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George S. Mickelson, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES
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DIVISION OF GEOLOGICAL SURVEY
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Open-File Report 56-UR

INVESTIGATION OF THE EXTENT AND GROUND-WATER QUALITY
OF THE DAKOTA FORMATION NEAR LENNOX, SOUTH DAKOTA

by

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INTRODUCTION

The investigation was conducted by the South Dakota Geological Survey (SDGS), at the request of the city of Lennox, South Dakota, to identify a potential source for a new municipal water supply. The investigation was financed by the city of Lennox and the state of South Dakota. This report contains the results of the investigation which was conducted in the Lennox area (fig. 1).

The city of Lennox (population 1,827) is located approximately 14 miles south of Sioux Falls, South Dakota, in Lincoln County. Because of the poor-quality water being obtained from the aquifer currently used by the city (Lennox aquifer), an investigation was designed to delineate that part of the Dakota Formation, near Lennox, which has a potential to yield a satisfactory quality and quantity of water.

METHODS AND PROCEDURES

Drilling and Well Installation

Drilling occurred during two periods; from May 9, 1988, through May 25, 1988, and from July 25, 1988, through August 4, 1988. Drilling was performed with a mud-rotary machine using a 5½-inch diameter drill bit. Nine test holes were drilled at map locations (ML) 2, 3, 4, 5, 6, 7, 10, 12, and 13 (fig. 2, app. A). Four of these test holes were completed as observation wells (ML 2, 3, 4, and 10). Geophysical logs are available, at the SDGS for eight of the holes and include the parameters single-point resistivity, natural gamma, and spontaneous potential (app. A).

Observation 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, either Wynot gravel (a poorly sorted, very fine sand to very coarse gravel) or Grand Island sand (a well sorted, coarse sand), was placed around the outside of the screen up to at least 7 feet above the top of the screen. A tremie pipe was used to ensure proper positioning of the filter pack. Bentonite grout was then pumped through the tremie pipe into the remaining annular space (from the bottom up to land surface) around the outside of the casing. At a later date, an upper portion of the annular space was filled with cement grout and finally topped with soil. These data are on file at the SDGS.

Surveying

Casing-top elevations of the observation wells and land-surface elevations next to the wells were surveyed to the nearest 0.01 foot. The bench mark used as a datum was a U.S. Coast and Geodetic Survey bench mark located in SE¼SE¼SE¼SE¼ sec. 33, T. 98 N., R. 51 W. It is stamped "2 SAN 1961" and has an elevation of 1,327.4 feet above mean sea level.

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

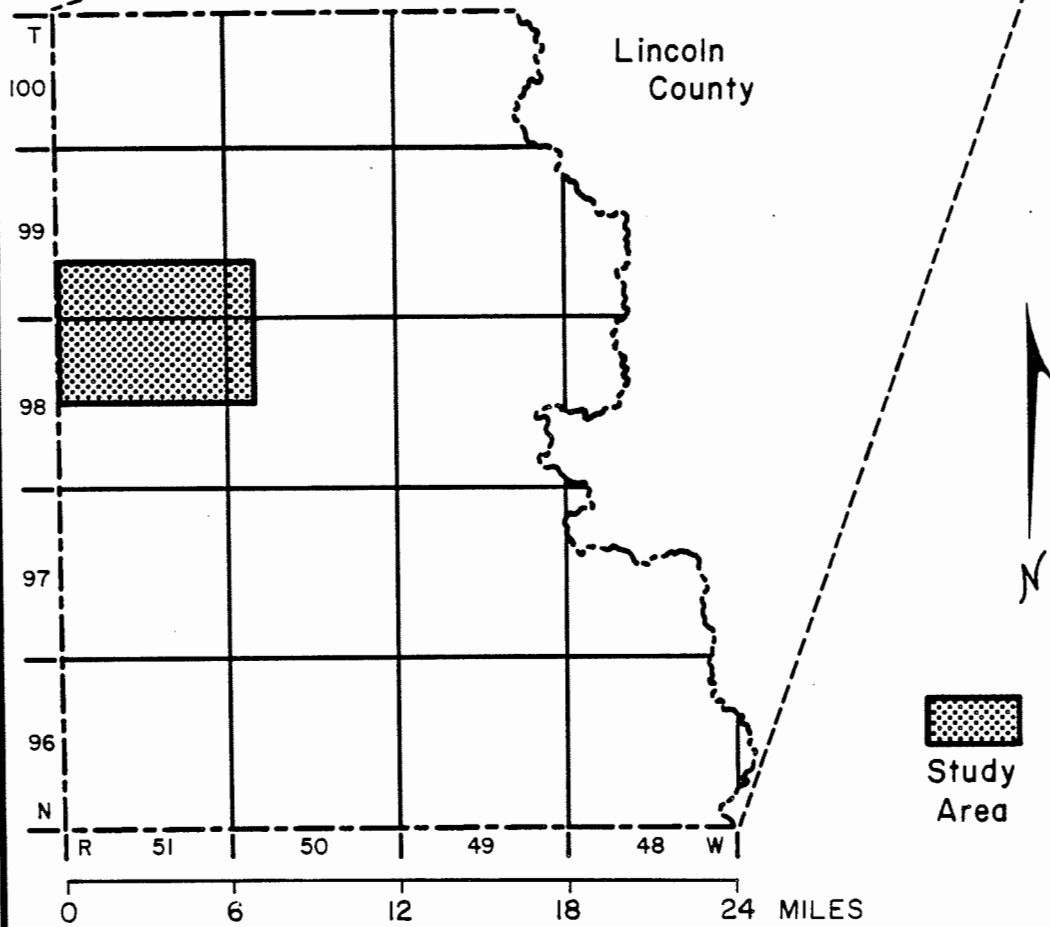
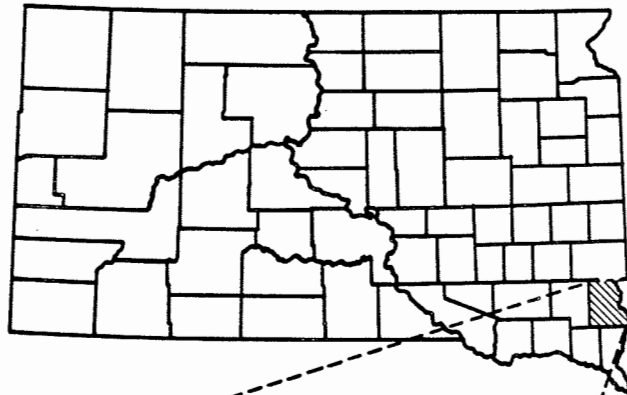


Figure 1. Location of the study area.

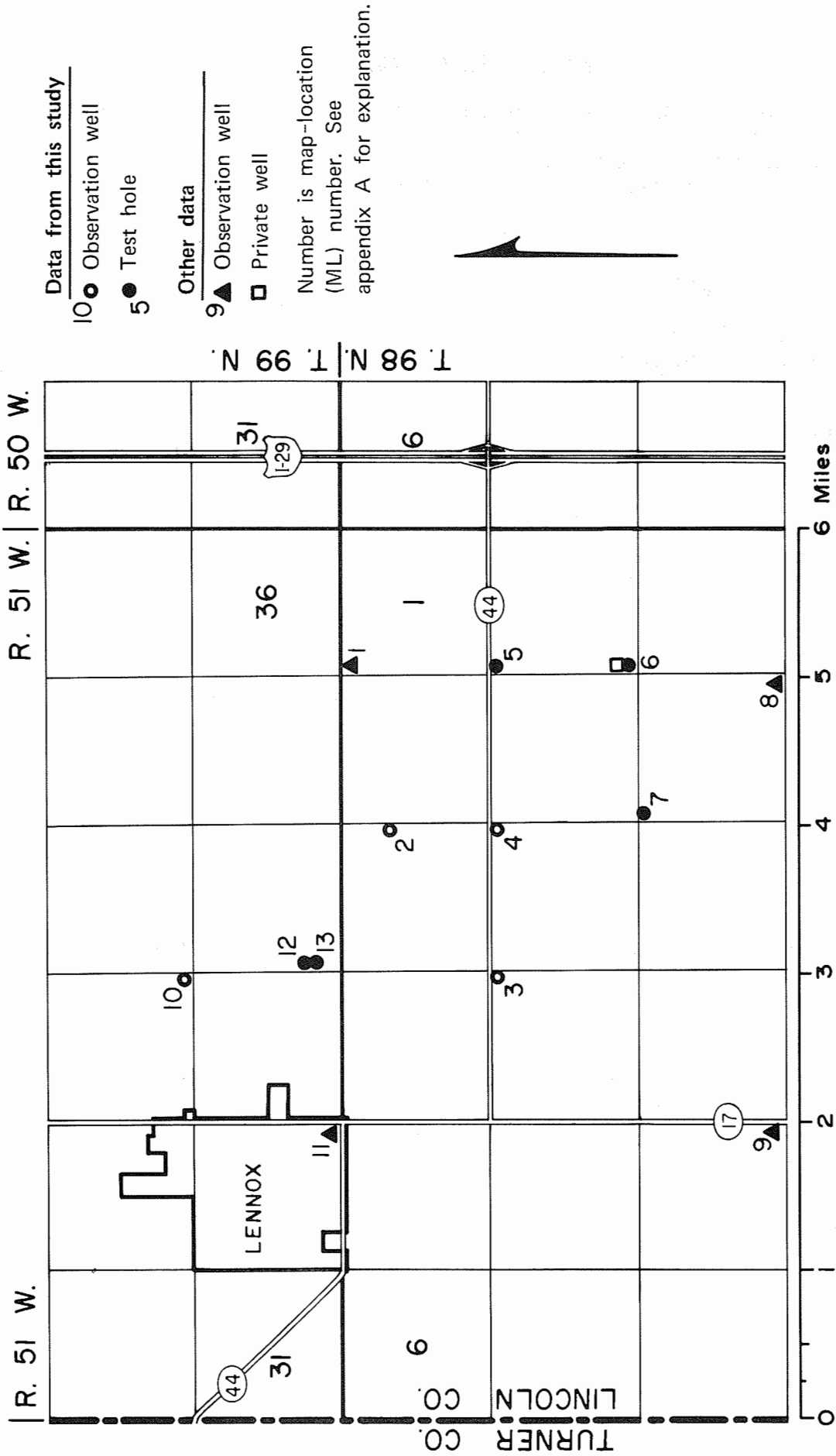


Figure 2. Locations of test holes and observation wells.

Water-level Measurements

The depth to water in the observation wells was measured on two occasions (table 1) to the nearest 0.01 foot. Measurements were made using a fiber glass tape measure with a concave-shaped device on the end which makes an audible sound upon impact with the water.

Well Development and Water Sampling

All observation wells were developed by pumping with compressed air. A minimum of 4 well volumes of water was removed from each well during this process.

All water samples, from observation wells, were collected with a bladder pump or, when that was not possible, with a bailer. A minimum of 3 well volumes of water were evacuated from each well before a sample was collected. Water samples were collected from the observation wells installed for this investigation, three observation wells controlled by the Division of Water Rights, and one private well. Water-quality analyses (table 2) were performed by the South Dakota Geological Survey.

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Table 1. Water levels in Dakota Formation observation wells

Map Location Number (1)	Location (2)	Well ID Number	Casing Top Elevation (3)	Depths to water and dates of measurement (4)	
				07-28-88	08-10-88
1	098N-51W-01BBBB	LN-80I	1342.72	107.91	108.09
2	098N-51W-03ADAD	R20-88-33	1327.33	97.48	97.70
3	098N-51W-09AAAA	R2-88-06	1315.91	110.98	111.40
4	098N-51W-10AAAA	R2-88-07	1322.37	102.34	102.32
9	098N-51W-17DDDA	LN-80L	1292.36	--	88.64
10	099N-51W-28DDDD	R2-88-05	1359.30	114.90	116.04
11	099N-51W-32DDDD2	LN-81F	1328.27	88.87	90.24

- =====
(1) Map-Location Number - corresponds to number on figure 2 and in appendix A.
(2) See appendix A for explanation of location format.
(3) Presented in feet above mean sea level.
(4) All water levels are presented in feet below top of casing.
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Table 2. Chemical analyses of water samples, Dakota Formation, Lennox area

		Concentrations in milligrams per liter (1)														
Location (2)	ML Number (2)	Well ID Number (2)	Date Sampled (3)	Well Conduc- tivity (mmhos) (4)	Hard- ness as CaCO ₃ (5)	TDS (5)	Fe (5)	Mn (5)	SO ₄ (5)	NO ₃ -N (6)	Na (6)	Ca (6)	Mg (6)	K (6)	Cl (6)	F (6)
						500	0.3	0.05	250	10	--	--	--	--	250	2.4
						(5)	(5)	(5)	(5)	(6)					(5)	(6)
98N-51W-01BBBB	ML 1	LN-801	06-03-88	580	286	612	<0.05	0.05	211	<0.04	98	75	24	16.8	9	1.26
98N-51W-03ADAD	ML 2	R20-88-33	08-04-88	529	854	1246	0.44	0.13	626	<0.04	77	235	65	11.8	6	0.69
98N-51W-09AAAA	ML 3	R2-88-06	05-19-88	601	858	1362	0.07	0.17	689	<0.04	103	233	67	13.3	7	1.06
98N-51W-10AAAA	ML 4	R2-88-07	06-02-88	577	178	914	<0.05	0.05	270	<0.04	264	45	16	14.0	22	2.79
98N-51W-12CCCB	--	Private	08-04-88	499	206	510	0.69	0.06	181	<0.04	98	51	19	18.2	6	1.02
98N-51W-17DDDA	ML 9	LN-80L	08-10-88	507	721	1040	0.15	0.13	470	<0.04	62	193	58	13.7	5	0.59
99N-51W-28DDDD	ML10	R2-88-05	05-12-88	307	1243	1944	1.68	0.99	1145	0.04	126	346	92	11.7	8	0.48
99N-51W-32DDDD2	ML11	LN-81F	05-31-88	418	1099	1826	1.66	0.98	935	<0.04	122	305	82	9.6	8	0.23

(1) TDS - total dissolved solids; Fe - iron; Mn - manganese; SO₄ - sulfate; NO₃-N - nitrate-nitrogen; Na - sodium; Ca - calcium; Mg - magnesium; K - potassium; Cl - chloride; F - fluoride.

(2) See appendix A for explanation of location format and map location (ML) number.

(3) Well depth is presented in feet below land surface.

(4) mmhos - micromhos.

(5) U.S. Environmental Protection Agency recommended maximum limit, (U.S. Environmental Protection Agency, 1985b).

(6) U.S. Environmental Protection Agency enforceable maximum limit, (U.S. Environmental Protection Agency, 1985a).

PRESENT LENNOX WATER SUPPLY

The city of Lennox pumps water from the Lennox aquifer (fig. 3). This aquifer consists of glacial outwash and lies directly on the bedrock surface (Iles, 1984). Two city wells completed in this aquifer are currently operational; well 1 was drilled in March, 1972, to a depth of 300 feet, and well 2 was drilled in September, 1972, to a depth of 295 feet. After construction, well 1 had a capacity of 300 gallons per minute at 19 feet of drawdown and well 2 had a capacity of 285 gallons per minute at 18 feet of drawdown. The static water level was approximately 100 feet below land surface in both wells.

Water produced from the two wells mentioned above is of poor quality. The Lennox municipal water supply (after treatment for iron and fluoride) has a total dissolved solids content of 2,080 milligrams per liter (mg/L), a hardness concentration (as CaCO_3) of 1,293 mg/L, a sulfate concentration of 1,157 mg/L, an iron concentration of 0.20 mg/L, and a manganese concentration of 0.36 mg/L (analyses performed by the State Health Laboratory, November 25, 1986).

HYDROGEOLOGIC SETTING

The study area is underlain by Pleistocene drift (Beffort, 1969). The drift is directly underlain by bedrock, either Cretaceous sediments (Niobrara Formation or Carlile Shale) or Precambrian Sioux Quartzite.

Drift is composed of till and outwash, both of which are present in the study area. Till, which forms the land surface in the study area, consists of a heterogeneous mixture of boulders, gravel, sand, clay, and silt. The till matrix is composed predominantly of clay and silt. 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, are found dispersed throughout the outwash matrix. One particular outwash, named the Lennox aquifer, is the source of water for the city of Lennox.

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 Niobrara Formation, Carlile Shale, Greenhorn Limestone, Graneros Shale, and Dakota Formation followed by quartzite wash, weathered quartzite and finally Precambrian Sioux Quartzite. For a brief description of the commonly encountered bedrock units, refer to table 3. The surface of the Sioux Quartzite generally rises in elevation from south to north in and near the study area. The relatively flat laying Cretaceous sediments above the Sioux Quartzite "pinch out" as the quartzite rises in elevation.

In the study area, the Dakota Formation, the zone of weathered quartzite, quartzite wash and occasionally the Sioux Quartzite

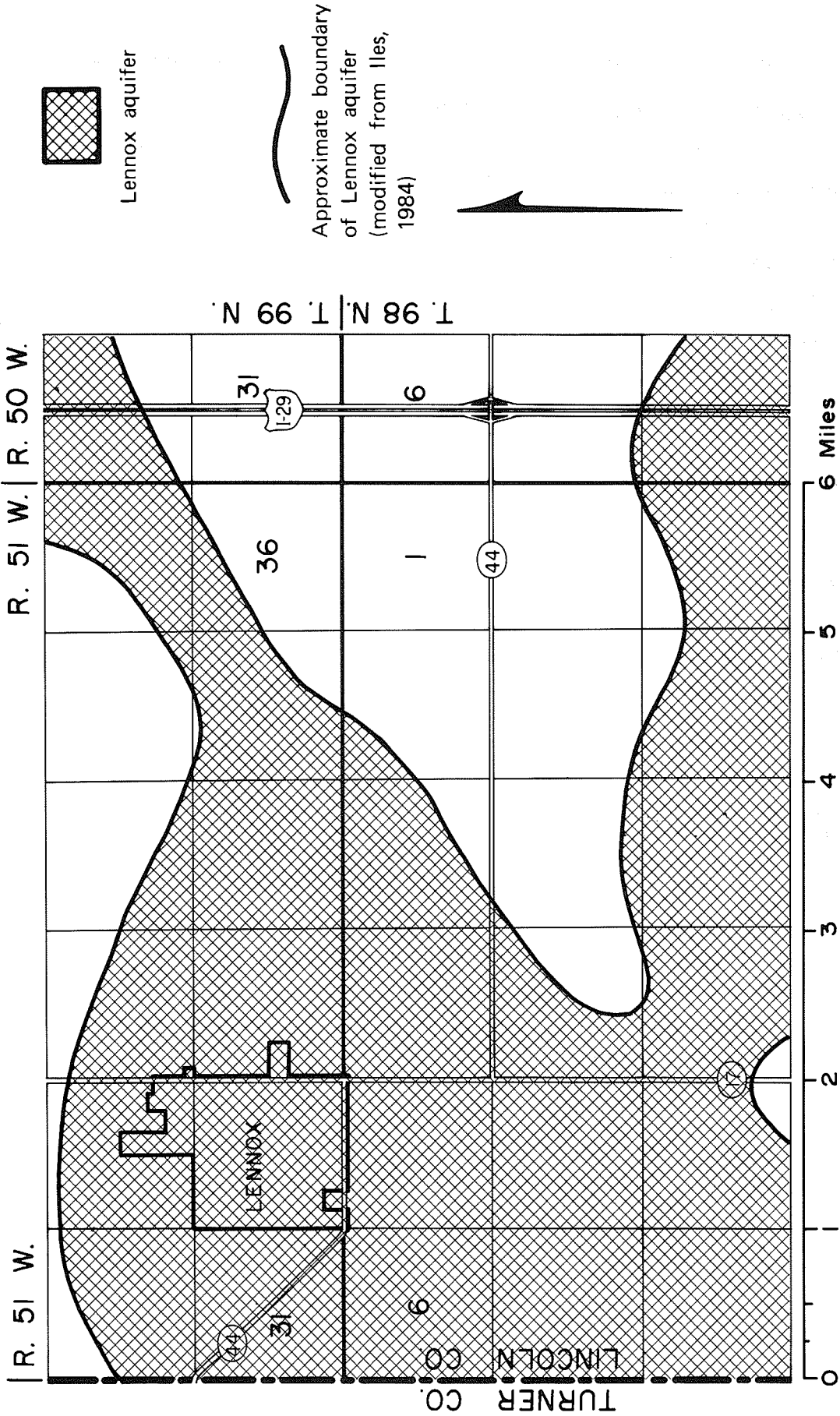


Figure 3. Extent of the Lennox aquifer.

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Table 3. Description of bedrock geologic units
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Geologic unit	General description
Niobrara Formation	White to buff, massive calcareous chalk; fossiliferous
Carlile Shale	Medium- to dark-gray shale with pyrite concretions; includes nearshore facies siltstone (Split Rock Creek Formation) at ML 12
Greenhorn Limestone	Dark-gray shale and buff to white fossiliferous limestone
Graneros Shale	Light- to dark-gray silicious shale, hard
Dakota Formation *	Fine to coarse, loose to cemented, light-brown sand or sandstone with alternating layers of shale; coal seams are often present
Quartzite wash and weathered quartzite *	Pinkish sand with white clay fragments; sand is composed almost entirely of Sioux Quartzite fragments
Sioux Quartzite	Pink to purple, very hard, orthoquartzite

* In this report, the Dakota Formation, quartzite wash and weathered quartzite are considered to act as one hydrologic unit and therefore are identified together as the Dakota Formation on figures 5, 6, 7, and 8.

General descriptions from Beffort (1969), and from drillers logs from this investigation.

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are considered aquifers. The Dakota Formation and the directly underlying quartzite wash, when present, probably act as one hydrologic unit, therefore, in this report, the quartzite wash is considered to be a part of the Dakota Formation. The Sioux Quartzite is considered an aquifer only where fractures exist that will yield sufficient quantities of water. The presence and extent of these fractures is very difficult to predict.

The Dakota Formation, in the Lennox area, consists of interbedded sand, sandstone, shale, and sandy shale. In the western part of the study area, the Dakota Formation "pinches out" against the quartzite surface and the Lennox aquifer lies directly on the quartzite surface (Iles, 1984). Thus, the Lennox aquifer and the Dakota Formation exist at essentially the same elevation and may be in contact beneath the city of Lennox (Iles, 1984).

RESULTS OF INVESTIGATION

General Geology

Three cross sections, whose locations are shown on figure 4, illustrate the spatial distribution of sediments in the study area (figs. 5, 6, and 7). The Niobrara Formation was encountered in only two drill holes (ML 6 and ML 7). Actual thickness of the Niobrara is unknown because after drilling 99 feet into the Niobrara at ML 7, drilling-mud circulation was lost and the hole was abandoned due to the possibility of hole collapse. Thickness of the Niobrara at ML 6 is 56 feet, but the bottom few feet are very shaley. Carlile Shale ranges in thickness from 62 feet (ML 10) to 250 feet (ML 6) and the Greenhorn Limestone varies in thickness from 5 feet (ML 11) to 47 feet (ML 8). Graneros Shale is very thin or absent in the study area and was found only at ML 1, ML 2, ML 6, and ML 8. Thickness of the Graneros varies from 5 feet (ML 2) to 20 feet (ML 1). A test hole at ML 12 encountered the Split Rock Creek Formation which is a nearshore facies of the Cretaceous age sediments (Shurr and others, 1987).

Dakota Formation

Extent and thickness of the Dakota Formation is shown in figure 8. Directly below the Dakota Formation, and the quartzite wash where present, is the Precambrian Sioux Quartzite (and possibly a Paleozoic sandstone, ML 2, or shale, ML 5). Directly above the Dakota Formation is either the Greenhorn Limestone or the Graneros Shale.

In the study area, the Dakota Formation has a minimum thickness of 41 feet (ML 10) and a maximum thickness of 238 feet (ML 6, which includes 11 feet of quartzite wash). In test holes which encountered it, the quartzite wash ranges in thickness from 11 feet (ML 6) to 35 feet (ML 1). It is important to remember, however, that not all of the Dakota Formation thickness consists

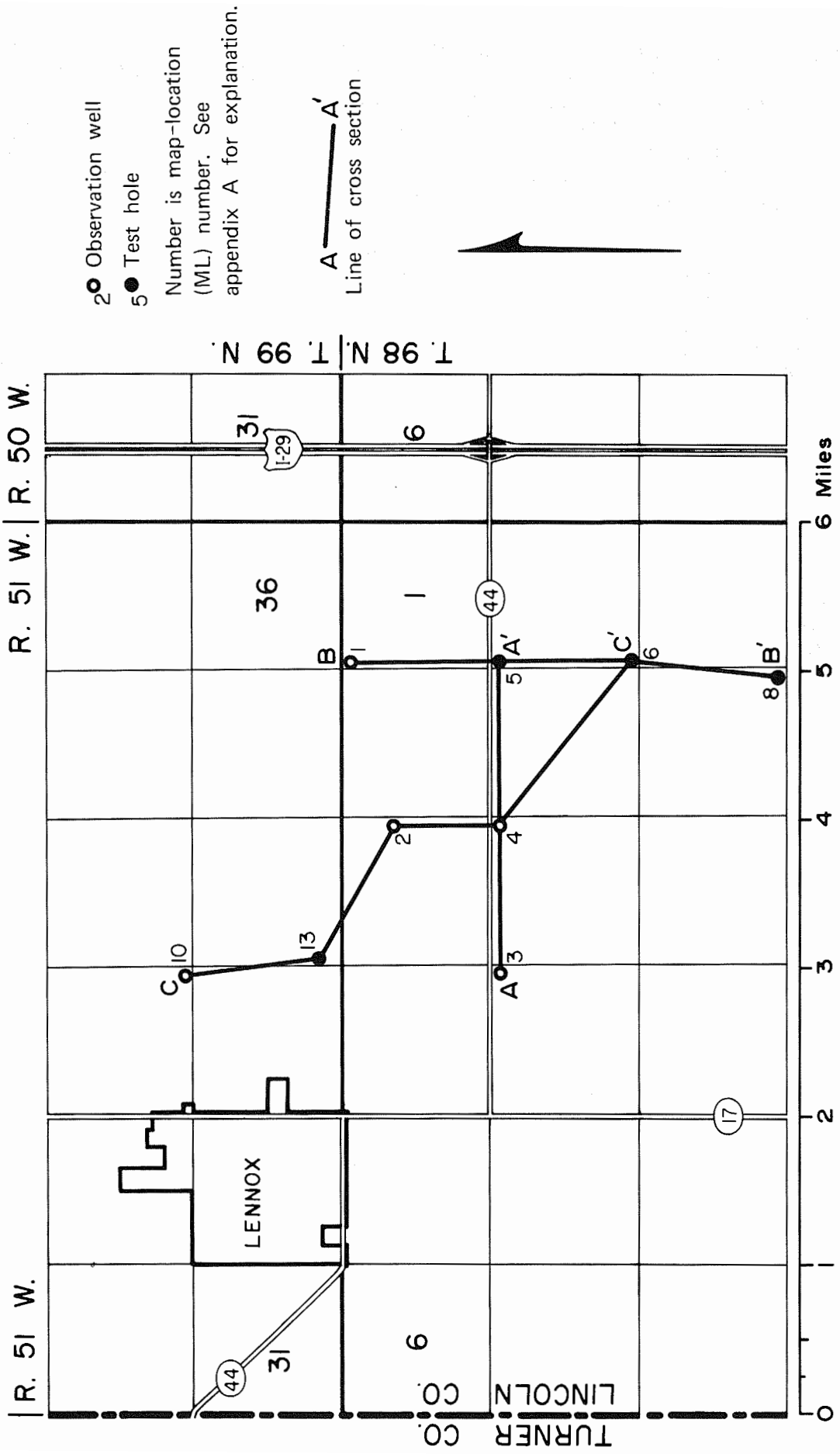
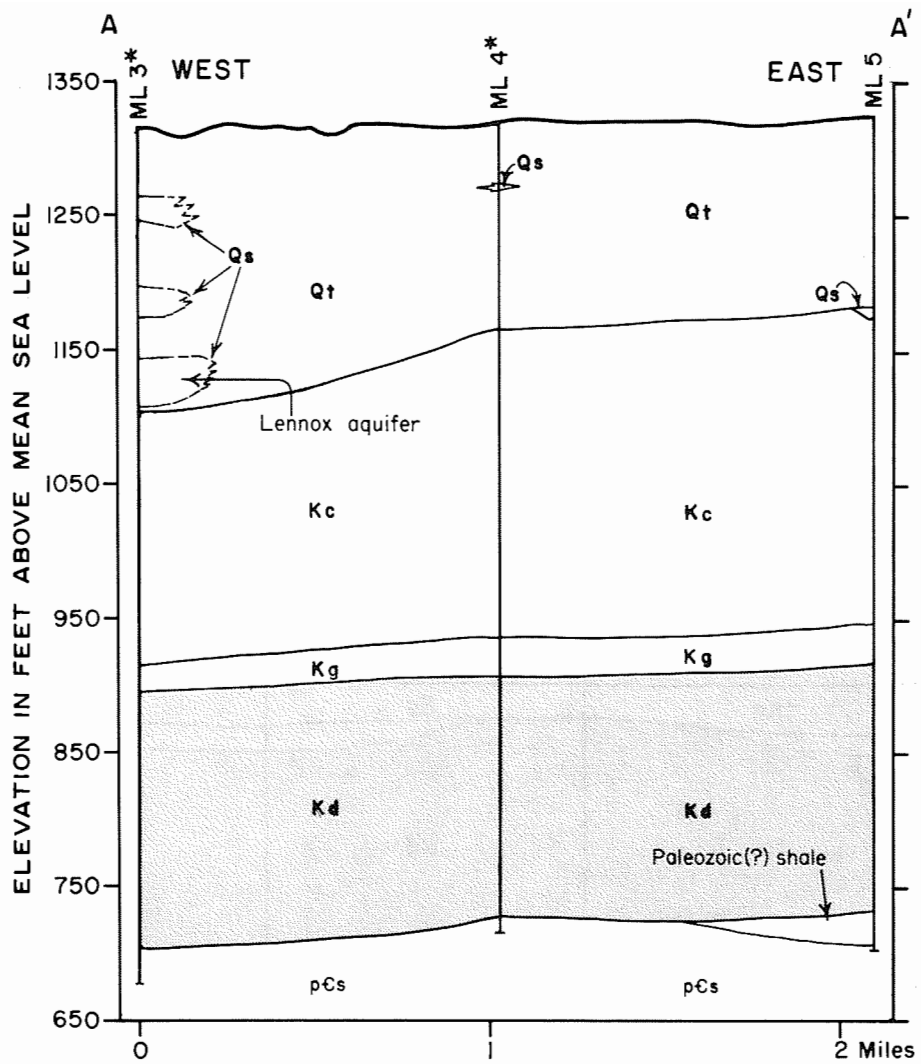


Figure 4. Locations of geologic cross sections.



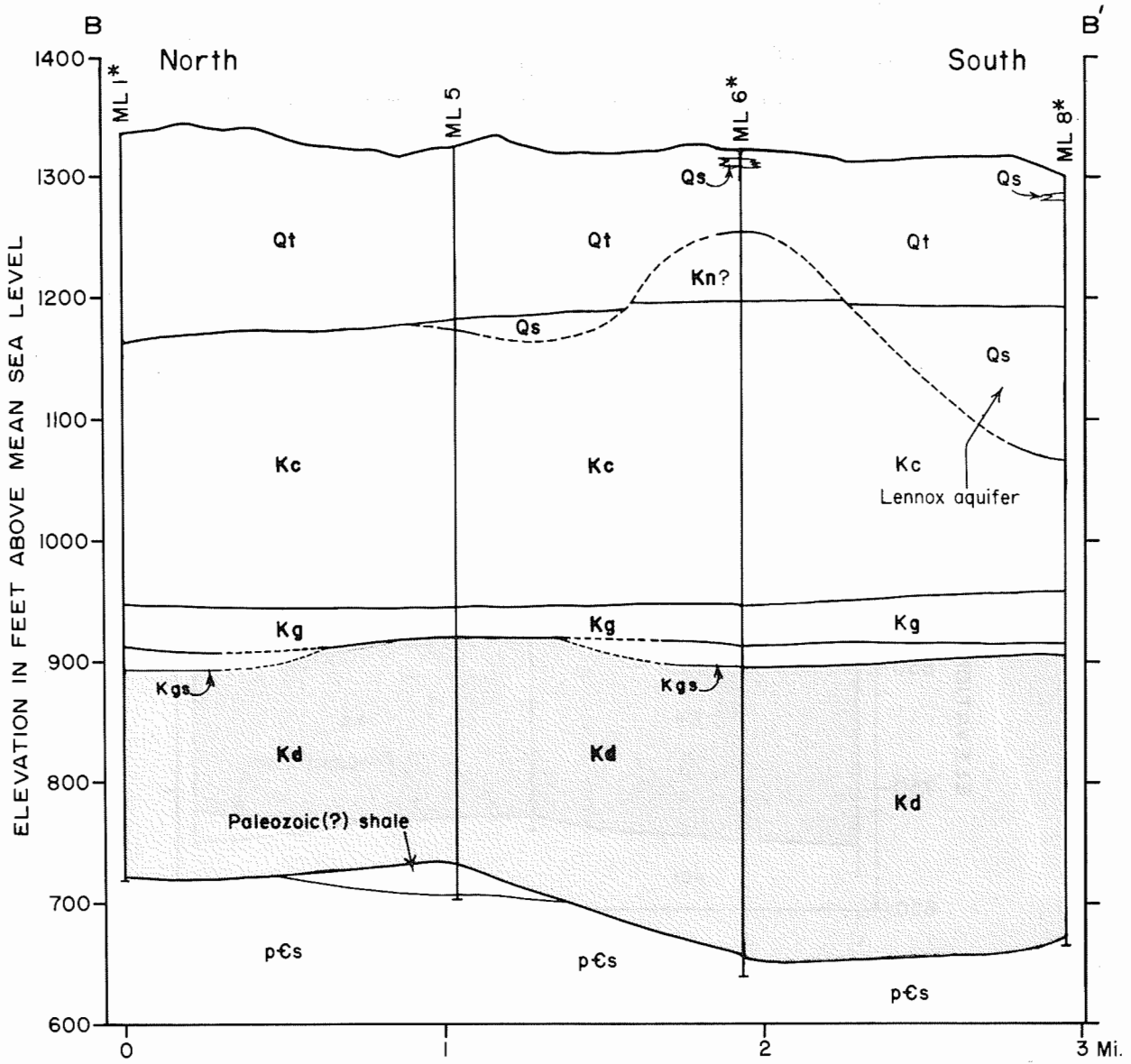
- Quaternary { Qt.....Glacial till
Qs.....Glacial sand and gravel
- Cretaceous { Kn.....Niobrara Formation
Kc.....Carlile Shale
Kg.....Greenhorn Limestone
Kgs.....Graneros Shale
Kd.....Dakota Formation
- Precambrian—pCs.....Sioux Quartzite

— Lithologic contact. Dashed where approximate.

ML 3* Well or test hole. Number is map-location (ML) number. See appendix A for explanation. An asterisk (*) indicates an underlying quartzite wash is included in the total thickness of the Dakota Formation.

Vertical exaggeration = 20x.

Figure 5. Geologic cross section A-A'.



- Quaternary
 - Qt.....Glacial till
 - Qs.....Glacial sand and gravel
 - Cretaceous
 - Kn.....Niobrara Formation
 - Kc.....Carlile Shale
 - Kg.....Greenhorn Limestone
 - Kgs.....Graneros Shale
 - Kd.....Dakota Formation
 - Precambrian—pCs.....Sioux Quartzite
- ~~~~~ Lithologic contact. Dashed where approximate.

ML 6* Well or test hole. Number is map-location (ML) number. See appendix A for explanation. An asterisk (*) indicates an underlying quartzite wash is included in the total thickness of the Dakota Formation.

Vertical exaggeration = 20x.

Figure 6. Geologic cross section B-B'.

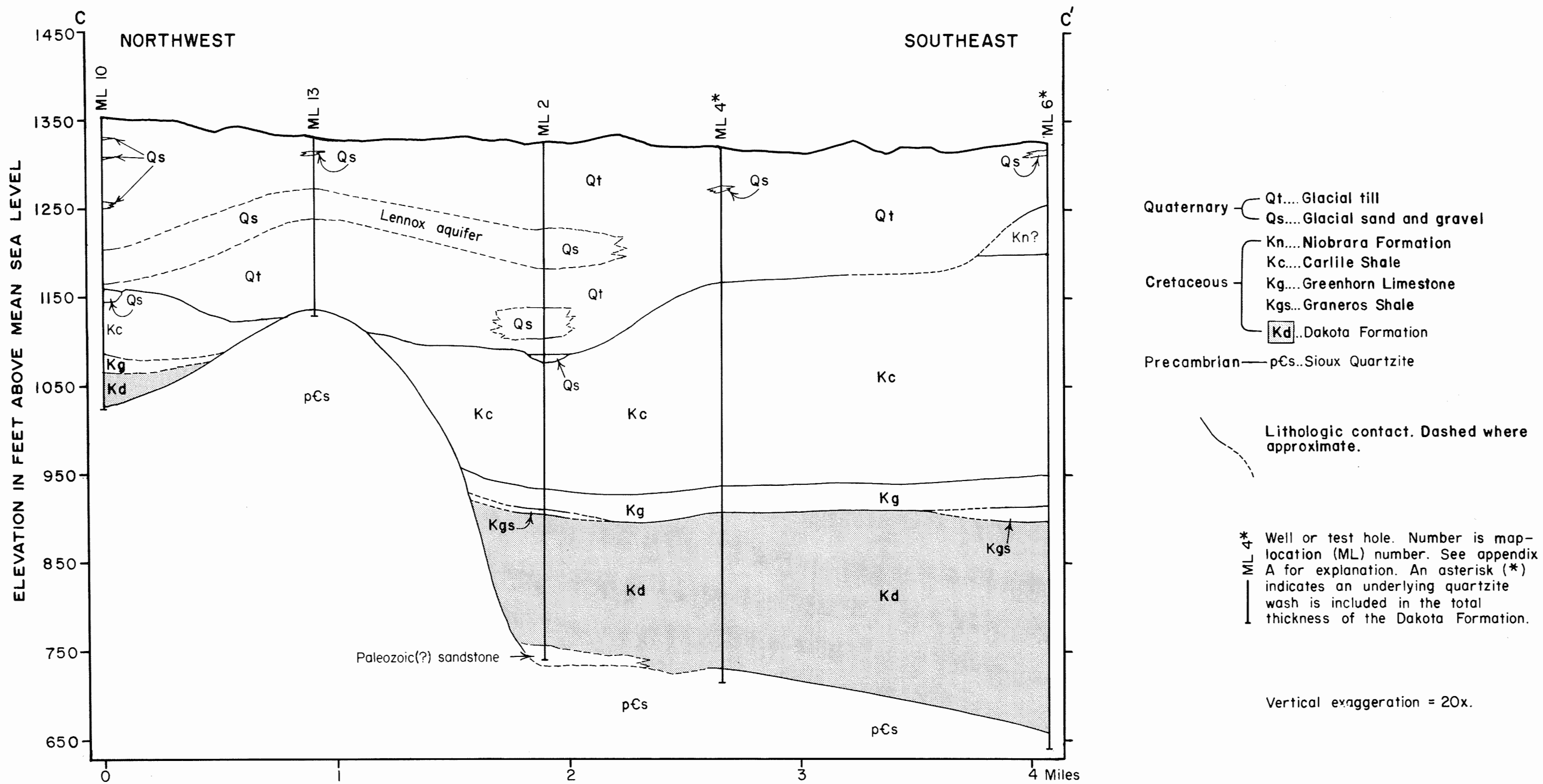


Figure 7. Geologic cross section C-C'.

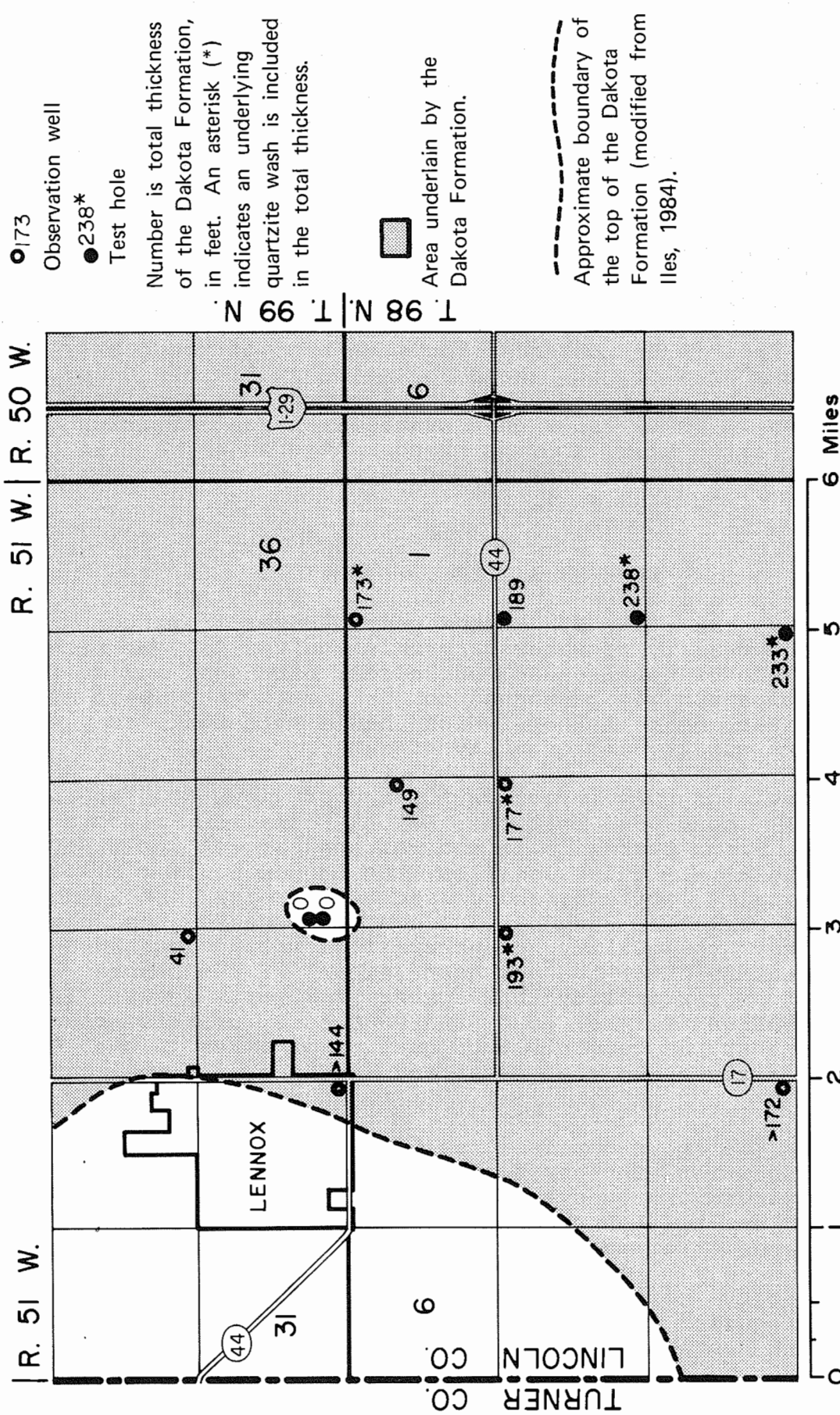


Figure 8. Extent and thickness of the Dakota Formation.

of sand. Varying thicknesses of clay are interbedded with the sand. Note also, that the test hole at ML 2 encountered a Paleozoic(?) sandstone between 569 feet and 585 feet and the test hole at ML 5 encountered a Paleozoic(?) Shale between 595 feet and 620 feet. For this report, neither the sand nor the shale unit were included as part of the Dakota Formation because their character was distinctly different than the Dakota Formation identified elsewhere in the study area.

The Dakota Formation is under confined conditions and the potentiometric surface slopes downward to the south (fig. 9). The quality of water found near the northern extent of the Dakota Formation is relatively poor but improves farther to the east and southeast of this boundary. This trend is illustrated in figures 10 and 11. Iles (1984) observed the same type of trend only over a much larger area of the Dakota Formation in Lincoln County. In the Lennox area, one water sample, collected from a private farm well drilled in 1976, shows an elevated iron concentration (0.69 mg/L) which is contrary to the trend mentioned above (fig. 11). Overall, however, the quality of water in the private well follows the trend (table 2).

SUMMARY AND RECOMMENDATIONS

Currently, the city of Lennox pumps water from the Lennox aquifer. The quality of water from this aquifer is poor with high concentrations of total-dissolved solids, hardness, and sulfates. This investigation was designed to delineate that part of the Dakota aquifer, near Lennox, which has a potential to yield a satisfactory quality and quantity of water.

As a result of this investigation and previous studies in the area, it was concluded that the Dakota Formation "pinches out" against the Sioux Quartzite in the western part of the study area (figs. 7 and 8). In this location, the Lennox aquifer also lies on the quartzite surface, and consequently, the Lennox aquifer and Dakota Formation may be in contact beneath the city of Lennox. Also, the quality of water from wells located in the Dakota Formation, near the northern extent of the Dakota Formation, is of poorer quality than water from wells located in the Dakota Formation farther east and southeast of this boundary. This means that, in general, the quality of water in the Dakota Formation improves to the east and southeast of the city of Lennox.

Based on the above conclusions, the area outlined in figure 12 is recommended for further testing. The process used to select this recommended area was to find a portion of the Dakota Formation, as close to Lennox as possible, which had a sufficient thickness and contained water of good quality.

If the city officials should decide to drill a well and conduct an aquifer test in the recommended area, they should hire a consulting engineer, licensed in South Dakota, to plan and

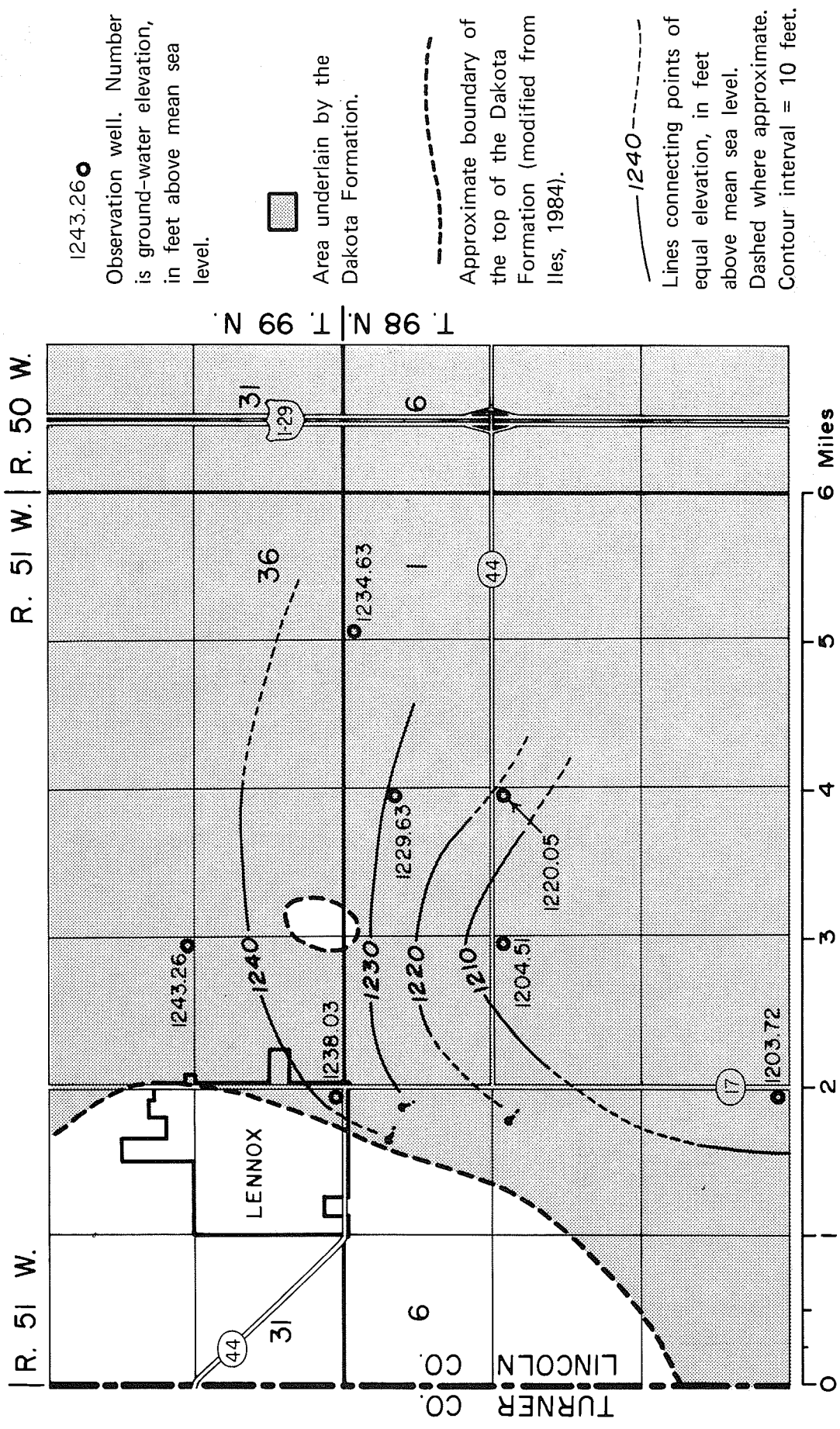


Figure 9. Potentiometric surface of the Dakota Formation, August 10, 1988.

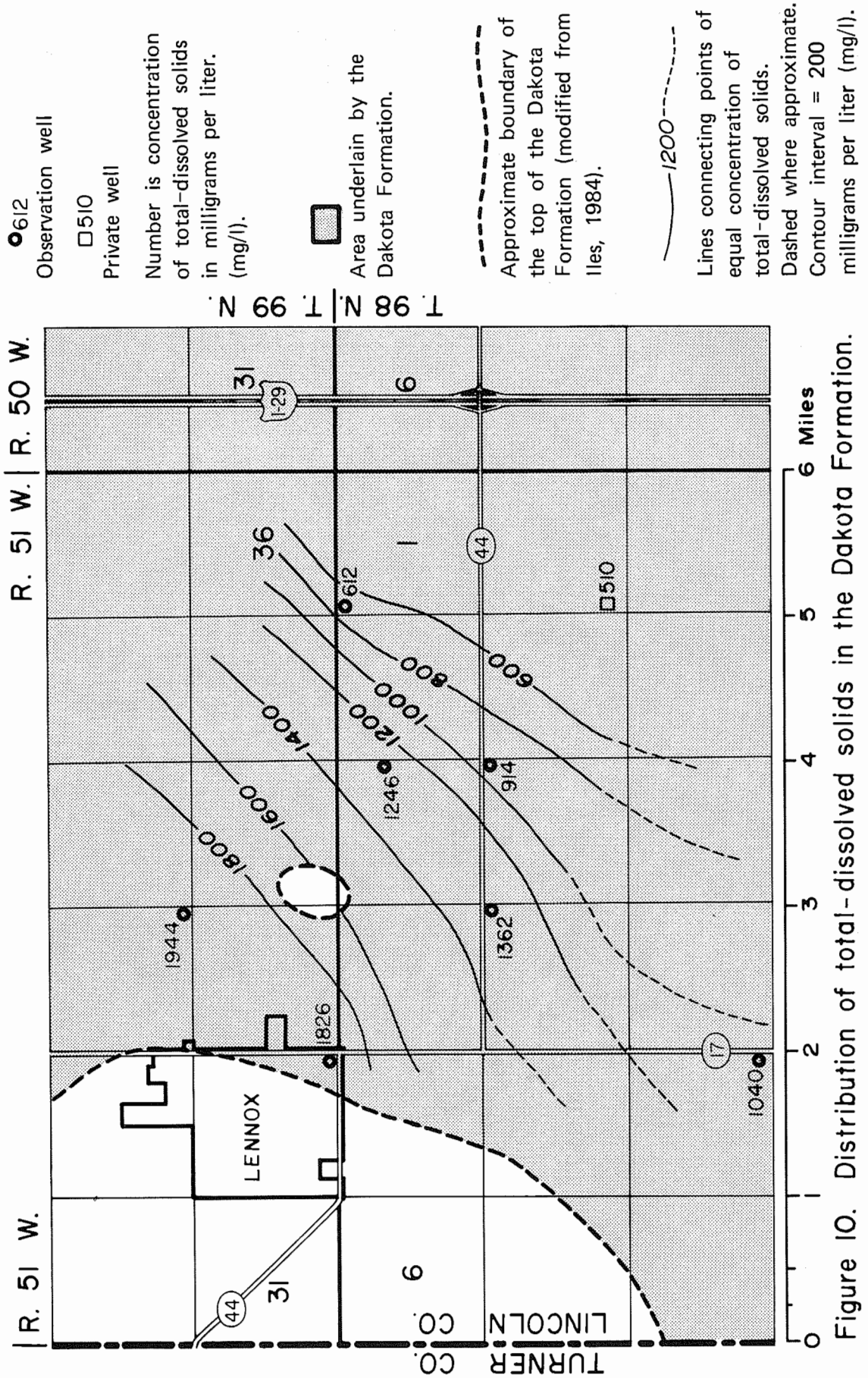


Figure 10. Distribution of total-dissolved solids in the Dakota Formation.

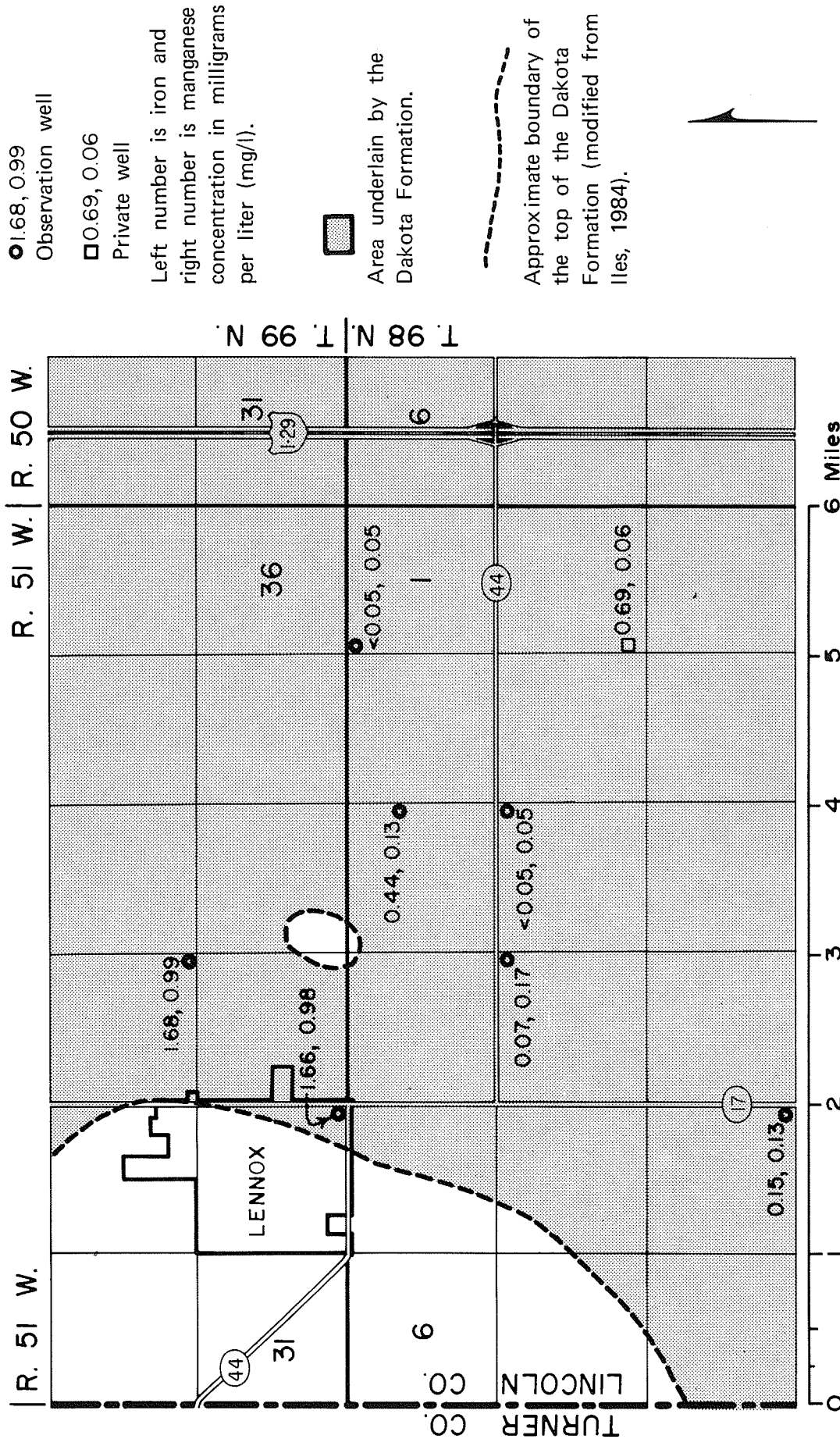


Figure 11. Distribution of iron and manganese concentrations in the Dakota Formation.

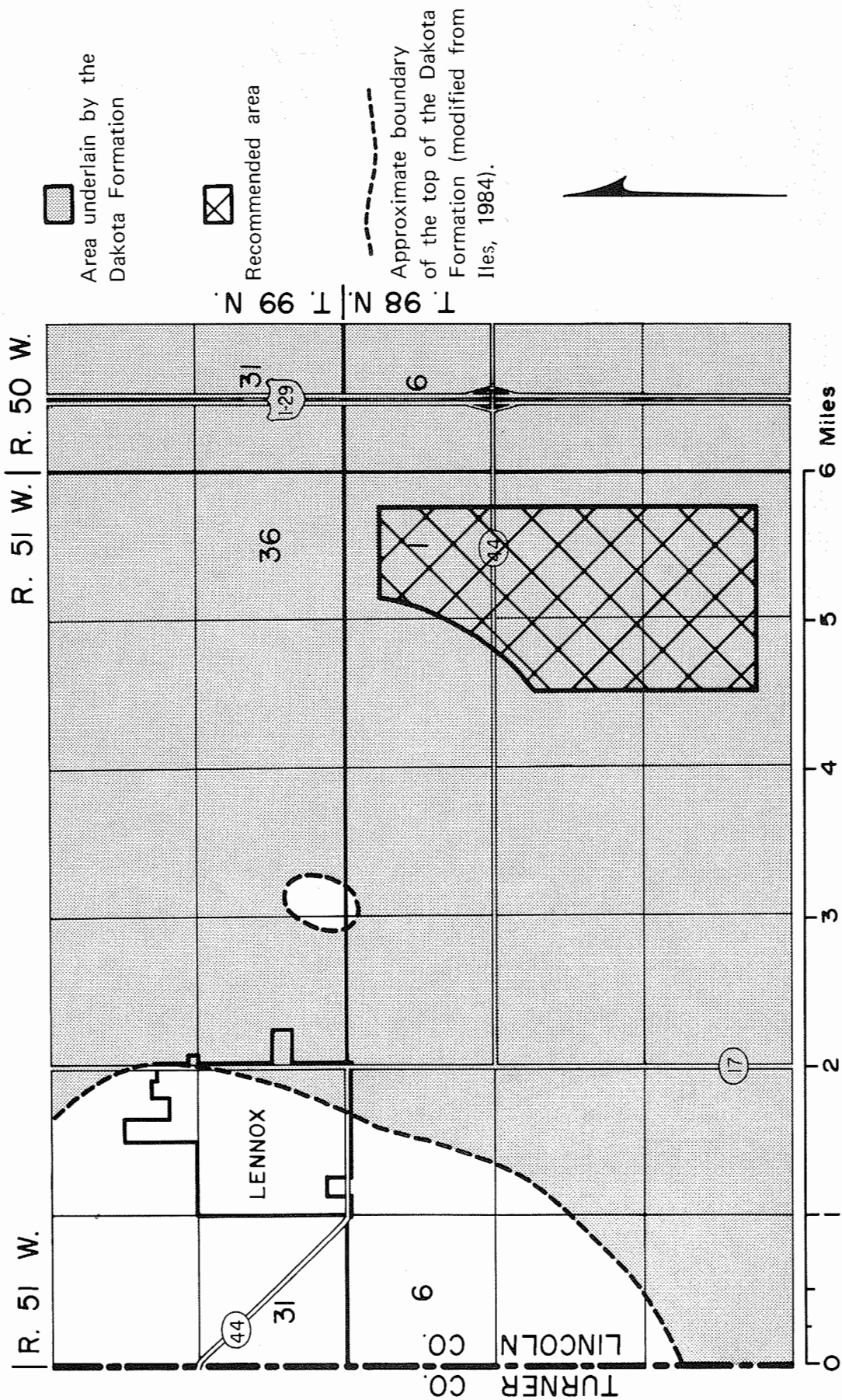


Figure 12. Area recommended for further testing.

coordinate additional testing. On the basis of the engineer's recommendation, a commercial well drilling company should be hired to drill a test hole, construct a production well, and install additional observation wells as necessary. An aquifer test should be conducted for a minimum of 72 hours. Water levels should be measured during the test and water samples collected for chemical analyses. At least one water sample should be collected during the test and sent to the Department of Health, Pierre, South Dakota, to determine the biological and chemical suitability of the water. If requested, the South Dakota Geological Survey will supervise the aquifer test and analyze the data. The results of these tests will help to determine the suitability of this site for development of a municipal well field. The Division of Water Rights, Department of Water and Natural Resources in Pierre, South Dakota, should be contacted to obtain water rights and a permit to drill a municipal well.

REFERENCES

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- U.S. Environmental Protection Agency, 1985a, National interim primary drinking water regulations - maximum contaminant levels for inorganic chemicals: Code of Federal Regulations, Title 40, Part 141, Section 141.11, p. 523-524.
- _____, 1985b, National secondary drinking water regulations - secondary maximum contaminant levels: Code of Federal Regulations, Title 40, Part 143, Section 143.3, p. 584.

APPENDIX A

Logs of test holes and observation 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 NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 09, T. 98 N., R. 51 W. is the same as a **LOCATION** of 098N-51W-09AAAA. 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.

CASING DIAMETER

The numbers are presented in inches.

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 $\frac{1}{2}$ minute series topographic map.

COUNTY: LINCOLN LOCATION: 098N-51W-01BBBB
 MAP LOCATION: 1
 LEGAL LOCATION: NW NW NW NW SEC. 01, T. 098 N., R. 51 W.
 LATITUDE: 43.2038 LONGITUDE: 96.4932

LAND OWNER:
 PROJECT: SIOUX FALLS-BRANDON STUDY
 DRILLING COMPANY: SDGS
 DRILLER: L. HELSETH/M. KOFFLER DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 07-22-1980 DRILLING METHOD: ROTARY
 GROUND SURFACE ELEVATION: 1338.00 T
 TOTAL DRILL HOLE DEPTH: 618.0 TEST HOLE NUMBER: SFB-175
 WATER RIGHTS WELL: LN-80I SDGS WELL NAME:
 OTHER WELL NAME:

BASIN: VERMILLION AQUIFER: DAKOTA
 MANAGEMENT UNIT:
 SCREEN TYPE: PVC, MFG. SCREEN LENGTH: 10.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION: 1342.72 I
 CASING STICK-UP: TOTAL CASING AND SCREEN:
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10170102
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: X SINGLE POINT RESISTIVITY: X
 NATURAL GAMMA: X EXTRA:
 SAMPLES:

BOTTOM OF WELL AT 580 FEET. TWO 5-FOOT SAND-POINTS GLUED TOGETHER.

0	-	8.0	CLAY, YELLOWISH-BROWN, SILTY, PEBBLY (TILL)
8.0	-	21.0	CHALK, YELLOWISH-BROWN; VERY CALCAREOUS
21.0	-	34.0	CLAY, BROWNISH-GRAY, SILTY, PEBBLY; NONCALCAREOUS (TILL)
34.0	-	71.0	CLAY, GRAY, SILTY, SLIGHTLY PEBBLY; SLIGHTLY CALCAREOUS (TILL)
71.0	-	111.0	CLAY, GRAY, SILTY, SLIGHTLY GRAVELLY; ROCKS AT 79, 84, AND 111 FEET (TILL)
111.0	-	125.0	CLAY, GRAY; LOTS OF CHALK IN THE CUTTINGS (TILL)
125.0	-	173.0	CLAY, GRAY, SILTY; GRAVELLY IN SPOTS, SLIGHTLY CALCAREOUS, LOTS OF YELLOW CALCAREOUS CHALK IN THE CUTTINGS (TILL)
173.0	-	327.0	CLAY, GRAY; NONCALCAREOUS, HARD SPOT AT 208 FEET (CARLILE SHALE)
327.0	-	392.0	CLAY, GRAY; SLIGHTLY CALCAREOUS, WITH SOME HARD LAYERS (CARLILE SHALE)
392.0	-	424.0	UNKNOWN; HARD LAYER, DARK-GRAY, CEMENTED, VERY CALCAREOUS WITH SOME WHITE SHELL-LIKE FRAGMENTS, ALSO SOME MEDIUM-GRAY TO DARK-BROWN CUTTINGS WHICH WERE VERY CALCAREOUS (GREENHORN LIMESTONE)
424.0	-	444.0	CLAY, LIGHT- TO MEDIUM-GRAY; SLIGHTLY

CALCAREOUS, FISSILE, POSSIBLY WITH SOME SAND LAYERS (GRANEROS SHALE)

444.0 -	474.0	SAND (DAKOTA FORMATION)
474.0 -	481.0	CLAY, GRAY (DAKOTA FORMATION)
481.0 -	485.0	CLAY, GRAY; WITH SAND (DAKOTA FORMATION)
485.0 -	498.0	SAND; INTERBEDDED WITH GRAY CLAY (DAKOTA FORMATION)
498.0 -	535.0	SAND (DAKOTA FORMATION)
535.0 -	570.0	CLAY, GRAY; INTERBEDDED WITH SAND (DAKOTA FORMATION)
570.0 -	582.0	SAND (DAKOTA FORMATION)
582.0 -	617.0	QUARTZITE, PINK; WITH WHITE CLAY, VERY WEATHERED(?) (SIOUX QUARTZITE)
617.0 -	618.0	QUARTZITE, PINK; HARD, THERE WAS ACTUALLY ONLY A FEW INCHES OF PENETRATION ACHIEVED (SIOUX QUARTZITE)

* * * *

COUNTY: LINCOLN

LOCATION: 098N-51W-03ADAD

MAP LOCATION: 2

LEGAL LOCATION: SE NE SE NE SEC. 03, T. 098 N., R. 51 W.

LATITUDE: 43.2023

LONGITUDE: 96.5047

LAND OWNER:

PROJECT: LINCOLN-UNION CO. STUDY

DRILLING COMPANY: SDGS

DRILLER: G. JENSEN

DRILLER'S LOG:

GEOLOGIST: R. HAMMOND

GEOLOGIST'S LOG: X

DATE DRILLED: 07-18-1988

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1326.02 I

TOTAL DRILL HOLE DEPTH: 585.0

TEST HOLE NUMBER: R20-88-33

WATER RIGHTS WELL:

SDGS WELL NAME: R20-88-33

OTHER WELL NAME:

BASIN: VERMILLION

AQUIFER: DAKOTA

MANAGEMENT UNIT:

SCREEN TYPE: PVC, MFG.

SCREEN LENGTH: 10.0

CASING TYPE: PVC, SCH. 80

CASING DIAMETER: 2.0

CASING TOP ELEVATION: 1327.33 I

CASING STICK-UP: 1.31

TOTAL CASING AND SCREEN: 530.0

WELL MAINTENANCE DATE:

USGS HYDROLOGICAL UNIT CODE: 10170102

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: X

SINGLE POINT RESISTIVITY: X

NATURAL GAMMA: X

EXTRA:

SAMPLES:

0 -	2.0	TOPSOIL, BROWN
2.0 -	21.0	CLAY, YELLOW-BROWN, PEBBLY, SILTY, SANDY (TILL)
21.0 -	99.0	CLAY, GRAY, SANDY, PEBBLY, SILTY; CALCAREOUS (TILL)
99.0 -	116.0	SAND, FINE TO MEDIUM, VERY SILTY
116.0 -	142.0	GRAVEL, MEDIUM, SANDY, SUBANGULAR
142.0 -	186.0	CLAY(?), GRAY; VERY POOR SAMPLES (TILL?)

186.0 - 223.0 SAND, WHITE, MEDIUM TO FINE ("WESTERN"
SAND?)
223.0 - 243.0 CLAY, REDDISH-BROWN, SILTY, PEBBLY, VERY
SANDY (TILL)
243.0 - 249.0 GRAVEL, VERY COARSE; COBBLES
249.0 - 376.0 SHALE, LIGHT-GRAY; VERY HARD; SLIGHTLY
CALCAREOUS IN SPOTS (CARLILE SHALE)
376.0 - 393.0 SHALE, GRAY-BROWN; HARD; CALCAREOUS
(FAIRPORT SHALE MEMBER - CARLILE SHALE)
393.0 - 415.0 SILTSTONE, GRAY; VERY CALCAREOUS
(GREENHORN LIMESTONE)
415.0 - 420.0 SHALE, DARK-GRAY; SLIGHTLY CALCAREOUS
(GRANEROS SHALE)
420.0 - 426.0 SANDSTONE, WHITE, FINE (DAKOTA FORMATION)
426.0 - 472.0 SHALE, DARK-GRAY, SILTY (DAKOTA
FORMATION)
472.0 - 569.0 SANDSTONE, WHITE, FINE, SHALEY AT 542 TO
550 FEET (DAKOTA FORMATION)
569.0 - 585.0 SANDSTONE, WHITE, MEDIUM TO FINE, CLAYEY;
VERY HARD (PALEOZOIC? SANDSTONE?)

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COUNTY: LINCOLN LOCATION: 098N-51W-09AAAA
MAP LOCATION: 3
LEGAL LOCATION: NE NE NE NE SEC. 09, T. 098 N., R. 51 W.
LATITUDE: 43.1949 LONGITUDE: 96.5201
LAND OWNER:
PROJECT: LENNOX CITY STUDY-1988
DRILLING COMPANY: SDGS
DRILLER: T. MCCUE DRILLER'S LOG:
GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
DATE DRILLED: 05-16-1988 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1313.58 I
TOTAL DRILL HOLE DEPTH: 635.0 TEST HOLE NUMBER: R2-88-06
WATER RIGHTS WELL: SDGS WELL NAME: R2-88-06
OTHER WELL NAME:
BASIN: VERMILLION AQUIFER: DAKOTA
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: 1315.91 I
CASING STICK-UP: 2.33 TOTAL CASING AND SCREEN: 634.5
WELL MAINTENANCE DATE:
USGS HYDROLOGICAL UNIT CODE: 10170102
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X EXTRA:
SAMPLES:

31 FEET OF BLANK CASING (CLOSED TO SCREEN) FROM
632 TO 601 FEET, SCREENED FROM 601 TO 591 FEET.

0 - 2.0 TOPSOIL, BLACK

2.0 -	9.0	CLAY, YELLOW-BROWN, SILTY (TILL)
9.0 -	16.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
16.0 -	22.0	CLAY, BROWN, SANDY, PEBBLY (TILL)
22.0 -	52.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
52.0 -	64.0	SAND AND GRAVEL, COARSE SAND TO COARSE PEBBLE GRAVEL, SILTY; WITH INTERBEDDED CLAY
64.0 -	115.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
115.0 -	139.0	GRAVEL, MEDIUM TO COARSE PEBBLE GRAVEL; OXIDIZED
139.0 -	171.0	CLAY, GRAY, SANDY (TILL)
171.0 -	204.0	SAND AND GRAVEL, MEDIUM SAND TO COARSE PEBBLE GRAVEL; CLAY STRINGER FROM 193 TO 197 FEET
204.0 -	209.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
209.0 -	397.0	SHALE, LIGHT-GRAY TO DARK-GRAY; NONCALCAREOUS (CARLILE SHALE)
397.0 -	418.0	LIMESTONE, BROWN; CALCAREOUS (GREENHORN LIMESTONE)
418.0 -	453.0	SAND, FINE (DAKOTA FORMATION)
453.0 -	508.0	CLAY, LIGHT-GRAY, SANDY (DAKOTA FORMATION)
508.0 -	522.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
522.0 -	564.0	SAND, FINE (DAKOTA FORMATION)
564.0 -	568.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
568.0 -	572.0	SAND, FINE (DAKOTA FORMATION)
572.0 -	578.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
578.0 -	581.0	SAND, FINE (DAKOTA FORMATION)
581.0 -	588.0	CLAY, GRAY TO BLACK; COAL SEAM(?) (DAKOTA FORMATION)
588.0 -	611.0	SAND, PINK, FINE; WITH WHITE CLAY PIECES
611.0 -	635.0	QUARTZITE, PINK; HARD (SIOUX QUARTZITE)

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COUNTY: LINCOLN

LOCATION: 098N-51W-10AAA

MAP LOCATION: 4

LEGAL LOCATION: NE NE NE NE SEC. 10, T. 098 N., R. 51 W.

LATITUDE: 43.1948

LONGITUDE: 96.5047

LAND OWNER:

PROJECT: LENNOX CITY STUDY-1988

DRILLING COMPANY: SDGS

DRILLER: T. MCCUE/M. THOMPSON

DRILLER'S LOG:

GEOLOGIST: P. DAWSON

GEOLOGIST'S LOG: X

DATE DRILLED: 05-26-1988

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1320.41 I

TOTAL DRILL HOLE DEPTH: 605.0

TEST HOLE NUMBER: R2-88-07

WATER RIGHTS WELL:

SDGS WELL NAME: R2-88-07

OTHER WELL NAME:

BASIN: VERMILLION

AQUIFER: DAKOTA

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: 1322.37 I

CASING STICK-UP: 1.96 TOTAL CASING AND SCREEN: 599.0

WELL MAINTENANCE DATE:

USGS HYDROLOGICAL UNIT CODE: 10170102

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X

NATURAL GAMMA: X EXTRA:

SAMPLES:

20 FEET OF BLANK CASING (CLOSED TO SCREEN) FROM
597 TO 577 FEET, SCREENED FROM 577 TO 567 FEET.

0	-	2.0	TOPSOIL, BLACK
2.0	-	8.0	CLAY, YELLOW-BROWN, SILTY, SANDY, PEBBLY (TILL)
8.0	-	11.0	CLAY, BROWN, SANDY, PEBBLY (TILL)
11.0	-	23.0	CLAY, BROWN TO GRAY, SILTY, SANDY (TILL)
23.0	-	28.0	CLAY, LIGHT-GRAY, SANDY, PEBBLY (TILL)
28.0	-	46.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
46.0	-	50.0	SAND, MEDIUM TO COARSE
50.0	-	154.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
154.0	-	382.0	SHALE, GRAY; NONCALCAREOUS (CARLILE SHALE)
382.0	-	414.0	LIMESTONE, DARK-GRAY; CALCAREOUS, HARD LAYER FROM 386 TO 391 FEET (GREENHORN LIMESTONE)
414.0	-	432.0	SAND, FINE (DAKOTA FORMATION)
432.0	-	442.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
442.0	-	466.0	SAND, FINE (DAKOTA FORMATION)
466.0	-	506.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
506.0	-	516.0	SAND, FINE (DAKOTA FORMATION)
516.0	-	534.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
534.0	-	546.0	SAND, FINE (DAKOTA FORMATION)
546.0	-	570.0	CLAY, GRAY TO BLACK; COAL SEAM(?) (DAKOTA FORMATION)
570.0	-	591.0	SAND, PINK, FINE; WITH WHITE CLAY PIECES
591.0	-	605.0	QUARTZITE, PINK; HARD (SIOUX QUARTZITE)

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COUNTY: LINCOLN

LOCATION: 098N-51W-12BBBB

MAP LOCATION: 5

LEGAL LOCATION: NW NW NW NW SEC. 12, T. 098 N., R. 51 W.

LATITUDE: 43.1938

LONGITUDE: 96.4938

LAND OWNER:

PROJECT: LINCOLN-UNION CO. STUDY

DRILLING COMPANY: SDGS

DRILLER: D. IVERSON

DRILLER'S LOG:

GEOLOGIST: R. HAMMOND

GEOLOGIST'S LOG: X

DATE DRILLED: 07-11-1988

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1326.00 T

TOTAL DRILL HOLE DEPTH: 622.0

TEST HOLE NUMBER: R20-88-31

USGS HYDROLOGICAL UNIT CODE: 10170102

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: X

SINGLE POINT RESISTIVITY: X

NATURAL GAMMA: X
SAMPLES:

EXTRA:

THIS HOLE WAS PLUGGED WITH A BENTONITE GROUT FROM
622 TO 5 FEET. CEMENT GROUT FROM 5 FEET TO 0
FEET.

0	-	2.0	TOPSOIL, DARK-BROWN
2.0	-	16.0	CLAY, YELLOW-BROWN, SILTY, PEBBLY; ABUNDANT CHALK PEBBLES, VERY CALCAREOUS (TILL)
16.0	-	90.0	CLAY, GRAY, SANDY, SILTY, PEBBLY; SAND LENS AT 64 TO 65 FEET (TILL)
90.0	-	98.0	CLAY, GRAY-BROWN, SANDY, SILTY, PEBBLY (TILL)
98.0	-	142.0	CLAY, GRAY, SANDY, SILTY, PEBBLY (TILL)
142.0	-	150.0	GRAVEL, MEDIUM, VERY SANDY
150.0	-	278.0	SHALE, BLACK TO DARK-GRAY; VERY FISSILE; NONCALCAREOUS (CARLILE SHALE)
278.0	-	378.0	SHALE, DARK-GRAY-BROWN; HARD, FISSILE; SLIGHTLY CALCAREOUS (FAIRPORT SHALE MEMBER - CARLILE SHALE)
378.0	-	406.0	SILTSTONE, DARK-GRAY; VERY HARD, ABUNDANT SHELL DEBRIS (GREENHORN LIMESTONE)
406.0	-	419.0	SANDSTONE, LIGHT-BROWN, FINE; NONCALCAREOUS (DAKOTA FORMATION)
419.0	-	454.0	SHALE, LIGHT-GRAY; VERY HARD AT 430 FEET (DAKOTA FORMATION)
454.0	-	489.0	SANDSTONE, LIGHT-GRAY, FINE (DAKOTA FORMATION)
489.0	-	563.0	SHALE, GRAY, SANDY; ABUNDANT THIN SANDSTONE LENSES (DAKOTA FORMATION)
563.0	-	571.0	SANDSTONE, WHITE, FINE TO MEDIUM (DAKOTA FORMATION?)
571.0	-	595.0	SHALE, LIGHT-GRAY; VERY HARD, NONCALCAREOUS, SEVERAL SANDSTONE LENSES (DAKOTA FORMATION?)
595.0	-	620.0	CLAYSTONE, WHITE, SANDY; VERY HARD (PALEOZOIC SHALE?)
620.0	-	622.0	QUARTZITE, PINK; VERY HARD; POOR SAMPLES (SIOUX QUARTZITE?)

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COUNTY: LINCOLN

LOCATION: 098N-51W-12CCCC

MAP LOCATION:

6

LEGAL LOCATION: SW SW SW SW SEC. 12, T. 098 N., R. 51 W.

LATITUDE: 43.1854

LONGITUDE: 96.4937

LAND OWNER:

PROJECT: LENNOX CITY STUDY-1988

DRILLING COMPANY: SDGS

DRILLER: G. JENSEN/D. IVERSON

GEOLOGIST: P. DAWSON

DATE DRILLED: 08-04-1988

DRILLER'S LOG:

GEOLOGIST'S LOG: X

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1325.00 T
TOTAL DRILL HOLE DEPTH: 685.0 TEST HOLE NUMBER: R20-88-35
USGS HYDROLOGICAL UNIT CODE: 10170102

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	6.0	CLAY, BROWN, SANDY, PEBBLY (TILL)
6.0	-	8.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
8.0	-	14.0	SAND, RED; ORTHOCLASE; WEATHERED GRANITE BOULDER(?)
14.0	-	66.0	CLAY, GRAY, SILTY
66.0	-	70.0	CLAY, LIGHT-GRAY, SILTY
70.0	-	126.0	CHALK, WHITE, SHALEY WITH DEPTH; CALCAREOUS (NIOBRARA FORMATION?)
126.0	-	376.0	SHALE, DARK-GRAY TO BLACK, FISSILE; NONCALCAREOUS (CARLILE SHALE)
376.0	-	412.0	LIMESTONE, BROWN; CALCAREOUS (GREENHORN LIMESTONE)
412.0	-	429.0	SHALE, BROWN; NONCALCAREOUS (GRANEROS SHALE)
429.0	-	444.0	SAND, LIGHT-BROWN, FINE; NONCALCAREOUS (DAKOTA FORMATION)
444.0	-	449.0	CLAY, LIGHT-GRAY, SANDY (DAKOTA FORMATION)
449.0	-	482.0	SAND, FINE, CLAYEY BETWEEN 450 AND 471 FEET (DAKOTA FORMATION)
482.0	-	495.0	CLAY, GRAY, SANDY (DAKOTA FORMATION)
495.0	-	539.0	SAND, FINE; CLEAN (DAKOTA FORMATION)
539.0	-	656.0	CLAY, GRAY; EXTREMELY SANDY (DAKOTA FORMATION)
656.0	-	667.0	SAND, FINE; WITH WHITE CLAY PIECES
667.0	-	685.0	PIPESTONE(?), REDDISH-PINK; VERY HARD (SIOUX FORMATION)

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COUNTY: LINCOLN LOCATION: 098N-51W-14BBBB
MAP LOCATION: 7
LEGAL LOCATION: NW NW NW NW SEC. 14, T. 098 N., R. 51 W.
LATITUDE: 43.1857 LONGITUDE: 96.5047
LAND OWNER:
PROJECT: LENNOX CITY STUDY-1988
DRILLING COMPANY: SDGS
DRILLER: G. JENSEN DRILLER'S LOG:
GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
DATE DRILLED: 07-26-1988 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1318.00 T
TOTAL DRILL HOLE DEPTH: 327.0 TEST HOLE NUMBER: R20-88-34
USGS HYDROLOGICAL UNIT CODE: 10170102
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:

NATURAL GAMMA:
SAMPLES:

EXTRA:

0	-	2.0	TOPSOIL, BLACK
2.0	-	22.0	CLAY, BROWN, SANDY, PEBBLY (TILL)
22.0	-	26.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
26.0	-	34.0	SAND, COARSE TO MEDIUM
34.0	-	56.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
56.0	-	100.0	SAND AND GRAVEL, MEDIUM SAND TO MEDIUM PEBBLE GRAVEL; OXIDIZED
100.0	-	141.0	CLAY, LIGHT-GRAY, SILTY
141.0	-	240.0	CHALK, LIGHT-GRAY; VERY CALCAREOUS (NIOBRARA FORMATION)
240.0	-	327.0	UNKNOWN; CHALK(?), SAND(?), VERY CALCAREOUS; VERY POOR CUTTINGS, LOST CIRCULATION

HOLE WAS TAKING LOTS OF WATER - POSSIBILITY OF
HOLE COLLAPSE, ABANDONED HOLE AT 327 FEET.

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COUNTY: LINCOLN

LOCATION: 098N-51W-14DDDD 1

MAP LOCATION: 8

LEGAL LOCATION: SE SE SE SE SEC. 14, T. 098 N., R. 51 W.

LATITUDE: 43.1806

LONGITUDE: 96.4933

LAND OWNER:

PROJECT: SIOUX FALLS-BRANDON STUDY

DRILLING COMPANY: SDGS

DRILLER: E. KOGLIN/M. KOFFLER

DRILLER'S LOG:

GEOLOGIST: D. ILES

GEOLOGIST'S LOG: X

DATE DRILLED: 07-31-1980

DRILLING METHOD: ROTARY

GROUND SURFACE ELEVATION: 1305.00 T

TOTAL DRILL HOLE DEPTH: 631.0

TEST HOLE NUMBER: SFB-180

USGS HYDROLOGICAL UNIT CODE: 10170102

ELECTRIC LOG INFORMATION:

SPONTANEOUS POTENTIAL: X

SINGLE POINT RESISTIVITY: X

NATURAL GAMMA: X

EXTRA:

SAMPLES:

0	-	16.0	CLAY, TAN, SILTY, SANDY, PEBBLY (TILL)
16.0	-	20.0	SAND, FINE TO MEDIUM
20.0	-	22.0	CLAY, TAN, SILTY, SANDY, PEBBLY (TILL)
22.0	-	73.0	CLAY, MEDIUM-GRAY, SILTY, SANDY, PEBBLY (TILL)
73.0	-	107.0	CLAY, TAN-GREEN, SILTY, PEBBLY; CALCAREOUS, DRILLS SLOWER THAN INTERVAL FROM 22 TO 73 FEET (TILL)
107.0	-	223.0	SAND AND GRAVEL, FINE SAND TO COARSE, GRAVEL; WITH SOME CLAY AND SOME CLAY LAYERS
223.0	-	342.0	CLAY, GRAY; SOME SAND (CARLILE SHALE)
342.0	-	389.0	CLAY, MEDIUM-BROWN, SILTY; CALCAREOUS, HARDER THAN INTERVAL FROM 223 TO 342

		FEET (GREENHORN LIMESTONE)
389.0 -	397.0	CLAY, GRAY (GRANEROS SHALE)
397.0 -	423.0	SAND; INTERBEDDED WITH GRAY CLAY (DAKOTA FORMATION)
423.0 -	442.0	SAND; SOME CLAY (DAKOTA FORMATION)
442.0 -	446.0	COAL(?), BLACK; SOFT (DAKOTA FORMATION)
446.0 -	462.0	SAND (DAKOTA FORMATION)
462.0 -	468.0	CLAY, GRAY (DAKOTA FORMATION)
468.0 -	487.0	SAND (DAKOTA FORMATION)
487.0 -	509.0	CLAY, GRAY; DECREASING IN SAND CONTENT TOWARDS THE BOTTOM OF THE INTERVAL (DAKOTA FORMATION)
509.0 -	514.0	SAND (DAKOTA FORMATION)
514.0 -	517.0	CLAY, GRAY (DAKOTA FORMATION)
517.0 -	525.0	SAND (DAKOTA FORMATION)
525.0 -	598.0	CLAY, GRAY; SANDY IN SPOTS (DAKOTA FORMATION)
598.0 -	630.0	SAND, FINE TO COARSE; WITH WHITE CLAY
630.0 -	631.0	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-51W-17DDDA
MAP LOCATION: 9	
LEGAL LOCATION: NE SE SE SE SEC. 17, T. 098 N., R. 51 W.	
LATITUDE: 43.1809	LONGITUDE: 96.5309
LAND OWNER:	
PROJECT: SIOUX FALLS-BRANDON STUDY	
DRILLING COMPANY: SDGS	
DRILLER: E. KOGLIN/M. KOFFLER	DRILLER'S LOG:
GEOLOGIST: D. ILES	GEOLOGIST'S LOG: X
DATE DRILLED: 08-06-1980	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1289.00 T	
TOTAL DRILL HOLE DEPTH: 520.0	TEST HOLE NUMBER: SFB-181
WATER RIGHTS WELL: LN-80L	SDGS WELL NAME:
OTHER WELL NAME:	
BASIN: VERMILLION	AQUIFER: DAKOTA
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 10.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1292.36 I	
CASING STICK-UP:	TOTAL CASING AND SCREEN:
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170102	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES:	

THE DRILLERS WERE UNABLE TO DETECT THE GRANEROS SHALE BUT IT IS UNDOUBTEDLY THERE. THEY WERE ALSO UNABLE TO DETECT THE CLAY LAYERS IN THE DA-

27.0 -	45.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
45.0 -	47.0	SAND, MEDIUM
47.0 -	62.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
62.0 -	71.0	CLAY, GRAY, SILTY (TILL)
71.0 -	95.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
95.0 -	102.0	SAND, MEDIUM
102.0 -	118.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
118.0 -	152.0	CLAY, GRAY, VERY SANDY (TILL)
152.0 -	189.0	GRAVEL, MEDIUM TO COARSE; OXIDIZED
189.0 -	194.0	CLAY, GRAY, PEBBLY (TILL)
194.0 -	206.0	GRAVEL, MEDIUM TO COARSE; OXIDIZED
206.0 -	268.0	SHALE, DARK-GRAY; NONCALCAREOUS (CARLILE SHALE)
268.0 -	287.0	LIMESTONE, BROWN; CALCAREOUS (GREENHORN LIMESTONE)
287.0 -	314.0	SAND, FINE; OXIDIZED (DAKOTA FORMATION)
314.0 -	322.0	CLAY, BLACK, SOMEWHAT SANDY; SLIGHTLY CALCAREOUS (DAKOTA FORMATION)
322.0 -	328.0	SAND, FINE; OXIDIZED (DAKOTA FORMATION)
328.0 -	330.0	QUARTZITE, PINK; HARD (SIOUX QUARTZITE)

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COUNTY: LINCOLN	LOCATION: 099N-51W-32DDDD 2
MAP LOCATION: 11	
LEGAL LOCATION: SE SE SE SE SEC. 32, T. 099 N., R. 51 W.	
LATITUDE: 43.2043	LONGITUDE: 96.5312
LAND OWNER:	
PROJECT: SE SO. DAK. UNIT STUDY	
DRILLING COMPANY: SDGS	
DRILLER: M. THOMPSON	DRILLER'S LOG:
GEOLOGIST: D. ILES	GEOLOGIST'S LOG: X
DATE DRILLED: 10-05-1981	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1326.00 T	
TOTAL DRILL HOLE DEPTH: 420.0	TEST HOLE NUMBER:
WATER RIGHTS WELL: LN-81F	SDGS WELL NAME: SESD-2
OTHER WELL NAME:	
BASIN: VERMILLION	AQUIFER: DAKOTA
MANAGEMENT UNIT:	
SCREEN TYPE: PVC, MFG.	SCREEN LENGTH: 5.0
CASING TYPE: PVC	CASING DIAMETER: 2.0
CASING TOP ELEVATION: 1328.27	
CASING STICK-UP:	TOTAL CASING AND SCREEN:
WELL MAINTENANCE DATE:	
USGS HYDROLOGICAL UNIT CODE: 10170203	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY: X
NATURAL GAMMA:	EXTRA:
SAMPLES:	

BOTTOM OF WELL AT 418 FEET.

0 -	1.0	TOPSOIL, BLACK
1.0 -	16.0	CLAY, YELLOW-BROWN, SILTY, PEBBLY (TILL)

16.0 -	23.0	CLAY, YELLOW-GRAY, SILTY, PEBBLY (TILL)
23.0 -	50.0	CLAY, GRAY, SILTY, PEBBLY (TILL)
50.0 -	99.0	CLAY, GRAY, SILTY, PEBBLY, GRAVELLY (TILL)
99.0 -	103.0	SILT, BLACK
103.0 -	108.0	GRAVEL, MEDIUM
108.0 -	114.0	CLAY, YELLOW-BROWN, SILTY, PEBBLY (TILL)
114.0 -	119.0	GRAVEL, FINE TO MEDIUM
119.0 -	153.0	CLAY, GRAY, SILTY, PEBBLY, GRAVELLY (TILL)
153.0 -	160.0	GRAVEL, FINE TO MEDIUM
160.0 -	188.0	CLAY, GRAY, SILTY, GRAVELLY (TILL)
188.0 -	198.0	GRAVEL
198.0 -	271.0	CLAY, GRAY (CARLILE SHALE)
271.0 -	276.0	CLAY, GRAY; HARD (GREENHORN LIMESTONE)
276.0 -	306.0	SAND, FINE TO COARSE; WITH SOME CLAY (DAKOTA FORMATION)
306.0 -	320.0	CLAY, GRAY (DAKOTA FORMATION)
320.0 -	420.0	SAND, FINE TO COARSE; WITH SOME CLAY (DAKOTA FORMATION)

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COUNTY: LINCOLN	LOCATION: 099N-51W-34CCBB
MAP LOCATION: 12	
LEGAL LOCATION: NW NW SW SW SEC. 34, T. 099 N., R. 51 W.	
LATITUDE: 43.2053.	LONGITUDE: 96.5156
LAND OWNER:	
PROJECT: LINCOLN-UNION CO. STUDY	
DRILLING COMPANY: SDGS	
DRILLER: D. IVERSON	DRILLER'S LOG:
GEOLOGIST: R. HAMMOND	GEOLOGIST'S LOG: X
DATE DRILLED: 07-13-1988	DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1330.60 I	
TOTAL DRILL HOLE DEPTH: 203.0	TEST HOLE NUMBER: R20-88-32
USGS HYDROLOGICAL UNIT CODE: 10170102	
ELECTRIC LOG INFORMATION:	
SPONTANEOUS POTENTIAL:	SINGLE POINT RESISTIVITY:
NATURAL GAMMA:	EXTRA:
SAMPLES: X	

THIS HOLE WAS PLUGGED WITH A BENTONITE GROUT FROM
0 TO 8 FEET, GRANULAR BENTONITE FROM 8 FEET TO
7 FEET, NON-SLIP PLUG AT 7 FEET, CEMENT GROUT
FROM 7 FEET TO 0 FEET.

0 -	2.0	TOPSOIL, BLACK
2.0 -	38.0	CLAY, YELLOW-BROWN, SANDY, SILTY, PEBBLY (TILL)
38.0 -	166.0	CLAY, GRAY, SANDY, SILTY, PEBBLY; CALCAREOUS (TILL)
166.0 -	197.0	CLAYSTONE, GRAY; FISSILE; HARD; SOME COAL AND PEAT LENSES (SPLIT ROCK CREEK FORMATION?)

197.0 - 203.0 QUARTZITE, PINK; FAIR TO POOR CEMENT
(SIOUX QUARTZITE)

CORED FROM 197 TO 203 FEET.

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COUNTY: LINCOLN LOCATION: 099N-51W-34CCBC
MAP LOCATION: 13
LEGAL LOCATION: SW NW SW SW SEC. 34, T. 099 N., R. 51 W.
LATITUDE: 43.2050 LONGITUDE: 96.5158
LAND OWNER:
PROJECT: LENNOX CITY STUDY-1988
DRILLING COMPANY: SDGS
DRILLER: T. MCCUE DRILLER'S LOG:
GEOLOGIST: P. DAWSON GEOLOGIST'S LOG: X
DATE DRILLED: 05-09-1988 DRILLING METHOD: ROTARY
GROUND SURFACE ELEVATION: 1332.72 I
TOTAL DRILL HOLE DEPTH: 202.0 TEST HOLE NUMBER: R2-88-04
USGS HYDROLOGICAL UNIT CODE: 10170102
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY: X
NATURAL GAMMA: X EXTRA:
SAMPLES:

0	-	2.0	TOPSOIL, BLACK
2.0	-	9.0	CLAY, YELLOW-BROWN, SILTY, PEBBLY (TILL)
9.0	-	15.0	CLAY, OLIVE, SILTY, PEBBLY (TILL)
15.0	-	17.0	CLAY, YELLOW-BROWN, SILTY, PEBBLY (TILL)
17.0	-	19.0	SAND, FINE TO MEDIUM
19.0	-	23.0	CLAY, YELLOW-BROWN, SILTY, SANDY, PEBBLY (TILL)
23.0	-	37.0	CLAY, BROWN, SILTY, SANDY (TILL)
37.0	-	58.0	CLAY, GRAY, SANDY, PEBBLY (TILL)
58.0	-	92.0	GRAVEL, FINE TO MEDIUM PEBBLE GRAVEL; OXIDIZED
92.0	-	132.0	CLAY, GRAY, SANDY (TILL)
132.0	-	172.0	CLAY, GRAY, SILTY (TILL)
172.0	-	194.0	CLAY, LIGHT-GRAY, SILTY (TILL)
194.0	-	199.0	QUARTZITE, PINK; SOFT, FRIABLE CHIPS (SIOUX QUARTZITE)
199.0	-	202.0	QUARTZITE, PINK; HARD (SIOUX QUARTZITE)

ROCK BIT (5 1/2 INCHES) PUT ON AT 194 FEET, ROCK
BIT REPLACED AGAIN AT 199 FEET.

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