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**Open-File Report 61-UR**

**INVESTIGATION OF THE GROUND-WATER  
QUALITY OF THE VALENTINE FORMATION  
NEAR BURKE, SOUTH DAKOTA**

**by**

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## INTRODUCTION

The investigation was conducted in August, 1988, by the South Dakota Geological Survey (SDGS) at the request of the city of Burke, South Dakota, to assist the city in locating a potential site for a new municipal well. The investigation was financed by the city of Burke and the state of South Dakota. This report contains the results of the investigation which was conducted in the Burke area (fig.1).

### Acknowledgements

The enormous assistance of Rich Bailey, Water Superintendent for the city of Burke, throughout the course of this investigation was greatly appreciated. Without his assistance, this project would not have been as successful.

### Present Burke Water Supply

The city of Burke (population 859) has six municipal wells, all of which pump water from the Valentine Formation of the Ogallala Group. This aquifer is commonly referred to as the Ogallala aquifer. Three municipal wells are located in the south-central portion of the city (fig. 2). Municipal well 1 was drilled in 1948 to a depth of 146 feet. The well is operational but started to pump sand and is currently used only as a standby well. Municipal well 2 was drilled in 1952 to a depth of 148 feet and has a pumping capacity of approximately 40 gallons per minute. Municipal well 3 was drilled in 1962 to a depth of 150 feet. Water produced from the wells is generally of very good quality (table 1), however, elevated nitrate concentrations are found in water produced by all three of these wells (tables 1 and 2). Table 2 shows that nitrate concentrations in these three municipal wells fluctuate over time, but generally the concentrations have increased from 1983 to the present.

The other three municipal wells are located approximately ½ mile west of the city (fig. 2). Well 4 was drilled in 1964 to a depth of 152 feet, well 5 was drilled in 1976 to a depth of 159 feet, and well 6 was drilled in 1978 to a depth of 158 feet. Water produced from these wells is of very good quality (table 1). Iron bacteria, however, was later detected in well 5 and this well was taken off line during the spring of 1988. Presently, the city is chemically treating the well for iron bacteria. Iron bacteria is not a problem in any of the other municipal wells.

Currently, the city blends water from wells 2, 3, 4, and 6, and uses this blended water as the municipal water supply. Nitrate concentrations in the municipal water supply, after blending, have always been below the enforceable federal drinking water standard of 10 milligrams per liter (mg/L). Municipal wells 2, 3, 4, 5, and 6 together produce approximately 450 to 500 gallons of water per minute, however, after well 5 was taken off line, combined production dropped to 350 gallons per minute. The static water level averages approximately 90 feet below land surface in all the municipal wells.

FIGURE 1. LOCATION OF THE STUDY AREA.

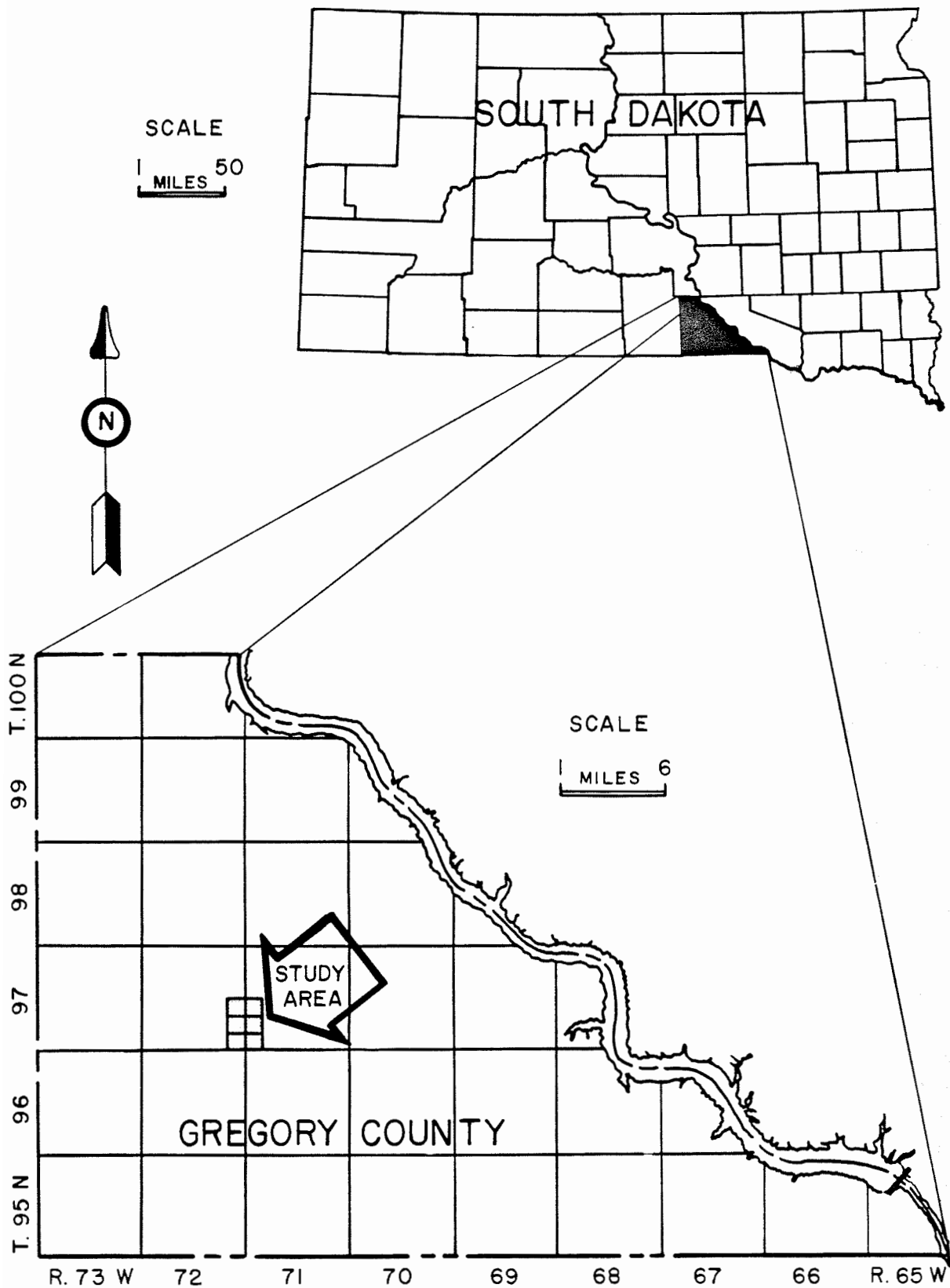
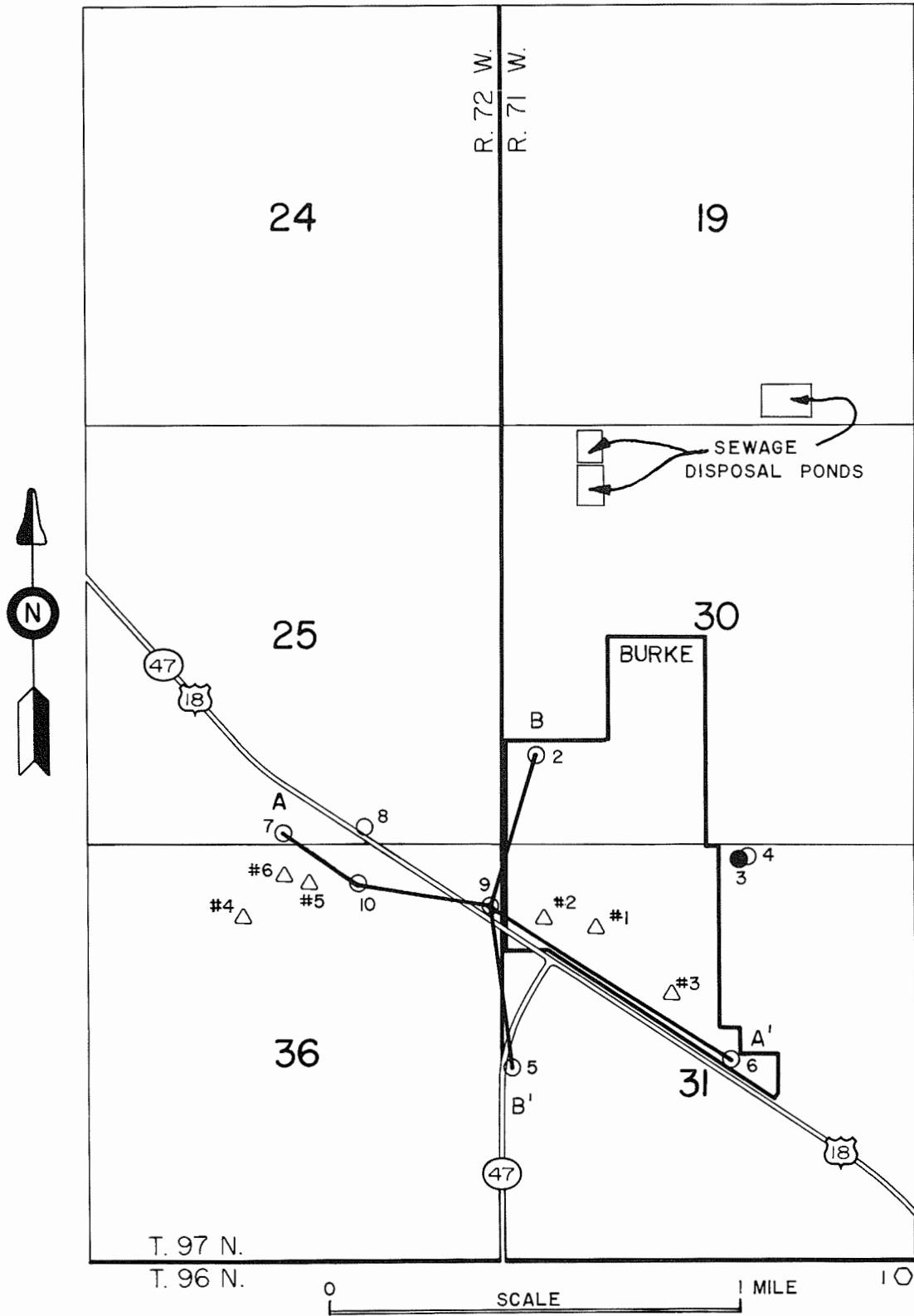


FIGURE 2. LOCATIONS OF A TEST HOLE, OBSERVATION AND MUNICIPAL WELLS, AND GEOLOGIC CROSS SECTIONS.



- OBSERVATION WELL
  - TEST HOLE
  - DIVISION OF WATER RIGHTS-OBSERVATION WELL
  - #6△ BURKE MUNICIPAL WELL
  - AC—○A' LINE OF CROSS SECTION
- NUMBER IS MAP-LOCATION (ML) NUMBER. SEE APPENDIX A FOR EXPLANATION.

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**Table 2. Nitrate-nitrogen concentrations in the Burke municipal wells**

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Date Collected	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6
12-04-74	8.83	5.18	10.2	1.30	----	----
07-19-76	----	----	----	----	2.67	----
02-07-80	----	----	----	----	----	2.0
01-05-83	----	5.7	5.7	1.8	1.5	1.4
07-01-86	----	6.1	7.8	1.6	1.5	1.5
08-01-88	7.66	10.6	8.40	----	1.42	----
08-02-88	----	----	----	2.46	----	1.76

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Nitrate-nitrogen concentrations reported in milligrams per liter.

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## **METHODS AND PROCEDURES**

### **Drilling and Well Installation**

Drilling occurred between August 22, 1988, and August 31, 1988, and was performed using the mud-rotary drilling method and a 5½-inch diameter drill bit. The auger drilling method was attempted at map location (ML) 3, but the sandstone was very cemented and could not be penetrated using the augers. The drill bit diameter was 11 inches for the test hole drilled at ML 3. Nine test holes were drilled (ML 2, 3, 4, 5, 6, 7, 8, 9, and 10; fig. 2, app. A), eight of which were completed as observation wells (ML 2, 4, 5, 6, 7, 8, 9, and 10). Geophysical logs are available, at the SDGS, for all nine test holes drilled for this investigation and include the parameters single-point resistivity and natural gamma (app. A).

Observation wells were constructed using 2-inch diameter, schedule 80, threaded, polyvinyl chloride (PVC) casing and screen. Blank casing (closed at the bottom and open to the screen) was installed below the well screen in all but one well (the exception being the well located at ML 4), allowing the blank casing to act as a water reservoir. This reservoir collects water from the formation and aids in the water-sampling process. Data on screen length, well depth, and blank-

Table 1. Chemical analyses of water samples

Location <sup>2</sup>	ML No. <sup>2</sup>	Well Name	Date Sampled	Well Depth (ft) <sup>3</sup>	Conduc-tivity (mmhos) <sup>4</sup>	Concentration in milligrams per liter <sup>1</sup>														Field pH
						TDS	Hard-ness as CaCO <sub>3</sub>	Fe	Mn	SO <sub>4</sub>	NO <sub>3</sub> -N	Na	Ca	Mg	K	Cl	F	Alk T	HCO <sub>3</sub>	
-----	----	-----	-----	-----	-----	500 <sup>5</sup>	----	0.3 <sup>5</sup>	0.05 <sup>5</sup>	250 <sup>5</sup>	10 <sup>6</sup>	----	----	----	----	250 <sup>5</sup>	2.4 <sup>6</sup>	----	----	----
096N-71W-06AAAA	ML 1	GY-78A	08-25-88	124.5	303	219	132	<0.05	<0.05	5	3.46	9.4	42	6.6	6.3	3	0.31	138	168	7.43
097N-71W-30CCBA	ML 2	R20-88-39	08-31-88	109.4	354	248	166	<0.05	<0.05	20	0.90	7.7	55	7.0	6.2	3	0.26	167	204	7.77
097N-71W-31ABBA2	ML 4	R20-88-38	08-24-88	161.5	288	196	88	<0.05	<0.05	8	1.30	26	27	5.0	7.3	2	0.46	143	174	7.74
097N-71W-31CBBB	ML 5	R20-88-44	09-01-88	78.8	275	178	120	<0.05	<0.05	3	1.15	8.9	37	6.7	6.5	2	0.22	142	173	7.81
097N-71W-31DBBB	ML 6	R20-88-43	09-07-88	130.5	265	162	107	<0.05	<0.05	4	1.33	14	34	5.4	6.4	2	0.28	130	158	7.82
097N-72W-25CDDD	ML 7	R20-88-40	09-06-88	153.7	277	192	79	<0.05	<0.05	4	1.39	28	24	4.6	7.2	2	0.41	137	167	7.94
097N-72W-25DCDC	ML 8	R20-88-42	09-07-88	126.9	257	152	95	<0.05	<0.05	3	1.23	18	29	5.4	6.9	1	0.31	130	158	7.89
097N-72W-36AADA	ML 9	R20-88-45	09-07-88	124.9	270	184	103	<0.05	<0.05	5	1.52	18	31	6.1	6.6	2	0.38	133	162	7.76
097N-72W-36ABAC	ML 10	R20-88-41	09-01-88	144.8	248	164	102	<0.05	<0.05	4	1.60	10	31	6.0	6.1	2	0.22	121	147	7.84
097N-71W-31BBCA	-----	City No. 2	08-01-88	148	498	346	223	<0.05	<0.05	18	10.6	11	73	10	8.2	10	0.20	186	227	7.62
097N-71W-31BBDD	-----	City No. 1	08-01-88	146	649	418	281	<0.05	<0.05	20	7.66	29	91	13	9.1	11	0.20	285	347	7.48
097N-71W-31BDAC	-----	City No. 3	08-01-88	150	508	348	233	<0.05	<0.05	19	8.40	12	75	11	7.7	11	0.24	200	244	7.61
097N-72W-36ABBD	-----	City No. 5	08-01-88	159	343	233	159	<0.05	<0.05	6	1.42	8.4	52	7.2	5.7	4	0.18	169	206	7.59
097N-72W-36BAAD	-----	City No. 6	08-02-88	158	326	222	150	<0.05	<0.05	5	1.76	7.7	48	7.4	5.7	1	0.20	161	196	7.65
097N-72W-36BACA	-----	City No. 4	08-02-88	152	262	193	120	<0.05	<0.05	6	2.46	6.3	38	6.0	4.9	1	0.20	128	156	7.77

<sup>1</sup> TDS - total-dissolved solids; FE - iron; MN - manganese; SO<sub>4</sub> - sulfate; NO<sub>3</sub>-N - nitrate-nitrogen; NA - sodium; CA - calcium; MG - magnesium; K - potassium; Cl - chloride; F - fluoride; Alk T - total alkalinity; HCO<sub>3</sub> - bicarbonate.

<sup>2</sup> See appendix A for explanation of location format and map-location (ML) number.

<sup>3</sup> Well depth is presented in feet below top of casing and excludes any blank casing below the screen.

<sup>4</sup> mmhos - micromhos.

<sup>5</sup> U.S. Environmental Protection Agency recommended maximum limit (U.S. Environmental Protection Agency, 1985b).

<sup>6</sup> U.S. Environmental Protection Agency enforceable maximum limit (U.S. Environmental Protection Agency, 1985a).



casing placement are presented in appendix A. Filter pack, either Grand Island sand (a well sorted, coarse sand) or local sand from the Herrick Formation (a poorly sorted, coarse sand to medium gravel), was placed around the outside of the screen up to at least 13 feet above the top of the screen. Bentonite grout was pumped 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. Two bench marks were used as datum. One was a U.S. Coast and Geodetic Survey bench mark and the other was a South Dakota Department of Transportation (DOT) bench mark. The U.S. Coast and Geodetic Survey bench mark is located in NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 31, T. 97 N., R. 71 W. This bench mark is stamped "C 139 1934" and has an elevation of 2,212.732 feet above mean sea level. The state DOT bench mark is located in NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 31, T. 97 N., R. 71 W. This bench mark is stamped with the elevation of 2,200.53 feet above mean sea level.

### Water-Level Measurements

The depth to water in the observation wells was measured on two occasions (table 3) 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 46 well volumes of water were 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 2 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, and one observation well controlled by the Division of Water Rights. Water-quality analyses (table 1) were performed by the South Dakota Geological Survey.

## **HYDROGEOLOGIC SETTING**

### General Geology

Surficial deposits in the study area include the Quaternary age Herrick Formation (fig. 3). Directly underlying the Quaternary deposits are sedimentary rocks of Tertiary age. For a brief

**Table 3. Water levels in observation wells**

ML No. <sup>1</sup>	Location <sup>2</sup>	Well Name	Casing Top Elevation <sup>3</sup>	Depth to water and date of measurement <sup>4</sup>	
				10-18-88	10-24-88
2	097N-71W-30CCBA	R20-88-39	2181.40	47.35	47.10
4	097N-71W-31ABBA2	R20-88-38	2212.64	91.00	90.75
5	097N-71W-31CBBB	R20-88-44	2148.34	17.58	17.54
6	097N-71W-31DBBB	R20-88-43	2202.90	79.12	78.88
7	097N-72W-25CDDD	R20-88-40	2225.47	84.33	84.16
8	097N-72W-25DCDC	R20-88-42	2205.38	64.80	64.56
9	097N-72W-36AADA	R20-88-45	2197.12	62.34	62.11
10	097N-72W-36ABAC	R20-88-41	2223.80	85.71	85.46

<sup>1</sup> Map-Location (ML) Number - corresponds to number on figure 2 and in appendix A.

<sup>2</sup> See appendix A for explanation of location format.

<sup>3</sup> Presented in feet above mean sea level.

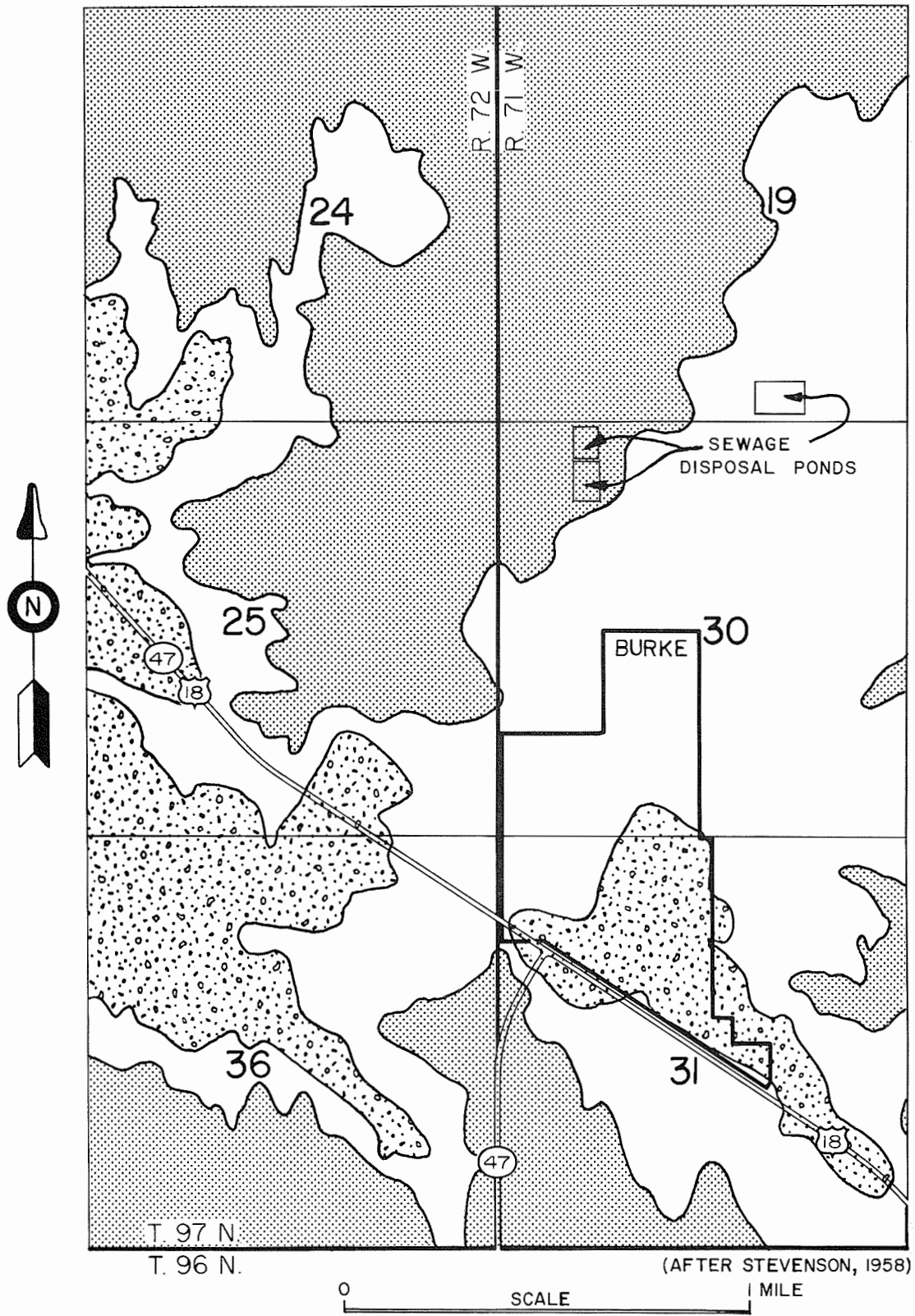
<sup>4</sup> All water levels are presented in feet below top of casing.




description of the Tertiary bedrock units, refer to table 4. If all commonly encountered bedrock units in the study area were present at one location, they would be encountered in descending order (youngest to oldest) as follows: Tertiary age Ash Hollow Formation, Valentine Formation, a White River Group transitional silt, and the Brule Formation followed by stratified sedimentary rocks of Mesozoic, Paleozoic, and Precambrian age. Only Quaternary and Tertiary age units were drilled into during this investigation, therefore only these units will be discussed. The Ash Hollow Formation and the Valentine Formation comprise the Ogallala Group and are thought to be fluvial deposits (Harksen, 1969). The White River Group underlies the Valentine Formation and is believed to be fluvial deposits which were derived in large part from airfall volcanic ash (Harksen, 1969; Seeland, 1985). The Brule Formation, a member of the White River Group, is a combination of "fluvatile and eolian deposits" (Harksen, 1969).

### Valentine Formation

The Valentine Formation is the only Tertiary age formation which will yield water readily in the Burke area (Christensen, 1962). The Valentine Formation is an unconfined to confined, buried ground water system composed of a greenish-tan to brown very fine to fine-grained sand. Interbedded in the formation may be small stringers of green clay. The Valentine Formation is a member of the Ogallala Group and is identified as part of the Ogallala aquifer.

FIGURE 3. GEOLOGIC MAP OF THE BURKE AREA.



-  HERRICK FORMATION - QUATERNARY AGE, COARSE FLUVIAL ARKOSIC SANDS
-  ASH HOLLOW FORMATION - TERTIARY AGE, FINE ARKOSIC SAND/SANDSTONE
-  VALENTINE FORMATION - TERTIARY AGE, FINE TO VERY FINE ARKOSIC SANDS: CLAYEY

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**Table 4. Description of Tertiary bedrock units**

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**Tertiary Period**

**Pliocene Epoch**

<b>Ogallala Group</b> .....	thought to be fluvial deposits
<i>Ash Hollow Formation</i> .....	interbedded greenish-tan fine-grained arkosic sand and sandstone, generally well cemented; clayey
<i>Valentine Formation</i> .....	greenish-tan to brown, very fine to fine-grained arkosic sand and sandstone, uncemented; may be clayey

**Oligocene Epoch**

<b>White River Group</b> .....	thought to be fluvial deposits derived in large part from airfall volcanic ash
<i>Brule Formation</i> .....	pink and greenish tuffaceous siltstone overlain by pinkish-tan to red-brown highly bentonitic clay including pink waxy clay and brown and pink nodular fine sand

General descriptions from Agnew and Tychsen (1965), Christensen (1962), Barari (1969), Harksen (1969), Seeland (1985), and from the drillers logs from this investigation.

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**RESULTS OF INVESTIGATION**

**General Geology**

Two cross sections, whose locations are shown in figure 2, illustrate the spatial distribution of Tertiary sediments in the study area (figs. 4 and 5). Surficial deposits in the study area include the Quaternary age Herrick Formation, the sands of which cover the upland areas (fig. 4) and small Pleistocene terrace deposits along present drainage (Christensen, 1962, and Barari, 1969). The Herrick Formation consists of fine to coarse, pebbly, fluvial sand and is 6 to 20 feet thick in the study area. Exposed sedimentary rocks in the study area consist of the Tertiary age Ogallala Group which includes the Ash Hollow Formation and the Valentine Formation. Directly underlying the Herrick Formation, and in some locations the soil profile, is the Ash Hollow Formation which

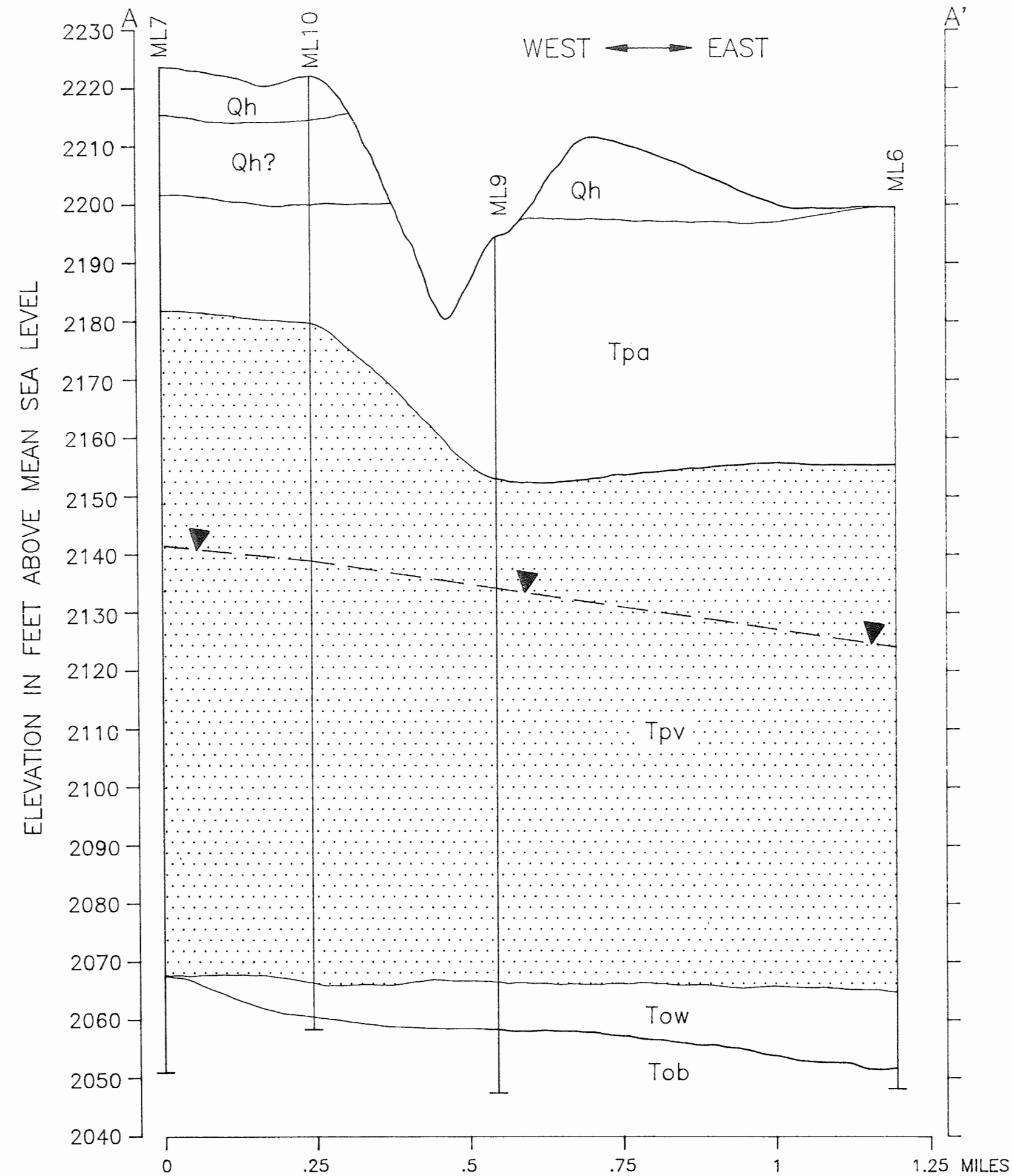
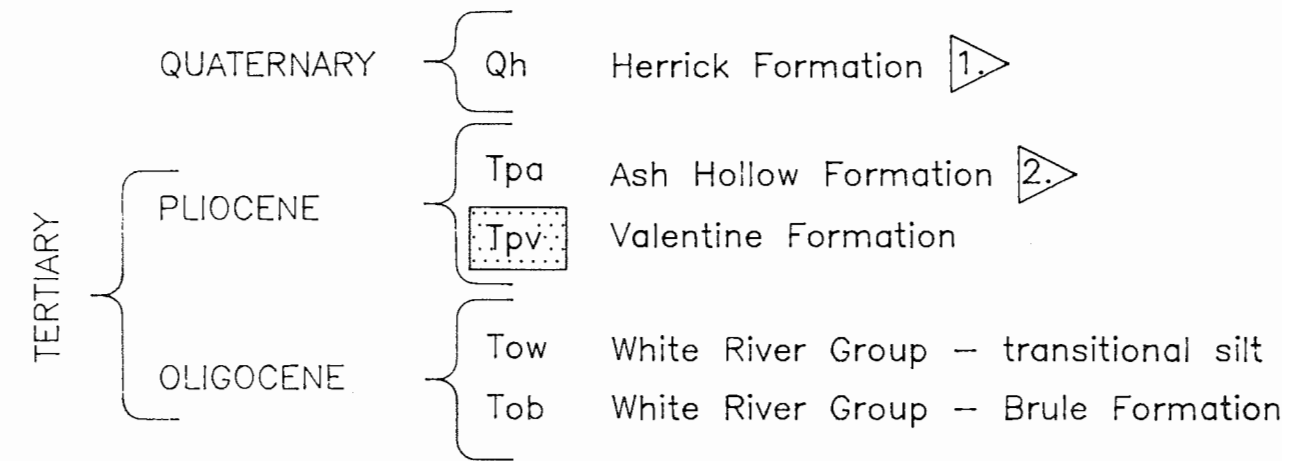


Figure 4.  
Geologic Cross Section A - A'.



1. Includes 2 to 3 feet of topsoil.

2. Includes 2 to 3 feet of topsoil where the formation directly underlies the soil profile.

— Lithologic contact.

┆ Observation well. Number is map-location (ML) number. See appendix A for explanation. See figure 2 for well location.

—▲— Approximate water level in Valentine Formation, 10-24-88.

VERTICAL EXAGGERATION = 50X

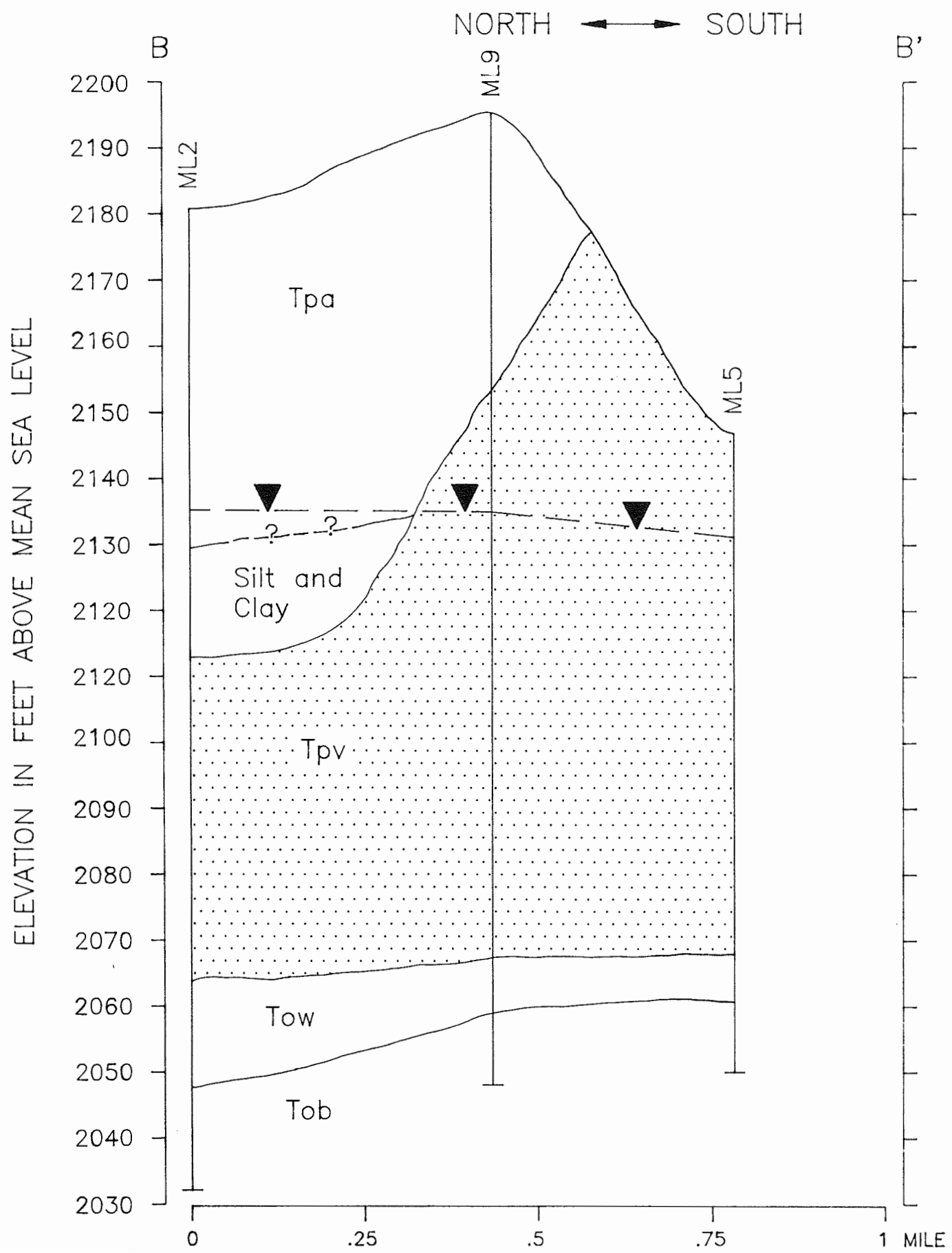


Figure 5.  
Geologic Cross Section B - B'.

TERTIARY	PLIOCENE	Tpa	Ash Hollow Formation	1.
		Tpv	Valentine Formation	1.
	OLIGOCENE	Tow	White River Group - transitional silt	
		Tob	White River Group - Brule Formation	

1. Includes 2 to 3 feet of topsoil.

—?— Lithologic contact. Dashed where approximate. A '?' indicates lateral extent is very uncertain.

⊥ Observation well. Number is map-location (ml) number. See appendix A for explanation. See figure 2 for well location.

▼ Approximate water level in Valentine Formation, 10-24-88.

VERTICAL EXAGGERATION = 50X

consists of a well cemented, calcareous sand and sandstone. The Ash Hollow Formation ranges in thickness from 20 feet (ML 10) to 51 feet (ML 4). The Valentine Formation, which will be discussed later, lies directly below the Ash Hollow Formation, and in some locations directly below the soil profile. The uppermost formation in the White River Group is the Brule Formation, a brown to red-brown clay. Directly overlying the Brule Formation is a silt layer ranging in thickness from 6 feet (ML 4 and ML 10) to 16 feet (ML 2). For the purpose of this investigation the silt unit is assumed to be a Pliocene-Oligocene (table 4) transitional zone and is considered to be part of the White River Group.

### Valentine Formation

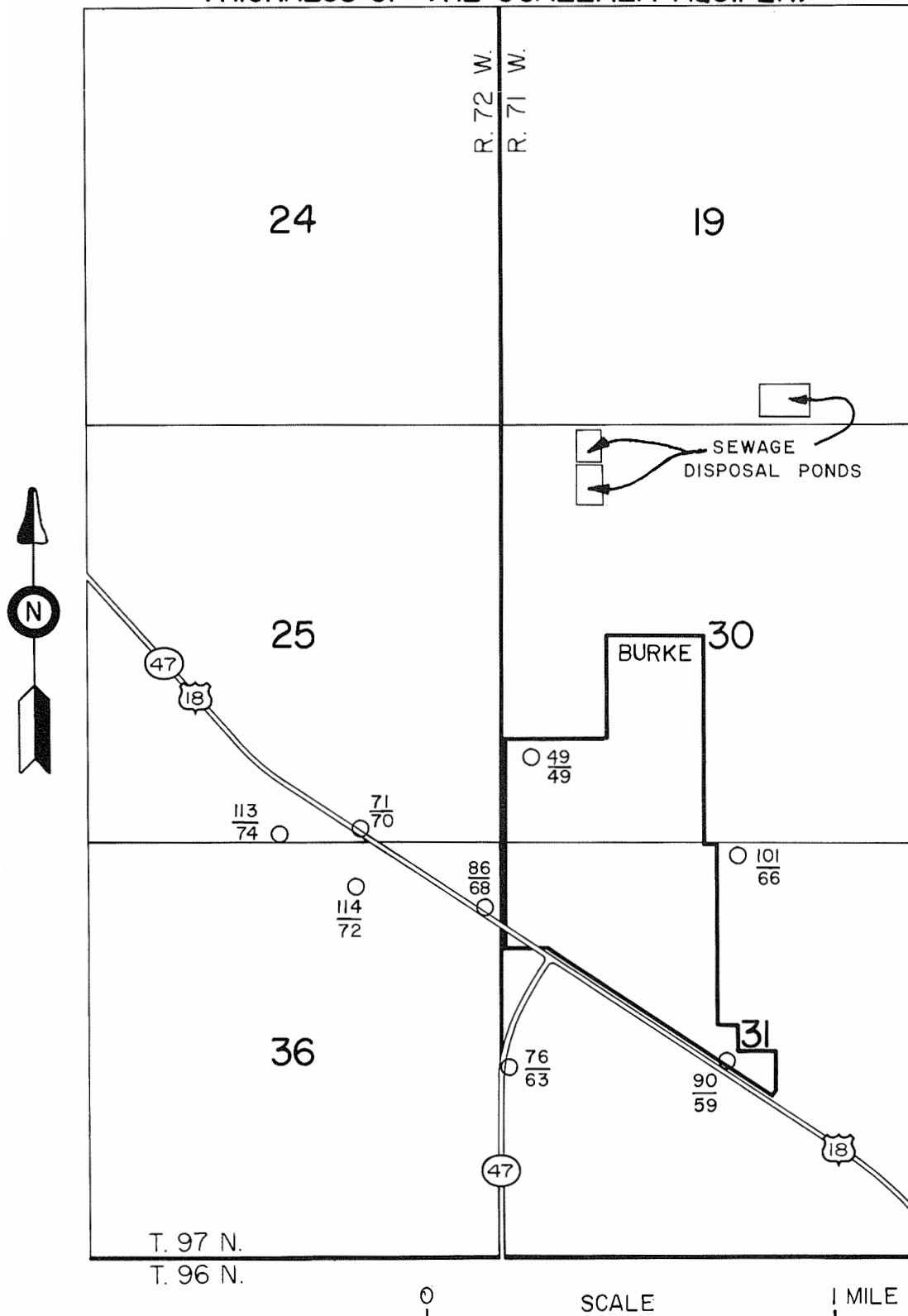
Where the Valentine Formation does not lie directly below the soil profile, the Ash Hollow Formation overlies the Valentine Formation. All but one of the test holes drilled for this investigation found the transitional silt of the White River Group to lie directly below the Valentine Formation. The exception (ML 7) found the Brule Formation to directly underlie the Valentine.

The Valentine Formation, a member of the Ogallala Group, comprises the Ogallala aquifer. In the study area, the Ogallala aquifer is an unconfined to confined buried aquifer composed of very fine to fine sand with some interbedded silt and clay lenses. The Valentine Formation underlies the entire study area and ranges in thickness from 49 feet (ML 2) to 114 feet (ML 10) (fig. 6). Saturated thickness (fig. 6) varies from approximately 49 feet (ML 2) to 74 feet (ML 7) and the potentiometric surface slopes downward to the east southeast (fig. 7).

Water samples were collected from observation wells installed for this investigation, one observation well controlled by the Division of Water Rights, and the six municipal wells. All wells were installed in the Valentine Formation (Ogallala aquifer). Table 1 indicates that in the study area, the quality of water in the Ogallala aquifer is generally quite good. Figure 8 shows the distribution of total-dissolved solids and hardness in the Ogallala aquifer. Total-dissolved solids range in concentration from 124 mg/L (ML 6) to 418 mg/L (municipal well 1). As illustrated by the figure, the general water quality is consistently good throughout the study area.

As mentioned earlier in this report, elevated nitrate concentrations are found in water produced by three of the municipal wells (wells 1, 2, and 3). Identifying the source of contamination was beyond the purpose and scope of this investigation. It is the hope and intent of the city to establish one or two new municipal wells, in the well field west of town, and thus allow the three older municipal wells, which show elevated nitrate concentrations, to be used as standby wells. Elevated nitrate concentrations were not found in any of the other municipal wells nor in any of the observation wells installed for this investigation (tables 1 and 2). Figure 9 illustrates quite clearly that nitrate contamination is not an aquifer-wide problem.

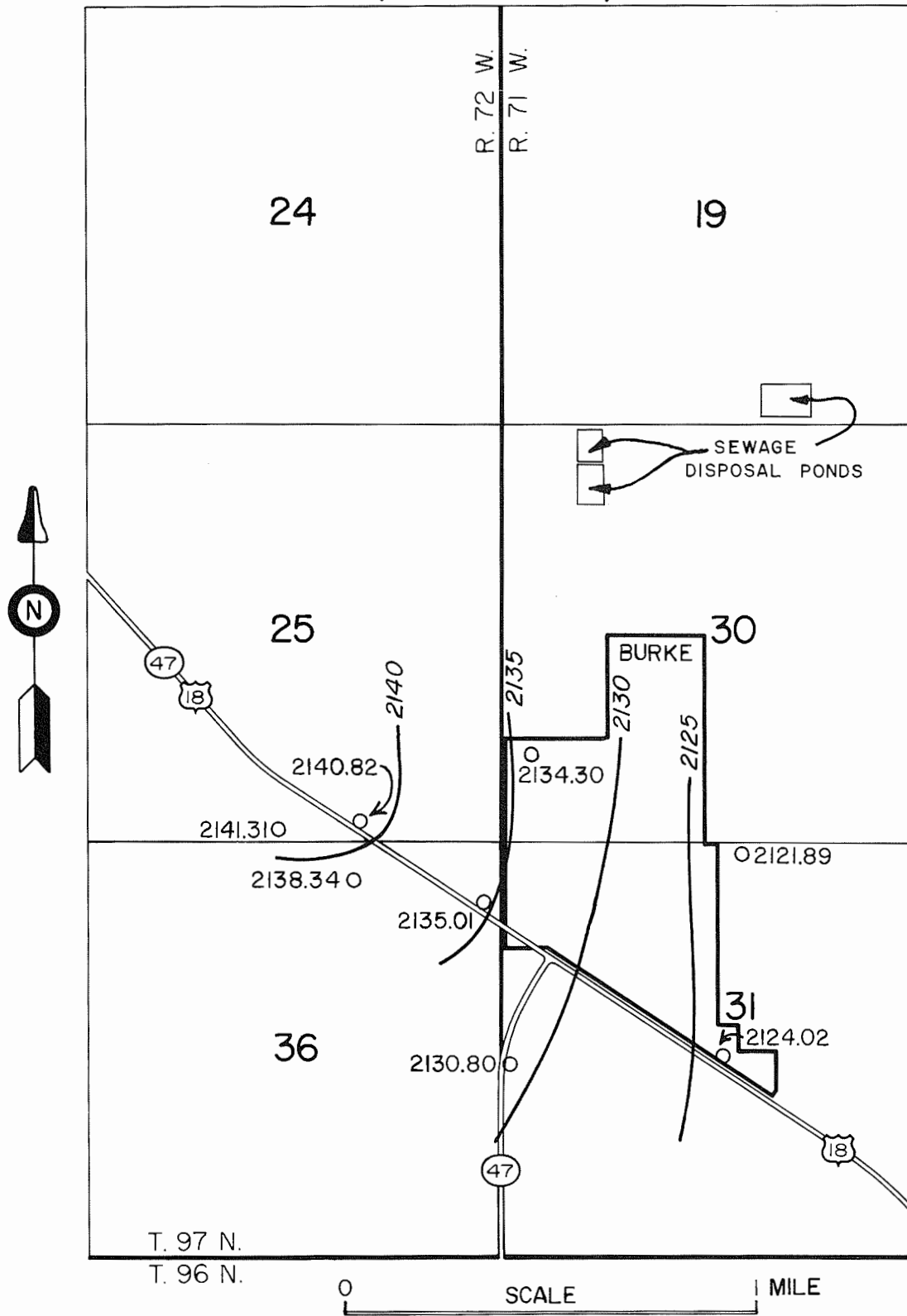
FIGURE 6. FORMATION THICKNESS AND SATURATED THICKNESS OF THE OGALLALA AQUIFER.



$\frac{76}{63}$  ○ OBSERVATION WELL. UPPER NUMBER IS THE FORMATION THICKNESS AND LOWER NUMBER IS SATURATED THICKNESS, IN FEET.



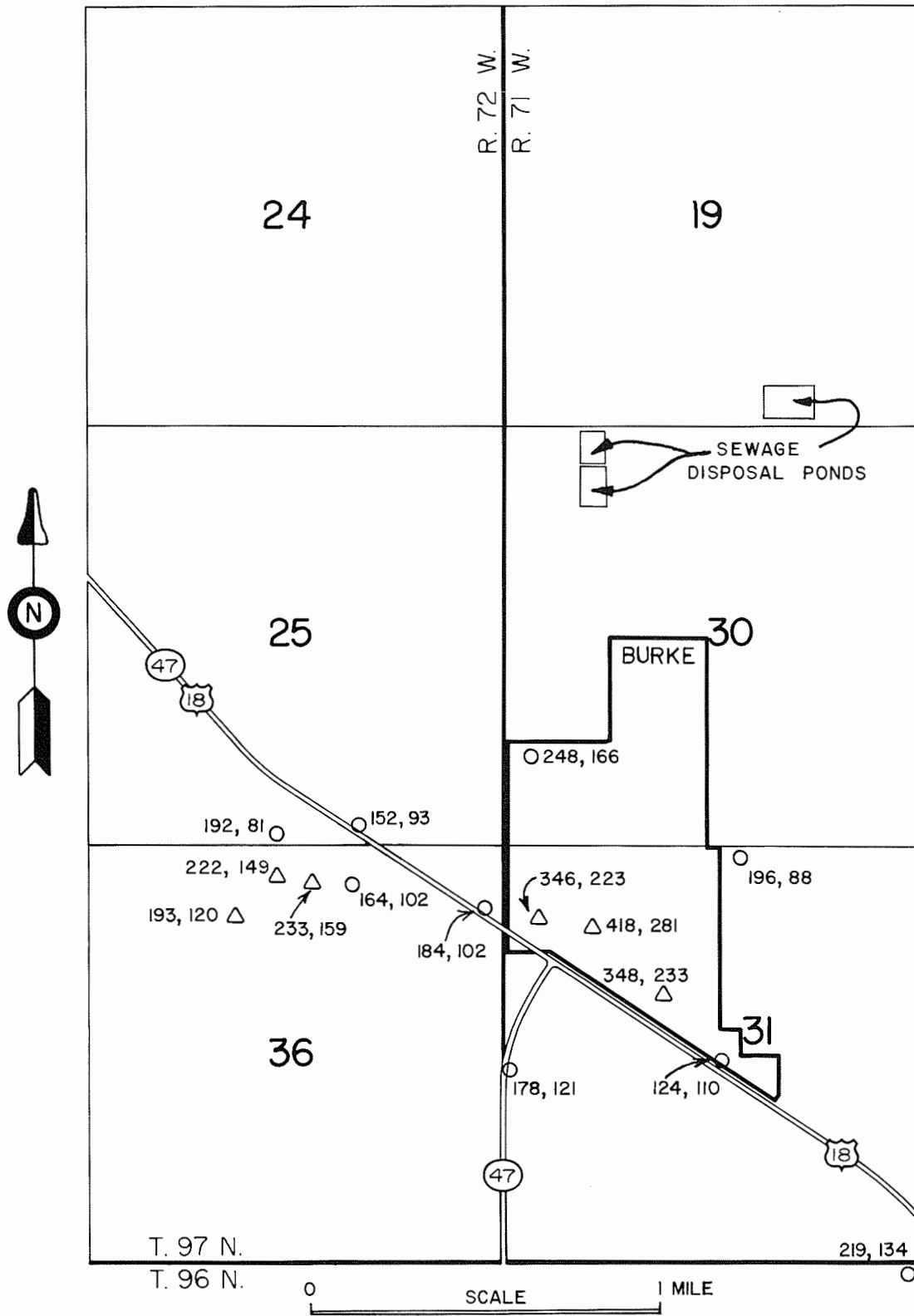
FIGURE 7. POTENTIOMETRIC SURFACE OF THE OGALLALA AQUIFER, OCTOBER 24, 1988.



2138.34 O OBSERVATION WELL - NUMBER INDICATES WATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL.

2140 — LINE CONNECTING POINTS OF EQUAL ELEVATION. CONTOUR INTERVAL = 5 FEET

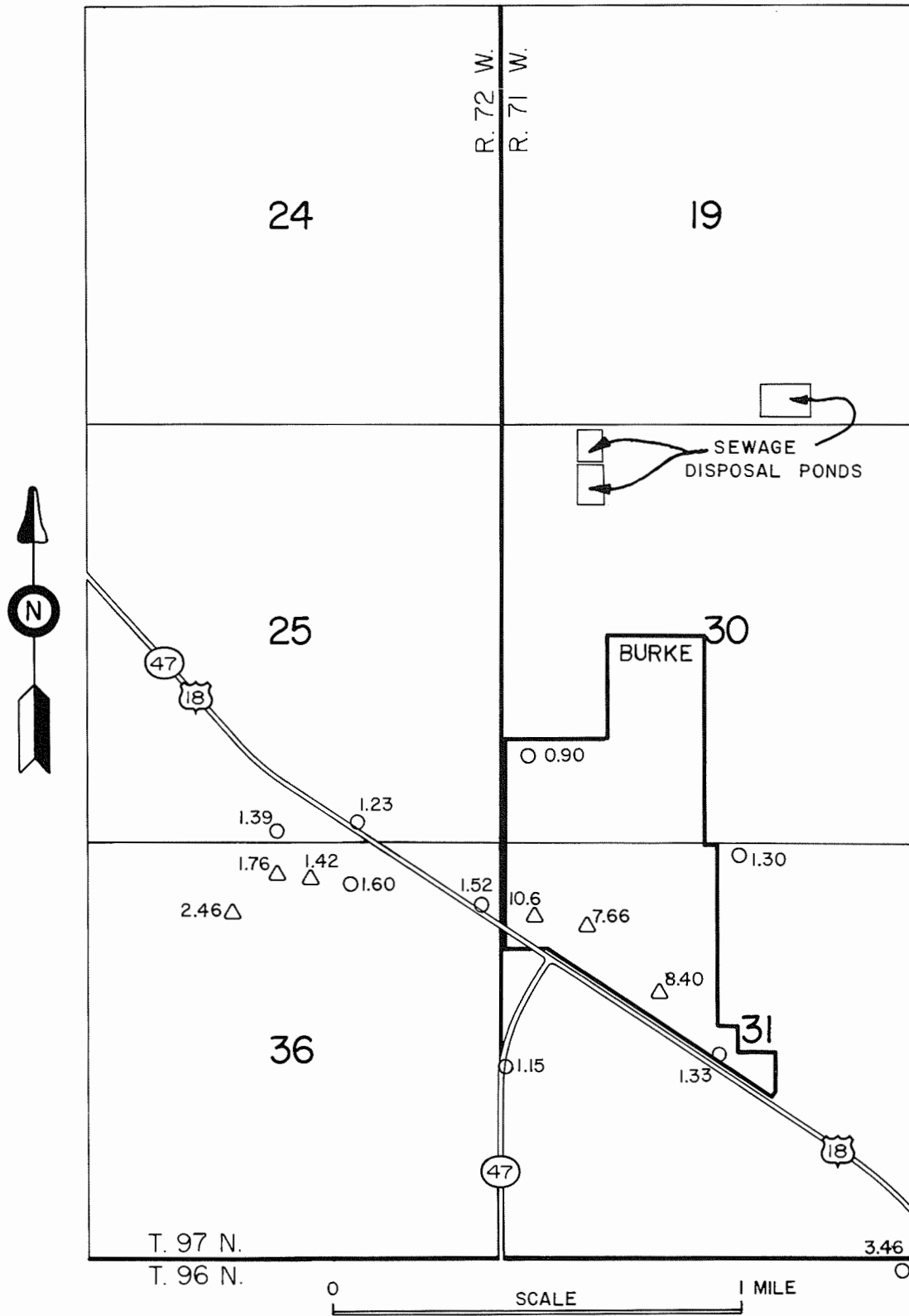
FIGURE 8. DISTRIBUTION OF TOTAL-DISSOLVED SOLIDS AND HARDNESS IN THE OGALLALA AQUIFER.



152, 930 ○ OBSERVATION WELL  
 418, 281 △ CITY WELL

NUMBERS REPRESENT CONCENTRATIONS OF TOTAL-DISSOLVED SOLIDS AND HARDNESS, RESPECTIVELY, IN MILLIGRAMS PER LITER.

FIGURE 9. NITRATE-NITROGEN CONCENTRATIONS IN THE OGALLALA AQUIFER.



1.60○ OBSERVATION WELL  
7.66△ CITY WELL

NUMBER REPRESENTS NITRATE-NITROGEN CONCENTRATION IN MILLIGRAMS PER LITER.

## SUMMARY AND RECOMMENDATIONS

The city of Burke pumps water from the Valentine Formation (Ogallala aquifer). In the study area, the water quality of the Ogallala aquifer is generally very good. However, three of the six municipal wells (wells 1, 2, and 3), which are located within the city limits, have elevated nitrate-nitrogen concentrations. Elsewhere in the study area nitrate-nitrogen concentrations are low (fig. 9).

A municipal well field has been established on the west side of the city (fig. 2) and currently three municipal wells are located there (wells 4, 5, and 6). In this area the water quality is good, the saturated thickness of the aquifer ranges from approximately 70 feet (ML 8) to 74 feet (ML 7), and the three municipal wells, on the average, each pump approximately 100 gallons of water per minute.

The city performed a pumping test prior to which municipal wells 4, 5, and 6 were shut down for 2½ days to allow the water table to come to equilibrium. Municipal well 5 was then pumped at a rate of 100 gallons per minute for 32 hours. Water-level measurements were recorded for municipal wells 4 and 6 and SDGS observation wells at ML 7 and ML 10. There was no change in the water levels in municipal well 4, or observation wells at ML 7 and ML 10; these wells are located 1,000 feet, 900 feet, and 712 feet, respectively, from municipal well 5. The water level in municipal well 6 dropped approximately 1 inch over the duration of the pumping test, and the water level recovered to the static level within 12 hours after the completion of the test. Municipal well 6 is located 356 feet from municipal well 5. From this information it was concluded that a distance of at least 700 feet is advisable to avoid drawdown interference between pumping wells.

As a result of this investigation, based on water quality and quantity data, it was concluded that a new municipal well could be drilled into the Ogallala aquifer and could be located in the city well field as long as the well is located a minimum distance of 700 feet from any pumping well. Such a separation distance reduces the possibility of interference between wells.

As a further result of this investigation, the Burke City Council hired a private drilling company and on August 15, 1989, drilling began for Burke municipal well 7. This well is located 1,000 feet south of municipal well 5, is 148 feet deep and has a static water level of approximately 65 feet. The well pumps 84 gallons per minute and according to the city water superintendent, well 7 will be on line in the spring of 1990. On August 21, 1989, drilling began for municipal well 8. This well is located 1,000 feet west of ML 7 and 8 feet behind the fence line. The well is 160 feet deep and has a static water level of approximately 75 feet. Test pumping of the well yielded 105 gallons per minute. Casing and screen have been installed in this well and a stainless steel plate has been welded over the top. According to the city water superintendent, this capped well will be put on line in the future.

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## 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 SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 34, T. 110 N., R. 49 W. is the same as a **LOCATION** of 110N-49W-34DDBC. In one **LOCATION**, 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.

#### 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 a 7.5 minute series topographic map.

County: GREGORY  
 Map Location: 1  
 Legal Location: NE NE NE NE sec. 06, T. 096 N., R. 71 W.  
 Latitude: 43.1007  
 Land Owner:  
 Project: WATER RIGHTS  
 Drilling Company: SDGS  
 Driller:  
 Geologist: J. GOODMAN  
 Date Drilled: 05-11-1978  
 Ground Surface Elevation: 2165.00 T  
 Total Drill Hole Depth: 185.0  
 Water Rights Well: GY-78A  
 Other Well Name:  
 Basin: PONCA  
 Management Unit:  
 Screen Type: PVC  
 Casing Type: PVC  
 Casing Top Elevation:  
 Casing Stick-up: 1.20  
 Well Maintenance Date: 06-30-1981  
 USGS Hydrological Unit Code: 10150001  
 Electric Log Information:  
 Spontaneous Potential:  
 Natural Gamma:  
 Samples:

Location: 096N-71W-06AAAA

Longitude: 99.1633

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

Test Hole Number: G4-78-2  
 SDGS Well Name:

Aquifer: OGALLALA

Screen Length: 45.0  
 Casing Diameter: 2.0

Total Casing and Screen: 124.5

Single Point Resistivity:  
 Extra:

Casing slotted 40 feet.

0	-	1	Topsoil, black, sandy
1	-	6	Clay, dark-brown, silty
6	-	23	Silt, white, sandy
23	-	37	Sandstone, brown, fine to medium
37	-	42	Sand, brown, fine to medium
42	-	104	Sandstone, brown, fine to medium; clean, with sand
104	-	108	Clay, green
108	-	126	Sand and sandstone, fine to medium; with green clay and sand layer
126	-	141	Silt, red-brown
141	-	145	Clay, red-gray-brown
145	-	167	Silt, red-brown
167	-	175	Silt, brown-gray
175	-	185	Clay, brown, gray; brittle, weathered shale (Pierre Shale?)

\* \* \* \*

County: GREGORY  
 Map Location: 2  
 Legal Location: NE NW SW SW sec. 30, T. 097 N., R. 71 W.  
 Latitude: 43.1113  
 Land Owner:  
 Project: BURKE CITY STUDY-1988  
 Drilling Company: SDGS  
 Driller: G. JENSEN  
 Geologist: P. DAWSON  
 Date Drilled: 08-24-1988

Location: 097N-71W-30CCBA

Longitude: 99.1738

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

Ground Surface Elevation: 2180.01 I  
Total Drill Hole Depth: 148.0  
Water Rights Well:  
Other Well Name:  
Basin: MISSOURI  
Management Unit:  
Screen Type: PVC, MFG.  
Casing Type: PVC  
Casing Top Elevation: 2181.40 I  
Casing Stick-up: 1.39  
Well Maintenance Date:  
USGS Hydrological Unit Code: 10140101  
Electric Log Information:  
Spontaneous Potential:  
Natural Gamma: X  
Samples:

Test Hole Number: R20-88-39  
SDGS Well Name: R20-88-39

Aquifer: OGALLALA

Screen Length: 10.0  
Casing Diameter: 2.0

Total Casing and Screen: 149.4

Single Point Resistivity: X  
Extra:

40 feet of blank casing (open to screen) from 148 to 108 feet, screened from 108 to 98 feet.  
Blank closed at bottom and used as reservoir.

0	-	3	Topsoil, black to dark-brown
3	-	10	Sand, tan, very fine to fine, silty, pebbly (Ash Hollow Formation)
10	-	32	Sand, tan, fine, very clayey (Ash Hollow Formation)
32	-	51	Sand and sandstone, light-brown, very fine to fine, silty; calcareous (Ash Hollow Formation)
51	-	64	Silt, tan, clayey, sandy; calcareous
64	-	68	Clay, brown, sandy
68	-	117	Sandstone, tan, very fine to fine, silty, clayey; calcareous (Valentine Formation)
117	-	133	Silt, tan, clayey, sandy; calcareous (White River Group?)
133	-	148	Clay, brown to red-brown, silty, sandy; calcareous (Brule Formation)

\* \* \* \* \*

County: GREGORY  
Map Location: 3  
Legal Location: NE NW NW NE sec. 31, T. 097 N., R. 71 W.  
Latitude: 43.1100  
Land Owner:  
Project: BURKE CITY STUDY-1988  
Drilling Company: SDGS  
Driller: G. JENSEN  
Geologist: P. DAWSON  
Date Drilled: 08-23-1988  
Ground Surface Elevation: 2210.00 T  
Total Drill Hole Depth: 52.0  
USGS Hydrological Unit Code: 10140101  
Electric Log Information:  
Spontaneous Potential:  
Natural Gamma: X  
Samples:

Location: 097N-71W-31ABBA 1

Longitude: 99.1708

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

Test Hole Number: R20-88-37

Single Point Resistivity:  
Extra:

0	-	3	Topsoil, black to dark-brown
3	-	12	Sand, brown, medium, pebbly, subangular (Ash Hollow Formation)
12	-	17	Sand, tan to light-green, medium to fine arkosic sand; cemented, very calcareous, some clay (Ash Hollow Formation)



- 17 - 26 Sand and sandstone, tan, fine; very cemented (Ash Hollow Formation)
- 26 - 52 Sand and sandstone, light-tan to greenish to light-brown, color changes with depth, fine sand; upper 2 feet noncalcareous, 29 to 52 feet very hard and very calcareous, clay 34 to 37 feet (Ash Hollow Formation)

Hole abandoned at 52 feet, could not auger through sandstone material.

\* \* \* \*

County: GREGORY	Location: 097N-71W-31ABBA 2
Map Location: 4	
Legal Location: NE NW NW NE sec. 31, T. 097 N., R. 71 W.	
Latitude: 43.1100	Longitude: 99.1708
Land Owner:	
Project: BURKE CITY STUDY-1988	
Drilling Company: SDGS	
Driller: G. JENSEN	Driller's Log:
Geologist: P. DAWSON	Geologist's Log: X
Date Drilled: 08-23-1988	Drilling Method: ROTARY
Ground Surface Elevation: 2211.24 I	
Total Drill Hole Depth: 187.0	Test Hole Number: R20-88-38
Water Rights Well:	SDGS Well Name: R20-88-38
Other Well Name:	
Basin: MISSOURI	Aquifer: OGALLALA
Management Unit:	
Screen Type: PVC, MFG.	Screen Length: 10.0
Casing Type: PVC	Casing Diameter: 2.0
Casing Top Elevation: 2212.64 I	
Casing Stick-up: 1.41	Total Casing and Screen: 161.5
Well Maintenance Date:	
USGS Hydrological Unit Code: 10140101	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity: X
Natural Gamma: X	Extra:
Samples:	

- 0 - 3 Topsoil, black to dark-brown
- 3 - 27 Sand, tan to greenish-tan, medium, pebbly; calcareous (Ash Hollow Formation)
- 27 - 54 Sand, tan to greenish-tan, medium to fine; calcareous (Ash Hollow Formation)
- 54 - 88 Sand, tan, fine to medium, somewhat clayey; noncalcareous (Valentine Formation)
- 88 - 155 Sand, brown, very fine to fine; clean (Valentine Formation)
- 155 - 161 Silt, brown to pinkish-brown, clayey (White River Group?)
- 161 - 187 Clay, brown to red-brown, sandy (Brule Formation)

\* \* \* \*

County: GREGORY	Location: 097N-71W-31CBBB
Map Location: 5	
Legal Location: NW NW NW SW sec. 31, T. 097 N., R. 71 W.	
Latitude: 43.1034	Longitude: 99.1745
Land Owner:	
Project: BURKE CITY STUDY-1988	
Drilling Company: SDGS	
Driller: G. JENSEN	Driller's Log:
Geologist: K. WILKIE/P. DAWSON	Geologist's Log: X

Date Drilled: 08-30-1988  
Ground Surface Elevation: 2146.54 I  
Total Drill Hole Depth: 97.0  
Water Rights Well:  
Other Well Name:  
Basin: PONCA  
Management Unit:  
Screen Type: PVC, MFG.  
Casing Type: PVC  
Casing Top Elevation: 2148.34 I  
Casing Stick-up: 1.80  
Well Maintenance Date:  
USGS Hydrological Unit Code: 10150001  
Electric Log Information:  
Spontaneous Potential:  
Natural Gamma: X  
Samples:

Drilling Method: ROTARY  
Test Hole Number: R20-88-44  
SDGS Well Name: R20-88-44  
Aquifer: OGALLALA  
Screen Length: 10.0  
Casing Diameter: 2.0  
Total Casing and Screen: 98.8  
Single Point Resistivity: X  
Extra:

20 feet of blank casing (open to screen) from 97 to 77 feet, screened from 77 to 67 feet.  
Blank closed at bottom and used as reservoir.

0	-	3	Topsoil, black to dark-brown
3	-	18	Sand, tan, fine to coarse, pebbly; noncalcareous (Valentine Formation)
18	-	35	Sand, tan, fine, silty, clayey; noncalcareous (Valentine Formation)
35	-	79	Sandstone, tan, very fine to fine, silty; slightly calcareous (Valentine Formation)
79	-	86	Silt, tan, clayey, sandy; noncalcareous (White River Group?)
86	-	97	Clay, red to red-brown, sandy (Brule Formation)

\* \* \* \*

County: GREGORY  
Map Location: 6  
Legal Location: NW NW NW SE sec. 31, T. 097 N., R. 71 W.  
Latitude: 43.1034  
Land Owner:  
Project: BURKE CITY STUDY-1988  
Drilling Company: SDGS  
Driller: G. JENSEN  
Geologist: K. WILKIE/P. DAWSON  
Date Drilled: 08-30-1988  
Ground Surface Elevation: 2200.37 I  
Total Drill Hole Depth: 152.0  
Water Rights Well:  
Other Well Name:  
Basin: PONCA  
Management Unit:  
Screen Type: PVC, MFG.  
Casing Type: PVC  
Casing Top Elevation: 2202.90 I  
Casing Stick-up: 2.54  
Well Maintenance Date:  
USGS Hydrological Unit Code: 10150001  
Electric Log Information:  
Spontaneous Potential:  
Natural Gamma: X

Location: 097N-71W-31DBBB  
Longitude: 99.1711  
Driller's Log:  
Geologist's Log: X  
Drilling Method: ROTARY  
Test Hole Number: R20-88-43  
SDGS Well Name: R20-88-43  
Aquifer: OGALLALA  
Screen Length: 10.0  
Casing Diameter: 2.0  
Total Casing and Screen: 154.5  
Single Point Resistivity: X  
Extra:

Samples:

24 feet of blank casing (open to screen) from 152 to 128 feet, screened from 128 to 118 feet.  
Blank closed at bottom and used as a reservoir.

0	-	3	Topsoil, black to dark-brown
3	-	13	Sand, tan, fine to coarse, pebbly; calcareous (Ash Hollow Formation)
13	-	45	Sand and sandstone, tan, fine, silty, clayey; calcareous; silty layer near bottom (Ash Hollow Formation)
45	-	135	Sandstone, tan, very fine to fine, silty; slightly calcareous to noncalcareous (Valentine Formation)
135	-	148	Silt, tan, clayey, sandy; slightly calcareous (White River Group?)
148	-	152	Clay, brown to red-brown, sandy, silty; slightly calcareous (Brule Formation)

\* \* \* \*

County: GREGORY	Location: 097N-72W-25CDDD
Map Location: 7	
Legal Location: SE SE SE SW sec. 25, T. 097 N., R. 72 W.	
Latitude: 43.1102	Longitude: 99.1825
Land Owner:	
Project: BURKE CITY STUDY-1988	
Drilling Company: SDGS	
Driller: G. JENSEN	Driller's Log:
Geologist: P. DAWSON	Geologist's Log: X
Date Drilled: 08-24-1988	Drilling Method: ROTARY
Ground Surface Elevation: 2223.76 I	
Total Drill Hole Depth: 172.0	Test Hole Number: R20-88-40
Water Rights Well:	SDGS Well Name: R20-88-40
Other Well Name:	
Basin: MISSOURI	Aquifer: OGALLALA
Management Unit:	
Screen Type: PVC, MFG.	Screen Length: 10.0
Casing Type: PVC	Casing Diameter: 2.0
Casing Top Elevation: 2225.47 I	
Casing Stick-up: 1.71	Total Casing and Screen: 173.7
Well Maintenance Date:	
USGS Hydrological Unit Code: 10140101	
Electric Log Information:	
Spontaneous Potential:	Single Point Resistivity: X
Natural Gamma: X	Extra:
Samples:	

20 feet of blank casing (open to screen) from 172 to 152 feet, screened from 152 to 142 feet.  
Blank closed at bottom and used as reservoir.

0	-	2	Topsoil, black to dark-brown
2	-	8	Sand, yellow-tan, fine to coarse, silty, pebbly; noncalcareous (Herrick Formation)
8	-	22	Clay, tan, very sandy (Herrick Formation?)
22	-	43	Sand and sandstone, tan to greenish-tan, medium to coarse, silty, clayey; calcareous (Ash Hollow Formation)
43	-	156	Sandstone, tan, very fine to fine; clean, calcareous, some small silt layers interbedded (Valentine Formation)
156	-	172	Clay, brown to red-brown, silty, somewhat sandy; calcareous (Brule Formation)

\* \* \* \*

County: GREGORY  
Map Location: 8  
Legal Location: SW SE SW SE sec. 25, T. 097 N., R. 72 W.  
Latitude: 43.1103  
Land Owner:  
Project: BURKE CITY STUDY-1988  
Drilling Company: SDGS  
Driller: G. JENSEN  
Geologist: K. WILKIE/P. DAWSON  
Date Drilled: 08-29-1988  
Ground Surface Elevation: 2203.51 I  
Total Drill Hole Depth: 147.0  
Water Rights Well:  
Other Well Name:  
Basin: MISSOURI  
Management Unit:  
Screen Type: PVC, MFG.  
Casing Type: PVC  
Casing Top Elevation: 2205.38 I  
Casing Stick-up: 1.87  
Well Maintenance Date:  
USGS Hydrological Unit Code: 10140101  
Electric Log Information:  
Spontaneous Potential:  
Natural Gamma: X  
Samples:

Location: 097N-72W-25DCDC

Longitude: 99.1810

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

Test Hole Number: R20-88-42  
SDGS Well Name: R20-88-42

Aquifer: OGALLALA

Screen Length: 10.0  
Casing Diameter: 2.0

Total Casing and Screen: 146.9

Single Point Resistivity: X  
Extra:

20 feet of blank casing (closed to screen) from 145 to 125 feet, screened from 125 to 115 feet.

0	-	3	Topsoil, black to dark-brown
3	-	12	Sand, tan, fine to coarse, pebbly; slightly calcareous (Herrick Formation)
12	-	62	Sand and sandstone, tan, very fine to fine, silty, clayey; calcareous (Ash Hollow Formation)
62	-	133	Sand, tan to greenish-tan, very fine to fine, clayey, silty; slightly calcareous to noncalcareous (Valentine Formation)
133	-	144	Silt, tan, sandy, clayey; calcareous (White River Group?)
144	-	149	Clay, brown to red-brown, silty, sandy; calcareous (Brule Formation)

\* \* \* \*

County: GREGORY  
Map Location: 9  
Legal Location: NE SE NE NE sec. 36, T. 097 N., R. 72 W.  
Latitude: 43.1052  
Land Owner:  
Project: BURKE CITY STUDY-1988  
Drilling Company: SDGS  
Driller: G. JENSEN  
Geologist: K. WILKIE/P. DAWSON  
Date Drilled: 08-31-1988  
Ground Surface Elevation: 2195.18 I  
Total Drill Hole Depth: 147.0  
Water Rights Well:

Location: 097N-72W-36AADA

Longitude: 99.1748

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

Test Hole Number: R20-88-45  
SDGS Well Name: R20-88-45

Other Well Name:  
 Basin: MISSOURI Aquifer: OGALLALA  
 Management Unit:  
 Screen Type: PVC, MFG. Screen Length: 10.0  
 Casing Type: PVC Casing Diameter: 2.0  
 Casing Top Elevation: 2197.12 I  
 Casing Stick-up: 1.94 Total Casing and Screen: 148.9  
 Well Maintenance Date:  
 USGS Hydrological Unit Code: 10140101  
 Electric Log Information:  
 Spontaneous Potential: Single Point Resistivity: X  
 Natural Gamma: X Extra:  
 Samples:

24 feet of blank casing (open to screen) from 147 to 123 feet, screened from 123 to 113 feet.  
 Blank closed at bottom and used as reservoir.

0	-	2	Topsoil, black to dark-brown
2	-	13	Sand, tan, fine to coarse, pebbly; calcareous (Ash Hollow Formation)
13	-	42	Sand, tan, fine, silty, clayey (Ash Hollow Formation)
42	-	128	Sandstone, tan, very fine to fine, silty, clayey; slightly calcareous to noncalcareous (Valentine Formation)
128	-	136	Silt, tan, clayey, sandy; slightly calcareous (White River Group?)
136	-	147	Clay, red to red-brown, silty, sandy; slightly calcareous (Brule Formation)

\* \* \* \*

County: GREGORY Location: 097N-72W-36ABAC  
 Map Location: 10  
 Legal Location: SW NE NW NE sec. 36, T. 097 N., R. 72 W.  
 Latitude: 43.1055 Longitude: 99.1811  
 Land Owner:  
 Project: BURKE CITY STUDY-1988  
 Drilling Company: SDGS  
 Driller: G. JENSEN Driller's Log:  
 Geologist: P. DAWSON Geologist's Log: X  
 Date Drilled: 08-24-1988 Drilling Method: ROTARY  
 Ground Surface Elevation: 2222.03 I  
 Total Drill Hole Depth: 164.0 Test Hole Number: R20-88-41  
 Water Rights Well: SDGS Well Name: R20-88-41  
 Other Well Name:  
 Basin: PONCA Aquifer: OGALLALA  
 Management Unit:  
 Screen Type: PVC, MFG. Screen Length: 10.0  
 Casing Type: PVC Casing Diameter: 2.0  
 Casing Top Elevation: 2223.80 I  
 Casing Stick-up: 1.77 Total Casing and Screen: 164.8  
 Well Maintenance Date:  
 USGS Hydrological Unit Code: 10150001  
 Electric Log Information:  
 Spontaneous Potential: Single Point Resistivity: X  
 Natural Gamma: X Extra:  
 Samples:

20 feet of blank casing (open to screen) from 163 to 143 feet, screened from 143 to 133 feet.

Blank closed at bottom and used as reservoir.

0	-	2	Topsoil, black to dark-brown
2	-	8	Sand, yellow-tan, fine to coarse; some pebbles, calcareous (Herrick Formation)
8	-	22	Clay, tan, very sandy (Herrick Formation?)
22	-	42	Sand and sandstone, tan, fine to medium, silty, clayey; calcareous (Ash Hollow Formation)
42	-	156	Sandstone, tan, very fine to fine, very silty, clayey; slightly calcareous to noncalcareous (Valentine Formation)
156	-	162	Silt, light-tan, clayey, sandy; slightly calcareous (White River Group?)
162	-	164	Clay, brown to red-brown, sandy (Brule Formation)

\* \* \* \*