: X
H₂SO₄ Or Formalin Treated: H
Other: UNTREATED; SAMPLE KEPT IN ICE

Location: 098N-49W-25DBAD

County: LYON, IA

Collection Date: 06-24-1988

SDGS Well (Or Other): PRIVATE

Well Depth: 38 feet

Depth To Water:

Screened: X

Basin: BIG SIOUX

HNO₃: X

Ca: 93 ppm
Mg: 41 ppm
Na: 10 ppm
K: 3.6 ppm
SO₄: 87 ppm
Cl: 5 ppm
HCO₃: 391 ppm
CO₃: ND
Fe: <0.05 ppm
Mn: <0.05 ppm
NO₃-N: 1.12 ppm
F: 0.43 ppm
TDS: 440 ppm @ 180°C
pH: 7.57
Conductivity: 741 umhos @ 25°C
Hardness: 401 ppm
Cations: 8.53 me/L
Anions: 8.47 me/L
ALK-P: ND
Field pH: 7.42
Field Temperature: 16°C

Notes: Total Alkalinity (field) = 310 mg/L as CaCO₃
Total Alkalinity (lab) = 321 mg/L as CaCO₃

APPENDIX D

Water-Quality Analyses Performed by the State Health Laboratory, Pierre, South Dakota

The water samples were taken from Canton municipal wells 9 and 10 and monitoring wells R2-88-02 and R2-88-09. Wells R2-88-02 and R2-88-09 are the nearest monitoring wells to municipal wells 9 and 10, respectively.

SOUTH DAKOTA DEPARTMENT OF WATER AND NATURAL RESOURCES
Office of Drinking Water
CHEMICAL ANALYTICAL DATA

Water Supply: CANTON MUNICIPAL
 City, County: CANTON, LINCOLN
 Source Sampled: Well CITY 10
 Depth 580 feet

Date Collected: 04/13/1989
 Collected by: L. J. Frykman
 Latitude: 43° 18' 08"
 Longitude: 96° 37' 12"

Date Drilled: 03/07/1989

Date sample was received by Laboratory: 04/14/1989

Parameter	Maximum Limit	Results	Parameter	Suggested Limit	Results
Arsenic	50 ug/L	<1.0	Chloride	250 mg/L	85.2
Barium	1000 ug/L	13	Iron	0.3 mg/L	0.70
Cadmium	10 ug/L	<1.0	Manganese	0.05 mg/L	0.12
Chromium	50 ug/L	<1.0	Sulfate	250 mg/L	288
Lead	50 ug/L	3.6	Dissolved Solids	500 mg/L	823
Mercury	2 ug/L	<0.2	pH	6.5 - 8.5	7.42
Nitrate as N	10 mg/L	1.2	Alkalinity-M	mg/L	271
Selenium	10 ug/L	<1.0	Alkalinity-P	mg/L	0
Silver	50 ug/L	<1.0	Bicarbonate	mg/L	331
Fluoride	2.4 mg/L	0.76	Carbonate	mg/L	0
Gross alpha	15 pCi/L	10.5±4.5	Specific Conductance		
Radium 226 *	pCi/L	1.8±0.3	at 25°C	umhos/cm	1236
			Calcium	mg/L	110
			Magnesium	mg/L	34.5
			Hardness as CaCO ₃	mg/L	417
			Langelier Index	----	0.05
			Sodium	mg/L	118
			Potassium	mg/L	14.4

mg/L = milligrams/liter = parts/million
 ug/L = micrograms/liter = parts/billion
 pCi/L = picocuries per liter
 umhos/cm = micromhos/centimeter

* The maximum limit for the combined total of radium 226 + radium 228 is 5 pCi/L.

SOUTH DAKOTA DEPARTMENT OF WATER AND NATURAL RESOURCES
Office of Drinking Water
CHEMICAL ANALYTICAL DATA

Water Supply: MONITORING WELL
 City, County: CANTON, LINCOLN
 Source Sampled: Well R2-88-02
 Depth 518 feet

Date Collected: 07/05/1988
 Collected by: L. J. Frykman
 Latitude: 43° 17' 51"
 Longitude: 96° 35' 33"

Date Drilled: 04/28/1988
 Date sample was received by Laboratory: 07/06/1988

Parameter	Maximum Limit	Results
Arsenic	50 ug/L	<6.1
Barium	1000 ug/L	132
Cadmium	10 ug/L	<1.0
Chromium	50 ug/L	6.7
Lead	50 ug/L	9.2
Mercury	2 ug/L	<0.2
Nitrate as N	10 mg/L	<0.1
Selenium	10 ug/L	3.4
Silver	50 ug/L	<1.0
Fluoride	2.4 mg/L	0.71
Radium 226 *	pCi/L	3.0±0.5
Radium 228 *	pCi/L	2.5±0.8

mg/L = milligrams/liter = parts/million
 ug/L = micrograms/liter = parts/billion
 pCi/L = picocuries per liter

* The maximum limit for the combined total of radium 226 + radium 228 is 5 pCi/L.

SOUTH DAKOTA DEPARTMENT OF WATER AND NATURAL RESOURCES
Office of Drinking Water
CHEMICAL ANALYTICAL DATA

Water Supply: MONITORING WELL
 City, County: CANTON, LINCOLN
 Source Sampled: Well R2-88-09
 Depth 555 feet

Date Collected: 07/05/1988
 Collected by: L. J. Frykman
 Latitude: 43° 18' 08"
 Longitude: 96° 37' 12"

Date Drilled: 06/16/1988

Date sample was received by Laboratory: 07/06/1988

Parameter	Maximum Limit	Results
Arsenic	50 ug/L	8.7
Barium	1000 ug/L	175
Cadmium	10 ug/L	1.2
Chromium	50 ug/L	11.0
Lead	50 ug/L	11.7
Mercury	2 ug/L	<0.2
Nitrate as N	10 mg/L	<0.1
Selenium	10 ug/L	1.2
Silver	50 ug/L	4.6
Fluoride	2.4 mg/L	1.04
Radium 226 *	pCi/L	2.3±0.5
Radium 228 *	pCi/L	2.9±0.5

mg/L = milligrams/liter = parts/million
 ug/L = micrograms/liter = parts/billion
 pCi/L = picocuries per liter

* The maximum limit for the combined total of radium 226 + radium 228 is 5 pCi/L.

SOUTH DAKOTA DEPARTMENT OF WATER AND NATURAL RESOURCES
Office of Drinking Water
CHEMICAL ANALYTICAL DATA

Water Supply: CANTON MUNICIPAL
 City, County: CANTON, LINCOLN
 Source Sampled: Well CITY 9
 Depth 520 feet

Date Collected: 08/22/1988
 Collected by: L. J. Frykman

Date Drilled: 07/07-08/1988

Date sample was received by Laboratory: 08/23/1988

Parameter	Maximum Limit	Results
Arsenic	50 ug/L	5.8
Barium	1000 ug/L	26
Cadmium	10 ug/L	<1.0
Chromium	50 ug/L	2.0
Lead	50 ug/L	9.4
Mercury	2 ug/L	<0.2
Nitrate as N	10 mg/L	0.3
Selenium	10 ug/L	5.1
Silver	50 ug/L	<1.0
Fluoride	2.4 mg/L	1.14
Radium 226 *	pCi/L	4.5±0.9
Radium 228 *	pCi/L	1.3±0.7

mg/L = milligrams/liter = parts/million
 ug/L = micrograms/liter = parts/billion
 pCi/L = picocuries per liter

* The maximum limit for the combined total of radium 226 + radium 228 is 5 pCi/L.

APPENDIX E

Water-Quality Analyses Performed by Pace Laboratories, Inc.

The water samples were taken from monitoring wells A2-88-177 and A2-88-178. These wells are completed in till.



REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa

South Dakota Geological Survey
UST Science Center
Vermillion, SD 57069

August 24, 1988
PACE Project Number: 880727505

Attn: Mr. Louis Frykman

Date Sample(s) Collected: 07/26/88
Date Sample(s) Received: 07/27/88

PACE Sample Number: Parameter	Units	MDL	216830 A2-88-177	216840 A2-88-178
1,1,2-Trichloroethylene	ug/L	0.5	ND	ND

MDL Method Detection Limit
ND Not detected at or above the MDL.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my direct supervision.

Sandra A. McDonald
Supervisor

APPENDIX F

**Results of a Permeability Test Conducted by Twin City Testing Corporation
on a Core Sample of the Paleozoic Sandstone Found Near Canton, South Dakota**

LABORATORY TEST DATA

PROJECT: CANTON, SOUTH DAKOTA

DATE: 8-12-88

REPORTED TO: South Dakota Geological Survey

JOB NO.: 6600 88-845

Sample No.	1		
Location	Canton, SD		
Elevation	---		
Type of Sample	3" core		
Soil Classification (ASTM:D2487)	Sandstone		
In-Place Moisture Content (%)	0.11		
Moisture-Density Relation of Soil (ASTM:D698)			
Max. Dry Density (PCF)	---		
Optimum Moisture Content (%)	---		
Permeability Test			
Trial No.	1		
Type of Test	Falling Head		
Type of Specimen	Undisturbed		
Specimen Height (inches)	3.13		
Specimen Diameter (inches)	2.72		
Dry Density (PCF)	153.0		
Percent of Max. Density	---		
Moisture Content (%)	0.11		
Max. Head Differential (ft)	5.0		
Confining Pressure (effective-PSI)	2.0		
Water Temperature (°C)	22		
Coefficient of Permeability K @ 20°C(cm/sec)	$< 5.1 \times 10^{-10}$		
K @ 20°C(ft/min)	$< 1.0 \times 10^{-9}$		
Atterberg Limits			
Liquid Limit (%)	Not Tested		
Plastic Limit (%)	Not Tested		
Plasticity Index	Not Tested		



TWIN CITY TESTING
CORPORATION

APPENDIX G

Aquifer-Test Data: Canton Municipal Wells 9 and 10

MUNICIPAL WELL 9

PUMPING WELL: Municipal well 9

DATE AND TIME THE TEST BEGAN: July 28, 1988; 7:00 a.m.

DATE AND TIME THE TEST ENDED: July 29, 1988; 2:20 a.m.

WELLS WHICH WERE MONITORED: 1. Municipal well 9
2. R2-88-02

The test terminated prematurely because of a malfunction in the pump motor. Municipal well 9 had been installed just prior to the test by Huron Drilling, Inc. Well R2-88-02 is a 2-inch diameter monitoring well which was installed by the South Dakota Geological Survey and is completed in the basal layer of the Dakota Formation. Water levels in the municipal well were recorded by Huron Drilling, Inc. Water levels in the monitoring well were recorded by the South Dakota Geological Survey and by the Canton Sewer and Water Department.

MUNICIPAL WELL 10

PUMPING WELL: Municipal well 10

DATE AND TIME THE TEST BEGAN: April 12, 1989; 9:00 a.m.

DATE AND TIME THE TEST ENDED: April 13, 1989; 9:30 a.m.

WELLS WHICH WERE MONITORED: 1. Municipal well 10
2. R2-88-09
3. R2-88-22

Municipal well 10 had been installed just prior to the test by Huron Drilling, Inc. Wells R2-88-09 and R2-88-22 are 2-inch diameter monitoring wells which were installed by the South Dakota Geological Survey. Well R2-88-09 is completed in the basal layer of the Dakota Formation and well R2-88-22 is completed in the upper layer of the Dakota Formation. Water levels in the municipal well were recorded by Huron Drilling, Inc. Water levels in the monitoring wells were recorded by the South Dakota Geological Survey and by the Canton Sewer and Water Department.

DRAWDOWN DATA

WELL: MUNICIPAL WELL 9

Pumping Rate: 160 gallons per minute

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
07/28/88	07:00	106.33	0	0.00
07/28/88	07:01	125.54	1	19.21
07/28/88	07:02	134.25	2	27.92
07/28/88	07:03	139.08	3	32.75
07/28/88	07:04	144.54	4	38.21
07/28/88	07:05	144.17	5	37.84
07/28/88	07:10	149.38	10	43.05
07/28/88	07:15	154.25	15	47.92
07/28/88	07:20	155.46	20	49.13
07/28/88	07:25	157.67	25	51.34
07/28/88	07:30	157.96	30	51.63
07/28/88	07:35	159.08	35	52.75
07/28/88	07:40	160.71	40	54.38
07/28/88	07:45	161.08	45	54.75
07/28/88	07:50	163.25	50	56.92
07/28/88	07:55	163.25	55	56.92
07/28/88	08:00	162.42	60	56.09
07/28/88	08:20	166.17	80	59.84
07/28/88	08:40	168.08	100	61.75
07/28/88	09:00	168.50	120	62.17
07/28/88	09:30	169.83	150	63.50
07/28/88	10:00	170.75	180	64.42
07/28/88	10:30	168.92	210	62.59
07/28/88	11:00	169.38	240	63.05
07/28/88	12:00	173.75	300	67.42
07/28/88	13:00	170.00	360	63.67
07/28/88	14:00	171.08	420	64.75
07/28/88	15:00	170.54	480	64.21
07/28/88	16:00	171.25	540	64.92
07/28/88	17:00	171.50	600	65.17
07/28/88	18:00	171.33	660	65.00
07/28/88	19:00	168.54	720	62.21
07/28/88	20:00	168.63	780	62.30
07/28/88	21:00	170.00	840	63.67
07/28/88	22:00	178.67	900	72.34
07/28/88	23:00	168.67	960	62.34
07/29/88	00:00	172.88	1020	66.55
07/29/88	01:00	172.71	1080	66.38
07/29/88	02:00	167.25	1140	60.92

Pump motor failed at 02:20. RPM's adjusted on pump motor at 22:00 because pumping had increased to 180 gpm. Water levels after adjustment indicate fluctuating RPM's on pump motor.

RECOVERY DATA

WELL: MUNICIPAL WELL 9

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
07/29/88	02:21	129.08	1161	21.00	55.29	22.75
07/29/88	02:22	126.92	1162	22.00	52.82	20.59
07/29/88	02:23	126.50	1163	23.00	50.57	20.17
07/29/88	02:24	124.92	1164	24.00	48.50	18.59
07/29/88	02:25	124.50	1165	25.00	46.60	18.17
07/29/88	02:30	118.50	1170	30.00	39.00	12.17
07/29/88	02:35	116.96	1175	35.00	33.57	10.63
07/29/88	02:40	115.17	1180	40.00	29.50	8.84
07/29/88	02:45	112.67	1185	45.00	26.33	6.34
07/29/88	02:50	111.33	1190	50.00	23.80	5.00
07/29/88	03:05	110.83	1205	65.00	18.54	4.50
07/29/88	03:20	110.17	1220	80.00	15.25	3.84
07/29/88	03:35	109.67	1235	95.00	13.00	3.34
07/29/88	03:40	109.29	1240	100.00	12.40	2.96
07/29/88	04:00	106.75	1260	120.00	10.50	0.42
07/29/88	04:20	106.33	1280	140.00	9.14	0.00
07/29/88	04:40	105.67	1300	160.00	8.13	-0.66
07/29/88	05:00	104.88	1320	180.00	7.33	-1.45
07/29/88	05:20	104.46	1340	200.00	6.70	-1.87
07/29/88	05:40	104.04	1360	220.00	6.18	-2.29
07/29/88	06:00	103.71	1380	240.00	5.75	-2.62
07/29/88	06:20	103.38	1400	260.00	5.38	-2.95
07/29/88	06:40	102.96	1420	280.00	5.07	-3.37
07/29/88	07:00	102.79	1440	300.00	4.80	-3.54
07/29/88	10:07	101.32	1627	487.00	3.34	-5.01

End of recovery measurements.

DRAWDOWN DATA

WELL: R2-88-02

Distance From Pumping Well (municipal well 9): 51 feet

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
07/28/88	07:00	96.58	0.00	0.00
07/28/88	07:00:30	97.61	0.50	1.03
07/28/88	07:01:30	100.71	1.50	4.13
07/28/88	07:02:02	102.34	2.03	5.76
07/28/88	07:02:30	103.85	2.50	7.27
07/28/88	07:03	104.79	3.00	8.21
07/28/88	07:04	106.51	4.00	9.93
07/28/88	07:04:30	107.24	4.50	10.66
07/28/88	07:05	107.95	5.00	11.37
07/28/88	07:05:30	108.58	5.50	12.00
07/28/88	07:06	109.16	6.00	12.58
07/28/88	07:06:34	109.62	6.57	13.04
07/28/88	07:07:06	110.12	7.10	13.54
07/28/88	07:07:33	110.48	7.55	13.90
07/28/88	07:08	110.88	8.00	14.30
07/28/88	07:08:30	111.26	8.50	14.68
07/28/88	07:09	111.58	9.00	15.00
07/28/88	07:09:33	111.94	9.55	15.36
07/28/88	07:10:32	112.52	10.53	15.94
07/28/88	07:11:04	112.82	11.07	16.24
07/28/88	07:12:07	113.34	12.12	16.76
07/28/88	07:14:06	114.33	14.10	17.75
07/28/88	07:15:01	114.70	15.02	18.12
07/28/88	07:16:02	115.09	16.03	18.51
07/28/88	07:17:02	115.51	17.03	18.93
07/28/88	07:18	115.88	18.00	19.30
07/28/88	07:19	116.24	19.00	19.66
07/28/88	07:20:01	116.58	20.02	20.00
07/28/88	07:21	116.85	21.00	20.27
07/28/88	07:22	117.13	22.00	20.55
07/28/88	07:23	117.40	23.00	20.82
07/28/88	07:24	117.66	24.00	21.08
07/28/88	07:25	117.91	25.00	21.33
07/28/88	07:26	118.12	26.00	21.54
07/28/88	07:27	118.36	27.00	21.78
07/28/88	07:28	118.57	28.00	21.99
07/28/88	07:29:03	118.79	29.05	22.21
07/28/88	07:30	119.02	30.00	22.44
07/28/88	07:31	119.25	31.00	22.67
07/28/88	07:32	119.47	32.00	22.89
07/28/88	07:33	119.67	33.00	23.09
07/28/88	07:34	119.88	34.00	23.30

WELL R2-88-02 -- DRAWDOWN DATA continued.

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
07/28/88	07:35	120.09	35.00	23.51
07/28/88	07:40	120.97	40.00	24.39
07/28/88	07:45	121.73	45.00	25.15
07/28/88	07:50	122.43	50.00	25.85
07/28/88	08:00	123.58	60.00	27.00
07/28/88	08:05	124.18	65.00	27.60
07/28/88	08:16:27	125.41	76.45	28.83
07/28/88	08:20	125.76	80.00	29.18
07/28/88	08:25	126.18	85.00	29.60
07/28/88	08:30	126.58	90.00	30.00
07/28/88	08:35	126.95	95.00	30.37
07/28/88	08:40:30	127.29	100.50	30.71
07/28/88	08:45	127.56	105.00	30.98
07/28/88	08:50	127.85	110.00	31.27
07/28/88	09:00	128.41	120.00	31.83
07/28/88	09:10	128.89	130.00	32.31
07/28/88	09:20	129.37	140.00	32.79
07/28/88	09:31	129.67	151.00	33.09
07/28/88	09:40	129.91	160.00	33.33
07/28/88	09:50	130.17	170.00	33.59
07/28/88	10:00:15	130.50	180.25	33.92
07/28/88	10:10	130.53	190.00	33.95
07/28/88	10:30	130.92	210.00	34.34
07/28/88	11:00	131.45	240.00	34.87
07/28/88	11:30	131.63	270.00	35.05
07/28/88	12:00	132.45	300.00	35.87
07/28/88	13:00	132.73	360.00	36.15
07/28/88	14:00	133.42	420.00	36.84
07/28/88	15:00	133.43	480.00	36.85
07/28/88	16:00	133.54	540.00	36.96
07/28/88	17:00	133.54	600.00	36.96
07/28/88	18:00	133.70	660.00	37.12
07/28/88	19:00	133.53	720.00	36.95
07/28/88	20:00	133.44	780.00	36.86
07/28/88	21:00	133.58	840.00	37.00
07/28/88	22:00	132.25	900.00	35.67
07/28/88	23:00	137.22	960.00	40.64
07/29/88	00:00	135.13	1020.00	38.55
07/29/88	01:00	135.13	1080.00	38.55
07/29/88	02:00	134.18	1140.00	37.60

Pump motor failed at 02:20. RPM's adjusted on pump motor at 22:00 because pumping had increased to 180 gpm. Water levels after adjustment indicate fluctuating RPM's on pump motor.

RECOVERY DATA

WELL: R2-88-02

Distance From Pumping Well (municipal well 9): 51 feet

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
07/29/88	02:28	119.75	1168.00	28.00	41.71	23.17
07/29/88	02:29	117.00	1169.00	29.00	40.31	20.42
07/29/88	02:32	116.18	1172.00	32.00	36.63	19.60
07/29/88	02:33	115.64	1173.00	33.00	35.55	19.06
07/29/88	02:36	114.70	1176.00	36.00	32.67	18.12
07/29/88	02:42	112.65	1182.00	42.00	28.14	16.07
07/29/88	02:48	111.50	1188.00	48.00	24.75	14.92
07/29/88	02:54	110.55	1194.00	54.00	22.11	13.97
07/29/88	03:00	109.75	1200.00	60.00	20.00	13.17
07/29/88	03:05	108.85	1205.00	65.00	18.54	12.27
07/29/88	03:10	108.41	1210.00	70.00	17.29	11.83
07/29/88	03:15	107.92	1215.00	75.00	16.20	11.34
07/29/88	03:20	107.35	1220.00	80.00	15.25	10.77
07/29/88	03:40	105.64	1240.00	100.00	12.40	9.06
07/29/88	04:00	104.90	1260.00	120.00	10.50	8.32
07/29/88	04:20	103.44	1280.00	140.00	9.14	6.86
07/29/88	04:40	103.12	1300.00	160.00	8.13	6.54
07/29/88	05:00	102.55	1320.00	180.00	7.33	5.97
07/29/88	05:20	102.15	1340.00	200.00	6.70	5.57
07/29/88	05:40	101.83	1360.00	220.00	6.18	5.25
07/29/88	06:01	101.46	1381.00	241.00	5.73	4.88
07/29/88	06:24	101.15	1404.00	264.00	5.32	4.57
07/29/88	06:40	100.98	1420.00	280.00	5.07	4.40
07/29/88	07:06	100.71	1446.00	306.00	4.73	4.13
07/29/88	07:31	100.49	1471.00	331.00	4.44	3.91
07/29/88	07:59	100.32	1499.00	359.00	4.18	3.74
07/29/88	08:30	100.10	1530.00	390.00	3.92	3.52
07/29/88	09:01	99.95	1561.00	421.00	3.71	3.37
07/29/88	09:30	99.85	1590.00	450.00	3.53	3.27
07/29/88	10:00	99.74	1620.00	480.00	3.38	3.16

End of recovery measurements.

DRAWDOWN DATA

WELL: MUNICIPAL WELL 10

Pumping Rate: 480 gallons per minute

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
04/12/89	09:00	136.33	0	0.00
04/12/89	09:01	162.58	1	26.25
04/12/89	09:02	180.00	2	43.67
04/12/89	09:03	180.50	3	44.17
04/12/89	09:04	180.58	4	44.25
04/12/89	09:05	181.00	5	44.67
04/12/89	09:06	181.58	6	45.25
04/12/89	09:07	182.08	7	45.75
04/12/89	09:08	182.75	8	46.42
04/12/89	09:09	183.08	9	46.75
04/12/89	09:10	182.92	10	46.59
04/12/89	09:11	182.83	11	46.50
04/12/89	09:12	182.83	12	46.50
04/12/89	09:13	183.33	13	47.00
04/12/89	09:14	183.75	14	47.42
04/12/89	09:15	184.67	15	48.34
04/12/89	09:20	185.92	20	49.59
04/12/89	09:25	186.58	25	50.25
04/12/89	09:30	187.25	30	50.92
04/12/89	09:35	187.75	35	51.42
04/12/89	09:40	188.50	40	52.17
04/12/89	09:45	189.70	45	53.37
04/12/89	09:50	190.21	50	53.88
04/12/89	09:55	190.00	55	53.67
04/12/89	10:00	190.29	60	53.96
04/12/89	10:30	192.00	90	55.67
04/12/89	11:00	192.25	120	55.92
04/12/89	11:30	194.17	150	57.84
04/12/89	12:00	195.00	180	58.67
04/12/89	12:30	196.08	210	59.75
04/12/89	13:00	197.33	240	61.00
04/12/89	13:30	198.00	270	61.67
04/12/89	14:00	198.08	300	61.75
04/12/89	15:00	198.75	360	62.42
04/12/89	16:00	201.25	420	64.92
04/12/89	17:00	199.58	480	63.25
04/12/89	18:00	200.25	540	63.92
04/12/89	19:00	200.71	600	64.38
04/12/89	20:00	202.42	660	66.09
04/12/89	21:00	202.75	720	66.42
04/12/89	22:00	203.83	780	67.50
04/12/89	23:00	204.50	840	68.17

MUNICIPAL WELL 10 -- DRAWDOWN DATA continued.

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
04/13/89	00:00	203.58	900	67.25
04/13/89	01:00	204.00	960	67.67
04/13/89	02:00	204.67	1020	68.34
04/13/89	03:00	204.92	1080	68.59
04/13/89	04:00	205.50	1140	69.17
04/13/89	05:00	205.58	1200	69.25
04/13/89	06:00	205.63	1260	69.30
04/13/89	07:00	206.42	1320	70.09
04/13/89	08:00	206.50	1380	70.17
04/13/89	08:30	206.50	1410	70.17
04/13/89	09:00	206.50	1440	70.17
04/13/89	09:30	206.50	1470	70.17

Pump off at 09:30.

RECOVERY DATA

WELL: MUNICIPAL WELL 10

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
04/13/89	09:30	206.50	1470	0.00	---	70.17
04/13/89	09:31	163.83	1471	1.00	1471.00	27.50
04/13/89	09:32	163.17	1472	2.00	736.00	26.84
04/13/89	09:33	162.50	1473	3.00	491.00	26.17
04/13/89	09:34	161.42	1474	4.00	368.50	25.09
04/13/89	09:35	158.17	1475	5.00	295.00	21.84
04/13/89	09:36	156.08	1476	6.00	246.00	19.75
04/13/89	09:37	155.92	1477	7.00	211.00	19.59
04/13/89	09:38	155.75	1478	8.00	184.75	19.42
04/13/89	09:39	155.67	1479	9.00	164.33	19.34
04/13/89	09:40	155.58	1480	10.00	148.00	19.25
04/13/89	09:41	155.54	1481	11.00	134.64	19.21
04/13/89	09:42	155.50	1482	12.00	123.50	19.17
04/13/89	09:43	155.50	1483	13.00	114.08	19.17
04/13/89	09:44	155.42	1484	14.00	106.00	19.09
04/13/89	09:45	155.42	1485	15.00	99.00	19.09
04/13/89	09:50	155.25	1490	20.00	74.50	18.92
04/13/89	09:55	155.00	1495	25.00	59.80	18.67
04/13/89	10:00	154.25	1500	30.00	50.00	17.92
04/13/89	10:05	153.75	1505	35.00	43.00	17.42
04/13/89	10:10	153.58	1510	40.00	37.75	17.25
04/13/89	10:15	152.08	1515	45.00	33.67	15.75
04/13/89	10:20	151.75	1520	50.00	30.40	15.42
04/13/89	10:25	151.38	1525	55.00	27.73	15.05
04/13/89	10:30	151.08	1530	60.00	25.50	14.75
04/13/89	11:00	150.42	1560	90.00	17.33	14.09
04/13/89	11:30	150.08	1590	120.00	13.25	13.75
04/13/89	12:00	150.08	1620	150.00	10.80	13.75
04/13/89	12:30	149.83	1650	180.00	9.17	13.50
04/13/89	13:00	149.50	1680	210.00	8.00	13.17
04/13/89	13:30	149.50	1710	240.00	7.13	13.17
04/13/89	14:00	149.42	1740	270.00	6.44	13.09
04/13/89	14:30	148.17	1770	300.00	5.90	11.84
04/13/89	15:30	147.92	1830	360.00	5.08	11.59
04/13/89	16:30	147.25	1890	420.00	4.50	10.92
04/13/89	17:30	146.83	1950	480.00	4.06	10.50
04/13/89	18:30	146.67	2010	540.00	3.72	10.34
04/13/89	19:30	146.42	2070	600.00	3.45	10.09
04/13/89	20:30	146.17	2130	660.00	3.23	9.84
04/13/89	21:30	145.92	2190	720.00	3.04	9.59
04/13/89	22:30	145.58	2250	780.00	2.88	9.25
04/13/89	23:30	145.42	2310	840.00	2.75	9.09

MUNICIPAL WELL 10 -- RECOVERY DATA continued.

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
04/14/89	00:30	145.17	2370	900.00	2.63	8.84
04/14/89	01:30	145.00	2430	960.00	2.53	8.67
04/14/89	02:30	141.58	2490	1020.00	2.44	5.25
04/14/89	03:30	141.42	2550	1080.00	2.36	5.09
04/14/89	04:30	141.33	2610	1140.00	2.29	5.00
04/14/89	05:30	141.13	2670	1200.00	2.23	4.80
04/14/89	06:30	141.00	2730	1260.00	2.17	4.67
04/14/89	07:30	140.88	2790	1320.00	2.11	4.55
04/14/89	08:30	140.71	2850	1380.00	2.07	4.38
04/14/89	10:00	140.63	2940	1470.00	2.00	4.30
04/14/89	15:00	140.08	3240	1770.00	1.83	3.75
04/14/89	22:30	139.79	3690	2220.00	1.66	3.46
04/15/89	07:30	139.29	4230	2760.00	1.53	2.96
04/15/89	14:00	138.96	4620	3150.00	1.47	2.63
04/16/89	01:30	138.63	5310	3840.00	1.38	2.30
04/16/89	10:30	138.50	5850	4380.00	1.34	2.17
04/16/89	23:30	138.63	6630	5160.00	1.28	2.30
04/17/89	08:00	138.50	7140	5670.00	1.26	2.17

End of recovery measurements.

DRAWDOWN DATA

WELL: R2-88-09

Distance From Pumping Well (municipal well 10): 120 feet

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
04/12/89	09:00	133.83	0	0.00
04/12/89	09:01	135.97	1	2.14
04/12/89	09:02	138.35	2	4.52
04/12/89	09:03	139.58	3	5.75
04/12/89	09:04	140.32	4	6.49
04/12/89	09:05	140.87	5	7.04
04/12/89	09:06	141.32	6	7.49
04/12/89	09:07	141.72	7	7.89
04/12/89	09:08	142.02	8	8.19
04/12/89	09:09	142.30	9	8.47
04/12/89	09:10	142.59	10	8.76
04/12/89	09:11	142.78	11	8.95
04/12/89	09:12	142.96	12	9.13
04/12/89	09:13	143.16	13	9.33
04/12/89	09:14	143.38	14	9.55
04/12/89	09:15	143.53	15	9.70
04/12/89	09:20	144.56	20	10.73
04/12/89	09:25	145.14	25	11.31
04/12/89	09:30	145.74	30	11.91
04/12/89	09:35	146.21	35	12.38
04/12/89	09:40	146.68	40	12.85
04/12/89	09:45	147.06	45	13.23
04/12/89	09:50	147.62	50	13.79
04/12/89	09:55	148.01	55	14.18
04/12/89	10:00	148.27	60	14.44
04/12/89	10:30	149.95	90	16.12
04/12/89	11:00	151.07	120	17.24
04/12/89	11:30	151.92	150	18.09
04/12/89	12:00	153.03	180	19.20
04/12/89	12:30	153.82	210	19.99
04/12/89	13:00	154.55	240	20.72
04/12/89	13:30	155.17	270	21.34
04/12/89	14:00	155.68	300	21.85
04/12/89	15:00	156.62	360	22.79
04/12/89	16:00	157.75	420	23.92
04/12/89	17:00	158.08	480	24.25
04/12/89	18:00	158.68	540	24.85
04/12/89	19:00	159.27	600	25.44
04/12/89	20:00	160.02	660	26.19
04/12/89	21:00	160.54	720	26.71
04/12/89	22:00	161.18	780	27.35
04/12/89	23:00	161.65	840	27.82

WELL R2-88-09 -- DRAWDOWN DATA continued.

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
04/13/89	00:00	161.95	900	28.12
04/13/89	01:00	162.15	960	28.32
04/13/89	02:00	162.47	1020	28.64
04/13/89	03:00	162.78	1080	28.95
04/13/89	04:00	163.05	1140	29.22
04/13/89	05:00	163.30	1200	29.47
04/13/89	06:00	163.53	1260	29.70
04/13/89	07:00	163.98	1320	30.15
04/13/89	08:00	164.25	1380	30.42
04/13/89	08:30	164.38	1410	30.55
04/13/89	09:00	164.47	1440	30.64
04/13/89	09:30	164.50	1470	30.67

Pump off at 09:30.

RECOVERY DATA

WELL: R2-88-09

Distance From Pumping Well (municipal well 10): 120 feet

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
04/13/89	09:30	164.50	1470	0.00	---	30.67
04/13/89	09:31	160.25	1471	1.00	1471.00	26.42
04/13/89	09:32	158.61	1472	2.00	736.00	24.78
04/13/89	09:33	157.42	1473	3.00	491.00	23.59
04/13/89	09:34	156.93	1474	4.00	368.50	23.10
04/13/89	09:35	156.53	1475	5.00	295.00	22.70
04/13/89	09:36	156.12	1476	6.00	246.00	22.29
04/13/89	09:37	155.75	1477	7.00	211.00	21.92
04/13/89	09:38	155.44	1478	8.00	184.75	21.61
04/13/89	09:39	155.17	1479	9.00	164.33	21.34
04/13/89	09:40	154.92	1480	10.00	148.00	21.09
04/13/89	09:41	154.68	1481	11.00	134.64	20.85
04/13/89	09:42	154.47	1482	12.00	123.50	20.64
04/13/89	09:43	154.30	1483	13.00	114.08	20.47
04/13/89	09:44	154.10	1484	14.00	106.00	20.27
04/13/89	09:45	153.92	1485	15.00	99.00	20.09
04/13/89	09:50	153.17	1490	20.00	74.50	19.34
04/13/89	09:55	152.60	1495	25.00	59.80	18.77
04/13/89	10:00	152.06	1500	30.00	50.00	18.23
04/13/89	10:05	151.60	1505	35.00	43.00	17.77
04/13/89	10:10	151.18	1510	40.00	37.75	17.35
04/13/89	10:15	150.81	1515	45.00	33.67	16.98
04/13/89	10:20	150.44	1520	50.00	30.40	16.61
04/13/89	10:25	150.08	1525	55.00	27.73	16.25
04/13/89	10:30	149.82	1530	60.00	25.50	15.99
04/13/89	11:00	148.35	1560	90.00	17.33	14.52
04/13/89	11:30	147.26	1590	120.00	13.25	13.43
04/13/89	12:00	146.38	1620	150.00	10.80	12.55
04/13/89	12:30	145.67	1650	180.00	9.17	11.84
04/13/89	13:00	145.03	1680	210.00	8.00	11.20
04/13/89	13:30	144.50	1710	240.00	7.13	10.67
04/13/89	14:00	144.02	1740	270.00	6.44	10.19
04/13/89	14:30	143.62	1770	300.00	5.90	9.79
04/13/89	15:30	142.89	1830	360.00	5.08	9.06
04/13/89	16:30	142.42	1890	420.00	4.50	8.59
04/13/89	17:30	141.97	1950	480.00	4.06	8.14
04/13/89	18:30	141.56	2010	540.00	3.72	7.73
04/13/89	19:30	141.23	2070	600.00	3.45	7.40
04/13/89	20:30	140.94	2130	660.00	3.23	7.11
04/13/89	21:30	140.69	2190	720.00	3.04	6.86
04/13/89	22:30	140.42	2250	780.00	2.88	6.59

WELL R2-88-09 -- RECOVERY DATA continued.

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
04/13/89	23:30	140.19	2310	840.00	2.75	6.36
04/14/89	00:30	139.96	2370	900.00	2.63	6.13
04/14/89	01:30	139.75	2430	960.00	2.53	5.92
04/14/89	02:30	139.53	2490	1020.00	2.44	5.70
04/14/89	03:30	139.36	2550	1080.00	2.36	5.53
04/14/89	04:30	139.20	2610	1140.00	2.29	5.37
04/14/89	05:30	139.07	2670	1200.00	2.23	5.24
04/14/89	06:30	138.95	2730	1260.00	2.17	5.12
04/14/89	07:30	138.85	2790	1320.00	2.11	5.02
04/14/89	08:30	138.76	2850	1380.00	2.07	4.93
04/14/89	10:00	138.64	2940	1470.00	2.00	4.81
04/14/89	15:00	138.17	3240	1770.00	1.83	4.34
04/14/89	22:30	137.85	3690	2220.00	1.66	4.02
04/15/89	07:30	137.35	4230	2760.00	1.53	3.52
04/15/89	14:00	137.05	4620	3150.00	1.47	3.22
04/16/89	01:30	136.69	5310	3840.00	1.38	2.86
04/16/89	10:30	136.57	5850	4380.00	1.34	2.74
04/16/89	23:30	136.56	6630	5160.00	1.28	2.73
04/17/89	08:00	136.59	7140	5670.00	1.26	2.76

End of recovery measurements.

DRAWDOWN DATA

WELL: R2-88-22

Distance From Pumping Well (municipal well 10): 2,870 feet

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
04/12/89	09:00	128.02	0	0.00
04/12/89	09:01	128.02	1	0.00
04/12/89	09:02	128.02	2	0.00
04/12/89	09:03	128.02	3	0.00
04/12/89	09:04	128.02	4	0.00
04/12/89	09:05	128.02	5	0.00
04/12/89	09:06	128.02	6	0.00
04/12/89	09:07	128.02	7	0.00
04/12/89	09:08	128.02	8	0.00
04/12/89	09:09	128.03	9	0.01
04/12/89	09:10	128.03	10	0.01
04/12/89	09:11	128.03	11	0.01
04/12/89	09:12	128.03	12	0.01
04/12/89	09:13	128.03	13	0.01
04/12/89	09:14	128.03	14	0.01
04/12/89	09:15	128.03	15	0.01
04/12/89	09:20	128.04	20	0.02
04/12/89	09:25	128.04	25	0.02
04/12/89	09:30	128.05	30	0.03
04/12/89	09:35	128.05	35	0.03
04/12/89	09:40	128.05	40	0.03
04/12/89	09:45	128.05	45	0.03
04/12/89	09:50	128.05	50	0.03
04/12/89	09:55	128.06	55	0.04
04/12/89	10:00	128.06	60	0.04
04/12/89	10:30	128.06	90	0.04
04/12/89	11:00	128.10	120	0.08
04/12/89	11:30	128.13	150	0.11
04/12/89	12:00	128.20	180	0.18
04/12/89	12:35	128.25	215	0.23
04/12/89	13:05	128.37	245	0.35
04/12/89	13:35	128.37	275	0.35
04/12/89	14:05	128.42	305	0.40
04/12/89	15:05	128.52	365	0.50
04/12/89	16:05	128.60	425	0.58
04/12/89	17:05	128.64	485	0.62
04/12/89	18:05	128.68	545	0.66
04/12/89	19:05	128.72	605	0.70
04/12/89	20:05	128.82	665	0.80
04/12/89	21:05	128.94	725	0.92
04/12/89	22:05	129.07	785	1.05
04/12/89	23:05	129.24	845	1.22

WELL R2-88-22 -- DRAWDOWN DATA continued.

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Drawdown, s (ft)
04/13/89	00:05	129.35	905	1.33
04/13/89	01:05	129.58	965	1.56
04/13/89	02:05	129.73	1025	1.71
04/13/89	03:05	129.92	1085	1.90
04/13/89	04:05	130.10	1145	2.08
04/13/89	05:05	130.24	1205	2.22
04/13/89	06:05	130.25	1265	2.23
04/13/89	09:30	130.50	1470	2.48

Pump off at 09:30.

RECOVERY DATA

WELL: R2-88-22

Distance From Pumping Well (municipal well 10): 2,870 feet

Date	Time	Water level (ft)	Time since pumping started, t (min.)	Time since pumping stopped, t' (min.)	Ratio, t/t'	Residual Drawdown s' (ft)
04/13/89	09:30	130.50	1470	0.00	---	2.48
04/13/89	09:31	130.50	1471	1.00	1471.00	2.48
04/13/89	09:32	130.50	1472	2.00	736.00	2.48
04/13/89	09:33	130.50	1473	3.00	491.00	2.48
04/13/89	09:34	130.50	1474	4.00	368.50	2.48
04/13/89	09:35	130.50	1475	5.00	295.00	2.48
04/13/89	09:36	130.50	1476	6.00	246.00	2.48
04/13/89	09:37	130.50	1477	7.00	211.00	2.48
04/13/89	09:38	130.50	1478	8.00	184.75	2.48
04/13/89	09:39	130.50	1479	9.00	164.33	2.48
04/13/89	09:40	130.50	1480	10.00	148.00	2.48
04/13/89	09:41	130.50	1481	11.00	134.64	2.48
04/13/89	09:42	130.50	1482	12.00	123.50	2.48
04/13/89	09:43	130.50	1483	13.00	114.08	2.48
04/13/89	09:44	130.50	1484	14.00	106.00	2.48
04/13/89	09:45	130.50	1485	15.00	99.00	2.48
04/13/89	09:50	130.50	1490	20.00	74.50	2.48
04/13/89	09:55	130.50	1495	25.00	59.80	2.48
04/13/89	10:00	130.50	1500	30.00	50.00	2.48
04/13/89	10:05	130.50	1505	35.00	43.00	2.48
04/13/89	10:10	130.50	1510	40.00	37.75	2.48
04/13/89	10:15	130.50	1515	45.00	33.67	2.48
04/13/89	10:20	130.50	1520	50.00	30.40	2.48
04/13/89	10:25	130.50	1525	55.00	27.73	2.48
04/13/89	10:30	130.50	1530	60.00	25.50	2.48
04/13/89	11:00	130.61	1560	90.00	17.33	2.59
04/13/89	11:30	130.74	1590	120.00	13.25	2.72
04/13/89	12:00	130.80	1620	150.00	10.80	2.78
04/13/89	12:30	130.86	1650	180.00	9.17	2.84
04/13/89	13:00	130.88	1680	210.00	8.00	2.86
04/13/89	13:30	130.91	1710	240.00	7.13	2.89
04/13/89	14:00	130.97	1740	270.00	6.44	2.95
04/13/89	14:30	130.97	1770	300.00	5.90	2.95
04/13/89	15:30	131.06	1830	360.00	5.08	3.04
04/13/89	16:30	131.08	1890	420.00	4.50	3.06

End of recovery measurements.