Chemical Quality of Irrigation Waters

in Southwestern Kansas

Chemical Quality Series 6

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CHEMICAL QUALITY OF IRRIGATION WATERS IN SOUTHWESTERN KANSAS

CHEMICAL QUALITY SERIES 6

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EXECUTIVE SUMMARY

The utilization of irrigation waters in Kansas has increased dramatically since the drought period of the 1950's. With this development has come the need for information which can be used in the determination of compatability of groundwaters with soils and crops and in the management of the groundwater systems tapped for agricultural purposes. An important component of this information is the chemical character of the waters under consideration.

Both human activity in the area of oil and gas development and natural sources such as mineralized waters from bedrock formations of Permian Age serve as potential agents for the alteration and deterioration in quality of groundwaters tapped for agricultural purposes in southwestern Kansas. The scarcity of historical groundwater data for portions of Morton, Stevens, and Seward counties and the general unavailability of data regarding subsurface brine chemistries of the area make an evaluation of the impact of past fuel resource development upon groundwater quality extremely difficult in these counties. Similarly, the historical data for Meade County appears inadequate to define clearly the area in which deterioration of groundwater quality results from upward movement of mineralized waters. The current study points to the need for additional sample data from these four counties in order to adequately moniter future changes in chemical quality with increased development of groundwater resources.

Other areas covered in this series of studies are Greeley, Wichita, Scott, Lane, and southern Wallace counties (Kansas Geological Survey Chemical Quality Series 2) and Hamilton, Kearny, Finney, and northern Gray counties (Kansas Geological Survey Chemical Quality Series 4). In addition, samples were collected in the Great Bend Prairie area and Ford County in 1977, and preparation is underway for the sampling of northwest Kansas during 1978.

CONTENTS

CHEMICAL QUALITY OF IRRIGATION WATERS IN
SOUTHWESTERN KANSAS

ABSTRACT

Two-hundred-sixty-four pumping irrigation wells were sampled in Stanton, Grant, Haskell, Morton, Stevens, Seward, Meade, and southern Gray counties and adjoining portions of Hamilton, Kearny, Finney and, northern Gray counties during July 1976. The general quality of these waters, with the exception of an area west of the Crooked Creek-Fowler fault complex in Meade County, places them in the medium to high salinity hazard and low alkali hazard ranges. Waters in the area west of the fault complex in Meade County are of a Na-Cl type and may fall in the medium to high alkali hazard range.

INTRODUCTION

This study represents the third part of a program begun in 1974 to establish chemical quality base-line data for irrigation waters of western Kansas. Previous studies have covered the west-central Kansas area (1974) and the Hamilton-Kearny-Finney-northern Gray county area (1975). The present 7-1/2-county area represents the final, lower portion of the southwestern Kansas region of groundwater studies (Figure 1).

Irrigation waters in the present study are derived mainly from undifferentiated Quaternary-Tertiary sequences; however, in the western third of the study area undifferentiated Mesozoic or undifferentiated Quaternary-Tertiary-Mesozoic sequences are important sources of groundwater. Alluvium associated with the Cimarron River system in the southern

Figure 1. Index map showing the area covered by this report (dark area) and areas covered by past studies in the Chemical Quality Program.

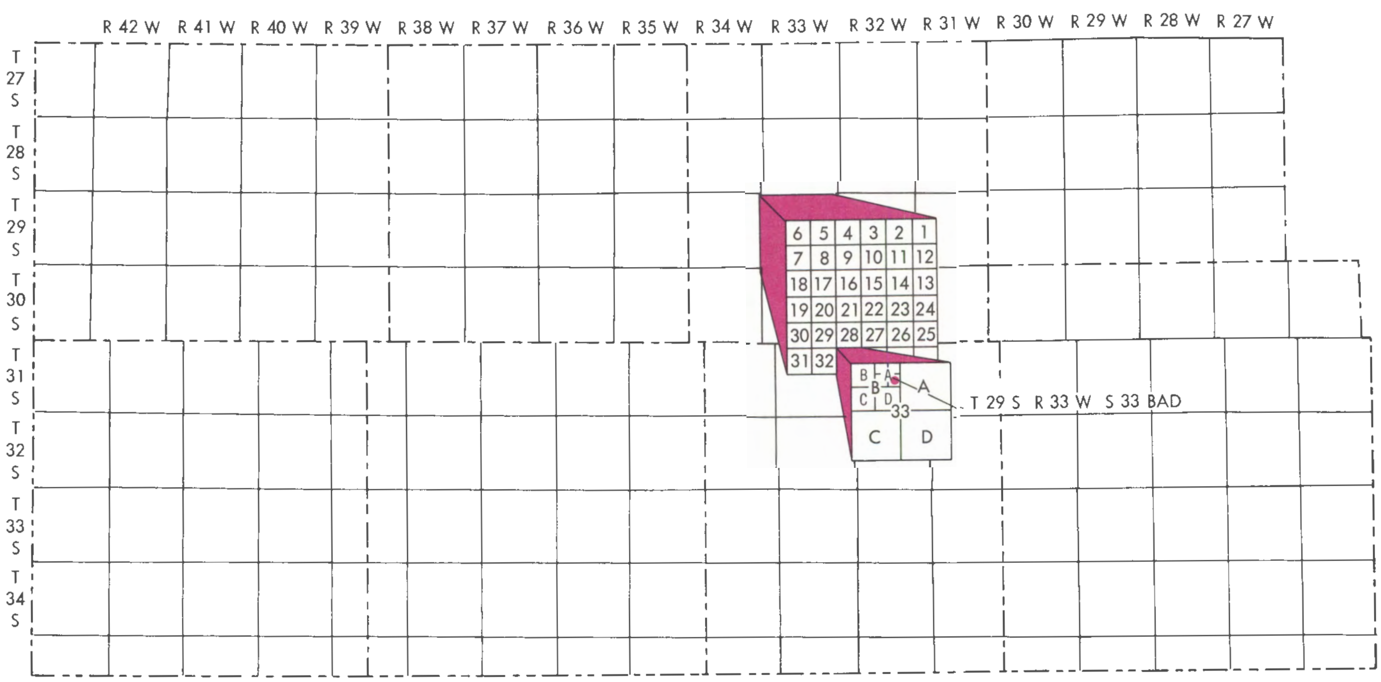


Figure 2. Map of study area illustrating Bureau of Land Management numbering system used for well locations.

portion of the study area also serves as an aquifer locally for wells located along that system.

Well locations used in this report are based upon the Bureau of Land Management numbering system. The location is composed of the township, the range, and the section number followed by letters designating the subdivision of the section on which the well is located (Figure 2).

TOPOGRAPHY

Smith (1940) has described the general topographic features of southwestern Kansas. The study area is a part of the central High Plains region and exhibits a general west to east slope of the land surface.

The Cimarron River, located in the southern portion of the study area, is the major stream in this region. The river enters the state in Morton County trending to the northeast; but bends in southern Grant County, assumes a southeasterly trend in Seward County and leaves the state in Meade County. The Cimarron Bend area south of the river is dotted with low uneven sandy hills and has no major outside drainage.

The North Fork of the Cimarron is the main tributary to the river in the study area; however, Crooked Creek in the eastern part of the study area joins the Cimarron River below the study area in Oklahoma. Bear Creek trends in a northeasterly direction through Stanton and Grant counties before terminating in a basin in Grant and Kearny counties.

BEDROCK

Consolidated rocks of undifferentiated Lower Cretaceous-Jurassic age form the bedrock in Stanton, Grant, and Haskell counties, but give

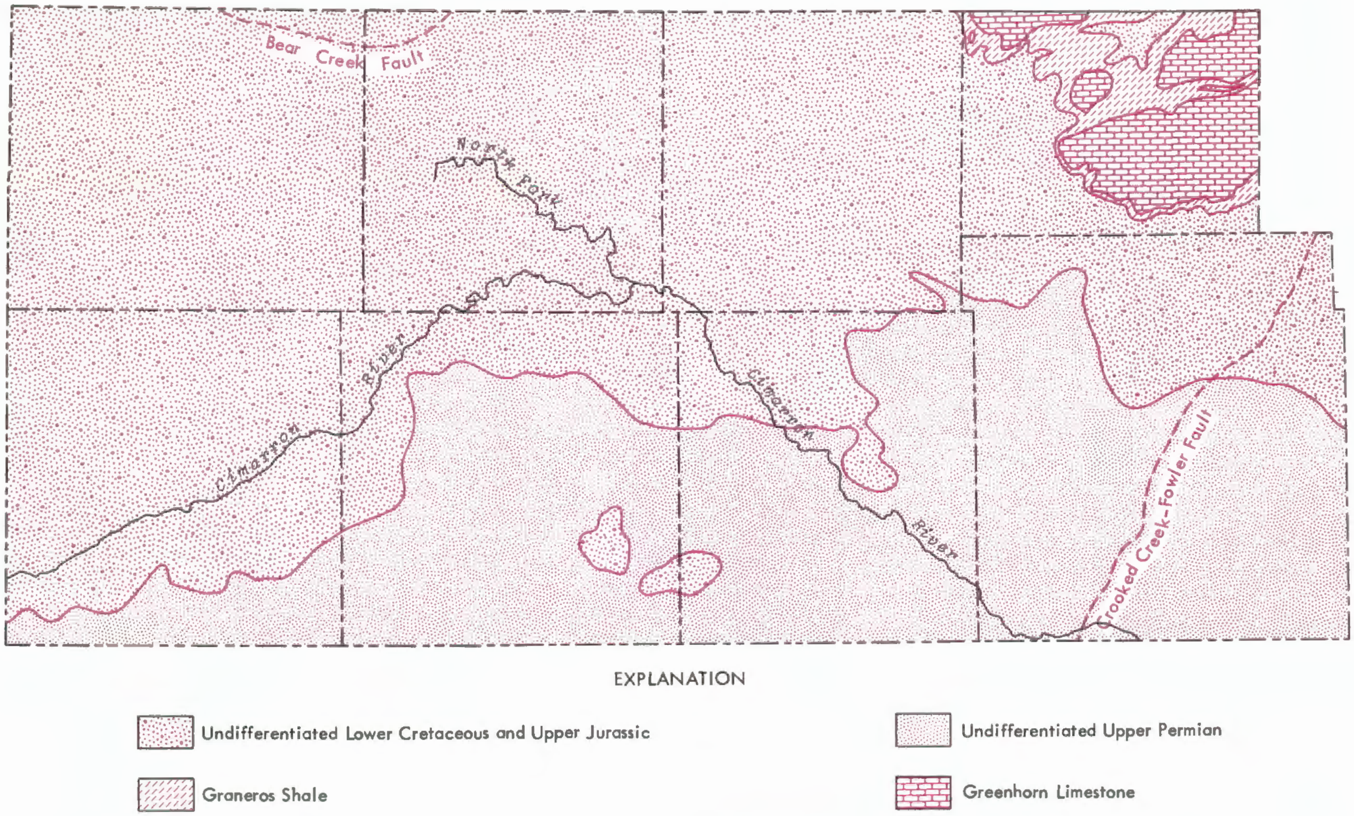


Figure 3. Bedrock geology of the study area.

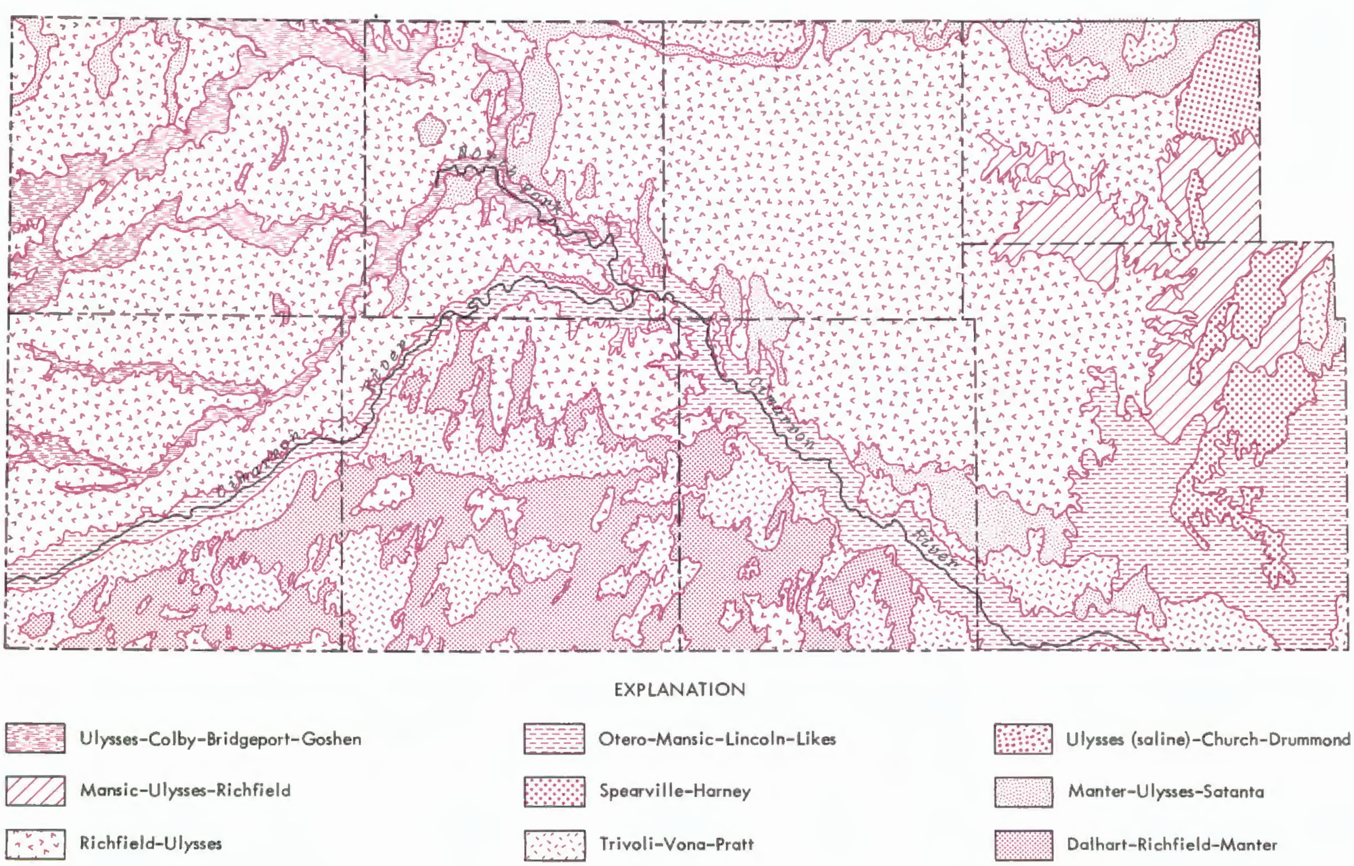


Figure 4. Soil association map of the study area.

way to rocks of Permian age in Morton, Stevens, Seward, and Meade counties (Figure 3). The extent to which Permian-age rocks contribute to the bedrock formation increases from west to east (i.e., from Morton County to Meade County) (Gutentag, Lobmeyer and Slagle, in prep.).

This general trend is somewhat altered in southern Gray County, where a regional elevation of the bedrock surface exists and upper Cretaceous (Graneros Shale and Greenhorn Limestone) and undifferentiated lower Cretaceous rocks form the bedrock surface (McGovern and Long, 1974).

Two fault systems (Bear Creek and Crooked Creek-Fowler) occur in the study area and tend to restrict the availability of groundwater on the up-throw side of the faults, i. e. in northeastern Stanton and eastern Meade counties, respectively, in the area covered by this report.

SOILS

Figure 4 is a generalized soil map of the study area. This map has been produced by combining data for individual counties. Some grouping of the various soil associations presented on general county soil maps and some regrouping of mapping units to better reflect the proportional pattern of soils in natural landscapes for a multi-county area was necessary (Dickey, Eeds and Hecht, 1961; Fleming, McBee, Hamilton and Sallee, 1961; Dickey, Swafford and Markley, 1965; Dickey, Swafford and Markley, 1963; Hamilton, Jantz, Lobmeyer, Markley and Swafford, 1968; Hamilton, Markely, Swafford and Dickey, 1969; Tomasu, 1977; Tomasu and Roth, 1968). A brief description of the soil associations used in this regional map is given in Table 1.

A notable feature of the regional map is the general transition from the silty upland Richfield-Ulysses soil association north of the

Table 1

1.	Richfield-Ulysses:	These silty soils are on broad, nearly level landscapes. This is the dominant soil association of the uplands. Little or no runoff occurs from these soils to stream systems.
2.	Ulysses-Colby-Bridgeport-Goshen:	Most of this association consists of silty and loamy soils on nearly level landscapes. These soils are associated with upland drainage ways.
3.	Spearville-Harney:	These clayey and silty soils are located on broad, nearly level landscales along the eastern edge of the study area.
4.	Mansic-Ulysses-Richfield:	Loamy and silty soils occurring on nearly level to strongly sloping landscapes. Found along the eastern edge of the study area along upland drainage ways.
5.	Tivoli-Vona-Pratt:	These sandy soils are found on undulating and hilly landscapes. The main areas of occurrence are south of the Cimarron River and north of the river in the eastern fourth of the study area. Little or no runoff occurs from these areas to stream systems.
6.	Manter-Ulysses-Satanta:	Loamy soils occuring on nearly level and gently undulating landscapes. Generally occur in transitional zones between sandy soils and silty soils on uplands.
7.	Ulysses (saline)-Church-Drummond:	Silty and clayey soils found on nearly level landscapes. They are slightly to highly saline and are found in the terminal portion of the Bear Creek.
8.	Otero-Mansic-Lincoln-Likes:	These loamy and sandy soils occur on nearly level to rolling landscapes. They occupy the flood plains and sloping areas along the Cimarron River. Some local spots of saline soils may occur in the flood plain.
9.	Dalhart-Richfield-Manter:	Loamy and silty soils occurring on nearly level to gently undulating landscapes. They occur south of the Cimarron River. There is little or no runoff from these areas to stream systems.

Cimarron River to the more sandy Tivoli-Vona-Pratt and Dalhart-Richfield associations south of the Cimarron River.

SAMPLING AND ANALYSIS

Groundwater samples were collected from 264 pumping irrigation wells over a four-day period, July 26-29, 1976. Sampling procedures and field determinations were the same as described earlier (Hathaway, et al., 1975, 1976). Historical chemical quality data, other than that gathered in the present series of studies, exist for about 20% of the wells sampled, with about half of those historical records existing for wells in Seward and Stevens counties (13 each). Duplicate sets of samples were collected at 50 sites. Twenty duplicate sets of samples were generated by individual field personnel collecting duplicate sets of samples from wells within their sampling area (Duplicate Sets). Thirty-two sets of duplicate samples were collected from wells located along the boundaries of different sampling areas by two individuals sampling the same well (Overlap Sets). In two cases wells used for an individual's duplicate set also corresponded to an overlap set. The time interval between collection of the pairs of samples from the overlap sites ranges from the same day to three days.

The locations of wells sampled in the study area as well as principal drainage systems of the area are shown in Figure 5. Wells were sampled north of the study area to provide greater control in mapping the chemical quality data and to provide greater interfacing of the data from this study with that collected the previous year. Analytical data for the control wells north of the study area are included in the compilation of chemical quality data in Appendix A. The distribution

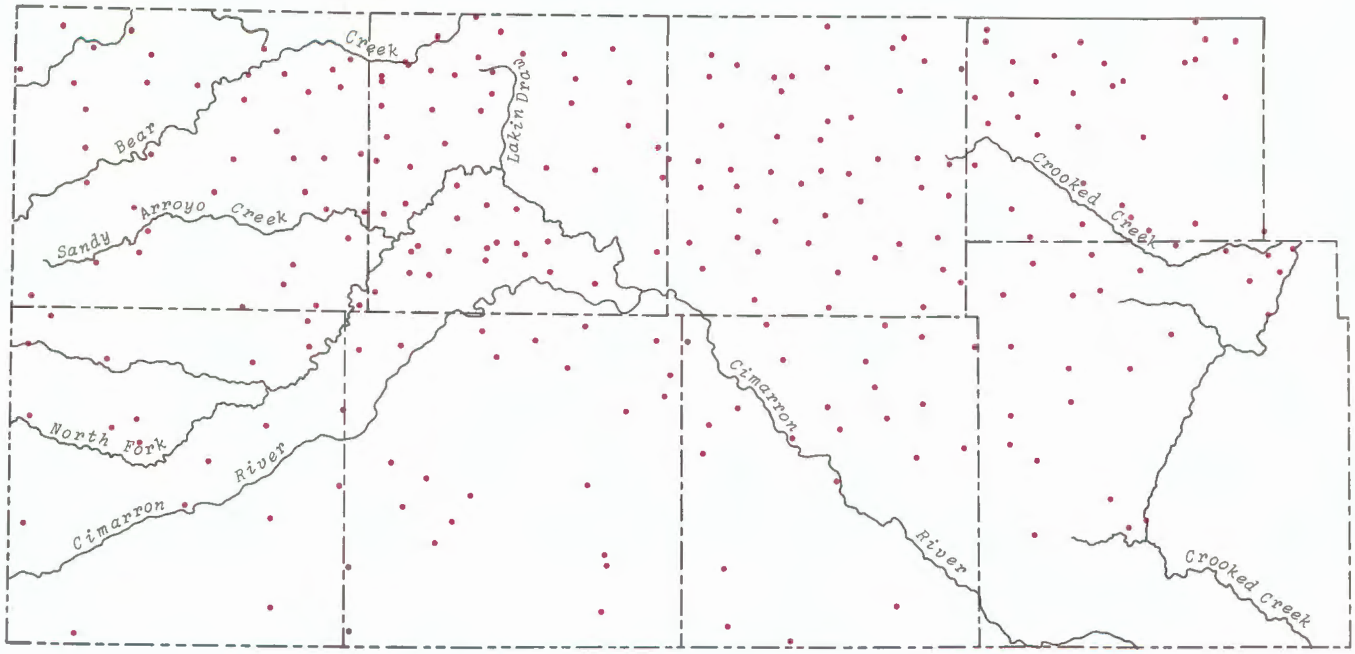


Figure 5. Location of wells in study area and principal drainage systems.

of wells sampled during the study follows closely the regions shown to have pumping potentials of 500 gal/min or greater on Map M-4A, General Availability of Ground Water and Normal Annual Precipitation in Kansas (C.K. Bayne et al., 1975). The density of wells sampled decreased somewhat in the southern third of the study area, particularly in parts of those regions overlying bedrock of Permian age.

Analytical procedures employed were the same as those described earlier (Hathaway, et al., 1975, 1976). Determinations of specific conductance and pH were made at the time of collection. Bicarbonate (HCO_3), chloride (Cl), and fluoride (F) analyses were performed at a field laboratory established in Liberal. Analyses of silica (SiO_2), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), sulfate (SO_4), nitrate (NO_3), phosphate (PO_4), strontium (Sr), and the trace elements were made in the Kansas Geological Survey laboratories in Lawrence.

Standard deviations for the major constituents in the 20 duplicate sets and 32 overlap sets are presented in Table 2. The standard deviations for the overlap sets are about twice that for the individual sets, indicating some time dependent variation in the sampling. The variations in the analytical data for the overlap samples average about 3.5% and as such do not appear to present a problem in grouping the sample data for the purpose of regional mapping of chemical quality data. Variation in the specific conductance for the overlap sets is 3.8%.

In the case of the trace elements iron (Fe), manganese (Mn), copper (Cu), nickel (Ni), and zinc (Zn), where concentration levels are usually in the parts per billion ranges, a more complicated situation exists as there is greater chance for contamination. First, incomplete flushing of the sampling outlet at the well can result in higher trace element levels due to inclusion of deposits which have built up around infrequently used taps. In this respect, direct sampling of the main flow of the well would be best, but this is not always possible under actual field conditions. Secondly, indentification tags were attached to the trace element sample bottles in the field laboratory by means of galvanized wire twists, in several cases there was visual evidence to suggest that these wires had produced Fe contamination and possibly Zn and some Mn contamination as well. Where Fe contamination was apparent, Fe values have been omitted in the reported data.

Table 2

Standard Deviations of Data for Duplicate Sets

Determination	Individual Duplicate Sets $\pm\sigma$	Overlap Duplicate Sets $\pm\sigma$
SiO_2	1.5 ppm*	3.2 ppm
Ca	0.6 ppm	1.2 ppm
Mg	0.2 ppm	0.5 ppm
Na	0.4 ppm	1.0 ppm
K	0.05 ppm	0.1 ppm
Sr	0.02 ppm	0.05 ppm
HCO_3	1.4 ppm	2.6 ppm
SO_4	1.8 ppm	3.8 ppm
Cl	0.5 ppm	1.8 ppm
F	0.02 ppm	0.1 ppm
NO_3	0.2 ppm	0.5 ppm
Total Dissolved Solids	6 ppm	11 ppm
Specific Conductance	---	21 μmho**

$$\pm\sigma = \sqrt{\frac{1/2 \sum_{i=1}^{N} r_i^2}{N}}$$

*parts per million
**micro-mhos at 25°C

r_i = range for analysis of sample pairs
N = number of sample pairs

A general compilation of chemical quality data for groundwater samples collected during this study is presented in Appendix A by county and location.

MAPPING OF CHEMICAL QUALITY DATA

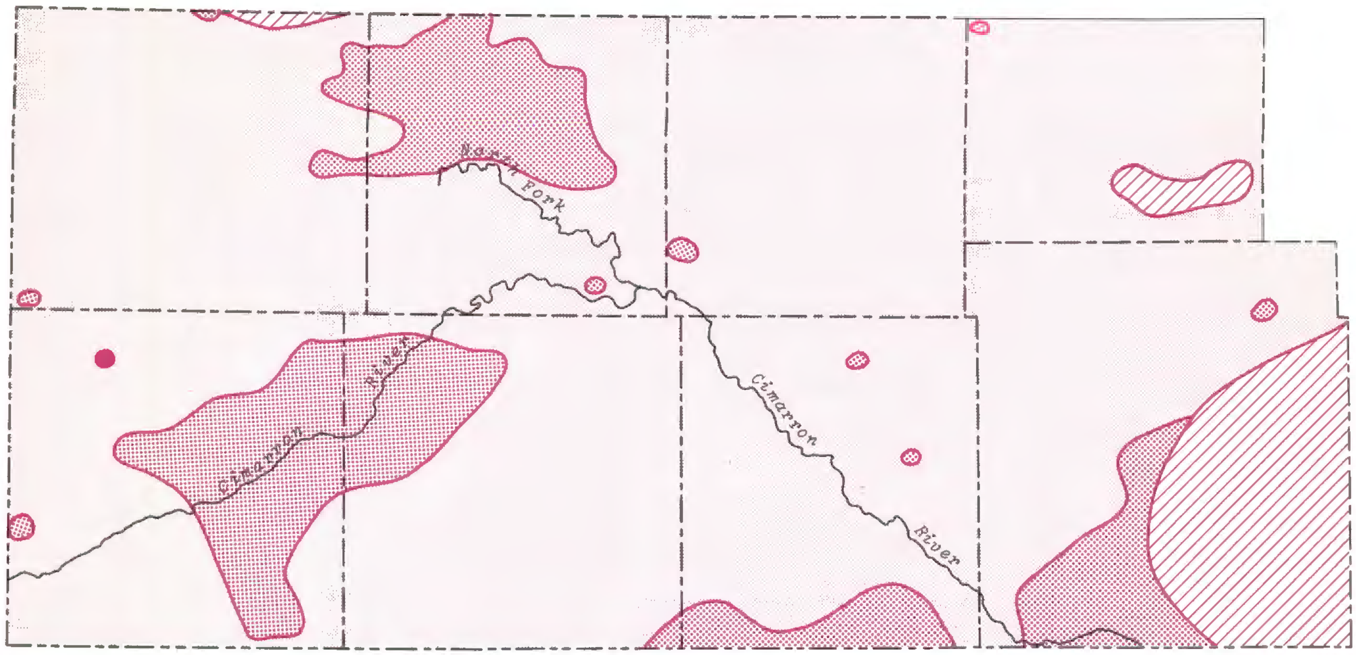
Chemical quality maps presented in this report were plotted manually using the <100 gal/min boundary from water quantity map M-4A as a cut-off for mapping.* Historical data back to 1970, and data for surface samples collected during July 1976 from the Cimarron River and Crooked Creek in Meade County, were also used to establish relative chemical quality boundaries in areas where NaCl begins to make an important contribution to the dissolved salt load of the groundwater.

Lack of comparable recent historical data for the remainder of the southern portion of the study area makes it impossible to increase the sample density in this region and reduce the uncertainty associated with the interpretation of the chemical quality data for this portion of the study area.

RESULTS AND DISCUSSION

The areal distribution of the specific conductance values for groundwater samples from the study area is displayed in Figure 6. From this figure it is apparent that areas of higher dissolved solids content exist either side of Lakin Draw in the area between Bear Creek and the North Fork of the Cimarron River, along the Cimarron River in eastern Morton and western Stevens counties, south of Liberal in Seward County, and in the eastern portion of the mapped area of Morton County. Higher

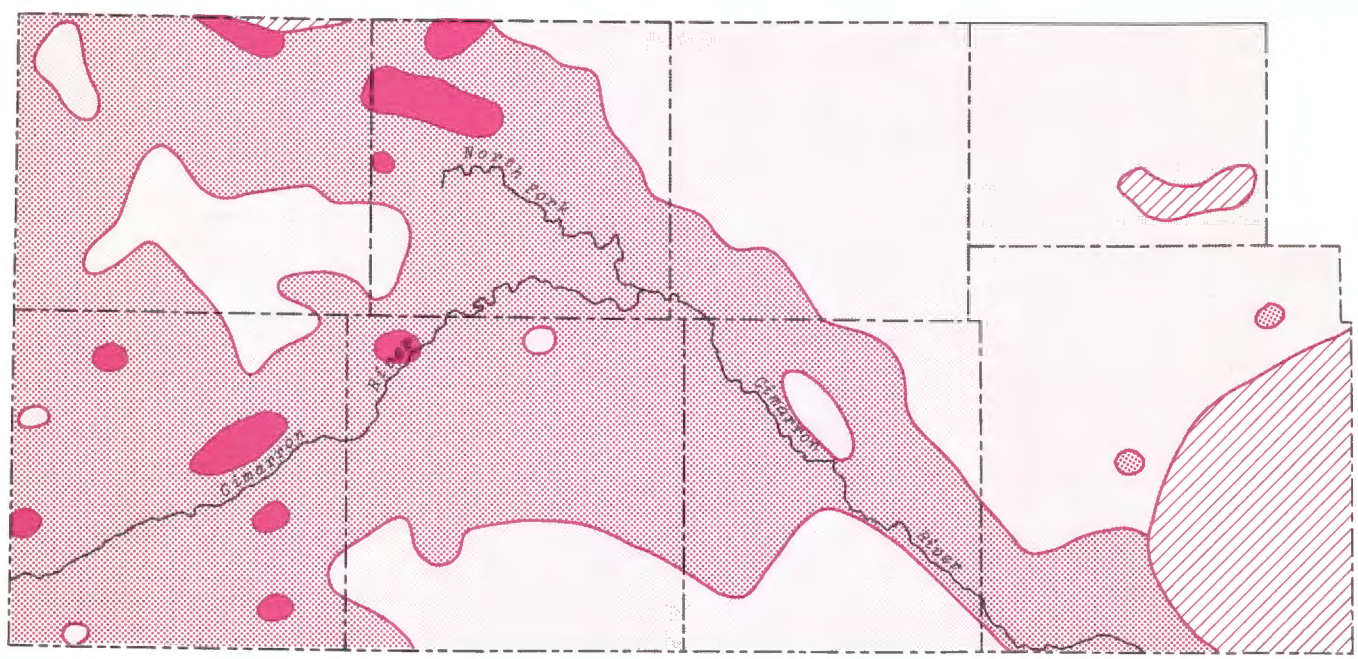
*The diagonal pattern on the maps represents areas of insufficient water quantity.



EXPLANATION

< 750 | 750–2250 | >2250

Figure 6. Map of specific conductance (in μMhos) for the study area. Levels correspond to medium, high, and very high salinity hazard ranges.



EXPLANATION

<100 | 100–250 | >250

Figure 7. Map of concentration levels of sulphate (in ppm) for the study area.

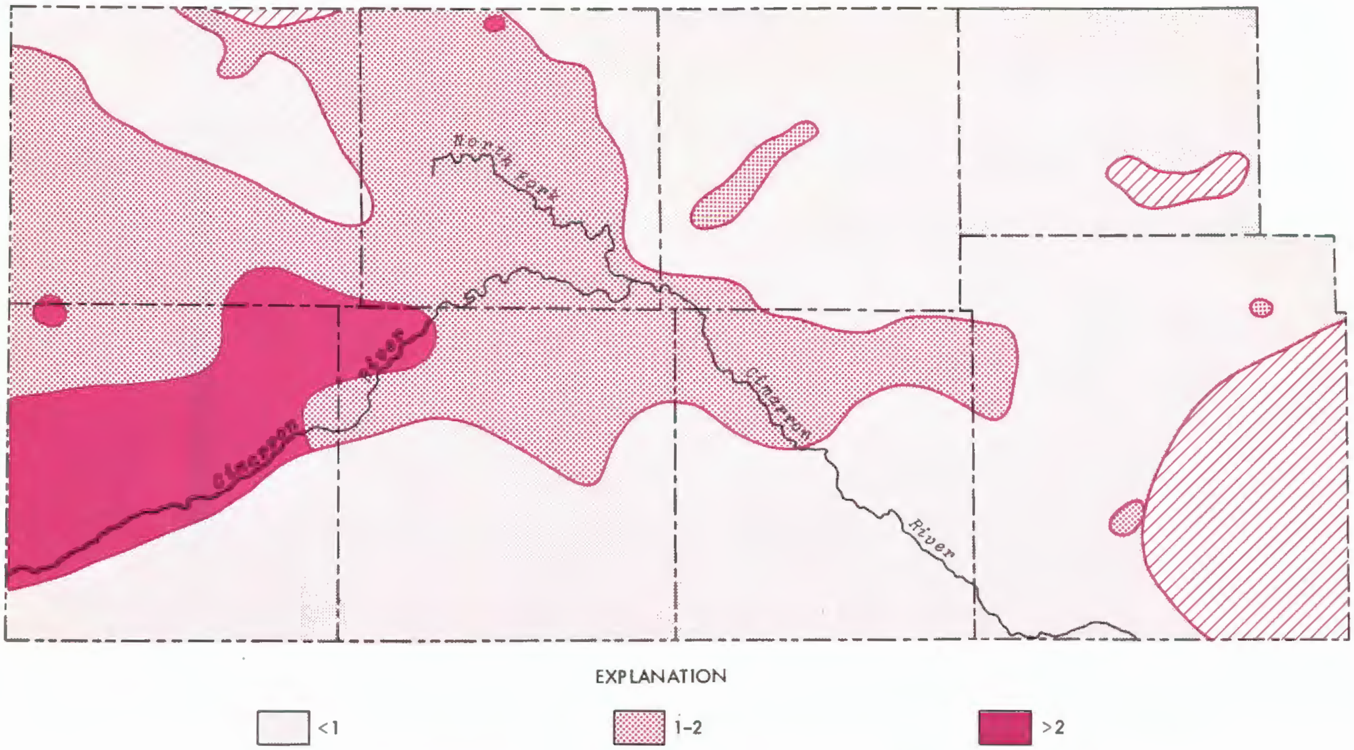


Figure 8. Map of concentration levels of fluoride (ppm).

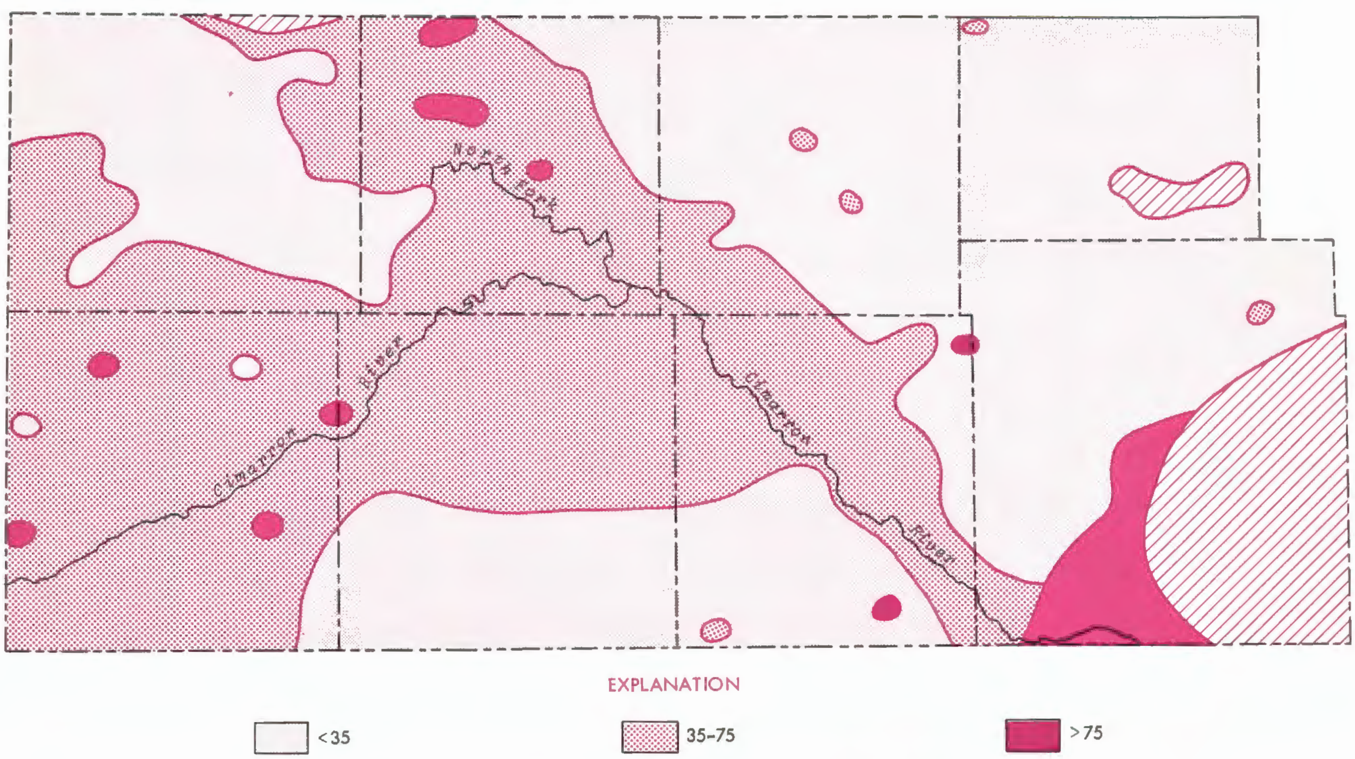


Figure 9. Map of concentration levels of sodium (ppm).

values in the Lakin draw-Bear Creek area may be related to accumulation of dissolved solids in shallow depressions in this region.

Areal distributions of SO_4, F, Na, and Cl are shown in Figures 7, 8, 9, and 10, respectively. Using the physiographic divisions of Smith (1940), one relatively common feature of these maps is the higher values found for waters associated with the Stanton and Cimarron Valley areas compared to waters from the Finney sand plain, Haskell, and south-central Cimarron Bend areas. Mg, Sr, and K all exhibit distribution patterns similar to that of SO_4. Both Na and Cl reach the highest levels of the study area in the Odee and southern Meade (below the City of Meade) areas. The higher Na-Cl levels of this area have been attributed to an upward movement of highly mineralized water from the Permian bedrock of this area (Gutentag, Lobmeyer and Slagle, in prep.). Measurements made near the Cimarron River in this area indicate the hydrostatic head in the Permian bedrock is greater than that for the overlying unconsolidated sediments (Gutentag, personal communication). Nitrate values in excess of 30 ppm are found in the area of the Bear Creek depression (McLaughlin, 1946) in northeastern Stanton and northwestern Grant counties. Minimum, maximum, and mean concentration levels of the major constituents, total dissolved solids, and specific conductance values are listed in Table 3.

Figure 11 is an areal display of Stiff diagrams (Stiff, 1951) for selected wells from the study area. This figure serves to illustrate the diversity in chemical character of groundwaters from this region as well as indicating the relative amounts of dissolved solids in these waters. These diagrams reflect the milliequivalents per liter levels, or relative combining capacities, of selected chemical species in these waters.

Table 3

Summary of Ranges and Means
for Chemical Quality Data

Variable	Min/Max Mean	Variable	Min/Max Mean
Ca	31/387 62	Cl	<1.0/445 22
Mg	5.6/77 20	F	0.3/3.5 1.0
Na	7.9/317 36	NO_3	0.4/84 14
K	2.1/9.4 4.1	SiO_2	12/43 23
Sr	.4/10 1.2	Total Dissolved Solids	164/2112 380
HCO_3	151/323 204	Specific Conductance	280/2400 609
SO_4	13/1344 109		

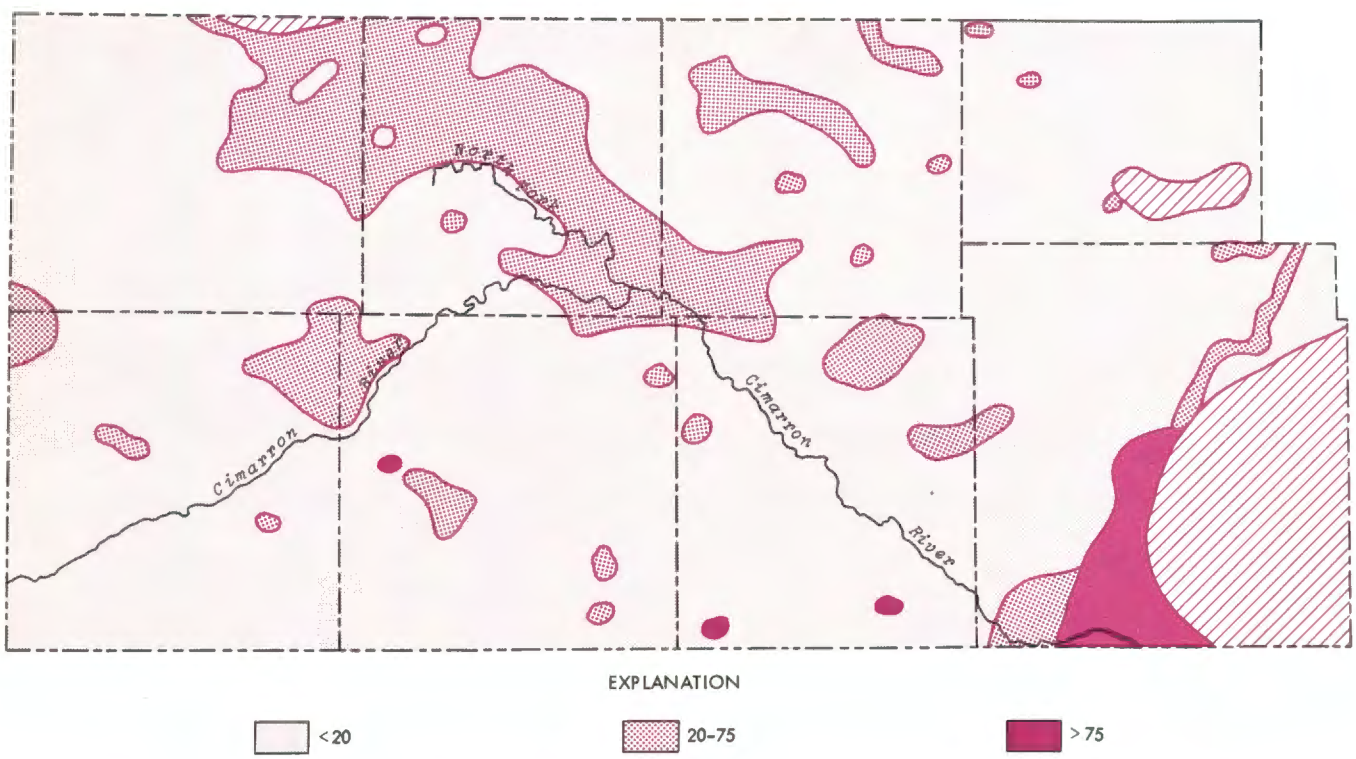


Figure 10. Map of concentration levels of chloride (ppm).

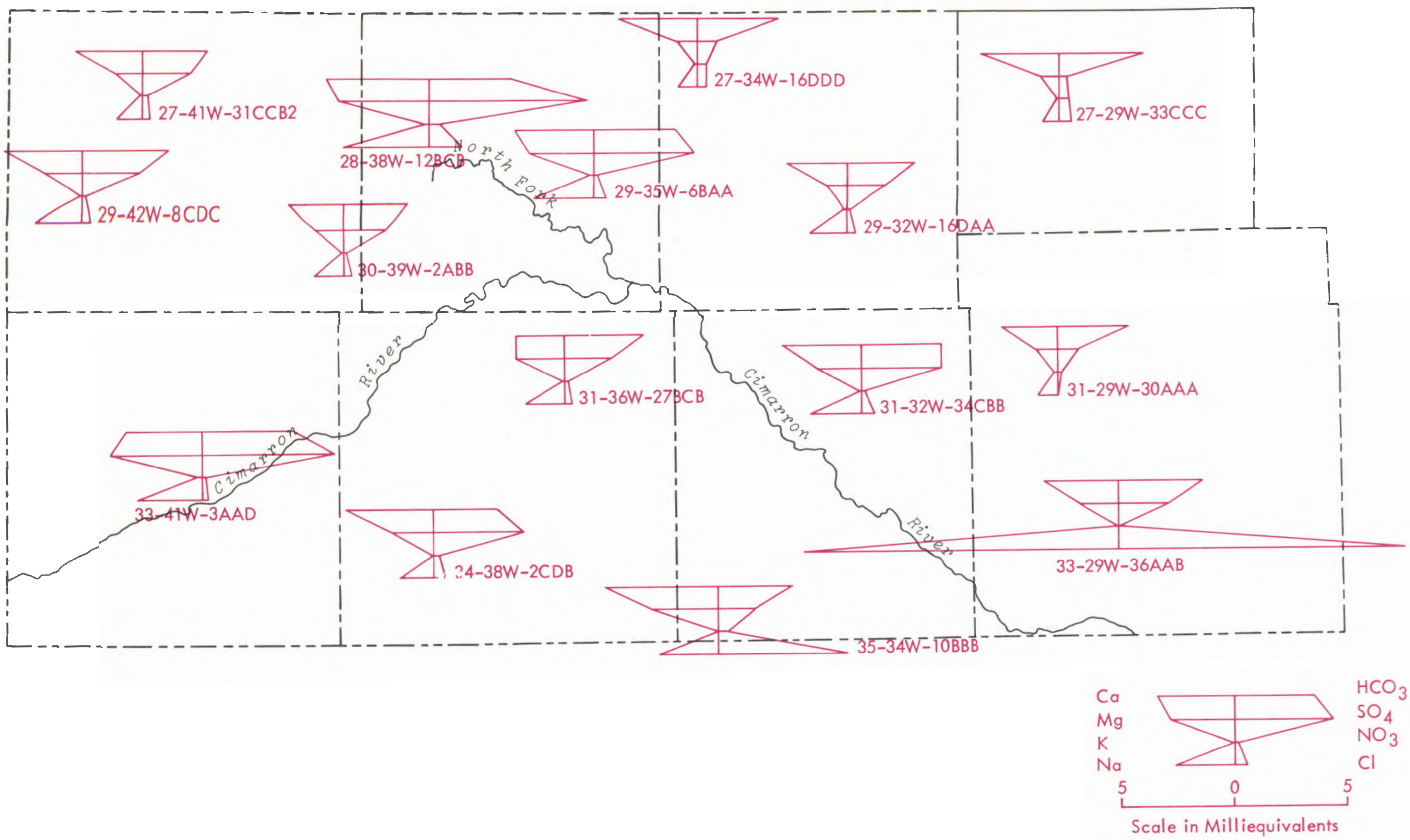


Figure 11. Areal display of Stiff diagrams for selected wells from the study area. Diagrams are centered on their well locations.

Figures 12 and 13 represent areal groundwater classifications by cation and anion types, respectively. Water-type classifications used in this report are based upon percent milliequivalent contributions of the various chemical species to the total number of milliequivalents of cations or anions. Areas of no control in Figures 12 and 13 reflect regions where the sample density is too low to allow extension of water-type boundaries. Table 4 provides a set of constants which can be used to convert data from parts per million to milliequivalents per liter.

Water from well 33-29W-36AAB, Meade County, (Figure 11) exhibits a strong NaCl component and lies within the domain of Na-Cl type waters of Figures 12 and 13. The water chemistry of this well is consistant with the notion of an upward movement of mineralized water from the Permian

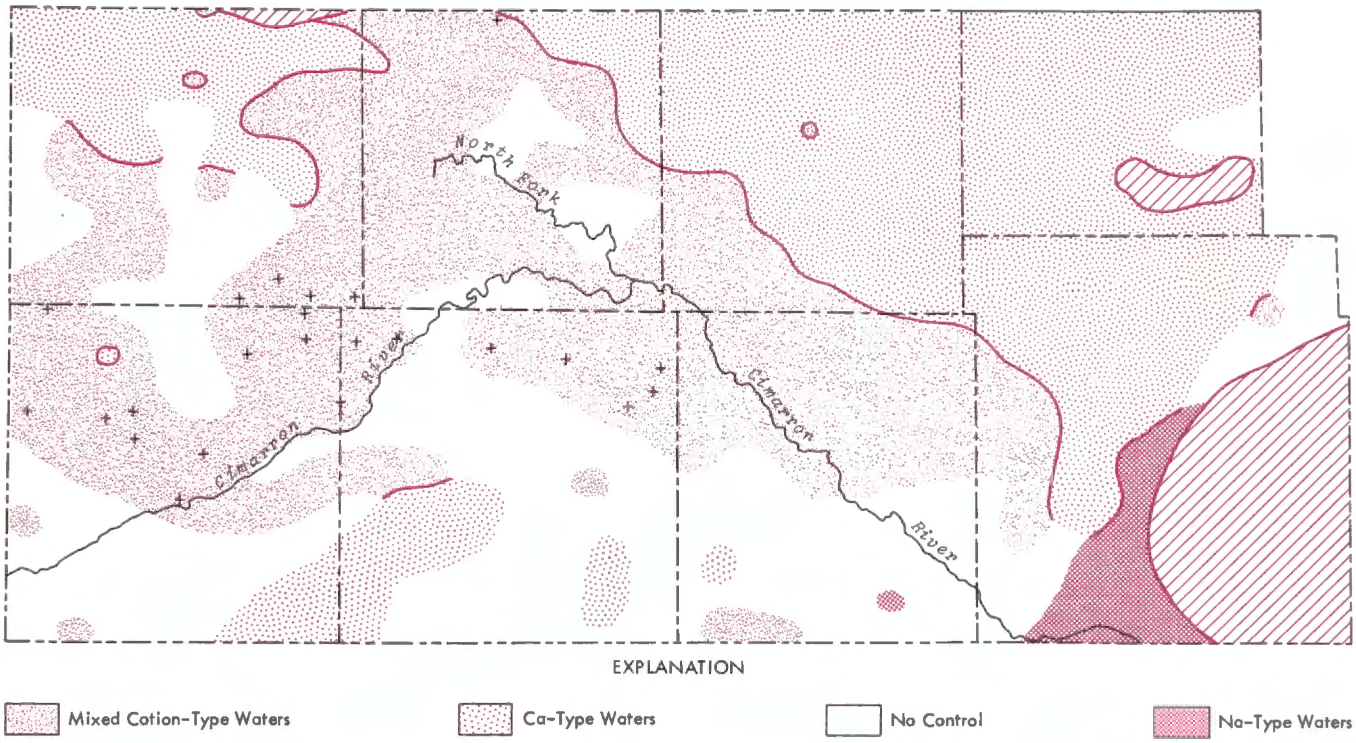


Figure 12. Groundwater classification by cation type (waters must have $\geq$ 50% of the cation milliequvalent abundance to qualify as Na or Ca types).

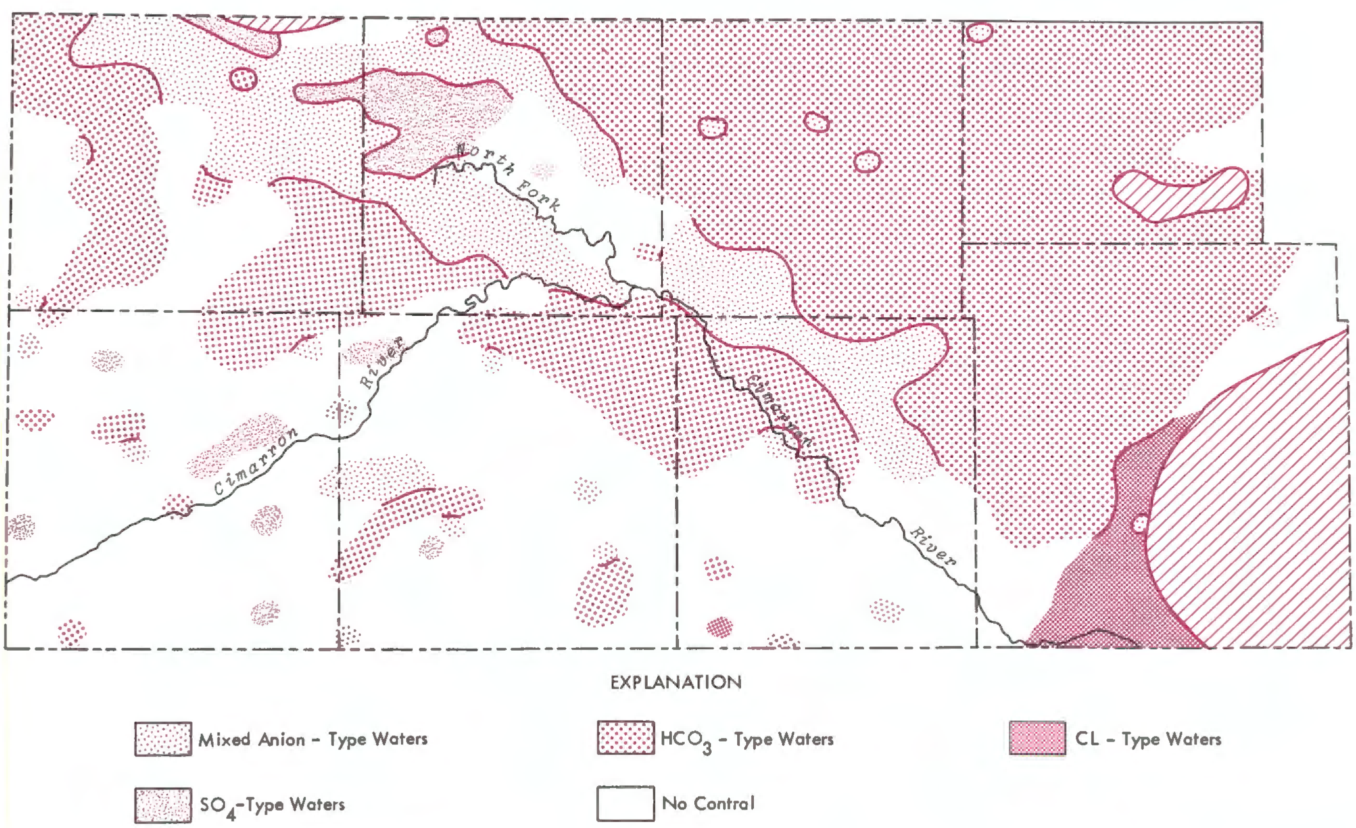


Figure 13. Groundwater classification by anion type (waters must have $\geq$ 50% of the anion milliequivalent abundance to qualify as SO_4, HCO_3, or Cl types).

Table 4

Factors for Conversion from Parts Per Million to Milliequivalents Per Liter

Species	Multiply by
Calcium (Ca)	0.04990
Magnesium (Mg)	0.08226
Sodium (Na)	0.04350
Potassium (K)	0.02557
Strontium (Sr)	0.02283
Bicarbonate (HCO_3)	0.01639
Sulfate (SO_4)	0.02082
Chloride (Cl)	0.02821
Fluoride (F)	0.05264
Nitrate (NO_3)	0.01613

bedrock and resultant deterioration of the water quality of groundwater in the unconsolidated sediments.

Well 35-34W-10BBB, Seward County, (Figure 11) produces water which approaches a Ca-Cl type. This water type is atypical when compared to other irrigation waters in the study area and suggests the possibility of intermixing of a Ca-Cl type brine with groundwater from the unconsolidated sediments in this region. Historical data for this well indicate a Ca-Mg-HCO_3 water type for a sample collected in 1966, but approaching the Ca-Cl water type for a sample collected in 1974. The 1974 data are also in good general agreement with data from the 1976 collections covered by this report.

The Stiff diagrams for wells 31-29W-30AAA (Meade County), 27-29W-33CCC (Gray County), 27-34W-16DDD (Haskell County), and 29-32W-16DAA (Haskell County) are typical patterns for the Ca-HCO_3 type waters found in the northeast quadrant of the study area.

The pattern of the cation portion of the Stiff diagram for well 33-41W-3ADD (Morton County) typifies the general pattern found for a band extending from northern Morton and southern Stanton counties into northern Stevens County (see Figure 12) and a single well in north-central Grant County where the milliequivalent ratio Mg/Ca > 1. Waters of this type could arise from loss of Ca by $CaCO_3$ precipitation from saturated solutions or from differential leaching of Mg and Ca from calcareous deposits in the subsurface. Preliminary calculations suggest all of these waters are saturated with respect to calcite. About 70% of the wells in this band have HCO_3-type waters and a number of these waters also exhibit F levels in excess of 2 ppm.

Figure 12 also shows that the area surrounding the Cimarron River and its tributaries in the western half of the study area is dominated by mixed cation type waters. Sulfate waters are found to be restricted to the western half of the study area (Figure 13), with the largest continuous area of occurrence being in the region between Bear Creek, the North Fork of the Cimarron and Lakin draw. An area of mixed anion type waters extends southeastward from south of the Bear Creek area in northern Stanton County to north of the Cimarron River in Seward County. The variability of anion type and low sample density in the southwestern quadrant and related areas of Figure 13 testify to the need for additional sampling in this area in order to better understand the water chemistry of groundwaters from the region.

A map of values of the sodium adsorption ratio (SAR) for groundwaters from the study area is presented in Figure 14. SAR values are computed using the equation

$$SAR = \frac{(Na)}{\sqrt{\frac{(Ca) + (Mg)}{2}}}$$

where values in parentheses are milliequivalents per liter of the specified ions. SAR values in excess of 3.0 are prominent in the region of Na-Cl type waters in Meade County. Water from well 35-29W-36ABB (Figure 11) has a SAR value of 8.7 and surface water samples from the Cimarron River and Crooked Creek within this part of Meade County exhibit values on the order of 11 and 18, respectively.

Specific conductance data (Figure 6) and SAR data (Figure 14) can be used with the aid of Figure 15 to evaluate the general suitability of waters for irrigation purposes. Groundwaters in the study area, with the exception of the Na-Cl type zone in Meade County, generally fall into the medium to high salinity hazard ranges and low alkali hazard range. Groundwaters from well 33-29W-36AAB in the Na-Cl type zone in

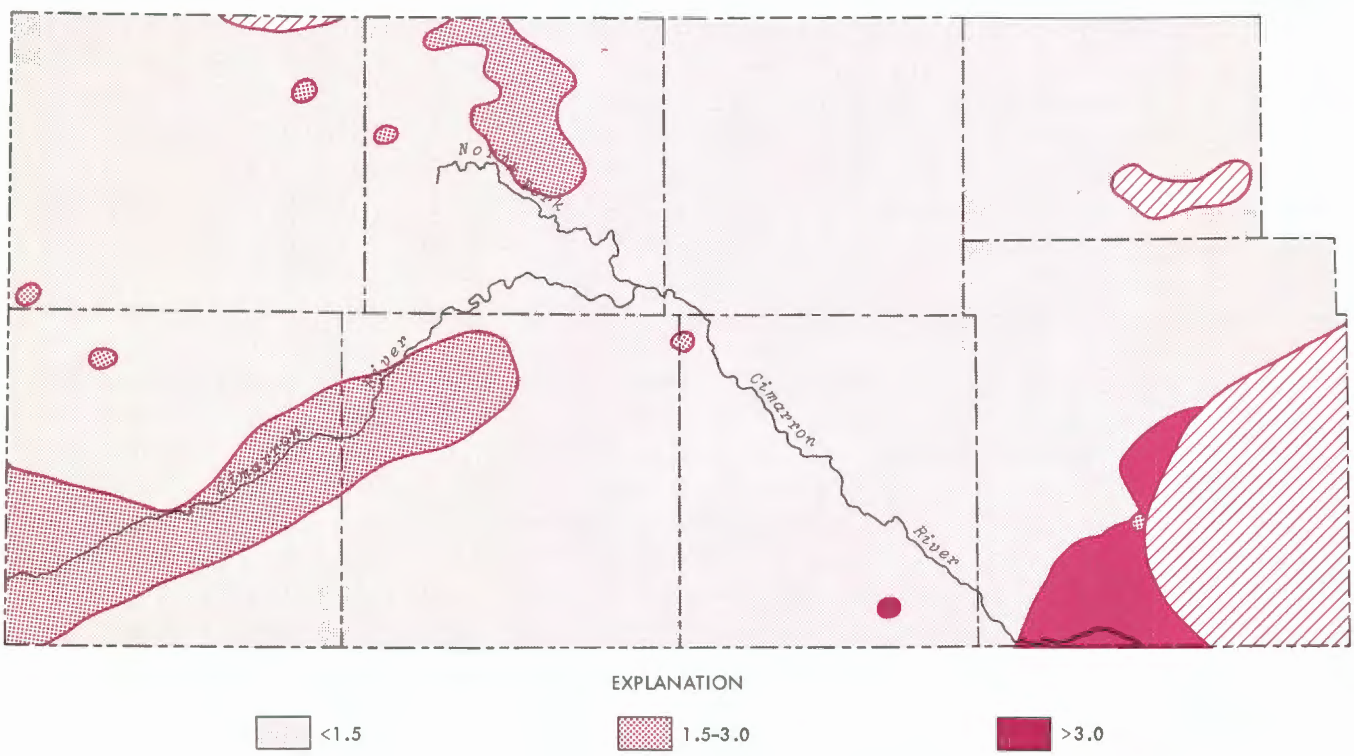


Figure 14. Map of values for sodium adsorption ratio for the study area.

Meade County falls in the high salinity-medium alkali hazard category. Therefore, it is extremely important to monitor the chemical quality of irrigation waters derived from and around the Na-Cl type zone in Meade County. Considering the relatively few data points used here to locate the general boundary of the Na-Cl type waters and the apparent artesian character of Permian mineralized waters in this area, a program to better define the limits of the zone for Na-Cl type waters in the unconsolidated sediments and potential effects upon the chemical quality by the mining of groundwater in this area seems warranted.

In conclusion, it should be noted that correlations of water quality with parameters such as surface and bedrock topography, depth to water, and soil type have not been treated in any great detail in the foregoing discussion. For the most part, these relationships in the present study area are generally more subtle than those noted in the two previous studies (Hathaway, et al., 1975, 1977). Computer analysis may aid in the evaluation of these and other aspects of the system. Another largely unknown quantity is the long-term effect of the extensive oil and gas development in the study area upon groundwater quality. Lack of a satisfactory uniform histo-

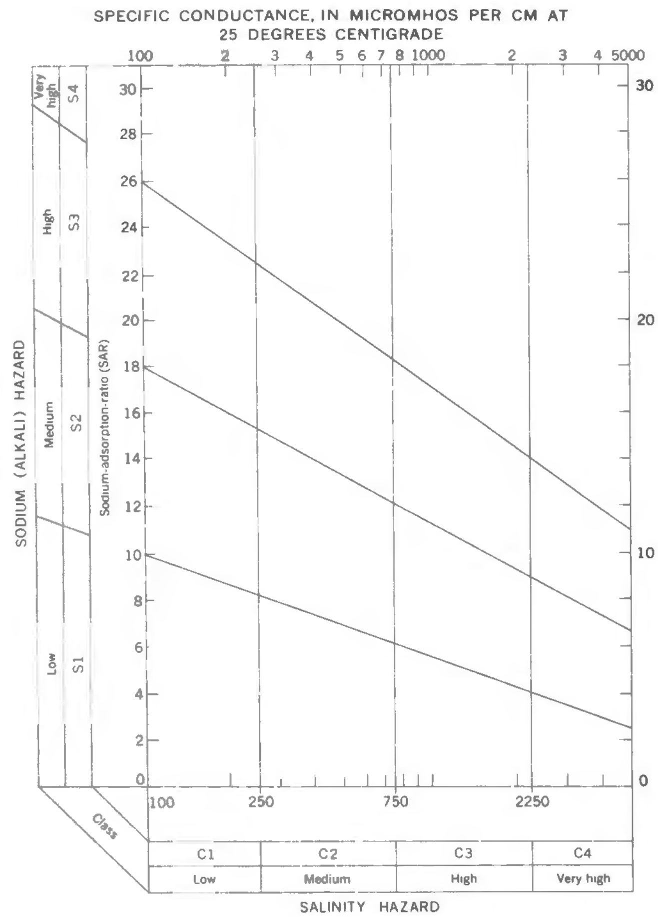


Figure 15. Diagram showing the relationship between specific conductance and the sodium adsorption ratio in evaluation of salinity and alkali hazards for irrigation waters.

rical data base for groundwater in the area and the general unavailability of data related to chemistries of subsurface brines from the producing horizons make assessment of this last consideration extremely difficult for the southwestern portion of the state.

ACKNOWLEDGMENTS

The services of personnel from the U.S.G.S. office in Garden City, Kansas, in the collection of the water samples; and A. M. Diaz of the U.S.G.S. office in Lawrence, Kansas, in the operation of the field laboratory are gratefully acknowledged. A special note of appreciation is also due Dr. W. Kirk, President, and Mr. W. G. Bolton, Natural Science Division, of Seward County Community College for making laboratory facilities available during the sampling program.

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APPENDIX

Chemical Quality Data

Finney County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm	PO_4** ppm
26-31-23CAD	Qu		21	57	9.0	24	3.3	.6	218	34	5.9	.5	22	
26-31-31CDC	Qu,TO	a	24	66	9.1	24	3.2	.6	209	46	19	.4	21	
26-31-36CAC	Qu,TO	a	19	52	8.1	20	3.0	.5	198	37	3.9	.5	13	
26-32-22ABB	Qu,TO	a	22	80	11	25	3.9	.7	213	57	34	.4	20	
26-32-35CDA	Qu,TO	a	22	71	9.0	20	3.6	.6	201	38	27	.4	21	
26-33-26ABB	Qu,TO	a	22	48	6.7	12	2.7	.5	181	15	1.4	.5	9.7	
26-34-24BDB	Qu		23	48	5.6	8.4	2.6	.4	171	13	1.0	.4	12	

Grant County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm	PO_4** ppm
27-35-17ADD	Qu,TO	a	15	46	5.7	9.4	2.2	.5	151	24	7.0	.4	6.6	
27-36-15DDD	Qu,TO	a	13	52	13	27	3.1	1.0	208	55	14	.8	9.1	
27-36-18DCB	Qu,TO	a	22	67	32	64	4.8	2.0	271	167	19	1.8	25	
27-36-26DDC	Qu,TO		17	66	29	58	4.5	1.8	255	159	16	1.4	21	
27-37-4ABB	Qu,TO	a	28	88	46	94	7.7	2.2	298	278	37	1.6	39	
27-37-11ABA	Qu,TO	a,b	32	39	26	51	5.0	1.3	244	94	9.4	2.1	12	
27-37-22BBB	Qu,TO,KJ	a	33	79	33	39	5.2	1.9	249	174	16	1.2	21	
27-37-29CBB	Qu,TO	a	29	84	32	54	4.8	2.1	224	177	44	1.4	37	
27-38-12ADC	Qu,TO		39	101	57	82	8.0	2.6	282	376	14	1.2	49	
27-38-22CCA	Qu,TO		28	87	29	46	5.3	1.8	243	160	22	1.1	49	
27-38-25BBB	Qu,TO	a	27	91	33	54	4.8	2.2	198	231	32	1.2	49	
27-38-29CCB	Qu,TO		32	101	35	43	5.2	2.3	200	253	38	1.1	35	
28-35-15CBB	Qu,TO		18	58	16	23	3.3	1.0	240	37	11	.6	20	
28-35-26ADA	Qu,TO		18	44	12	21	2.9	.8	191	34	3.4	.8	14	
28-35-36ABC	Qu,TO		20	50	14	21	3.1	.9	194	45	11	.6	15	
28-36-2CDD2	Qu,TO,KJ		24	88	34	579	5.3	2.2	231	214	38	1.2	20	
28-37-2BBB3	Qu,TO,KJ		30	82	35	52	4.7	2.4	217	227	25	1.3	14	
28-37-10BCD2	Qu,TO		33	82	44	76	5.4	2.8	220	290	39	1.6	15	
28-37-30BBD	Qu,TO		28	73	40	56	5.4	2.4	200	244	27	1.9	14	
28-38-8BBB	Qu,TO		32	81	43	59	4.9	2.8	193	270	44	1.8	17	
28-38-12BCB	Qu,TO		32	90	49	86	5.2	3.1	214	336	50	1.9	22	
28-38-20DCB	Qu,TO		14	50	22	63	4.7	1.5	188	164	17	1.2	8.2	
28-38-31DBB	Qu,TO		20	96	36	45	5.3	2.2	162	276	38	1.1	16	
29-35-1CCC	Qu,TO		21	59	19	33	3.5	1.1	223	86	11	.6	17	
29-35-6BAA	Qu,TO		43	68	34	59	5.5	2.4	220	213	20	1.3	15	
29-36-4BAA2	Qu,TO	b	32	49	24	96	4.9	1.7	209	223	26	1.2	7.3	
29-36-19BCB	Qu,TO		22	62	28	40	5.1	1.9	200	160	16	1.3	21	
29-37-8CBA	Qu,TO		23	56	26	35	4.4	1.6	186	144	12	1.4	11	
29-37-22AAB	Qu,TO		23	60	28	38	4.7	1.9	187	167	16	1.3	11	
29-37-29BBD	Qu,TO		27	60	22	42	5.1	1.5	193	136	25	1.1	10	
29-38-3BAA	Qu,TO		23	69	29	41	4.6	1.9	176	189	26	1.3	13	
29-38-20CDC	Qu,TO,KJ		22	51	17	31	3.9	1.1	177	91	11	1.0	9.4	
29-38-22BBB	Qu		20	53	20	34	4.2	1.3	182	118	12	1.2	11	
30-35-2DBC	Qu,TO		28	59	24	42	5.5	1.6	214	127	21	.9	12	
30-35-19BCD	Qu,TO		24	68	31	55	5.7	1.9	220	181	26	1.2	12	
30-36-4ABB	Qu,TO,KJ		26	56	23	44	4.7	1.7	186	151	14	1.2	11	
30-36-6BBC	Qu,TO		23	61	27	38	4.9	1.9	193	149	19	1.2	11	
30-36-7AAB	Qu,TO		26	67	31	36	5.4	2.2	184	155	43	1.4	14	
30-36-16DAB	Qu,TO		25	68	29	44	5.3	2.0	220	160	24	1.2	12	
30-37-2BAA2	Qu,TO		25	62	25	40	5.1	1.7	198	148	18	1.2	11	
30-37-3DBA	Qu,TO,KJ		26	56	23	46	4.9	1.6	190	150	12	1.1	12	
30-37-6DCC	Qu,TO		24	57	22	42	4.6	1.3	200	131	13	1.2	10	
30-37-10DCB	Qu,TO		21	53	23	37	4.8	1.5	198	112	16	1.2	11	.3
30-38-2CBB	Qu,TO		19	53	19	39	4.4	1.2	190	120	12	1.0	11	
30-38-3DCC	Qu,TO		15	54	18	36	3.9	1.1	187	105	16	1.0	11	
30-38-13CCC	Qu,TO,KJ	b	19	52	21	47	4.2	1.2	203	128	12	1.0	8.9	
30-38-15DBC	Qu		17	49	18	40	3.8	1.1	192	110	10	1.0	7.7	
30-38-30ACA	Qu,TO		17	44	16	32	3.6	1.0	180	74	6.6	1.4	8.8	

* a = 1975 K.G.S. Sampling Program
b = U.S.G.S. data files
** Ortho PO_4 values below 0.1 ppm not listed

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
188	3.0	2.0	1.6	18.0	270	180	1	462	.78	7.7
48	4.7	.8	13	16.5	320	203	32	506	.73	7.6
32	2.0	7.0	1.3	17.0	243	164	1	452	.68	7.7
22	2.8	5.5	10	17.0	356	246	71	580	.69	7.5
11	.7	5.4	10	16.0	306	215	50	510	.59	7.5
31	5.5	1.9	7.1	17.5	200	148	0	340	.43	7.7
7.1	.5	3.7	5.8	17.5	197	143	3	483	.31	7.7

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
11	.4	.7	1.5	18.0	164	139	15	330	.35	7.6
58	8.0	1.9	1.5	21.0	272	184	14	460	.87	7.6
43	4.1	1.6	1.5	19.0	485	301	79	850	1.60	7.5
61	5.9	.7	1.3	18.0	476	286	77	790	1.49	7.6
101	4.0	2.2	1.8	17.5	718	411	167	1160	2.02	7.4
33	4.3	1.6	4.9	19.0	380	206	6	610	1.55	7.9
113	5.9	1.1	2.6	17.5	507	335	131	820	.93	7.5
16	6.4	.9	2.2	17.5	573	344	160	900	1.27	7.6
24	3.3	2.8	2.2	17.0	805	489	258	1240	1.61	7.5
4.3	.3	1.3	3.9	16.5	538	338	139	940	1.09	7.6
40	5.1	17	4.4	18.0	611	365	203	940	1.23	7.5
8.6	.4	1.0	5.0	17.5	642	399	235	940	.94	7.6
49	3.1	3.3	.9	20.0	293	212	15	520	.69	7.5
--	4.0	.9	3.2	19.0	238	160	4	380	.72	7.5
34	.9	1.6	2.0	19.0	262	183	24	460	.67	7.8
90	3.5	3.2	2.6	19.0	576	362	173	940	1.30	7.3
--	21	2.3	3.9	19.0	557	351	173	880	1.21	7.4
21	.8	1.5	1.5	19.0	674	389	208	1004	1.68	7.4
38	4.0	1.1	2.1	18.0	584	350	186	840	1.30	7.6
55	8.8	39	1.9	18.0	656	382	224	970	1.31	7.5
79	12	4.1	2.1	19.0	773	430	254	1040	1.80	7.4
--	93	1830	17	20.0	437	217	63	660	1.86	7.8
27	1.2	9.1	10	17.5	612	389	257	920	.99	7.8
33	5.0	3.1	1.6	19.0	349	227	44	560	.95	7.8
16	.3	1.6	2.1	19.0	532	312	132	850	1.45	7.8
44	9.2	2.8	1.5	--	539	223	52	848	2.80	7.8
98	7.2	2.2	1.3	--	424	272	108	682	1.05	7.7
28	2.4	1.2	4.3	18.0	396	249	96	600	.97	7.7
12	2.6	8.8	2.0	--	425	267	114	655	1.01	7.7
52	5.8	14	3.2	19.0	414	242	84	640	1.17	7.7
--	4.5	1.6	3.2	18.0	476	294	149	770	1.04	7.8
82	1.0	.9	2.5	18.0	289	198	53	510	.96	7.8
57	7.5	2.3	3.3	18.0	357	216	67	580	1.01	7.7
30	5.4	1.8	6.0	19.0	399	247	72	655	1.16	7.9
146	8.9	3.2	2.3	17.0	490	299	119	830	1.38	7.8
--	6.0	2.2	1.8	--	406	236	84	630	1.25	7.9
10	0.4	31	2.6	--	414	265	107	640	1.01	7.7
42	121	10	1.1	--	438	297	146	735	0.91	7.7
46	18	1.3	1.9	--	454	291	111	718	1.12	7.7
109	2.0	120	3.8	--	411	260	97	645	1.08	7.7
32	2.5	6.9	1.7	--	408	236	80	640	1.30	7.7
--	16	2.7	4.4	18.0	391	234	70	630	1.19	7.6
152	6.2	0.8	1.8	--	365	229	66	585	1.06	7.7
66	12	84	13	25.0	361	212	56	600	1.17	7.7
32	3.3	1.1	3.6	19.0	361	210	57	580	1.08	7.7
57	1.1	0.7	2.1	19.0	387	218	51	640	1.39	7.7
79	8.7	1.8	1.1	19.0	338	198	40	560	1.24	7.7
62	7.4	.9	2.6	18.0	298	175	20	475	1.04	7.8

Gray County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm	PO_4** ppm
26-27-27CDD	Qu,TO	a	23	62	9.4	26	4.6	.5	242	34	9.3	.5	20	
26-28-19ABD	Qu,TO	a	22	56	8.8	21	3.6	.5	208	35	5.8	.5	17	
26-30-24DDD	Qu,TO	a	20	67	10	22	4.1	.6	227	36	16	.5	18	
26-30-28DAA	Qu,TO		19	57	8.6	20	3.5	.6	202	27	6.0	.5	22	
27-27-6BBB	Qu,TO	a	26	64	9.0	19	4.2	.5	220	35	9.6	.5	24	.1
27-27-10CDB	Qu,TO		24	58	8.1	17	3.8	.5	221	23	6.5	.5	12	
27-28-24BBD	Qu,TO		24	59	7.8	20	4.2	.5	224	25	4.7	.5	18	
27-29-9DA	Qu,TO	a	21	68	10	24	4.5	.7	245	26	10	.5	31	
27-29-23ADC	Qu,TO	a	19	57	7.9	18	4.0	.5	208	21	4.9	.5	20	
27-29-33CCC	Qu,TO	a	21	69	9.9	17	3.7	.6	227	15	19	.4	25	
27-29-36ABB	Qu,TO		20	58	7.5	18	3.7	.5	211	17	6.1	.5	20	
27-30-8BBB	Qu,TO	a	22	100	15	35	4.2	.9	229	99	63	.4	22	
27-30-8CBB	Qu,TO		27	60	9.5	22	3.0	.6	200	40	16	.5	15	
27-30-22BLC	Qu,TO		24	59	8.3	19	3.8	.5	208	37	8.4	.5	13	
27-30-25CCB	Qu,TO	a	20	72	10	20	3.5	.7	203	44	28	.4	25	
27-30-34CCC	Qu,TO	a	21	70	10	20	3.4	.7	217	42	15	.4	20	
28-27-4ABB	Qu,TO		26	55	8.3	18	3.4	.5	198	33	6.4	.5	11	
28-28-20ADD2	Qu,TO	b	27	53	10	16	4.1	.6	186	38	11	.6	17	
28-29-16ACC	Qu,TO		25	61	9.9	19	3.4	.7	195	50	14	.5	19	
28-30-6BBA	Qu,TO	a	21	62	8.3	18	3.1	.6	196	39	16	.4	19	
28-30-10DDD	Qu,TO		23	59	8.1	17	3.0	.6	188	25	18	.4	17	
28-30-17BBA	TO	b	22	57	8.3	17	2.8	.5	176	41	18	.4	15	
28-30-24BAB	Qu,TO		23	57	9.2	17	3.2	.5	189	35	16	.4	15	
28-30-31CCB	Qu,TO		23	48	6.8	11	2.6	.5	174	22	5.6	.4	10	
29-27-30BCC	Qu,TO		34	60	14	16	4.1	.8	222	29	16	.6	14	
29-27-36ABA	Qu,TO		33	57	14	10	4.0	.8	242	15	4.6	.7	7.0	
29-28-18CCC	Qu,TO	b	24	66	14	17	4.2	.8	236	27	20	.5	20	
29-28-19DDD	Qu,TO		26	64	13	17	3.9	.7	205	40	19	.5	16	
29-28-28CDC	TO	b	26	57	12	16	3.8	.7	193	35	9.5	.6	15	
29-29-10BBB	TO	b	23	60	11	17	3.4	.6	198	43	18	.5	13	
29-29-27BCB	Qu,TO		25	53	12	15	3.3	.7	208	35	5.0	.5	11	
29-30-22BBC	Qu,TO		24	46	8.2	16	2.7	.6	180	28	4.5	.5	11	
29-30-35ACD	Qu,TO		23	47	8.5	14	2.8	.6	181	23	6.1	.5	15	

Hamilton County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
26-41-20BBD	Qu,TO	a	28	213	68	95	9.4	4.4	294	628	97	1.1	7.4
26-41-36CC	Qu,TO	a	30	99	38	56	6.2	2.3	222	289	23	1.5	17
26-42-22CDB	Qu,TO	a	16	69	17	23	4.4	1.1	176	116	16	.7	12
26-43-25DCC	Qu,TO,KJ	a	15	65	16	25	4.3	1.1	182	120	8.2	.8	7.0

Haskell County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm	PO_4** ppm
27-31-21BBC	Qu,TO		18	70	9.0	20	3.2	.6	203	45	21	.4	19	
27-31-24CDC	Qu,TO	a	22	66	9.1	17	3.2	.6	200	38	19	.4	18	
27-31-31CBC	Qu,TO		22	56	6.2	11	2.8	.5	171	29	16	.3	9.6	
27-32-6CBB	Qu,TO	a,b	21	46	7.5	17	2.5	.6	172	37	1.5	.6	9.0	
27-32-13ABB	Qu,TO	b	21	77	9.2	22	3.6	.6	238	32	23	.3	25	
27-32-19CCD	Qu,TO	a	23	58	7.3	14	2.7	.5	191	20	13	.4	18	
27-33-27CAD	Qu,TO	a	22	50	8.6	17	3.6	.6	177	30	11	.5	13	.2
27-33-29DAA	Qu,TO	a	21	50	7.4	14	2.5	.6	173	24	6.9	.4	14	
27-33-33DCD	Qu,TO	a	21	57	9.5	22	2.5	.7	173	30	39	.5	14	
27-34-16DDD	Qu,TO	a	22	68	9.3	19	3.0	.7	211	40	15	.3	26	

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
81	5.3	2.2	5.4	15.0	295	194	0	460	.82	7.6
17	3.3	4.3	4.3	16.0	280	177	6	415	.69	7.7
12	.7	3.7	1.7	16.0	288	209	23	450	.66	7.4
26	5	6.0	5.6	17.0	278	180	14	420	.65	7.4
11	.6	2.8	3.0	17.0	281	197	17	460	.59	7.7
164	3.3	1.6	3.8	16.0	252	179	0	405	.55	7.7
7.8	1.0	48	5.3	17.0	266	180	0	430	.65	7.6
46	9.7	3.7	1.7	16.0	339	212	11	470	.72	7.3
46	10	2.2	1.4	16.0	258	175	5	390	.59	7.4
7.2	.3	2.7	1.2	17.0	302	214	28	470	.51	7.4
49	15	13	15	17.0	267	176	3	400	.59	7.4
73	4.7	1.0	2.2	16.0	427	312	125	754	.86	7.5
57	6.5	1.0	3.3	16.0	262	189	25	430	.70	7.6
43	3.7	.6	4.2	16.0	253	184	13	380	.61	7.6
22	1.1	2.4	5.9	16.0	320	222	55	505	.58	7.4
37	1.0	24	.8	16.0	293	217	39	480	.59	7.4
9.9	.9	2.2	3.9	17.0	242	172	10	385	.60	7.7
168	13	5.0	2.1	17.0	272	174	22	405	.53	7.6
46	2.9	22	6.5	16.0	300	194	34	440	.59	7.5
56	1.5	.8	2.0	16.5	283	190	29	450	.57	7.7
137	8.0	.9	7.4	16.0	255	181	27	390	.55	7.7
11	.1	1.6	7.0	17.0	274	177	33	410	.56	7.7
2.0	0.0	.6	3.7	17.0	279	181	26	415	.55	7.6
5.6	.4	.7	3.6	17.0	215	148	6	325	.39	7.7
2.6	0	1.1	3.6	16.5	275	208	26	472	.48	7.6
65	6.6	3.7	7.0	16.0	261	201	2	416	.31	7.6
15	.4	.7	1.1	16.0	320	223	30	530	.50	7.6
36	3.7	.8	1.5	16.0	301	214	46	482	.51	7.7
58	4.4	2.2	2.9	16.0	264	189	20	449	.51	7.6
262	7.0	3.1	3.4	15.0	280	196	33	445	.53	7.6
19	2.2	2.9	5.3	16.5	267	182	12	419	.48	7.6
26	4.4	1.4	5.6	17.5	231	149	2	350	.57	7.9
53	4.2	2.2	5.2	18.0	223	153	5	367	.49	7.7

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
773	35	1.2	6.6	16.0	1194	816	575	1700	1.45	7.4
80	3.7	1.2	2.5	17.0	659	406	224	980	1.21	7.4
14	1.8	4.6	3.3	17.5	348	243	99	590	.64	7.5
7.1	.2	6.5	4.8	18.0	360	229	80	560	.72	7.6

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
7.6	.1	1.2	1.6	24.0	316	212	46	480	.60	7.5
21	3.7	11	3.3	17.0	291	202	38	471	.52	7.6
54	4.6	3.6	2.4	17.0	243	166	26	377	.37	7.8
15	2.5	1.0	6.6	18.5	229	146	5	345	.61	7.7
--	6.3	25	2.5	17.0	316	231	36	534	.63	7.5
21	2.3	1.0	5.0	17.5	265	175	19	412	.46	7.7
374	61	1.5	7.1	22.0	227	161	16	367	.58	8.2
54	5.8	1.7	5.6	18.0	235	156	14	388	.49	7.7
26	5.5	1.9	1.7	19.0	281	182	40	455	.71	7.7
28	2.4	1.9	1.2	18.0	313	209	36	479	.57	7.6

Haskell County (cont.)

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
27-34-28DAA	Qu,TO	a	20	64	15	20	3.0	.9	175	56	34	.6	24
28-31-32ABB	Qu,TO		22	48	6.1	13	2.6	.5	172	19	5.1	.3	10
28-31-35CCB	Qu,TO		23	58	7.7	13	3.0	.6	177	26	22	.4	13
28-32-9CCC	Qu,TO		23	61	9.1	15	2.8	.7	163	33	40	.4	14
28-32-18BBB2	Qu,TO	b	23	80	12	21	3.3	.8	178	64	50	.4	24
28-32-35BBA	Qu,TO		24	66	12	27	3.0	.8	172	32	73	.4	12
28-33-21BCC	Qu,TO		20	45	8.8	19	2.9	.7	180	34	3.8	.8	13
28-33-24DBC	Qu,TO		35	41	8.6	38	3.6	.7	183	65	4.1	1.0	8.8
28-34-15DAB	Qu,TO	b	22	61	14	30	3.5	.9	175	66	44	.9	17
28-34-32ADD	Qu,TO		20	43	12	20	2.9	.8	194	36	3.3	.8	14
29-31-9CB	Qu,TO		25	50	7.6	16	2.7	.6	177	27	7.4	.4	12
29-31-14BBB	Qu,TO	b	27	52	8.0	15	2.8	.5	181	28	11	.4	12
29-31-34BCA	Qu,TO		23	53	10	21	3.0	.7	182	41	18	.5	13
29-32-4BCC	Qu,TO	b	17	49	10	30	2.9	.8	194	60	5.8	.5	2.3
29-32-16DAA	Qu,TO		25	53	10	36	3.2	.8	181	81	9.8	.6	7.2
29-32-19CC	Qu,TO		24	48	12	29	3.3	.8	190	55	9.6	.8	6.2
29-33-1AAB	Qu,TO		24	49	9.5	22	2.9	.6	179	39	9.6	.6	11
29-33-5ACA	Qu,TO		18	44	11	24	3.2	.8	191	45	5.5	1.1	6.5
29-33-11BBC	Qu,TO		20	58	13	28	3.4	.9	203	67	21	.7	9.5
29-33-28BCB	Qu,TO		19	43	11	22	3.4	.7	187	38	5.2	.9	5.6
29-34-2ABB	Qu,TO		20	50	15	24	3.2	.8	196	51	14	.8	15
29-34-9CBB	Qu,TO		19	58	18	31	3.5	1.1	201	87	19	.7	16
29-34-11ADD	Qu,TO		21	49	14	29	3.2	.8	200	60	9.7	.9	12
29-34-24BCC	Qu,TO		21	47	15	38	3.3	.9	204	82	8.5	1.0	8.5
29-34-36CBC	Qu,TO		20	52	16	33	3.4	.9	212	79	8.8	.9	12
30-31-6BBB	Qu,TO		21	49	10	23	3.2	.7	177	50	13	.6	11
30-31-15ABB	Qu,TO		21	51	12	21	3.6	.8	194	44	13	.6	8.4
30-31-24BBB	Qu,TO		20	49	12	20	3.5	.7	186	43	12	.7	8.9
30-31-33BBB	Qu,TO		21	47	12	26	3.8	.8	188	60	7.8	.8	7.6
30-32-11BBB	Qu,TO		21	54	12	25	3.6	.8	179	57	26	.7	12
30-32-17BCC	Qu,TO		18	47	12	269	3.5	.7	191	56	6.5	.8	5.8
30-32-31BAB	Qu,TO		21	57	17	35	3.8	1.0	215	87	12	1.0	14
30-33-2AAB	Qu,TO		20	49	13	28	3.3	.8	190	57	20	.9	8.0
30-33-6DBD	Qu,TO		22	66	20	39	4.0	1.2	195	103	42	.9	19
30-33-30CBD	Qu,TO	b	23	68	26	49	4.9	1.6	212	168	23	1.1	15
30-34-5BBB	Qu,TO		22	77	30	51	5.0	1.8	197	175	51	.9	17
30-34-16BBB	Qu,TO		24	67	25	50	4.7	1.6	200	166	26	.9	13

Kearny County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
26-35-31DCA	Qu,TO	a	21	47	6.0	10	2.3	.5	172	20	1.7	.3	8.2
26-36-16DDB	Qu,TO		16	43	6.0	7.9	2.1	.4	155	17	1.0	.5	12
26-37-22CCA	Qu,TO		21	47	14	19	3.4	1.0	212	25	4.3	.9	8.7
26-37-26DBC	Qu,TO	a	22	44	12	14	2.9	.8	199	26	2.5	.8	6.7

Meade County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm	PO_4** ppm
30-26-4CBB	Qu,TO		27	56	13	16	3.7	.8	229	28	6.9	.9	6.8	.1
30-26-7BBB	Qu,TO		24	83	21	23	4.5	1.2	242	86	35	.7	13	
30-26-17BBC	Qu,TO		22	54	13	18	3.6	.8	222	42	6.6	.8	4.4	
30-26-31CBC	Qu,TO		32	72	32	45	7.0	2.6	222	156	42	1.4	12	
30-27-4DBD	Qu,TO		22	77	21	21	4.3	1.2	215	99	30	.7	14	
30-27-23ABB	Qu,TO	b	22	54	13	19	3.6	.8	193	49	12	.7	9.0	
30-28-2BAA	Qu,TO		24	52	11	16	3.9	.7	204	30	9.4	.6	13	
30-28-17ABB	Qu,TO	b	17	51	12	14	3.6	.8	198	26	14	.7	12	
30-29-3DCC	Qu,TO		22	47	9.6	13	3.1	.6	184	27	4.4	.5	14	
30-29-23CAD	Qu,TO		17	44	9.1	15	3.1	.7	180	18	4.7	.6	14	

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
187	12	3.1	5.1	18.5	306	222	82	520	.58	7.8
28	2.6	2.7	2.1	17.5	205	145	5	345	.47	7.7
3.0	1.4	2.6	2.7	17.5	233	177	32	354	.42	7.7
167	5.2	1.6	1.7	17.5	280	190	57	460	.47	7.6
22	0.0	1.2	6.6	17.5	392	250	104	604	.58	7.6
92	5.3	9.7	2.4	19.0	316	215	74	555	.80	7.9
27	2.4	1.0	6.2	19.0	240	149	2	366	.68	7.8
22	.3	.6	1.9	22.5	296	139	0	414	1.40	7.8
30	4.2	.7	.7	19.0	357	211	67	555	.90	7.7
13	.4	1.4	2.5	18.5	236	158	0	394	.69	7.8
21	.9	1.3	2.2	17.0	218	157	12	377	.56	7.5
37	2.4	1.0	3.7	17.5	229	163	15	391	.51	7.6
--	12	1.8	3.6	17.5	264	174	25	431	.69	7.7
56	30	8.6	1.1	19.0	262	164	5	444	1.02	7.8
52	4.2	2.0	.7	19.0	305	174	26	488	1.19	7.7
--	4.2	1.9	1.0	18.5	255	170	14	452	.97	7.8
61	4.8	1.1	1.2	18.5	255	162	15	412	.75	7.7
45	5.7	1.8	7.5	19.0	245	156	0	394	.84	7.8
169	4.9	2.6	1.5	19.0	324	199	33	510	.86	7.6
7.6	.1	1.2	.7	18.0	200	153	0	393	.77	7.7
27	2.9	1.4	16	18.5	274	187	27	486	.76	7.9
107	10	3.9	2.3	19.0	347	220	55	570	.91	7.8
--	8.5	2.6	4.3	19.0	263	181	17	470	.94	7.9
69	12	3.2	7.4	19.0	311	180	13	520	1.23	7.9
90	2.3	6.6	3.6	19.0	337	197	23	520	1.02	7.8
24	3.1	2.5	.8	18.0	259	164	19	428	.78	7.7
63	11	3.9	1.0	17.5	270	178	19	437	.69	7.8
33	4.3	1.8	6.5	17.5	253	173	21	419	.67	7.7
14	4.1	1.5	7.4	18.0	267	168	14	440	.88	7.7
592	15	3.6	2.9	18.0	291	185	38	484	.80	7.7
86	10	3.8	1.8	18.0	278	167	11	445	.87	7.7
--	9.4	1.9	7.1	18.0	349	212	37	554	1.05	7.7
34	1.1	2.4	2.6	19.0	297	177	21	477	.92	7.8
30	.6	1.5	3.7	19.0	388	248	89	666	1.08	7.9
20	7.6	1.4	9.5	21.5	471	277	104	723	1.28	7.8
27	1.8	1.0	2.0	19.5	524	317	155	800	1.25	7.8
51	2.5	1.3	2.0	19.5	468	272	108	737	1.32	7.8

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
11	4.5	1.6	2.1	18.0	186	142	1	310	.37	7.6
41	2.6	2.5	1.8	17.0	171	131	5	280	.30	7.7
129	4.2	1.8	1.8	17.0	243	176	3	440	.61	7.5
35	3.9	.9	1.7	18.0	220	160	0	350	.48	7.7

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
47	3.4	2.1	2.2	15.0	274	194	6	480	.50	7.7
--	6.5	3.8	2.6	15.0	420	295	97	675	.58	7.5
--	9.4	19	1.7	15.0	276	189	7	450	.57	7.6
17	5.7	1.8	1.9	18.0	511	314	132	750	1.10	7.6
62	3.8	1.3	2.9	15.0	393	280	104	650	.55	7.7
41	.8	1.3	3.1	16.0	276	189	31	475	.60	7.6
16	6.0	2.1	2.2	16.0	250	176	9	425	.52	7.7
43	.9	2.0	5.0	15.5	241	178	15	410	.46	7.8
22	5.7	2.1	1.4	16.5	222	158	6	389	.46	7.8
48	5.4	3.0	9.1	16.0	229	148	1	380	.54	7.6

Meade County (concl.)

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
30-29-28BBB	Qu,TO	b	19	42	9.0	18	3.2	.6	182	25	3.1	.6	12
30-30-12CBB	Qu,TO	b	17	45	9.0	18	3.0	.6	182	28	6.6	.6	13
30-30-28ABB	Qu,TO		21	46	10	21	3.2	.6	182	40	8.8	.8	10
31-28-10BCB	Qu,TO		18	54	11	13	3.2	.8	203	23	12	.7	15
31-29-25AAA2	Qu,TO		18	43	9.4	16	3.3	.7	186	22	2.8	.7	11
31-29-30AAA	Qu,TO		26	48	11	20	4.0	.8	192	43	<1.0	.7	7.3
31-30-16BBC	Qu,TO		23	45	11	22	3.8	.7	190	41	6.3	1.0	8.0
32-29-5CC	Qu,TO	b	25	52	12	21	4.0	.8	192	50	8.7	.8	8.5
32-30-9CCC	Qu,TO		19	49	16	28	4.2	1.1	190	66	22	1.0	11
32-30-28BBC	Qu,TO		26	50	15	31	4.3	1.0	196	69	15	.9	8.9
32-30-35CAA	Qu,TO		30	49	16	31	4.2	1.1	197	73	13	.9	9.8
33-28-29BC	TO	b	30	54	17	95	3.7	1.2	213	60	118	1.0	5.0
33-29-36AAB	Qu,TO		27	66	21	317	4.4	1.4	226	108	445	1.0	5.0
33-30-35CB	Qu,TO		24	52	16	31	4.5	1.0	201	74	11	.9	7.7

Morton County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
31-39-18CCC	Qu,TO		26	63	41	49	5.4	2.1	210	192	37	2.6	12
31-40-1DA	Qu,TO		27	41	26	36	4.1	1.4	195	94	19	2.4	10
31-40-29ABB	Qu,TO		25	44	27	33	3.8	1.5	204	91	20	2.4	15
31-42-29AAB	Qu,TO,KJ		16	387	77	128	6.5	10	181	1344	14	1.4	4.3
31-43-3CB	Qu,TO,KJ		21	51	32	53	4.5	1.9	238	133	25	3.0	10
31-43-17CDC	Qu,TO		18	73	32	36	3.9	1.7	211	140	42	1.4	16
32-39-9DD	Qu,TO		35	60	41	82	6.5	2.0	288	194	36	1.6	11
32-40-21ADB	Qu,TO		33	99	58	74	6.4	3.2	239	414	13	2.4	12
32-42-14CCC	Qu,TO,KJ	b	28	40	38	46	4.0	1.8	232	136	12	3.5	10
32-42-21BCC	Qu,TO,KJ		28	41	36	50	4.4	1.8	237	123	23	2.9	14
32-42-26CDD	Qu,TO,KJ		28	61	44	57	5.5	2.3	266	199	26	2.4	10
32-43-17DCC	TO		32	35	32	31	3.9	1.6	233	66	16	2.8	14
33-39-16ABB	Qu,TO	b	33	61	33	60	5.0	1.5	246	183	18	.9	9.4
33-40-27CCC	Qu,TO		30	103	39	106	5.2	1.6	268	336	58	.6	11
33-41-3AAD	Qu,TO,KJ		33	67	49	64	5.8	2.4	246	278	8.9	2.3	7.4
33-43-32BCC	KJ		25	85	42	129	5.1	2.6	246	432	7.4	2.3	13
35-40-3BBB	Qu,TO	b	30	111	31	57	3.4	1.4	210	317	18	.4	9.2
35-43-13BDB	Qu,TO		25	58	29	55	4.9	1.2	323	96	14	.9	6.1

Seward County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
31-31-8BCC	Qu,TO	b	23	63	18	42	4.4	1.2	188	83	60	1.1	12
31-31-13BCB	Qu,TO		21	46	13	26	3.7	.8	186	60	10	1.0	8.2
31-32-3DAD	Qu,TO	b	21	64	20	34	4.2	1.2	234	82	26	1.0	19
31-32-21CBA	Qu,TO		22	74	25	50	5.1	1.5	212	177	30	1.0	16
31-32-34CBB	Qu,TO		21	72	23	50	5.1	1.5	215	168	20	1.0	14
31-33-6CBD	Qu,TO	b	24	62	25	41	4.7	1.6	210	116	33	1.0	19
31-33-20DBB	Qu,TO		25	50	21	46	5.0	1.2	223	102	16	1.4	11
31-34-18BBB	Qu,TO	b	24	56	30	58	6.0	1.5	253	153	16	1.3	8.1
32-31-8BBB	Qu,TO		21	53	15	32	4.1	.9	204	78	13	.9	8.6
32-31-26CAA	Qu,TO	b	19	58	17	33	4.6	1.1	201	91	22	.8	11
32-31-31ACC	Qu,TO	b	22	68	25	51	5.1	1.6	214	173	19	.8	14
32-32-14BBB	Qu,TO		21	64	21	44	5.0	1.3	213	137	18	.8	13
32-32-19BAB	Qu,TO		21	48	18	37	5.2	1.1	215	75	14	1.0	9.9
32-33-12BCC	Qu,TO		21	52	20	36	5.8	1.2	217	89	15	1.1	9.6
32-34-10DA	Qu,TO	b	22	48	27	35	4.9	1.5	216	99	12	1.3	10
32-34-17DCC	Qu,TO	b	28	58	26	37	4.3	1.5	214	117	22	.9	13
32-34-32BBB	Qu,TO	b	29	55	29	44	4.7	1.6	238	122	19	.9	15
33-33-12AAD	Qu,TO		23	65	23	32	4.1	1.2	226	109	14	.9	15
34-32-35ADA	Qu,TO		27	56	20	130	4.0	1.3	230	74	170	.7	18
34-34-16DAA	Qu,TO	b	30	72	18	24	3.4	1.1	188	113	14	.5	15
35-33-16BCA	Qu,TO	b	30	51	23	27	3.6	1.4	224	72	15	.7	13
35-34-10BBB	Qu,TO	b	30	100	37	61	4.2	1.6	198	76	200	.9	26

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
14	.4	3.3	7.8	17.0	221	143	0	370	.66	7.7
30	2.9	1.9	4.1	18.0	218	150	1	390	.64	7.8
25	7.6	2.2	9.5	18.0	235	157	7	400	.73	7.7
--	10	4.9	6.1	16.5	244	181	15	615	.42	7.7
13	2.6	1.2	1.0	16.0	228	147	0	385	.57	7.6
16	2.4	.8	7.4	16.0	247	166	4	510	.68	7.6
15	.8	1.7	11	18.0	235	158	3	440	.76	7.8
11	1.0	.6	6.9	16.0	261	180	23	465	.68	7.6
90	10	3.0	2.5	18.0	317	189	34	540	.89	7.7
27	7.6	2.0	2.3	16.0	298	188	27	505	.98	7.7
15	1.6	39	7.8	17.0	309	189	28	505	.98	7.7
4.4	4.0	.8	3.1	16.0	471	207	32	875	2.88	7.6
30	.3	1.7	14	16.0	1097	253	67	2150	8.68	7.6
--	2.5	1.0	6.4	16.0	298	197	32	495	.96	7.7

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
23	1.1	1.4	2.3	18.0	492	328	156	790	1.18	7.5
22	3.4	4.8	1.4	18.0	340	210	50	550	1.07	7.8
14	.2	1.2	2.2	18.0	339	223	55	565	.96	7.7
73	3.4	.3	2.5	21.0	2112	1294	1145	2400	1.55	7.5
42	3.5	.8	1.6	17.0	436	260	65	710	1.43	7.8
68	.3	.9	2.4	18.0	444	316	143	710	.88	7.8
30	3.1	1.5	2.7	22.0	576	321	85	930	1.99	7.5
14	4.6	1.4	2.4	19.0	771	489	293	1120	1.46	7.5
102	5.1	.7	2.2	18.0	443	258	68	660	1.25	7.9
40	3.8	3.3	2.3	18.0	402	252	58	670	1.37	7.8
19	1.3	1.7	14	19.0	527	336	118	825	1.35	7.7
84	8.4	.9	2.1	19.0	305	221	30	530	.91	7.8
83	9.4	1.5	3.3	19.0	488	289	87	760	1.53	7.6
43	.7	4.6	2.2	19.0	795	419	200	1100	2.25	7.5
23	1.0	2.0	4.6	19.0	611	371	170	900	1.44	7.6
121	2.8	2.2	2.2	20.0	860	388	186	1200	2.85	7.9
54	1.8	5.7	3.5	20.0	669	406	234	940	1.23	7.7
29	1.2	1.1	2.5	19.0	406	265	1	660	1.46	7.6

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Temperature °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
122	11.3	1.7	6.9	17.5	391	233	79	642	1.20	7.8
28	.8	27	11	17.0	272	169	17	460	.87	7.8
28	1.2	1.8	7.8	18.0	376	242	51	604	.94	7.7
27	3.8	3.0	12	18.0	491	289	115	780	1.28	7.7
23	3.3	1.9	12	18.0	466	276	100	680	1.31	7.9
17	9.3	7.6	10.1	18.0	410	256	84	673	1.12	7.8
--	14	3.5	12	18.0	367	213	30	615	1.37	7.8
100	11	2.0	3.9	19.0	458	265	58	718	1.55	7.7
42	.7	1.4	3.8	16.0	334	195	28	520	1.00	7.8
27	4.3	3.0	12	16.0	362	216	51	520	.98	7.8
24	.2	3.0	3.7	19.0	466	274	99	780	1.34	7.9
107	9.2	3.3	2.7	18.0	432	248	73	660	1.22	7.6
25	.2	3.7	3.4	18.0	333	195	19	550	1.15	7.6
123	8.5	1.0	1.6	18.0	358	213	36	580	1.07	7.8
11	.4	1.8	12	18.0	350	233	56	580	1.00	7.9
107	3.5	1.0	1.9	20.0	382	253	78	625	1.01	7.7
14	2.8	1.0	1.6	18.5	406	259	64	670	1.20	7.7
17	.8	1.6	6.8	18.0	407	258	73	620	.87	7.8
263	3.0	5.3	3.4	18.0	614	224	35	1100	3.78	7.9
19	3.2	3.5	16	18.0	377	255	101	580	.65	7.7
23	1.1	3.9	12	18.0	312	223	40	750	.79	8.0
10	.3	1.2	7.0	16.0	612	404	241	1060	1.32	7.7

Stanton County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
27-39-23ACC2	Qu,TO	a	29	117	36	38	6.1	2.3	280	188	29	1.0	84
27-39-27BBA	Qu,TO	a	33	76	25	31	4.8	1.8	188	172	18	1.1	14
27-39-34DDD	Qu,TO		38	71	36	42	4.4	2.2	183	220	25	1.8	16
27-41-19BAD	Qu,TO	a	18	63	18	27	4.3	1.2	176	125	12	.9	9.0
27-41-31CCB2	Qu,TO		22	58	15	25	4.2	1.0	172	102	9.4	.7	9.2
27-42-31CCC	Qu,TO,KJ	a,b	14	52	13	25	3.5	.7	162	74	14	1.0	16
27-43-12BCC	Qu,TO	a	15	59	14	24	4.0	1.0	164	99	12	.8	13
27-43-29DAB	Qu,TO		15	58	16	22	3.8	.8	165	103	11	1.0	8.8
28-39-5BBB2	Qu,TO		14	48	19	75	4.5	1.3	198	183	9.0	.9	3.4
28-39-31BCC	Qu,TO		20	69	21	31	4.4	1.4	172	140	27	.6	13
28-39-33ACC	Qu,TO		20	94	35	41	5.3	2.3	169	205	67	.8	36
28-39-36ABB	Qu,TO		20	74	29	35	4.8	1.9	164	180	36	1.2	14
28-40-4CCC	Qu,TO		17	64	19	26	4.2	1.3	167	121	23	.9	13
28-40-23ACC	Qu,TO		20	69	25	30	4.5	1.8	164	152	32	.9	15
28-40-32CCB	Qu,TO		19	59	17	31	4.0	1.1	170	112	22	.8	13
28-41-31BDD	Qu,TO		14	48	16	14	4.3	.9	158	61	10	1.1	25
28-42-8CCC	Qu,TO		12	50	14	26	3.4	.9	165	88	12	1.0	10
28-42-32BBB	KJ		13	56	26	52	5.0	1.3	212	161	13	1.6	.4
29-39-17BCB	Qu,TO		17	48	14	25	3.7	.8	167	74	9.2	.7	9.8
29-39-21DBD	Qu,TO		18	48	15	29	3.6	.9	172	80	9.1	.8	9.8
29-39-24DDA	Qu,TO	b	17	55	18	299	3.9	1.1	178	88	21	.9	16
29-41-13ACC	Qu,TO		22	57	19	32	4.2	1.1	204	102	14	1.3	4.8
29-41-31CBD	KJ		20	56	21	23	3.9	1.2	203	66	18	1.6	28
29-42-8CDC	KJ		17	66	19	44	5.0	1.0	229	124	13	1.2	5.4
29-42-24CCC	Qu,TO,KJ	b	18	52	22	37	4.4	1.3	215	93	16	1.7	7.4
30-39-2ABB	Qu,TO		19	47	15	30	3.7	1.0	163	90	11	1.0	8.7
30-39-18BBB	Qu,TO,KJ		22	43	20	33	3.6	1.2	193	82	14	1.7	8.4
30-39-32DA	Qu,TO		24	41	30	38	4.4	1.6	196	107	21	2.7	9.5
30-39-36BDD	Qu,TO		21	41	30	46	4.5	1.6	206	115	20	2.5	11
30-40-24CDC	Qu,TO,KJ	b	23	40	27	42	4.3	1.4	209	108	16	2.5	9.0
30-40-33CCB	KJ		19	32	22	35	4.3	1.2	201	66	6.9	2.2	7.5
30-42-12ACC	KJ		21	47	27	44	4.6	1.3	221	114	14	1.6	5.6
30-42-16BDB	KJ	b	23	46	24	28	3.8	1.3	214	80	14	1.6	7.0
30-43-34BBB	Qu,TO		22	78	44	72	5.2	2.1	231	221	60	1.4	49

Stevens County

Well Location	Geological Unit	Historical Data*	SiO_2 ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	HCO_3 ppm	SO_4 ppm	Cl ppm	F ppm	NO_3 ppm
31-35-15BAA	Qu,TO		25	57	29	49	5.4	1.7	236	149	16	1.3	6.4
31-35-26DCC	Qu,TO	b	24	50	31	38	5.3	1.7	216	112	25	1.4	12
31-36-2CDD	Qu,TO	b	22	51	28	48	5.4	1.6	226	118	24	1.3	12
31-36-18BAA	Qu,TO		24	42	24	40	4.2	1.4	211	97	12	1.6	8.9
31-36-27BCB	Qu,TO	b	24	42	25	40	4.2	1.4	211	103	9.8	1.6	8.4
31-37-9BCC	Qu,TO		21	47	27	51	5.1	1.5	228	126	15	1.6	9.9
31-37-22BCC	Qu,TO		29	55	34	65	5.8	1.8	238	190	18	1.6	8.8
31-38-17CDA	Qu,TO	b	25	73	48	59	6.1	2.5	201	275	37	2.1	15
31-39-23BBB	Qu,TO	b	29	69	42	56	5.9	2.1	210	246	21	2.3	12
32-35-2CBB	Qu,TO	b	25	52	31	35	5.3	1.8	215	133	14	1.1	12
32-35-8DDD	Qu,TO	b	25	45	28	42	4.6	1.6	226	116	14	1.1	11
33-36-11DDC	Qu,TO		35	64	28	38	4.5	1.6	212	147	18	1.0	17
33-37-17CCC	Qu,TO	b	26	68	19	40	3.5	.9	212	122	22	.5	17
33-38-6AAB	Qu,TO		31	87	40	66	5.3	1.7	229	192	89	.6	31
33-38-10ACC	Qu,TO		35	60	30	51	4.7	1.5	211	156	28	.8	17
33-38-20DDB	Qu,TO	b	27	58	18	28	2.9	.9	182	102	16	.5	14
33-38-25DDC	Qu,TO		27	79	17	27	3.4	.8	188	107	38	.5	17
34-35-7BCC	Qu,TO	b	30	87	15	17	3.2	.6	182	71	60	.4	18
34-35-18BCA	Qu,TO	b	31	75	16	17	2.9	.8	183	80	35	.4	17
34-38-2CDB	Qu,TO		27	78	23	34	3.7	1.1	170	186	18	.5	11
34-39-15CAD	Qu,TO		27	64	11	11	2.9	.5	222	20	15	.4	11
35-36-1AAA	Qu,TO	b	33	65	19	19	3.8	1.0	189	91	20	.5	14
35-39-10CAD	Qu,TO	b	28	82	14	23	2.7	.6	166	145	16	.5	13

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Tempera-ture °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
37	4.1	3.8	2.0	16.5	637	443	213	978	.78	7.3
19	.5	1.5	3.2	19.5	460	295	140	700	.79	7.7
28	3.8	2.0	3.3	18.0	538	328	178	800	1.01	7.7
15	1.3	1.1	7.8	17.5	352	233	88	580	.77	7.7
33	4.0	.9	3.2	18.0	329	208	67	510	.76	7.8
25	.9	2.3	3.1	17.0	251	184	51	490	.80	7.7
59	10	1.4	2.3	18.5	338	206	72	510	.73	7.6
25	.9	2.6	7.9	17.0	292	211	76	520	.66	7.7
32	13	5.5	7.1	19.0	440	199	37	700	2.30	7.7
48	1.6	3.8	1.8	18.0	407	260	119	680	.84	7.9
26	0.0	1.6	2.4	17.0	597	381	243	930	.91	7.8
29	2.2	6.5	1.2	17.5	475	303	169	725	.88	7.7
28	.5	2.0	3.8	17.0	351	239	103	610	.73	7.6
27	2.3	1.5	5.8	18.0	421	277	143	700	.78	7.6
55	3.0	4.9	4.6	18.0	344	218	79	570	.91	7.8
148	7.9	2.1	1.2	18.5	261	187	57	430	.45	7.6
52	2.2	15	1.8	19.5	279	183	48	490	.84	7.5
87	1.8	1.1	2.1	18.0	421	248	74	690	1.44	7.1
14	.5	11	7.4	18.0	276	175	39	460	.82	8.0
13	.8	3.0	11	19.0	290	183	42	500	.93	7.9
52	6.1	20	2.5	18.0	310	213	67	565	.87	7.7
37	5.1	.6	3.3	17.5	316	222	54	570	.94	7.8
229	10	3.0	1.9	18.0	324	227	60	550	.67	7.8
7.7	1.7	1.8	.8	18.0	390	244	56	660	1.23	7.3
107	13	2.0	2.1	17.0	348	222	46	600	1.02	7.4
120	5.4	1.4	4.4	18.0	249	180	47	500	.97	7.8
36	.1	4.4	3.9	17.0	283	191	33	510	1.04	7.9
20	5.7	1.9	2.8	17.5	358	226	65	588	1.09	7.7
36	3.8	1.0	3.8	18.0	377	227	58	615	1.32	7.8
338	12	2.5	7.4	17.5	330	212	41	570	1.25	7.7
20	6.0	2.5	5.1	18.5	280	169	4	468	1.18	7.8
34	3.3	1.5	2.7	19.0	377	230	49	620	1.26	7.7
59	3.8	.9	.6	17.0	315	215	40	540	.83	7.7
--	6.6	4.1	1.5	17.0	678	378	189	1040	1.61	7.6

Fe ppb	Mn ppb	Cu ppb	Ni ppb	Tempera-ture °C	Total Dis. Solids (180°C)	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ Non-Carbonate ppm	Specific Conductance (micromhos at 25°C)	SAR	pH
17	.4	.8	1.1	19.0	454	263	70	670	1.31	7.6
41	5.2	1.7	3.1	18.5	394	255	78	640	1.02	7.8
132	5.8	5.2	2.6	19.0	407	244	59	638	1.32	7.7
26	1.5	1.5	5.6	19.0	359	205	33	550	1.21	7.8
27	3.1	1.0	1.1	19.0	364	209	36	560	1.20	7.7
16	3.7	1.4	3.7	18.0	387	229	43	635	1.47	7.8
50	2.1	.5	1.6	18.0	478	279	84	770	1.69	7.6
17	2.6	.8	2.4	19.0	631	382	218	945	1.31	7.7
24	.6	1.2	2.4	18.0	543	347	175	850	1.31	7.8
18	.6	1.0	12	18.0	393	259	83	640	.95	7.8
20	2.1	.8	1.8	22.0	358	229	44	610	1.21	7.6
16	1.1	.9	7.7	19.0	446	277	103	670	.99	7.7
9.4	.3	1.6	13	19.0	416	248	74	610	1.10	7.7
21	.6	1.1	7.8	19.0	614	384	196	990	1.47	7.7
26	5.4	.7	2.0	19.0	453	275	102	730	1.34	7.6
53	2.3	2.9	2.2	19.0	349	220	71	510	.82	7.8
56	2.2	1.0	1.3	19.0	404	268	114	600	.72	7.7
33	.3	1.2	2.8	20.0	382	279	130	590	.44	7.8
59	3.6	1.6	3.0	20.0	370	254	104	530	.46	7.5
18	3.4	3.6	15	20.0	462	291	151	650	.87	7.6
12	1.8	1.1	16	20.0	272	206	24	420	.33	7.5
28	2.7	2.6	14	21.0	346	242	87	530	.53	7.9
32	1.9	2.5	14	21.0	390	263	127	610	.62	7.6