REANALYSES OF GROUND WATER
IN CHASE COUNTY, KANSAS

by

THOMAS JAMES HANSEN

B. S., Kansas State University, 1967

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

Approved by:

Henry V. Beck
Major Professor

TABLE OF CONTENTS

ILLUSTRATIONS

INTRODUCTION

Many types of pollution exist today, such as noise, air, water and soil. Much attention is given to stream pollution of various types, because people may readily observe stream pollution in nature. They do not realize gound-water pollution is occurring under the land which they inhabit. Ground-water pollution has not been presented to the public as much as other types of pollution, but it does exist.

Smith (1967), Stewart et.al. (1967) and Metzler (1958) did work in Missouri, Colorado, and Kansas respectively indicating many types of pollution have occurred in these areas. Nitrate pollution is one type of pollution found in these areas and is primarily due to feedlots. From these studies it is evident ground-water pollution is occurring in the United States and within Kansas.

Purpose of Study

Chase County (Fig. 1) was chosen as the area of study. It was undertaken to determine if ground-water pollution is occurring in Chase County, Kansas, and what is its cause. Variations in other ions were also noted. The county is approximately 774 square miles in area and lies in the approximate center of the eastern half of the State. Most of the county is included in the Cottonwood Falls quadrangle map published by U.S. Geological Survey.

Previous Investigations

The ground-water study by O'Connor in 1948 is the only comprehensive study to date on Chase County. The geology and topography of Chase County

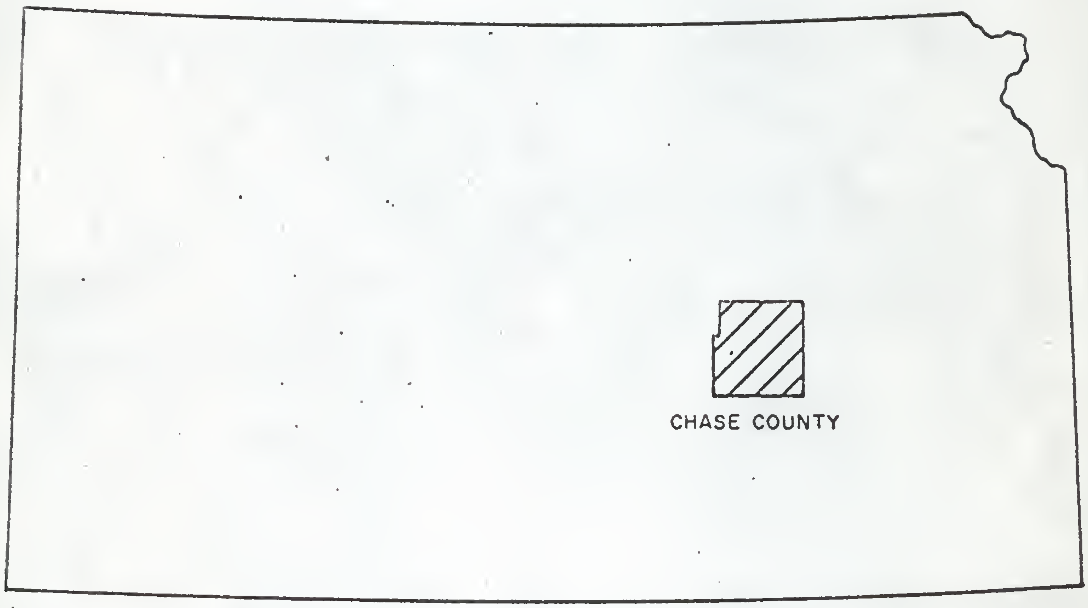


FIGURE 1. — INDEX MAP OF KANSAS SHOWING LOCATION OF CHASE COUNTY.

were described by Prosser and Beede (1904). Moore (1918), Fath (1921), Bass (1929), Condra and Upp (1931), Jewett (1941), Moore, Jewett, and O'Connor (1951), and Mudge and Yochelson (1962) have described the outcropping rocks in the Flint Hills in Chase and other counties. Since Precambrian rocks are close to the surface in the Nemaha anticline, the subsurface geology of Chase County has been investigated. McClellan (1930), Lee et.al. (1946), and Moore et. al. (1951) have described the subsurface geology in Chase County.

Oil and gas in Chase County is not abundant, but the geology of both has been discussed by Jewett and Abernathy (1945), Jewett (1941), and Moore et. al. (1951). Mineral resources were described briefly by Landes (1937), and then in greater detail by Moore et.al. (1951).

The water wells were located according to General Land Office surveys and according to the following formula: township, range, section, 160-acre tracts which were divided and labeled a, b, c, and d in a counterclockwise direction beginning in the northeast quarter. This system is used by the State Geological Survey of Kansas in cooperative ground-water studies with the U. S. Geological Survey. Below are two examples illustrating the well-numbering system:

WELL NUMBER:	GENERAL LAND OFFICE DESCRIPTION:
19-8-5 ba	NE¼ NW¼ Sec. 5, T. 19 S., R. 8 E.
22-8-20 ca	NE¼ SW¼ Sec. 20, T. 22 S., R. 8 E.

Procedures

In 1948 O'Connor inventoried the water wells in Chase County and analyzed water samples from 34 water wells in the county. The water samples were collected by O'Connor in 1948 from wells distributed evenly as possible within the county, and the results were published in Geology, Mineral Resources, and Ground-water Resources of Chase County, Kansas, by Moore et.al. (1951). Cattle feeding since 1948 has increased within Chase County from 27,100 cattle to 84,000 cattle on January 1, 1967. (Reports of the Kansas State Bulletin of Agriculture 1947 and 1967). After considering this fact and the availability of well-water data for comparison study, Chase County was chosen as the study area.

Over one-third of these water wells were resampled during the fall of 1968 and spring of 1969. The waters were analyzed by the Sanitary Engineering Laboratory of the Kansas State Department of Health in Topeka. Water samples were analyzed as recommended in "Standard Methods for Examination of Water and Wastewater," 12th Edition, 1965. The analyses consisted of determination for the following ions: silica, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, flouride, nitrate, and total dissolved solids.

CHARACTERISTICS OF CHASE COUNTY

Climate

The climate of Chase County is classified as subhumid by the Kansas Water Resources Board (1960). Principal source of precipitation is warm, moist, tropical air from the Gulf of Mexico. Most of the precipitation occurs from April to September causing heavy flood damage some years in the county. The average annual precipitation is 32 inches.

The average annual temperature for the county is about 57 degrees Fahrenheit (Kansas Water Resources Board, 1960), but varies greatly. A temperature of 118 degrees was recorded at Cottonwood Falls in 1936. The lowest temperature recorded in the area was -32 degrees in 1947 at Council Grove. The average growing season for Chase County is about 180 days.

Physiography

Chase County is within the Osage Plains section of the Central Lowland Province (Fenneman, 1931). The Osage Plains section is divided into three subdivisions: Flint Hills Upland, Osage Cuestas, and Cherokee Lowlands.

The Flint Hills Upland division comprises the greatest part of Chase County and the remainder is within the Osage Cuestas division. The Cherokee Lowlands division is not present in Chase County.

Surface features in the Flint Hills Upland area are a result of differential weathering of the flint or chert-bearing limestones and less resistant shales. Hilly topography has resulted because of the difference in erosion rates. The streams have deep and narrow valleys rimmed with outcropping rock ledges.

The Osage Cuestas division is present in the northeast part of the county. This area consists of east-facing escarpments which are a result of westward-dipping resistant limestones. Hilly terrain is typical in this area and is a result of differential erosion.

Outcropping Rocks

Valleys of the Cottonwood River, South Fork of the Cottonwood River, and Diamond Creek contain Pleistocene deposits of gravel, sand, silt and clay which are as much as 55 or 60 feet thick (Moore, et al., 1951). These Pleistocene deposits occur as stream-valley alluvium and older terrace deposits. The terrace deposits are most prominent and extensive along the valleys of the Cottonwood River and South Fork Cottonwood River (Moore, et. al,, 1951) near Emporia, where they have been mapped as the Emporia terrace.

Above these Pleistocene terrace deposits in the major stream valleys at elevations ranging from 50 to 150 feet are terraces of Pliocene age. The higher terraces are more dissected than the Emporia terrace which is of Kansan age.

All other exposed rocks in Chase County belong to the Permian System. They are of the Gearyan Stage except for the Wellington Shale, which is in the Cimarronan Stage. The individual formations of the Permian system have been described in many geologic reports (Moore, 1918; Fath, 1921, Bass, 1929; Condra and Upp, 1931; Jewett, 1941, Moore, Jewett, and O'Connor, 1951; Mudge and Yochelson, 1962). It is suggested these publications be consulted for a description of the outcropping rocks in Chase County.

Soils

A published report on the soils of Chase County has not been completed, but the soils of the county have been surveyed and a published report should be forthcoming. University of Wisconsin (1960) described the major soils in Kansas which included Chase County. The Kansas Water Resources Board (1960) also described the soils in Chase County briefly and placed Chase County soils in area 4. Area 4 is known as the Flint Hill-Bluestem pasture area. Permian limestones and shales are the parent materials of those soils. Soils in this area are very thin because of hilly topography and are very susceptible to erosion. The soils are classified as Sogn-Florence soils. Alluvial soils are another type found in Chase County. These soils provide most of the land under cultivation in the county, and may be classified as bottomlands undifferentiated. Soils on some of the broad hilltops have developed from loess and are under cultivation (Bidwell, 1956). These soils are also thin, but will produce wheat.

Industry

Chase County has a limited amount of large industries within its boundaries. The main industries are limestone, gravel, and sand quarries, oil, gas, and feedlots.

As in most areas of Kansas, the mining of sand, gravel, and limestone has taken place, but is not active at the present time because of the small amount of road building in the area. Many of those quarries were located in the Strong City area.

Oil and gas wells are very limited in the county. Eight gas fields are present in Chase County. These fields are as follows: Altemus, Davis, Elk, Elmdale, Hymer, Lipps, Neva, and Strong City. The Atyeo field and Teeter field are the only oil fields in the county. They are located in the southeastern part of the county. No recent data were obtained on the oil and gas activity.

Cattle feeding is the major industry of Chase County. Most of the cattle feeding is in confined feedlots along the river valleys. All of these large-scale feeding operations (Plate 1) are listed with the Kansas State Department of Health. If a feedlot contains more than 300 head of livestock, it must be registered with this department. The Kansas State Department of Health had listed the total capacity of these registered operations as 38,500. Observation on these operations is maintained for possible sources of stream pollution. An unknown number of small feeding operations are also present.

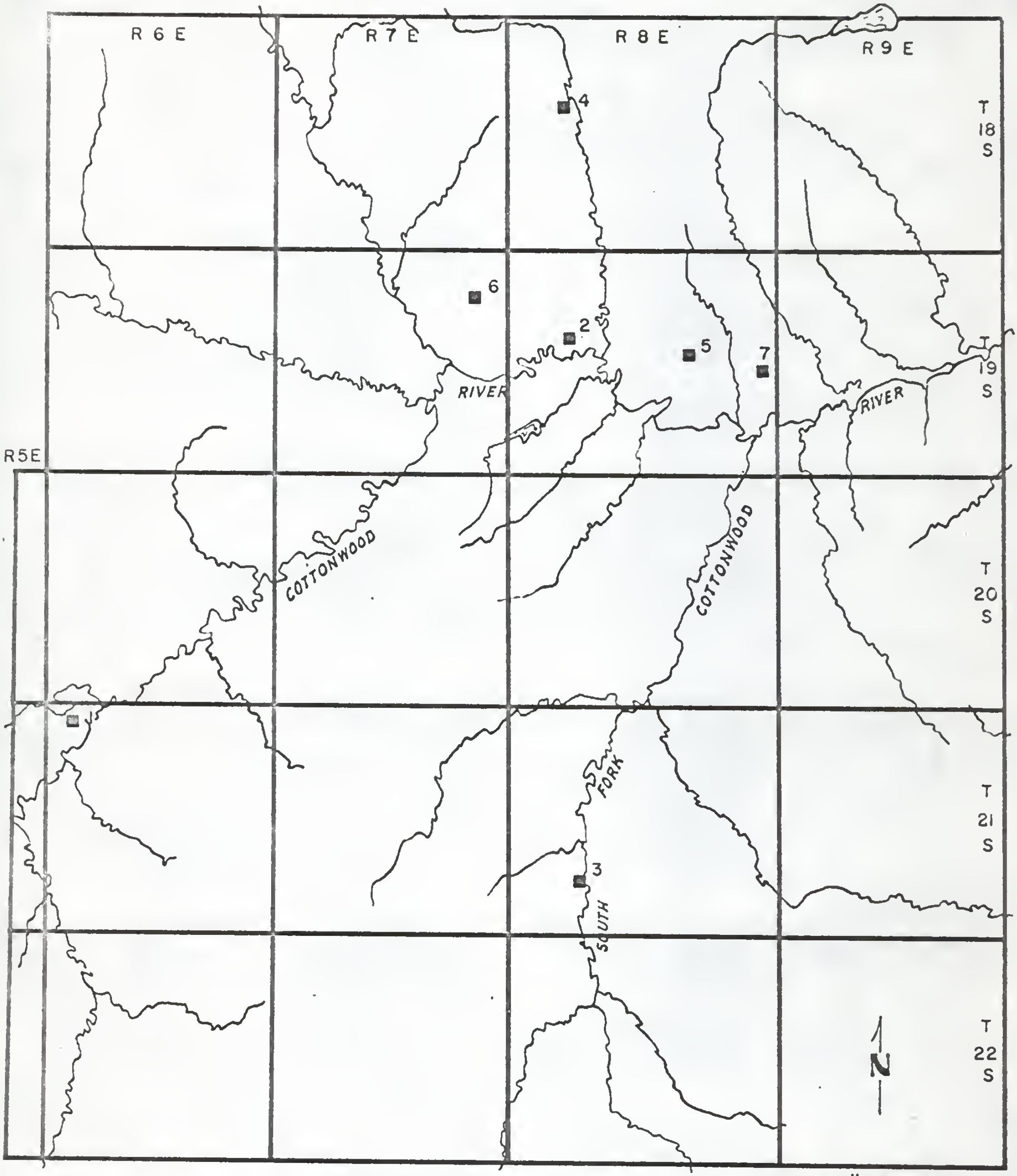
GROUND WATER IN CHASE COUNTY

Chase County has only a moderate supply of ground water. Most ground water is produced from alluvium and terrace deposits in the river valleys. Moore, et. al. (1951) estimated some of the wells should be capable of pumping 75 to 200 gallons a minute. Permian rocks of the Chase Group also yield

EXPLANATION OF PLATE I

Large-scale feedlots in Chase County, Kansas

PLATE I



CHASE COUNTY KANSAS

Scale: 1" = 4 Miles

■ Feedlots
(1) Crofoot Robinson Inc
(2) Crofoot Cottle Co Inc
(3) Trusler Crotoot Cattle Co
(4) Crofoot Cattle Co.
(5) Miller Cottle Co
(6) Ryon Creek Cottle Co
(7) - Mork Cattle Co

moderate supplies in the area. The average yield of bedrock aquifers is 5 to 10 gallons a minute but some wells produce from 50 to 100 gallons a minute (Moore et. al., 1951).

Most ground-water recharge in Chase County is from precipitation. Of the 32 inches received in the county, approximately 11 percent (Moore et. al., 1951) forms surface runoff. A small amount of the remaining 29 inches enters the ground-water supply, because the bulk is lost by evapotranspiration. The amount of water lost by evapotranspiration according to Moore, et. al. (1951) depends upon the temperature, humidity, vegetative cover, wind velocity, depth to the water table below land surface, and the length of time the processes have access to moisture.

Other sources of ground-water recharge are seepage from streams and ponds and percolation through the stratified and unstratified rocks from the adjacent areas. Seepage and movement from adjacent areas contribute only a small amount to the recharge of the ground water supply. Ground water in Chase County is discharged by evapotranspiration, through springs and seeps, and/or wells.

Water uses in the county include municipal supplies, irrigation, domestic, and livestock. Ground water is not used by industry in Chase County. Strong City, Cottonwood Falls, Elmdale, and Matfield Green have municipal water supplies from shallow wells.

The amount of irrigation in the county is small and no estimates on the amount of irrigated land were obtained. An increase in irrigated crop and pasture acreage is not predicted by the Kansas Water Resources Board (1960) thus the amount of water needed for irrigation should not increase. If a drought should occur and the stored surface water depleted, the actual consumption of ground water for irrigation may increase.

Rural domestic and livestock needs are currently met by wells, cisterns, springs, and small ponds. (Kansas Water Resources Board, 1960). Average water use is about 35 gallons per capita per day. The Kansas Water Resources Board (1960) estimated an average animal consumption of 15 gallons per day. Present trends indicate the population of both humans and animals will remain approximately constant in future years. This would imply no increase in the amount of ground water needed by the rural domestic and livestock users.

ANALYSIS OF GROUND WATER

Of the 34 wells (Plate 2) analyzed by O'Connor in 1948, 18 of the wells were revisited during this study. Five of the wells had been abandoned since 1948. The remaining 13 were sampled and the samples sent to Topeka to be analyzed. Two wells (Plate 2) were also sampled which were not tested in 1948. An ion comparison (Table 1) shows the number of wells decreasing or increasing in ion content from the 1948 study. Only three ions showed an increase in more wells than a decrease. These were silica, bicarbonate, and calcium. The water analyses were given in Table 2.

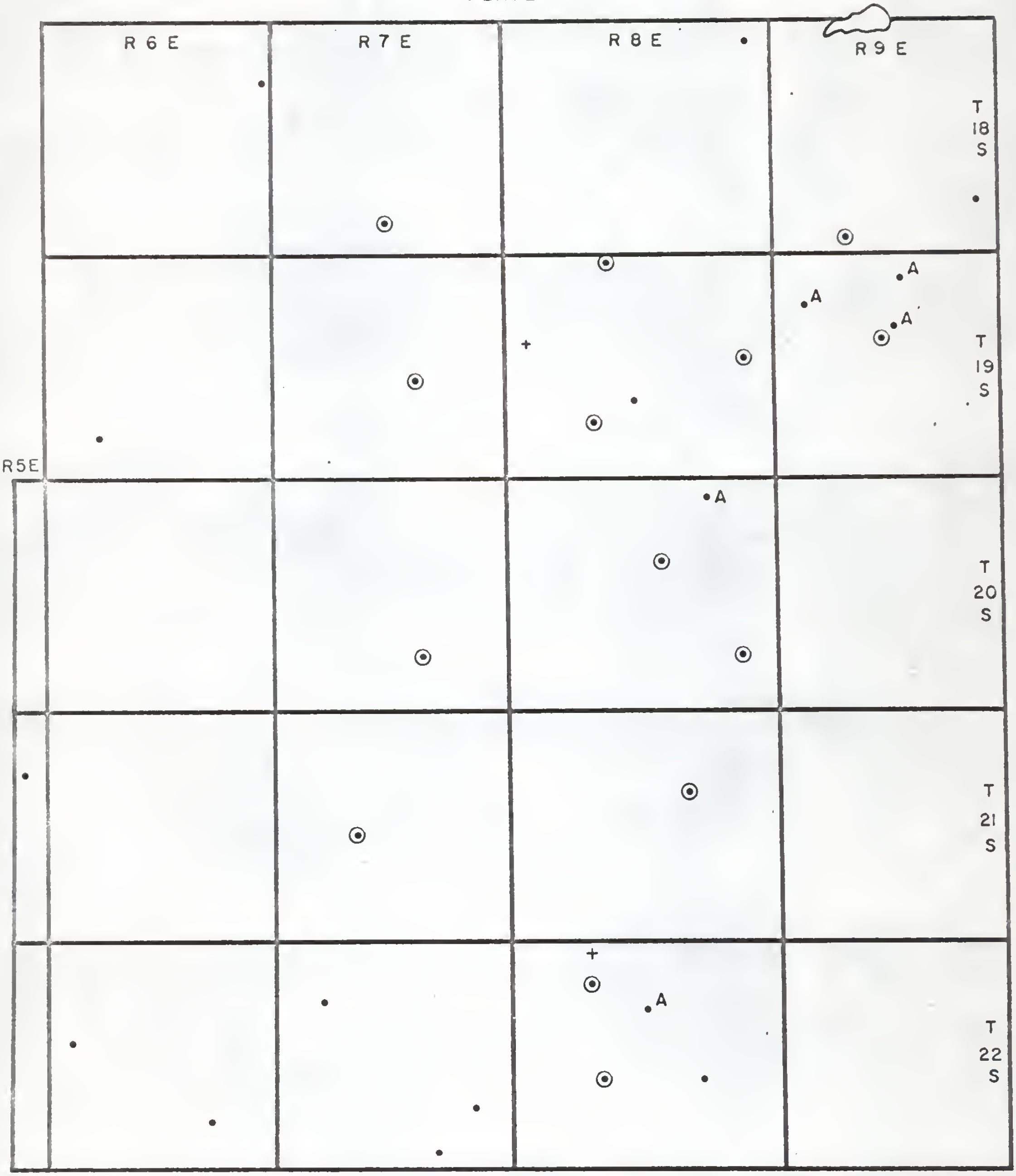
Hardness

Water which does not produce an excessive amount of soap suds is hard. It is this property which is readily observed by most people. Hardness causes scaling in pans when water is boiled and in hot water tanks. Moore, Jewett, and O'Connor (1951) stated calcium and magnesium are the constituents that cause practically all the hardness of water. They also stated that carbonate hardness is due to the presence of calcium and magnesium bicarbonate and is sometimes called temporary hardness. The presence of sulfates or chlorides of calcium and magnesium causes noncarbonate hardness (permanent hardness) which cannot be removed by boiling. Hardness of the 15 water samples from

EXPLANATION OF PLATE II

Water wells sampled in Chase County, Kansas, during this study and the 1948 study by O'Connor.

PLATE II



CHASE COUNTY KANSAS

Scale: 1" = 4 Miles

- • Wells Sampled By O'Cannar
- ⊙ Wells Sampled During This Study
- • A Abandan Since 1948 (Sampled By O'Cannar)
- \+ Wells Nat Sampled In 1948, But Sampled In This Study

TABLE I. — NUMBER OF WELLS IN THIS STUDY INCREASING, DECREASING, AND REMAINING THE SAME IN ION CONTENT FROM 1948 STUDY BY O'CONNOR.

ION	NUMBER INCREASING	NUMBER DECREASING	NUMBER REMAINING THE SAME
NITRATE	4	8	1
F	2	7	4
Cl	5	8	0
SO_4	5	7	1
BICARBONATE	9	4	0
Na + K	5	8	0
Mg	1	12	0
Ca	7	5	1
Fe	5	8	0
SiO_2	9	3	1
TOTAL DISSOLVED SOLIDS	6	7	0
TOTAL HARDNESS AS $CaCO_3$	4	9	0
CARBONATE HARDNESS	9	4	0
NON-CARBONATE HARDNESS	6	7	0

TABLE 2 – ANALYSES OF WATER FROM WELLS IN CHASE COUNTY, KANSAS ALL IONS LISTED
IN PARTS PER MILLION. TOP NUMBER IS 1948 SAMPLE ANALYSIS BOTTOM NUMBER IN PPM IS 1968-69 SAMPLE ANALYSIS

WELL NO.	LOCATION	DEPTH	GEOLOGIC SOURCE	DISSOLVED SOLIDS	SILICA SiO_2	IRON Fe	CALCIUM Ca	MAGNESIUM Mg	SODIUM & POTASSIUM Na+K	BICAR-BONATE HCO_3	SULFATE SO_4	CHLORIDE Cl	FLUORIDE F	NITRATE NO_3	HARDNESS AS $CaCO_3$ TOTAL	CAR-BONATE	NON CAR-BONATE
19-8-5 ba	NE 1/4, NW 1/4, SEC 5,	37.9	ALLUVIUM	310	7.6	0.44	98	9.4	7.4	331	15	5.5	0.2	4.4	283	272	11
	T. 19 S., R 8 E.			372	11.0	0.05	117.0	16.0	3.8	400 0	230	5 0	0.2	1.5	358	328	30
19-8-29 bc 2	SW 1/4, NW 1/4, SEC. 29	80	ESKRIDGE SH. &	1,869	14.0	1.9	217	108	220	315	1,121	17	1.1	16	986	258	728
	T 19 S, R 8 E.		GRENOLA LS.	498	12.0	.06	96	40	30.2	420	91	16 0	.2	16.0	404	344	60
19-7-22 ac	SW 1/4, NE 1/4, SEC. 22	50 3	HUGHES CREEK SH	1,220	13.0	1.4	68	51	324	371	64	490	0.7	26	379	304	75
	T. 19 S., R. 7 E		& AMERICUS LS.	1,084	13.0	4.0	70	40	305.5	625	3	334	0.6	4 9	339	339	0
19-8-13 cb	NW 1/4, SW 1/4, SEC. 13	91.4	BURR & SALLYARDS LS	522	10 0	0.16	130	32	8.7	388	136	5.5	0.3	8	456	318	138
	T. 19 S, R. 8 E.		ROCA SH	554	11.0	0.4	131	29	16.4	371	163	7.0	0.2	0.0	446	304	142
18-9-32 da	NE 1/4, SE 1/4, SEC 32	45 6	EASILY CR. &	610	7.0	1.9	110	52	28	411	95	32	0.4	84	488	337	151
	T. 18 S., R 8 E.		BADER LS.	570	13.0	0.07	98	0.00	24.8	405	95	26	0.4	58	470	332	138
22-8-20 ca	NE 1/4, SW 1/4, SEC. 20	25.3	CROUSE LS	1,075	14.0	0.47	178	37	113	355	152	109	0.1	297	596	291	305
	T. 22 S., R. 8 E			495	15.0	0.00	128	24	17.2	417	48	30	0.2	21	418	342	76
22-8-7 aa	NE 1/4, NE 1/4, SEC 7	58.9	BADER LS.	2,116	14.0	0.30	210	118	345	184	748	585	0.8	4.1	1,009	151	858
	T. 22 S., R 8 E			395	12.0	0.06	109	20.0	14.4	364	40	20	0.1	7.1	354	298	56
19-9-15 bb	NW 1/4, NW 1/4, SEC 15	17.2	ALLUVIUM	520	10.0	0.60	94	22	70	383	61	67	0.2	7.1	325	314	11
19-9-16 ad	SE 1/4, NE 1/4, SEC.16	27.	ALLUVIUM	940	15.0	0.00	182	00.0	104.2	395	185	146	0.2	93	578	324	254
	T. 19-S., R. 9 E.																
20-8-26 da	NE 1/4, SE 1/4, SEC. 26	27.9	GRENOLA LS.	603	7.8	.30	107	39	48	368	84	54	4	84	428	302	126
	T. 20 S., R 8 E.			420	15.0	.11	107	27	13.5	420	44	14	.2	1.3	378	344	34
20-8-16 aa 2	NE 1/4, SE 1/4, SEC. 16	32.4	BEATTIE LS.	618	9.2	0.56	118	45	24	349	115	28	.4	106	480	286	194
	T. 20 S, R 8 E.			804	6.2	---	203	26	28.4	446	112	71	.2	114	614	366	248
18-7-33 aa	NE 1/4, NE 1/4, SEC. 33	35	COTTONWOOD LS.	501	8.6	.05	130	24	19	438	61	11	.1	31	423	359	64
	T. 18 S, R 7 E.			406	14	.09	115	21	10.8	412	38	8	.1	6.2	374	338	36
21-8-15 ba	NE 1/4, NW 1/4, SEC. 15	64	COTTONWOOD LS.	435	8.2	.30	70	47	21	346	99	16	.4	3	368	284	84
	T. 21 S, R. 8 E.			1,088	12	.33	227	31	71	388	107	87	.1	320	694	318	376
20-7-27 da 1	NE 1/4, SE 1/4, SEC. 27	112	WREFORD LS	357	9.8	.02	74	36	13	405	14	8 5	.1	26	332	332	0
	T. 20 S, R. 7 E.			372	13	.06	81	31	13.1	395	21	9	.2	5.3	330	324	6
22-8-6 aa	NE 1/4, NE 1/4, SEC 6	50	ALLUVIUM	666	15.0	0.02	182	0.00	24 7	459	124	55	0.1	4 2	540	376	164
	T 22 S, R. 8 E																
19-8-18 ad	SE 1/4, NE 1/4, SEC 18	30	ALLUVIUM	732	15 0	0.04	174	45	23 4	527	67	65	0.1	89	619	432	187
	T 19 S, R. 8 E																

wells in Chase County is shown in Table 3.

Total Dissolved Solids

Table 3 shows the variance in total dissolved solids of ground water from wells in Chase County. Waters satisfactory for domestic use contain less than 500 parts per million. Water which contains more than 1000 parts per million is usually unsuitable for domestic use, because of an excess of certain constituents and perceptible taste (Moore, Jewett, and O'Connor, 1951). More than half of the wells contained less than 500 parts per million. Only two wells contained dissolved solids greater than 1000 parts per million, which would indicate these wells may be unsuitable for domestic use. Well number 19-7-22ac was not being used for domestic purposes.

Iron

Iron in water may cause staining of plumbing fixtures and clothes washed in the water. A reddish sediment may be precipitated if the water contains more than .1 part per million of iron (Moore, Jewett, and O'Connor, 1951). Aeration and filtration are methods used for removing iron from water. Water samples analyzed from wells in Chase County are shown in Table 3. Well number 19-7-22ac which was not being used contained 4 ppm.

Fluoride

Mottled tooth enamel is associated with a fluoride content in water of greater than 1.5 parts per million (Moore, Jewett, and O'Connor, 1951). All the samples contained less than .4 parts per million of fluoride thus mottled enamel probably does not occur in Chase County. Studies also indicate concentrations of fluoride between 1.0 and 1.5 parts per million in the water decreases the incidence of tooth decay.

TABLE 3 CHEMICAL CHARACTERISTICS OF WATER SAMPLES IN CHASE COUNTY, KANSAS.

HARDNESS		TOTAL DISSOLVED SOLIDS		IRON		NITRATE	
PPM	NUMBER OF SAMPLES	PPM	NUMBER OF SAMPLES	PPM	NUMBER OF SAMPLES	PPM	NUMBER OF SAMPLES
200 OR LESS	0	300 OR LESS	0	LESS THAN 0.1	11	1 OR LESS	1
201 — 300	0	301 — 400	3	0.1 — 1.0	3	2 — 10	7
301 — 400	6	401 — 500	4	1.1 — 2.0	0	11 — 30	2
401 — 500	4	501 — 600	2	2.1 — 3.0	0	31 — 50	0
501 — 600	2	601 — 700	1	3.1 — 4.0	1	51 — 70	1
601 — 700	3	701 — 800	1			71 — 90	1
701 — 1000	0	801 — 900	1			MORE THAN 90	3
MORE THAN 1000	0	901 — 1000	1				
		MORE THAN 1000	2				

Nitrate

In recent years much attention has been given to well water pollution by nitrates. Metzler (1958) suggested the following possible sources of nitrates in well waters:

1.) Nitrogenous organic matter of animal origin especially liquid and solid wastes such as manure and sewage.
2.) Nitrate formation in normal agricultural soils.
3.) Nitrate fixation by legume crops.
4.) Organic and inorganic fertilizers to enrich the soil.
5.) Decay of vegetable matter.
6.) Buried organic materials in sediments, peat deposits.
7.) Nitrate deposits in geological formations.
8.) Nitrogenous industrial wastes.
9.) Oxidation of atmospheric nitrogen during electrical storms.

Of the above sources livestock feeding operations have received blame for the majority of nitrate pollution of ground water by most authors.

Studies by Smith (1967) indicated soil texture influenced the lateral movement of nitrates, but the nitrate concentration in the soil usually decreased 200 to 300 feet from the pollution area. Smith also found nitrogen leaching from fertilizer, to be an insignificant source of nitrates in Missouri. A vertical variation (Plate 3) in nitrate concentration was shown to occur in Colorado by Stewart et. al. (1965). Smith (1967) stated that once nitrate moves to a depth of more than five feet below the surface it is preserved. This is the reason nitrates under feedlots tend to accumulate over the years.

Water containing 90 parts per million of nitrate is considered to be dangerous to infants by the Kansas State Board of Health. Cyanosis of infants ("blue babies") may result if water used in feeding is greater than 90 parts per million nitrate (Metzler and Stoltenberg, 1950). This concentration of nitrates does not affect older children and adults.

Smith (1965) considers nitrite to be at least ten times as toxic to livestock as nitrate. He found more wells to contain higher concentrations of nitrates during summer months than during fall and winter. This may be a result of plant growth causing a deficiency of O_2 and anaerobic organisms may reduce NO_3 to NO_2 (Smith, 1965). Smith also stated a chemical reduction of NO_3 to NO_2 may take place as the water stands in zinc-lined pipes during the summer months.

Some studies indicate a relationship between well depth and nitrate concentration. Nitrate has been found to reach maximum concentration following periods of maximum and minimum precipitation during the year (Metzler, 1958). The nitrate concentration from the water wells sampled in Chase County probably would be close to the yearly maximum because the samples were collected during the winter months when precipitation is minimum.

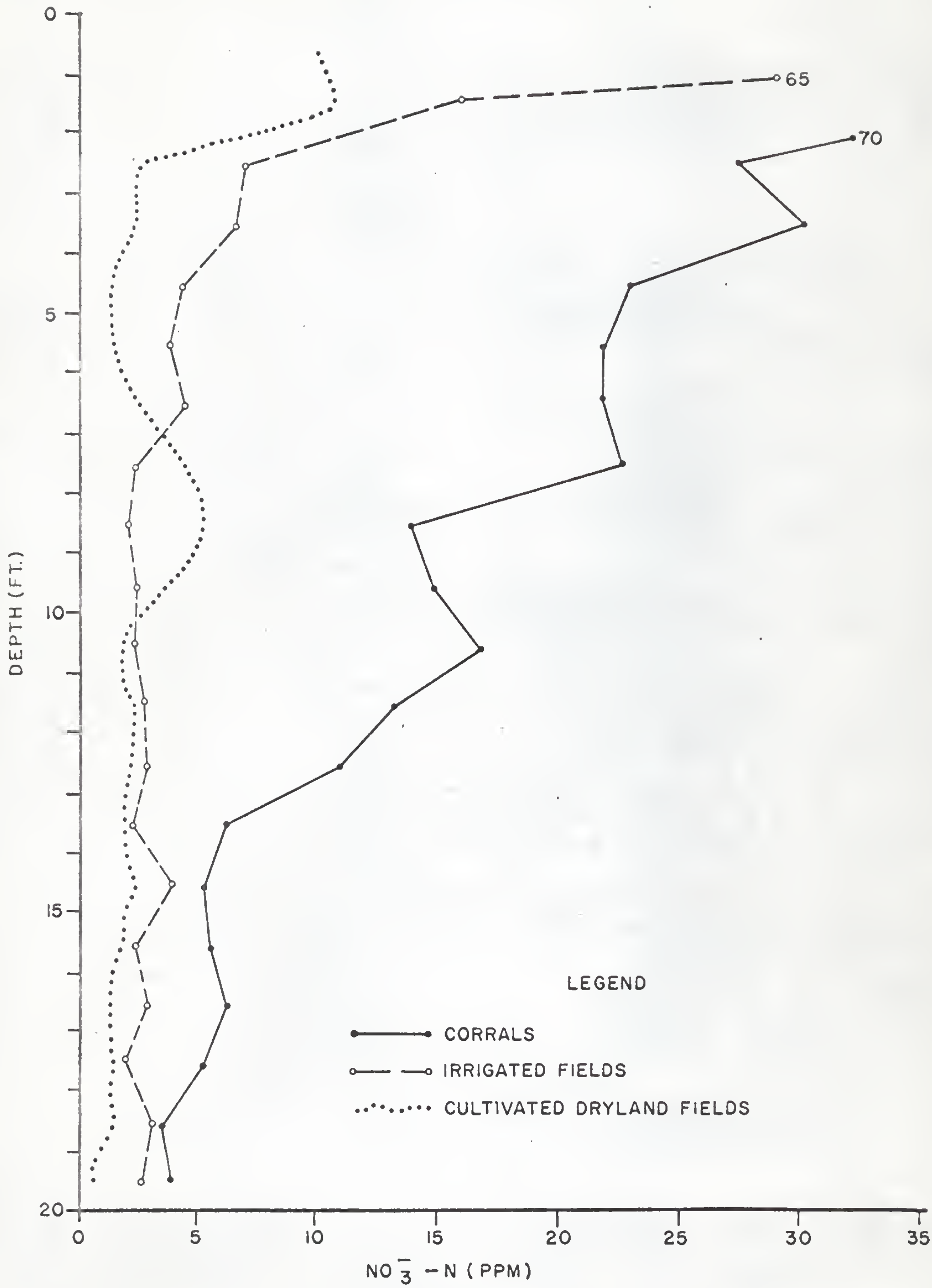
Of the fifteen wells sampled the maximum nitrate concentration was 320 parts per million (21-8-15ba) and the minimum was zero (19-8-13cb). Only four of the wells contained enough nitrate to be dangerous to infants. The wells which contained a high concentration of nitrate were 19-9-16ad (93 ppm), 21-8-15ba (320 ppm), 20-8-16aa2 (114 ppm) and 19-8-18ad (89 ppm). Three of the four wells were shallow but no relationship was noted in the other wells between depth of well and nitrate concentration. The four wells high in nitrate were drilled wells.

Well number 19-9-16ad was not sampled in 1949 by O'Connor, but is located about one-fourth mile southwest of well number 19-9-15bb which was tested in 1949, but had been abandoned by the time of this study. The well tested was 30 feet deep and downstream from the Crofoot feedlots. This may be the reason

EXPLANATION OF PLATE III

Average nitrate -N distribution with depth of profiles in South Platte Valley of Colorado (Stewart et. al., 1967).

PLATE III



0
5
10
15
20
DEPTH (FT.)
65
70
0
5
10
15
20
25
30
35
NO_3^- – N (PPM)
LEGEND
CORRALS
IRRIGATED FIELDS
CULTIVATED DRYLAND FIELDS

for the high nitrate (93 ppm). Alfalfa was the dominant crop surrounding the well and may have added to the nitrate concentration.

A nitrate concentration of 89 parts per million was present in well number 19-8-18ad. This well is about one-eight mile up stream from the large Crofoot feedlots west of Strong City, Kansas. The well is 30 feet deep and produces water from alluvium. One would expect the well to be higher in nitrates, but being upstream from the feedlots and according to Smith (1967) over 200-300 feet from source area,may explain the lower nitrate concentration.

Well number 21-8-15ba, with a nitrate concentration of 300 parts per million, contained the maximum nitrate content of all the wells tested. The well is located about 150 feet from a small feedlot. An alfalfa field is located about 500 feet to the east. Cattle had also been grazing near the well. All these conditions are probably responsible for the high nitrate concentration.

The fourth well which contained a high nitrate concentration (114 ppm) is well number 20-8-16aa2. Farm land and a wooded area are located to the south and pasture to the east. A small feedlot and barn are located about 300 feet northwest. The well is located downhill from the feedlot and barn. This is probably the source of pollution for this well, if it were not cased properly, or if the casing has deteriorated.

All the other wells are in areas surrounded predominantly by pasture. Well number 18-9-32da is an exception which is surrounded by pasture land with a small feedlot about 100 feet from the well. The nitrate concentration of 58 parts per million, which is higher than some, may be the result of the feedlot.

SUMMARY

Chase County, Kansas, furnished an ideal situation for an ion comparison study, especially the nitrate ion. The main reasons for this were the 1948 study to use for a comparison and the large amount of cattle feeding operations within the county.

Chase County has a subhumid climate. The rocks outcropping within the county are of Permian age. Soils in the county are very poorly developed, except in the river valleys. Most of the farming operations are located in the valleys upon the alluvial soils. The major industry of the county is the large-scale cattle feeding operations. Kansas State Department of Health listed the total capacity of these operations as 38,500 head. A large-scale cattle operation is one feeding more than 300 head at any given time during the year.

Only a moderate supply of ground water is available in Chase County. The main source of recharge is the annual precipitation, which averages 32 inches per year. Two other sources of recharge are seepage from streams and ponds, and percolation through the stratified and unstratified rocks from the surrounding areas.

Municipal water supplies, irrigation, rural domestic, and livestock are the main consumers of ground water in Chase County. An increase in the consumption is not predicted in the near future, because the county has mainly a rural population. If an increase does take place, the increased water demand will have to be met by surface water.

Thirteen out of the 34 wells analyzed by O'Connor in 1948 were reanalyzed during this study. Two wells were also analyzed which were not included in the 1948 study by O'Connor. The ion content of 15 wells is included in this report.

The ion content in most wells decreased in concentration from the 1948 study by O'Connor. The bicarbonate, calcium, and silica ions were the only ions which showed a general increase in concentration from the 1948 study. No explanation is presented for this decreased ion concentration.

Nitrate was the ion of major interest, because it is an indicator of pollution in ground water. The nitrate concentration ranged from 0 to 320 parts per million. Only 4 of the 15 wells analyzed contained dangerous amounts of the nitrate ion. The nitrate concentration tends to be greater during the summer months and during minimum rainfall. These wells probably contained the largest annual amount of nitrate at the time they were sampled. These wells were all drilled wells. No relationship between the depth of a well and nitrate pollution was observed. The condition of the casing was not determined, except at the surface. The four wells at the surface were somewhat deteriorated. The deteriorated condition of the casing at the surface and age of the well would furnish a means by which pollutants may enter the ground water supply.

Movement of nitrate in the soil may be vertical or lateral. Smith (1967) stated the extent of lateral movement of nitrate in the soil was from 200 to 300 feet from the source area, although it may move a much greater distance on the earth's surface and pollute the streams. Streams in Chase County are polluted sometimes by the feedlots after a heavy rainfall. Several large fish kills have been reported in the county. The study by Stewart et. al. (1965) showed nitrate concentration to be near the earth's surface in almost all soils and was shown to accumulate in soils beneath feedlots. The soils in Chase County are mainly silty clay loam on the hills and the soils developed upon the alluvium vary in texture.

The above facts point out nitrate pollution of ground water would be almost impossible unless the water well was improperly cased or the recharge area of an aquifer was near the source of nitrate pollution.

Nitrate pollution of ground water is occurring on a small scale in Chase County. Stream pollution is a much more serious problem in the county at the present time. The main source for ground-water pollution is probably improperly cased wells being located near a feedlot. Nitrates from fertilizer would be a minor source, because of the small amount of land under cultivation within the county.

This study is a small part of the work needed in Chase County. The wells in this study need to be sampled regularly during the year for several years to determine the time of greatest nitrate concentration and any other general trends in the ion concentration during the year. This more extensive study would permit a continuing control on the ground water quality surrounding the feedlots in Chase County.

ACKNOWLEDGMENTS

The residents of Chase County were very helpful in providing information concerning their water wells. Their concern and helpfulness is greatly appreciated by the author. Special thanks is extended to the Sanitary Engineering Laboratory of the Kansas State Department of Health in Topeka for its assistance in the analysis of the well water samples and to the Environmental Health Services of the Kansas State Department of Health for its assistance in obtaining information pertaining to the feedlots in Chase County.

Individuals adding their skills and wisdom to the project include Drs. Henry V. Beck, O. W. Bidwell, and C. P. Walters. The author's utmost appreciation is especially extended to Dr. Henry V. Beck, major advisor, for his interest and encouragement during the preparation of this paper. Kansas Academy of Science Foundation provided the funds for this study. Without their assistance the fieldwork would have been impossible.

REFERENCES CITED

Bass, N. W. (1929) The geology of Cowley County, Kansas, with special reference to the occurence of oil and gas: Kansas Geol. Survey, Bull. 12, p. 1-203.

Bidwell, O. W. (1956) Major soils of Kansas: Kansas State College of Agriculture and Applied Science, Circular 335, 13 p.

Condra, G. E. and Upp, J. E. (1931) Correlation of the Big Blue Series in Nebraska: Nebraska Geol. Survey, Bull. 6, 2d ser., p. 1-76.

Fath, A. E. (1921) Geology of the El Dorado oil and gas field: Kansas Geol. Survey, Bull. 7, p. 1-187.

Fenneman, N. W. (1931) Physiography of the Western United States: McGraw-Hill Inc., New York. 534 p.

Jewett, J. M. (1941) The geology of Riley and Geary Counties, Kansas: Kansas Geol. Survey, Bull. 39. 164 p.

Jewett, J. M., and Abernathy, G. E. (1945) Oil and gas in eastern Kansas: Kansas Geol. Survey Bull. 57, 255p.

Kansas Water Resources Board (1960), State water plan studies, Part A, preliminary appraisal of Kansas water problems: Sec. 7, 135 p.

Landes, K. K. (1937) Mineral resources of Kansas counties: Kansas Geol. Survey, Min. Res. Circ. 6, 110 p.

Lee, Wallace, and Others (1946) Structural development of the Forest City basin of Missouri, Kansas, Iowa, and Nebraska: U.S. Geol. Survey, Oil and Gas Investi., Prelim. Map 48, sheets 1-7.

McClellan, H. W. (1930) Subsurface distribution of pre-Mississippian rocks of Kansas and Oklahoma: Am. Assoc. Petroleum Geologist Bull., vol. 14, no. 12, p. 1535-1556.

Metzler, Dwight F. (1958) An investigation of the sources and seasonal variations of nitrates in private and public water supply wells, particularly with respect to the occurence of infant cyanosis: Final rpt., Project No. RG 4775, University of Kansas, p. 1-33.

Metzler, D. F., and Stoltenberg, H. A. (1950) The public health significance of high nitrate waters as a cause of infant cyanosis and methods of control: Kansas Acad. Sci. Trans., v. 53, p. 194-221.

Moore, R. C. (1918) The environment of Camp Funston: Kansas Geol. Survey, Bull. 4, 81 p.

Moore, R. C., Frye, J. C., Jewett, J. M., Lee, W., and O'Connor, H. G. (1951) The Kansas Rock Column: Kansas Geol. Survey Bull. 89.

Moore, R. C.; Jewett, J. M., and O'Connor H. G. (1951) Geology, mineral resources and ground-water resources of Chase County, Kansas: State Geological Survey of Kansas, Vol. 11, 49 p.

Mudge, and Yochelson, E. L. (1962) Stratigraphy and palenontology of the uppermost and lowermost Permian rocks in Kansas: U.S. Geol. Survey Prof. Pap. 323. 211 p.

Prosser, C. S., and Beede, J. W. (1904) Description of Cottonwood Falls quadrangle: U.S. Geol. Survey, Geol. Atlas of U.S., Folio 109, p. 1-6.

Smith, G. E. (1965) Nitrate problems in water as related to soils, plants, and water; Water Forum, Mo. Univ. Spec. Rpt. 55, p. 42-52.

Smith, G. E. (1967) Fertilizer nutrients and contaminants in water supplies: Am. Assoc. Adv. of Sci., Pub. 85, p. 173-186.

Stewart, B. A., Viets, F. G., Jr., Hutchinson, G. L., Kemper, W. D., Clark, F. E., Fairbourn, M. L., and Strauch, F. (1967) Distribution of nitrates and other water pollutants under fields and corrals in the middle South Platte Valley of Colorado: Agriculture Research Service 41-134. 206 p.

University of Wisconsin (1960) Soils of the north central region of the United States: Agricultural Experiment Station, Bull. 544, pub. no. 76, 192 p.

REANALYSES OF GROUND WATER IN CHASE COUNTY, KANSAS

by

THOMAS JAMES HANSEN

B. S., Kansas State University, 1967

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Geology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1969

ABSTRACT

Chase County has a subhumid climate. It is within the Osage Plains section of the Central Lowland Province. The rocks outcropping within the county are of Permian age. Soils in the county are very thin and poorly developed, except in the river valleys. Alluvial soils furnish most of the land under cultivation in the county.

Total number of cattle within the county has increased from 27,100 in 1948 to 84,000 as of January 1, 1967. Today the major industry of the county is the large-scale cattle feeding operations. Kansas State Department of Health listed the total capacity of these operations as 38,500 head, the remaining 45,500 head are found in smaller cattle feeding operations and in pastures. A large-scale cattle operation is one feeding more than 300 head at any given time during the year.

Municipal water supplies, irrigation, rural domestic, and livestock are the main consumers of the ground water in Chase County. An increase in the consumption is not predicted in the near future, because the county has mainly a rural population. If an increase does take place, the increased water demand will have to be met by surface water because of the moderate supply of ground water available in the county.

Eighteen water wells were inventoried in Chase County, Kansas, during this study, which had been analyzed in 1948. Five of the wells had been abandoned since 1948, thus 13 remained for a comparison study. Two other water wells were sampled, which were not analyzed in 1948.

The nitrate concentration in the 15 wells varied from 0 parts per million to 320 parts per million. Only four of the wells contained dangerous amounts of nitrate. Many authors blame cattle-feeding operations for pollution of streams and ground water. This is a possible cause for the high nitrates in

Chase County, Kansas. The most likely cause of ground-water pollution in this area is poorly constructed wells.

The ion content in most wells decreased in concentration from the 1948 study. The bicarbonate, calcium, and silica ions were the only ions which increased in concentration from the 1948 study.