

Geologic and Ground-Water Reconnaissance of the Loup River Drainage Basin Nebraska

By R. T. SNIEGOCKI

With a section on CHEMICAL QUALITY OF THE WATER

By R. H. LANGFORD

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CONTENTS

	Page
Abstract.....	1
Introduction.....	1
Purpose and scope of the investigation.....	1
Previous investigations.....	2
Acknowledgments.....	5
System used in numbering wells and test holes.....	5
Geography.....	5
Location, extent, and climate of the area.....	5
Topography and drainage.....	12
Natural vegetation.....	32
Population.....	32
Agriculture and industry.....	32
Geology.....	33
Tertiary system.....	37
Quaternary system.....	38
Ground water.....	40
Natural recharge and discharge.....	41
Artificial recharge and discharge.....	42
Movement.....	47
Water-level fluctuations.....	49
Chemical quality of the water, by Russell H. Langford.....	50
Chemical characteristics of the water.....	50
Suitability of the water for irrigation.....	58
Suitability of the water for domestic use.....	59
Conclusions.....	60
References cited.....	61
Basic data.....	63
Index.....	105

ILLUSTRATIONS

[Plates in pocket]

PLATE 1. Map of the Loup River drainage basin, Nebraska, showing the configuration of the water table and the locations of wells and test holes.	
2. Geologic cross section from Buffalo County to Boone County, Nebr.	Page
FIGURE 1. Map showing extent of area described in this report and in previous reports.....	3
2. Diagram of system used in numbering wells and test holes....	6
3. Map showing location of principal towns and canals in the Loup River drainage basin.....	7

	Page
FIGURE 4. Annual precipitation at Halsey, 1903-52, and at Burwell, Nebr., 1891-1952.....	8
5. Annual precipitation and cumulative departure from average annual precipitation at Ravenna, 1878-1952.....	9
6. Annual precipitation and cumulative departure from average annual precipitation at Genoa, 1876-1952.....	10
7. Minimum, average, and maximum monthly precipitation in the Loup River drainage basin, 1900-38.....	11
8. Oblique aerial view to the west near Dunning, Blaine County, showing the confluence of the Dismal and Middle Loup Rivers and the windrow dune topography.....	13
9. Oblique aerial view to the south near Ellsworth, Sheridan County, showing blowout development in the Sand Hills region.....	14
10. Oblique aerial view to the southeast near Milldale, Custer County, showing dissection of the formerly continuous loess plain.....	15
11. Map showing location of stream-gaging stations in the Loup River drainage basin.....	17
12. Map showing discharge of streams in the Loup River drainage basin in 1952.....	18
13. Map showing depth to, and altitude of, the Cretaceous bed-rock surface in the Loup River drainage basin.....	35
14. Subsurface geologic map of the Cretaceous bedrock in the Loup River drainage basin, showing also the areal extent of the Ogallala formation of Tertiary (Pliocene) age.....	36
15. Cumulative number of irrigation wells drilled in the Loup River drainage basin, 1935-52.....	43
16. Map of Boone County showing the locations at which surface water is pumped for irrigation.....	45
17. Hydrographs for wells 122 (A18-1-31ad) and 126 (A18-1-28cd) of the Loup River Public Power District.....	48
18. Map of the Loup River drainage basin showing the location of sampling points and the concentration of dissolved solids in the ground water.....	54
19. Chemical classification of waters in the Loup River drainage basin.....	56
20. Relation of cations and alkalinity to total concentration, Loup River drainage basin.....	57

TABLES

TABLE 1. Precipitation in the Loup River drainage basin, 1948-52.....	11
2. Monthly and annual discharge of streams in the Loup River drainage basin.....	19
3. Runoff from the Sand Hills part and the loess plains and hills part of the Loup River drainage basin.....	31
4. Data on selected municipal water supplies in the Loup River drainage basin.....	46

	Page
TABLE 5. Chemical analyses of water from streams during periods of low flow and from lakes in the Loup River drainage basin..	51
6. Chemical analyses of ground water in the Loup River drainage basin.....	52
7. Maximum, minimum, and average concentrations of some of the constituents of ground and surface water.....	55
8. Summary of published logs of test holes drilled in the Loup River drainage basin by the Conservation and Survey Division, University of Nebraska.....	64
9. Summary of published logs of test holes drilled in the Loup River drainage basin by the Spelts, Cunningham, and Mevis Oil Exploration Co.....	71
10. Previously unpublished logs of test holes and wells in the Loup River drainage basin.....	72
11. Measurements of the water level in wells.....	82
12. Record of wells and springs.....	93

GEOLOGIC AND GROUND-WATER RECONNAISSANCE OF THE LOUP RIVER DRAINAGE BASIN, NEBRASKA

By R. T. SNEGOCKI

ABSTRACT

The Loup River and its tributaries drain an area of about 15,230 square miles in central Nebraska. The upper three-fifths of the drainage basin is in the Sand Hills region of Nebraska, and the lower two-fifths is in the loess plains and hills region. An eastward-thinning wedge of semiconsolidated and unconsolidated deposits of Tertiary and Quaternary age underlies the surficial dune sand and loess. These deposits, which are recharged by infiltrating precipitation, contain a tremendous volume of water—at least 400 million acre-feet—and annually discharge about 1.7 million acre-feet into streams. Although wells supply nearly all the water used in the area for municipal, rural domestic, and livestock requirements, and some of the water used for irrigation, the withdrawals are small compared to the yield that the ground-water reservoir is capable of sustaining. Moreover, it seems unlikely that withdrawals ever will equal the potential for ground-water development except, perhaps, locally. The U.S. Bureau of Reclamation has prepared plans for greater utilization of the surface-water resources of the basin—overland runoff and ground-water discharge into streams—for generation of hydroelectric power and irrigation of farmland both within the basin and in the adjacent lower Platte River valley.

The chemical characteristics of the ground and surface water are uniform. The water is of the calcium bicarbonate type, generally contains less than about 500 parts per million of dissolved solids, and is suitable for irrigation and most domestic uses.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

The investigation of the Loup River drainage basin in Nebraska had a twofold objective: one to summarize available pertinent geologic and hydrologic information, and the other to collect enough field data on the occurrence, present use, and chemical quality of the ground water that general conclusions could be drawn about the potential for additional ground-water development in the area.

The locations of all wells having a large discharge were recorded. From water-level measurements made in some of these and in selected other wells and from information obtained from topographic maps, the general configuration of the water table was depicted by

means of contour lines. Data obtained by test drilling were used in constructing a cross section of the rocks of Tertiary and Quaternary age in the southeastern part of the drainage basin. Chemical analyses of samples collected from streams and representative wells provide an index to the chemical quality of water supplies throughout the area.

The investigation was made as part of the program of the Department of the Interior for development of the Missouri River basin. The fieldwork was done in 1952 under the general supervision of G. H. Taylor, regional engineer, and under the direct supervision of C. F. Keech, district engineer, both of the Ground Water Branch. The study of the chemical quality of the water was made under the supervision of P. C. Benedict, regional engineer, Quality of Water Branch.

PREVIOUS INVESTIGATIONS

Several reports dealing specifically with the geology or ground-water resources, or both, describe areas that extend into, or are completely within, the Loup River drainage basin. (See fig. 1.) The earliest of these was written by Darton (1898), who described both the bedrock and mantling deposits and discussed the occurrence of ground water in an area that includes Dawson, Buffalo, and Hall Counties. Lugn and Wenzel (1938) described in greater detail the deposits of Quaternary age and presented a water-table contour map for a somewhat larger part of the Loup River drainage basin; their report, like Darton's, was written without benefit of information from test drilling.

Several reports prepared as part of the program for the development of the Missouri River basin deal specifically with the geology and water resources of parts of the Loup River drainage basin (fig. 1.) One, by Miller (1951), describes the exposed rocks in Valley County but mentions only briefly the occurrence of ground water. Another, by Connor (1951), gives chemical analyses of samples collected from the principal streams in the Loup River drainage basin and discusses the geochemical relationships and salinity characteristics of the water. A third report, by Brown (1955), describes ground-water resources of the lower Middle Loup River valley and the upland in east-central Sherman County and west-central Howard County. A fourth, by Sniegocki (1955), describes ground water in the Prairie Creek unit, which is a triangular area bounded by the Loup and Platte Rivers and the east edge of Hall and Howard Counties. A fifth, by Schreurs (1956), describes the geology and ground-water resources of Buffalo County and small parts of Hall, Howard, Sherman, Custer, and Dawson Counties. The reports by Sniegocki and Schreurs contain much information based on test drilling by the

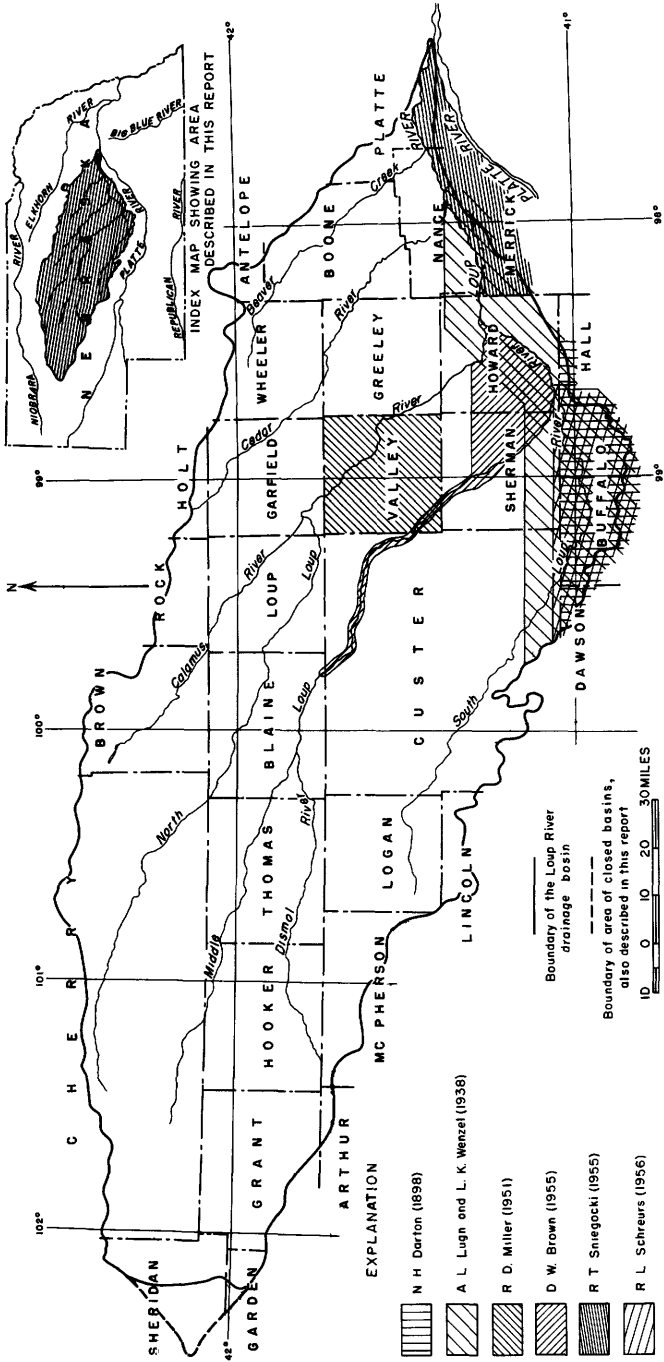


FIGURE 1.—Map showing extent of area described in this report and in previous reports.

Conservation and Survey Division of the University of Nebraska in cooperation with the U.S. Geological Survey.

The relation of the lakes to the ground-water reservoir in the Sand Hills region, much of which lies within the Loup River drainage basin, was discussed by Condra (1932). Other papers (Lugn, 1935; Condra, 1936, 1944, 1945, 1947; Condra and Reed, 1936; and Condra, Reed, and Gordon, 1947) discuss the geology, ground-water storage, and problems relating to land and water conservation in areas larger than, but including, the Loup River drainage basin. Geographic, geologic, and hydrologic data in the files of Federal and State agencies, private organizations, and individuals were compiled and analyzed in reports by the Nebraska State Planning Board (1936, 1941), together with firsthand information gathered by members of the board's staff. These publications contain much of the background material used in preparing this report.

As part of the program of geologic and ground-water studies made in Nebraska by the Conservation and Survey Division of the University of Nebraska in cooperation with the U.S. Geological Survey, 147 test holes had been drilled in the southeastern part of the Loup River drainage basin before this investigation was made. The logs of these test holes are summarized in table 8. Also, the Speltz, Cunningham, and Mevis Oil Exploration Co. had drilled 52 test holes in or near the Loup River drainage basin in 1941. The logs of 27 of these were presented by Schreurs (1956) and are summarized in table 9. The logs of the other 25 are reproduced in table 10, together with the logs of 8 wells drilled for the Chicago, Burlington & Quincy Railroad. Information from the logs of these test holes and well has contributed much to the understanding of the geology of the Loup River drainage basin.

Also as part of the State-Federal program of geologic and ground-water studies, many measurements of the water level in selected wells have been made during the past 17 years. (See table 11.) These records of water-table fluctuations are an index to the magnitude of changes in ground-water storage.

As part of the program for development of the Missouri River basin, the U.S. Geological Survey has prepared topographic quadrangle maps for about two-thirds of the Loup River drainage basin. In addition to portraying the topography, the quadrangle maps show the location of flowing wells, the altitude of the water surface of lakes, and the altitude of the land surface at livestock wells. The location of flowing wells and the contour lines depicting the configuration of the water table in the upper part of the Loup River drainage basin, as shown on plate 1 of this report, are based, in part, on data obtained from the quadrangle maps.

ACKNOWLEDGMENTS

Many persons supplied data that otherwise could not have been obtained readily, if at all. E. C. Reed and V. C. Dreeszen of the Conservation and Survey Division, University of Nebraska, made available their files of pertinent geologic and hydrologic data and assisted in interpretation of the data. County agricultural extension agents and local personnel of the U.S. Bureau of Reclamation and U.S. Soil Conservation Service supplied information on the location and characteristics of irrigation wells; and city and town officials furnished information on municipal water-supply systems. Farmers permitted the measurement of their wells and supplied many data that could not have been obtained readily by inspection of the wells.

SYSTEM USED IN NUMBERING WELLS AND TEST HOLES

All wells and test holes referred to in this report have been assigned numbers indicating their location within the land subdivisions surveyed by the U.S. Bureau of Land Management. The first numeral within the number indicates the township, the second the range, and the third the section in which the well or test hole is located. The lowercase letters (a, b, c, d) following the section number designate the quarter section and the quarter-quarter section. The letters are assigned in a counterclockwise direction beginning with "a" in the northeast quadrant. If two or more wells or test holes within the same quarter-quarter section are listed, they are distinguished by adding consecutive numerals after the lowercase letters. An uppercase letter "A" at the beginning of a well number indicates that the well is east of the principal meridian. The system used in numbering is illustrated in figure 2.

GEOGRAPHY

LOCATION, EXTENT, AND CLIMATE OF THE AREA

The Loup River drainage basin is in central Nebraska and includes all, or parts, of 30 counties. (See figs. 1 and 3.) It comprises about 15,230 square miles, or about one-fifth of the area of the State. It is about 275 miles long and in its central part is about 85 miles wide. On the northwest it is bordered by the drainage basin of the Niobrara River, on the northeast by the drainage basin of the Elkhorn River, and on the southwest and southeast by the drainage basin of the Platte River. Also described in this report is a triangular area of closed basins, which is about 155 square miles in extent and adjoins the west end of the Loup River drainage basin.

The climate of the Loup River drainage basin grades from semiarid at the west end, where the mean annual precipitation is about 18 inches,

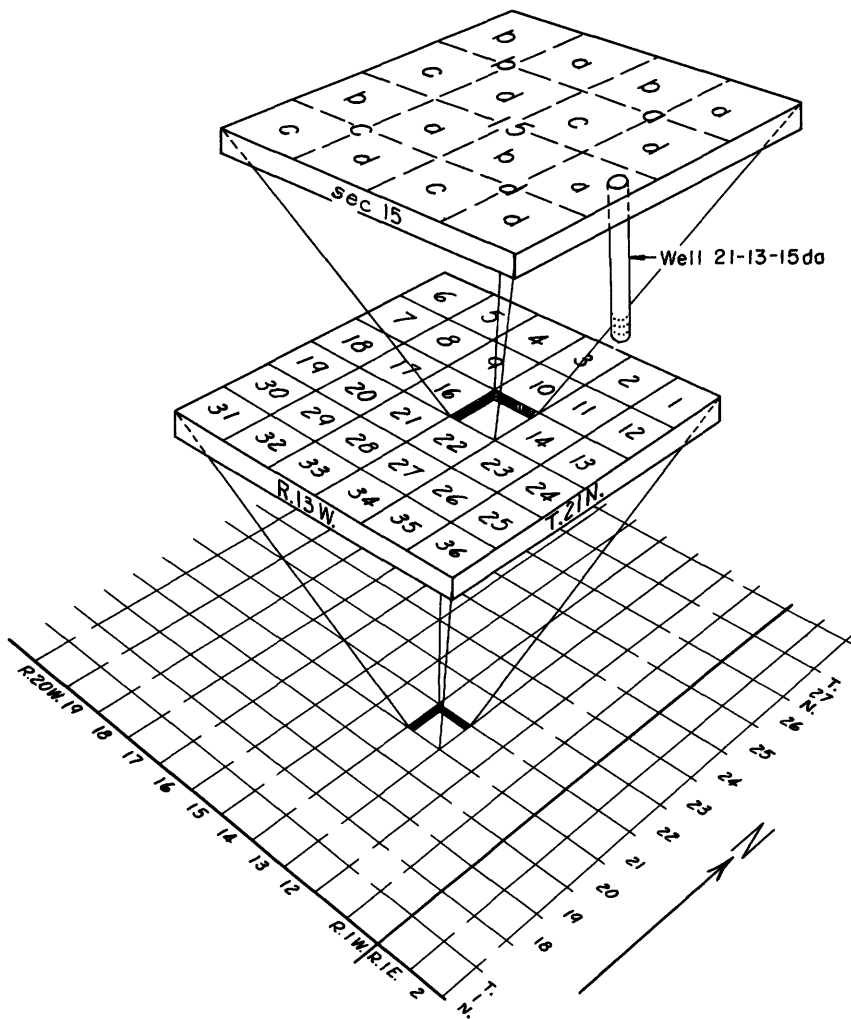


FIGURE 2.—Diagram of system used in numbering wells and test holes.

to subhumid at the east end, where the precipitation is about 26 inches. Precipitation records for selected stations in the basin are shown by graphs in figures 4 to 6. About 80 percent of the precipitation falls in the period April through September. (See fig. 7.) At Genoa, where records have been kept since 1876, precipitation of 2 inches or more within 24 hours occurs on an average of every 1.2 years. The maximum recorded rainfall in a 24-hour period was 12 inches at both Greeley and Loup City on June 5, 1896.

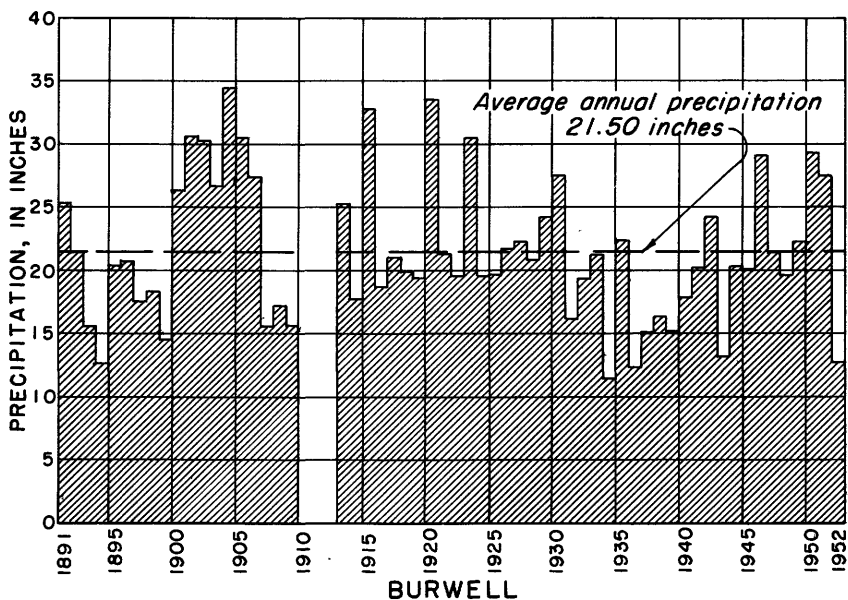
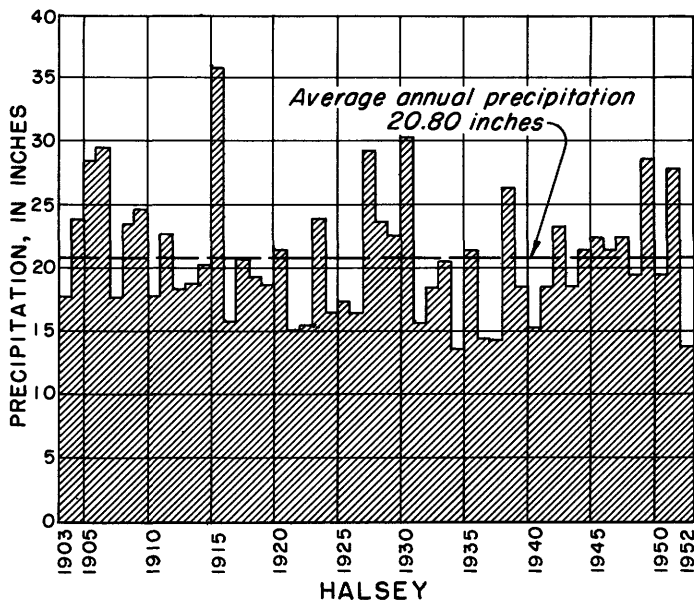


FIGURE 4.—Annual precipitation at Halsey, Nebr., 1903–52, and at Burwell, Nebr., 1891–1952.

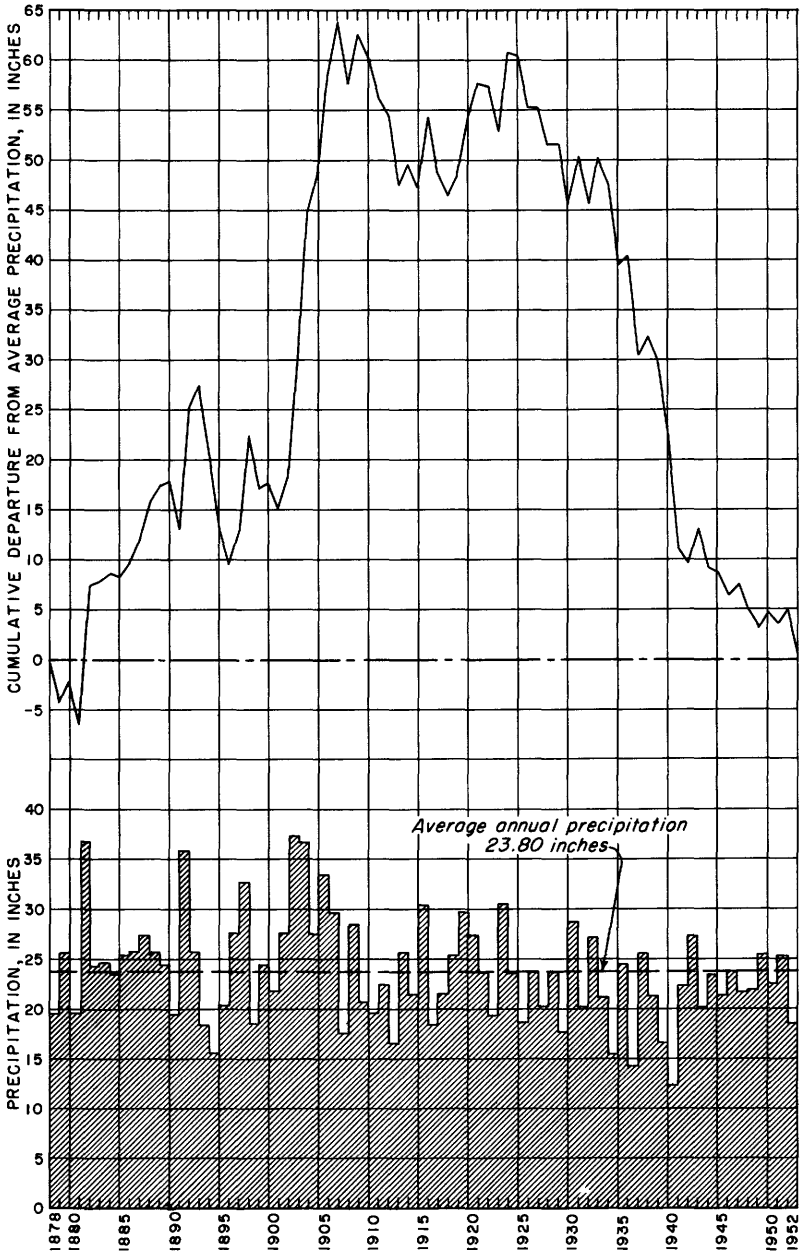


FIGURE 5—Annual precipitation and cumulative departure from average annual precipitation at Ravenna, Nebr., 1878-1952.

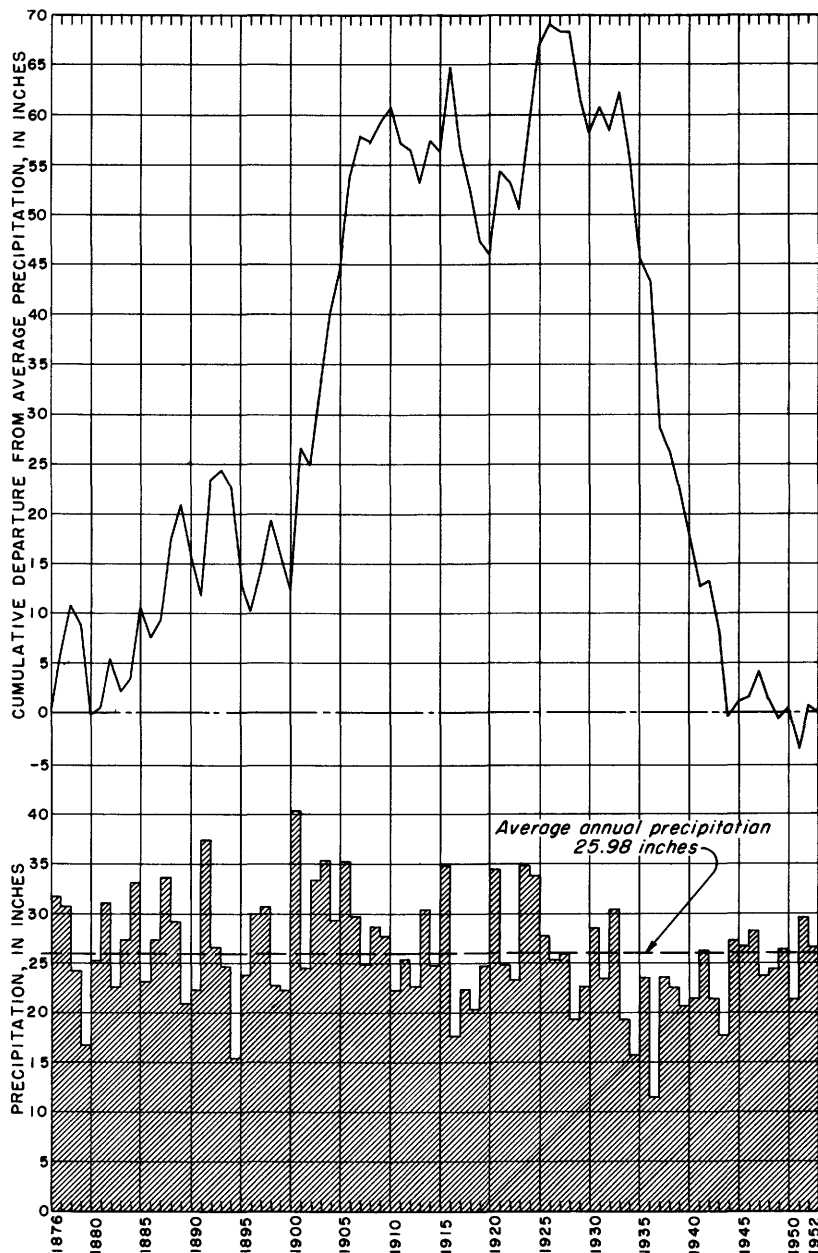


FIGURE 6.—Annual precipitation and cumulative departure from average annual precipitation at Genoa, Nebr., 1876-1952.

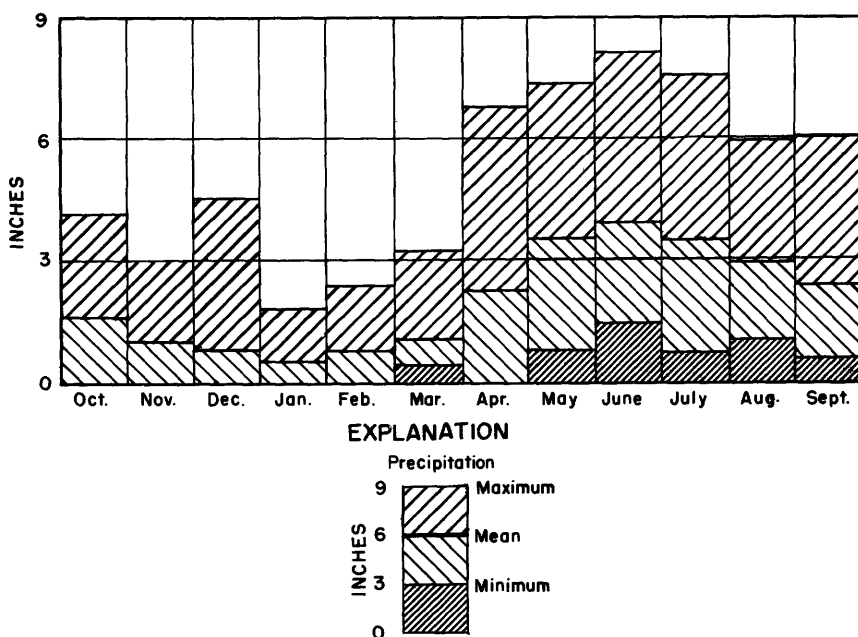


FIGURE 7.—Minimum, average, and maximum monthly precipitation in the Loup River drainage basin, 1900-38. From Nebraska State Planning Board, 1941.

Precipitation in the Sand Hills part and in the loess plains and hills part of the Loup River drainage basin during water years 1948-52 is given in table 1.

TABLE 1.—Precipitation in the Loup River drainage basin, 1948-52

Water year	Precipitation			
	Sand Hills part of the basin		Loess plains and hills part of the basin	
	Weighted average (inches)	Total volume (millions of acre-feet)	Weighted average (inches)	Total volume (millions of acre feet)
1948	19.38	8.9	22.72	8.0
1949	24.86	11.4	25.65	9.1
1950	23.98	11.0	24.36	8.6
1951	27.24	12.5	27.80	9.8
1952	16.60	7.6	17.77	6.3

The average annual temperature at Halsey is 48° F and at Loup City is 49° F. The average daily minimum and maximum temperatures are 33.9° F and 62.2° F at Halsey, and 35.9° F and 62.1° F at Loup City.

The lowest and the highest temperatures recorded at Halsey are -34°F and 108°F , and at Loup City -39°F and 110°F . Temperatures of 0°F or below are recorded on 15 to 30 days each winter and of 100°F or above on 7 to 15 days each summer. The average length of the growing season ranges from 145 days in the western part of the basin to 160 days in the eastern part.

The evaporation rate is not recorded at any of the climatological stations of the U.S. Weather Bureau in the Loup River drainage basin, but it is estimated from a partial record kept at the Valentine Migratory Waterfowl Refuge, a few miles north of the basin boundary, that evaporation from a free water surface is about 50 inches per year. Actual water loss—evaporation plus plant transpiration—from the drainage basin of the Middle Loup and North Loup Rivers above St. Paul averaged about 19.5 inches per year during the period 1929–33 (Williams and others, 1940). This figure was obtained by subtracting measured runoff from precipitation.

TOPOGRAPHY AND DRAINAGE

The northwestern three-fifths of the Loup River drainage basin is within the Sand Hills region of Nebraska. This part of the basin consists of sand dunes and intervening sand-floored valleys. Viewed from the air, the landscape appears to be similar to the surface of a billowy sea. At some places the dunes are alined in nearly parallel windrows (fig. 8) and at others they are arranged haphazardly (fig. 9). Generally the dunes are steepest on their east side, indicating that they were formed by westerly winds. The land surface in this part of the basin is mostly sod covered, but the tops of many of the dunes have been hollowed out by wind action (fig. 9). The craterlike hollows of bare sand commonly are referred to as "blowouts." There are hundreds of small lakes and marshes in the Sand Hills region. During periods of prolonged drought the larger and deeper lakes become smaller and shallower, and the smaller and shallower lakes and marshes may disappear entirely. Conversely, during a succession of years of above-average precipitation, new lakes and marshes may appear where lakes and marshes formerly had been and the lakes already in existence increase in size and depth.

The remaining two-fifths of the basin once was a fairly smooth constructional plain but now is being dissected by the headward erosion of streams (fig. 10). Because the plain is the top surface of a thick layer of wind-deposited dust, or loess, this part of the basin is called the loess plains and hills region. Although some fairly extensive upland flats remain, most of this part of the basin is character-



FIGURE 8.—Oblique aerial view to the west near Dunning, Blaine County, showing the confluence of the Dismal (left) and Middle Loup (right) Rivers and the windrow dune topography. Photograph by H. E. Skibitzke.

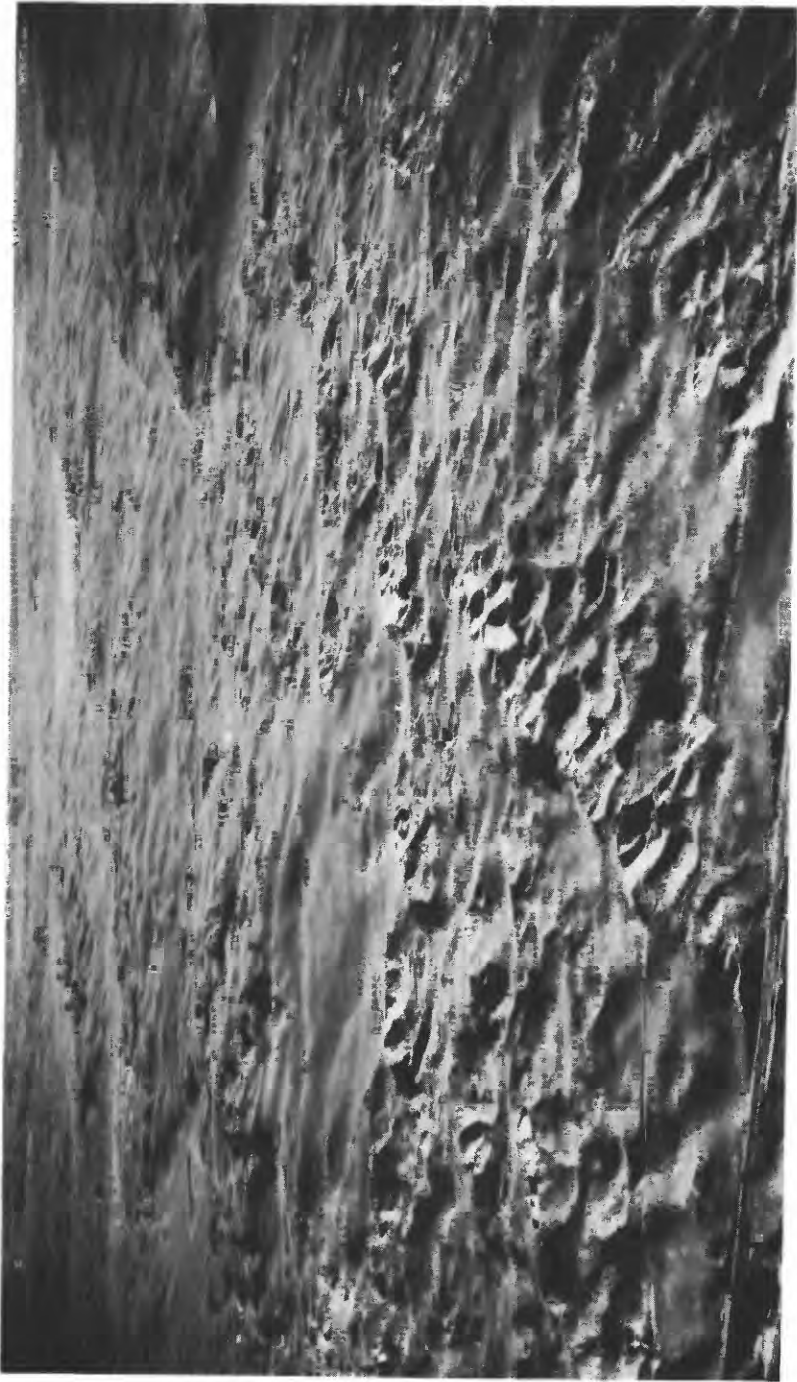


FIGURE 9.—Oblique aerial view to the south near Ellsworth, Sheridan County, showing blowout development in the Sand Hills region. Photograph by H. E. Skibitzke.



FIGURE 10.—Oblique aerial view to the southeast near Mildale, Custer County, showing dissection of the formerly continuous loess plain. Photograph by H. E. Skibitzke.

ized by smooth hills and valleys or, where erosion is more active, by sharp ravines and ridges.

The general slope of the Loup River drainage basin is southeastward; the streams have an average gradient of 7.5 feet per mile. The tops of the highest hills at the west end of the area are about 4,300 feet above sea level and the altitude of the Loup River where it flows into the Platte River is 1,415 feet above sea level. Relief along any line transverse to the regional slope is less than about 600 feet.

The principal streams in the Loup River drainage basin have their origin in the Sand Hills part of the basin. The South Loup River heads in Logan County and flows southeastward to north-central Buffalo County, where it veers northeastward and flows into the Middle Loup River near Boelus in Howard County. The Middle Loup heads in southwestern Cherry County and flows southeastward to Boelus, there veering northeastward and joining the North Loup River near St. Paul to form the northeastward-flowing Loup River. The Dismal River, which rises in eastern Grant County, flows into the Middle Loup at Dunning in southwestern Blaine County. Both the North Loup River, which rises in west-central Cherry County, and the Calamus River, which rises in western Brown County, flow southeastward—the Calamus flowing into the North Loup at Burwell. The Cedar River and Beaver Creek rise in southwestern Holt County and central Wheeler County, respectively, and flow southeastward, both entering the Loup River in Nance County. In Platte County the Loup River arcs southeastward and enters the Platte River near Columbus. The Loup River and the lower reaches of its principal tributaries flow in broad, nearly flat valleys.

Stream and canal discharge has been or is measured at the gaging stations shown in figure 11; the discharge measurements are summarized in table 2. The discharge of streams in the Loup River drainage basin in 1952 is represented by the width of the streams in figure 12.

The discharge measurements made at the gaging stations Middle Loup River at Seneca, Middle Loup River at Dunning, Dismal River near Gem, and Dismal River at Dunning indicate that the rate of flow of streams in the Sand Hills part of the basin is remarkably uniform. During the 3 water years 1950–52, the variation in annual discharge at these stations was 6, 6, 2, and 4 percent, respectively, of the average annual discharge during the same period. Because only about 9 percent of the Sand Hills part of the basin contributes direct overland runoff to the streams, most of the discharge of streams in this part of the Loup River drainage basin is water that reaches the streams by subterranean routes. In the loess plains and hills part of the basin,

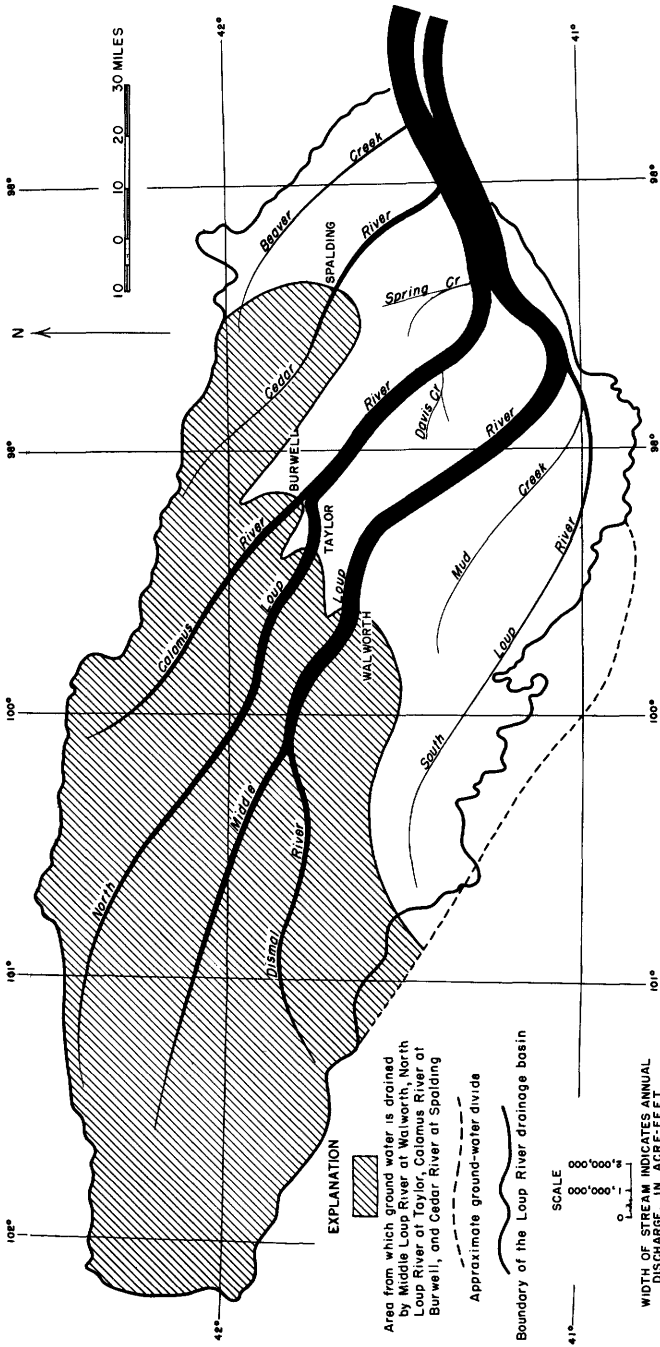


FIGURE 12.—Map showing discharge of streams in the Loup River drainage basin in 1952.

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska

[Annual discharge values rounded according to standard practice]

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
Middle Loup River near Mullen													
1946-47	8,420	8,150	7,870	8,420	6,990	8,360	8,930	8,050	11,600	7,810	7,390	7,680	99,560
1947-48	8,080	7,900	8,250	8,170	7,440	8,240	7,990	8,130	7,710	7,860	8,040	7,470	96,180
Middle Loup River near Seneca													
1947-48							3,760	11,020	11,290	11,340	11,470	10,210	
1948-49	11,820	11,090	11,980	12,440	11,970	14,560	14,110	14,250	12,340	11,750	10,650	10,740	147,500
1949-50	11,150	10,770	11,870	11,790	11,140	12,440	12,010	12,240	11,940	11,300	12,000	12,640	141,800
1950-51	12,400	11,220	11,720	11,670	11,310	11,370	11,010	14,140	13,230	13,260	12,410	14,680	148,300
1951-52	11,440	11,820	11,330	11,010	12,840	12,680	14,140	13,300	11,670	11,650	11,680	11,920	146,000
Middle Loup River at Dunning													
1944-45													
1945-46	24,420	23,200	22,880	26,010	23,680	25,520	23,190	22,890	20,520	20,090	21,360	13,570	276,600
1946-47	26,800	23,980	25,070	23,940	20,770	24,640	24,380	22,940	26,890	22,200	20,950	21,290	283,000
1947-48	22,800	21,640	22,280	24,600	21,290	23,830	22,670	21,710	20,350	22,180	22,020	21,520	263,900
1948-49	22,010	23,610	23,560	19,800	23,640	29,340	25,640	24,040	22,970	22,060	21,410	22,000	281,900
1949-50	21,480	22,880	20,640	21,400	21,420	22,420	23,350	23,450	20,490	21,850	21,810	21,230	264,400
1950-51	21,280	22,820	24,160	22,810	23,900	23,200	19,850	25,100	24,200	23,360	22,540	23,720	277,000
1951-52	23,880	22,930	23,830	23,370	23,270	26,860	25,760	23,130	21,150	21,490	22,390	20,440	280,500
Dismal River near Gem													
1946-47	16,700	16,060	15,660	17,040	15,390	16,400	16,930	15,890	16,720	16,000	16,090	16,290	195,100
1947-48	16,640	15,660	16,980	15,180	13,040	17,110	15,880	16,820	16,000	15,440	15,480	15,910	190,500
1948-49	16,460	15,840	16,750	16,600	16,660	17,520	17,550	16,600	16,150	15,840	16,710	15,520	198,200
1949-50	16,880	16,960	16,940	15,470	16,440	17,790	16,720	17,490	16,010	18,590	17,430	17,890	204,600
1950-51	18,050	16,880	17,930	16,940	17,380	16,820	16,280	19,030	17,520	17,860	16,420	16,890	208,000
1951-52	16,860	16,390	17,660	18,720	17,670	19,670	17,010	17,210	15,380	16,230	16,670	16,080	203,000

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska—Continued

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
Dismal River at Dunning													
1945-46	19,500	20,270	19,690	20,150	19,760	20,280	18,150	18,090	16,340	16,520	17,890	16,950	223,600
1946-47	19,560	18,490	17,910	20,970	19,340	19,030	19,470	18,200	21,850	18,560	17,520	18,080	229,000
1947-48	18,410	18,430	19,480	17,760	15,760	20,080	18,190	19,890	18,110	18,480	17,320	18,690	221,500
1948-49	18,780	18,160	19,600	19,740	19,640	20,620	20,760	19,460	18,600	18,040	18,890	18,860	231,000
1949-50	19,010	18,270	18,400	17,120	18,100	19,860	19,140	18,550	17,230	20,070	17,930	19,010	222,700
1950-51	19,870	18,420	20,030	18,860	19,430	18,770	18,150	21,420	19,540	19,680	17,950	19,080	231,200
1951-52	18,220	18,090	19,840	20,470	19,500	21,680	19,120	19,200	18,060	18,200	18,730	18,070	228,200
Middle Loup River near Milburn													
1951-52	51,090	48,460	43,110	50,640	49,090	54,390	56,400	50,610	44,640	42,330	45,670	44,090	581,700
Middle Loup River at Walworth													
1940-41	47,470	50,870	38,950	44,500	57,890	42,630	43,720	49,170	43,030	44,330	44,010	46,030	552,600
1941-42	53,150	46,990	48,330	51,390	47,210	61,040	51,090	49,510	48,150	46,500	43,440	45,270	589,400
1942-43	47,670	51,900	42,330	43,140	46,430	52,620	48,220	54,200	50,020	44,380	43,570	48,730	573,200
1943-44	46,000	43,450	40,600	52,600	51,470	56,630	45,080	45,790	40,200	37,620	41,880	45,450	546,800
1944-45	53,960	46,300	44,210	44,410	41,000	53,130	48,450	48,700	73,290	43,950	43,300	43,840	584,900
1947-48	47,770	47,300	49,150	44,350	51,150	51,340	50,330	45,980	44,640	44,050	42,930	42,160	561,000
1948-49	43,330	43,560	40,560	38,440	46,430	62,200	59,490	57,680	51,770	43,180	45,310	46,630	573,600
1949-50	49,300	49,260	41,480	38,700	52,280	56,050	53,900	50,270	42,010	49,530	48,980	47,120	578,900
1950-51	48,910	49,200	41,660	44,390	50,130	51,490	51,960	62,970	55,190	50,180	51,650	50,890	616,000
1951-52	53,550	46,110	43,800	56,910	56,150	56,840	56,780	55,020	44,600	44,100	45,610	43,390	603,400

Middle Loup River at Sargent

1936-37	51,120	42,660	43,120	50,690	61,120	51,070	50,790	42,300	44,420	40,180	45,890
1937-38	50,320	45,670	43,380	43,250	58,010	56,620	58,810	50,570	48,770	44,260	47,690
1938-39		47,190									588,000

Middle Loup River near Comstock

1936-37	41,300	49,840	66,240	53,550	49,710	46,250	43,070				
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Middle Loup River at Arcadia

1936-37	53,860	40,270	48,480	44,670	68,190	69,300	70,400	53,960	44,190	43,450	45,280	623,100
1937-38	45,240	44,780	56,140	25,100	63,690	45,660	50,260	50,770	48,780	41,000	43,300	536,300
1938-39	46,620	49,910	35,140	53,970	63,660	48,270	38,060	42,970	33,370	32,990	33,120	512,300
1939-40	42,890	53,030	63,660	58,380	48,070	33,310	38,670	36,440	25,840	29,180	31,840	532,300
1940-41	54,980	45,370	48,880	53,490	64,160	60,860	59,850	53,610	32,360	27,110	48,270	607,200
1942-43	53,860	58,490	38,860	48,410	57,330	56,150	43,940	47,710	34,540	37,140	46,010	563,700
1943-44	53,830	49,090	52,540	56,100	67,490	66,440	63,010	47,530	40,120	30,140	42,720	615,500
1944-45	51,260	49,240	46,510	50,700	57,180	55,090	55,620	52,240	39,890	38,450	38,510	578,100
1945-46	46,100	45,060	52,580	49,060	63,540	42,770	39,770	34,590	29,470	28,850	39,360	513,100
1946-47	66,340	49,740	47,420	45,000	60,600	56,340	47,150	110,200	45,050	29,070	39,460	642,300
1947-48	44,620	50,130	43,460	51,170	56,340	50,160	56,670	40,520	36,570	44,890	31,680	552,700
1948-49	42,880	48,110	45,100	47,700	79,510	66,990	69,800	52,710	34,570	34,270	46,990	599,000
1949-50	51,880	52,190	43,890	50,520	57,820	56,350	54,080	36,840	55,440	48,120	46,780	600,600
1950-51	55,620	47,080	42,480	51,790	54,260	52,180	70,680	51,820	56,210	49,580	53,880	631,500
1951-52	53,680	49,850	56,030	56,260	70,710	64,690	61,350	33,010	29,860	30,710	36,170	587,600

Middle Loup River at Loup City

1936-37	54,110	47,540	40,990	51,550	68,720	58,160	53,800	51,890	45,600	44,880	53,910	
1937-38			49,300	47,180	78,260	81,950		35,090	33,500	33,680	44,580	
1948-50	51,400	50,350	41,710	80,840	60,990	57,870	57,560	37,670	56,240	49,500	43,640	603,800
1949-51	55,450	47,800	44,540	51,040	59,740	58,740	61,540	53,090	62,520	48,070	59,670	652,300
1951-52	60,880	46,470	61,330	62,620	73,400	64,280	68,820	33,680	27,420	34,860	53,070	618,400

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska—Continued

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
Boeclus power canal near Boeclus													
1951-52.....											25, 630	28, 540	
Middle Loup River at Boeclus													
1936-37.....	50, 160	43, 420	42, 460	22, 280	55, 520	105, 900	51, 610	50, 650	57, 290	49, 200	38, 430	46, 960	
1937-38.....				51, 150	49, 820	73, 770	61, 110	68, 310	45, 600	50, 930	35, 980	43, 050	615, 800
1951-52.....										3, 410	6, 700	7, 230	
South Loup River near Cumro													
1945-46.....	19, 670	10, 340	9, 220	8, 330	10, 590	10, 470	10, 950	8, 830	10, 680	7, 720	5, 600	7, 650	
1946-47.....	7, 620	8, 590	9, 540	9, 790	12, 130	16, 930	8, 920	7, 710	35, 110	12, 830	7, 440	7, 190	151, 000
1947-48.....	7, 240	8, 140	8, 970	6, 850	8, 870	14, 410	14, 530	11, 910	8, 620	11, 620	8, 670	6, 180	116, 300
1948-49.....	8, 580	8, 810	8, 140	7, 540	10, 120	12, 080	10, 440	11, 370	12, 010	7, 740	6, 560	11, 820	119, 000
1949-50.....	8, 850	8, 700	8, 240	8, 710	9, 040	9, 890	10, 560	23, 080	8, 500	10, 030	8, 110	7, 850	111, 000
1950-51.....	9, 550	9, 060	8, 360	10, 190	11, 820	13, 110	10, 660	9, 770	13, 570	10, 560	9, 000	9, 420	129, 100
1951-52.....									7, 230	6, 340	6, 770	6, 200	109, 100
South Loup River at Ravenna													
1940-41.....	7, 380	10, 460	16, 470	14, 580	16, 670	17, 530	16, 280	18, 000	16, 120	9, 570	4, 440	9, 000	156, 500
1941-42.....	8, 580	7, 780	11, 310	9, 650	11, 350	14, 710	10, 190	9, 760	29, 840	9, 690	7, 870	26, 190	159, 600
1942-43.....	7, 890	8, 720	11, 310	8, 190	9, 800	11, 380	14, 110	9, 760	38, 340	16, 050	6, 380	6, 050	151, 300
1943-44.....	6, 310	8, 250	7, 380	8, 850	12, 080	13, 110	20, 280	22, 560	14, 280	9, 860	6, 510	6, 160	137, 900
1944-45.....	6, 230	8, 250	7, 380	8, 850	12, 080	13, 110	20, 280	22, 560	14, 280	9, 860	6, 510	6, 160	137, 900
1945-46.....	6, 230	8, 250	7, 380	8, 850	12, 080	13, 110	20, 280	22, 560	14, 280	9, 860	6, 510	6, 160	137, 900
1946-47.....	28, 430	14, 600	10, 650	10, 580	10, 670	14, 130	9, 800	10, 580	46, 120	9, 810	10, 290	7, 300	158, 200
1947-48.....	8, 000	14, 700	10, 650	10, 200	14, 100	14, 280	14, 230	10, 140	11, 670	8, 200	4, 650	9, 300	115, 400
1948-49.....	7, 500	9, 360	8, 450	5, 700	12, 420	27, 670	11, 010	9, 350	17, 470	18, 960	7, 410	7, 190	243, 600
1949-50.....	9, 730	10, 080	8, 780	7, 540	10, 700	19, 550	19, 550	15, 960	26, 120	17, 700	14, 540	5, 930	163, 100
1950-51.....	10, 560	10, 810	10, 900	9, 150	11, 350	12, 510	13, 950	30, 370	19, 640	15, 630	9, 300	9, 850	188, 600
1951-52.....	10, 900	11, 650	9, 430	9, 850	14, 710	19, 080	14, 290	13, 300	8, 300	6, 610	5, 750	5, 220	128, 500

Mud Creek near Broken Bow

1949-50	42	50	46	41	64	100	93	113	73	596	355	70	1,640
1950-51	69	69	74	72	70	87	108	291	189	602	142	99	1,880
1951-52	81	86	105	87	107	220	143	126	59	40	44	25	1,130

Mud Creek near Sweetwater

1945-46	9,480	1,710	1,680	1,830	4,100	2,270	2,230	2,080	59,620	4,600	440	1,650	92,520
1946-47	1,230	1,640	1,640	2,430	3,980	18,920	2,460	1,880	5,300	5,230	1,580	1,340	54,320
1947-48	1,110	1,320	1,380	1,590	3,980	4,270	3,050	2,860	6,340	2,210	6,800	996	54,320
1948-49	1,370	1,400	1,370	1,120	2,360	2,760	2,500	4,200	3,370	11,720	7,820	3,430	32,440
1949-50	3,160	2,030	1,670	1,760	1,980	2,280	2,800	5,640	5,510	6,970	4,070	2,300	42,290
1950-51	2,070	2,060	1,850	2,730	3,400	5,050	2,780	2,350	1,570	1,120	4,873	2,510	40,390
1951-52												851	26,700

South Loup River at St. Michael

1943-44	8,800	10,440	9,900	10,120	12,510	15,060	26,370	32,380	17,850	12,300	7,440	7,830	171,000
1944-45	9,220	11,350	8,940	10,450	14,600	12,590	13,340	20,490	66,270	17,010	11,570	8,000	203,800
1945-46	9,810	10,430	8,370	11,540	11,800	15,600	10,610	12,110	16,160	9,093	4,880	11,560	132,000
1946-47	38,070	16,160	12,420	12,000	18,220	18,050	17,310	12,340	163,100	24,090	9,080	8,520	349,400
1947-48	8,940	11,720	12,090	11,840	21,820	46,910	13,100	11,480	25,870	23,160	23,670	7,040	197,900
1948-49	8,580	10,950	10,610	8,910	15,070	29,000	23,240	20,380	31,570	9,390	7,650	22,040	197,900
1949-50	11,460	11,420	10,620	9,650	17,160	19,020	15,150	20,780	15,900	25,760	16,360	12,380	185,700
1950-51	14,100	12,280	10,700	10,620	12,970	14,330	17,880	34,570	26,240	25,190	16,070	13,590	208,500
1951-52	12,950	12,750	11,500	12,240	17,970	26,460	18,290	16,250	9,750	8,530	6,460	6,280	159,400

Oak Creek near Danneberg

1949-50	64	66	70	60	348	480	130	1,390	1,220	8,370	579	91	12,870
1950-51	182	92	130	87	133	179	1,180	2,830	1,600	2,510	238	538	9,700
1951-52	104	120	74	172	290	699	258	233	53	319	23	8,5	2,350

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska—Continued

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
Middle Loup River at St. Paul													
1927-28	70,100	80,900	29,900	33,800	41,300	128,000	91,000	127,100	102,000	76,900	53,900	56,300	886,000
1928-29	61,500	44,000	29,900	43,900	134,000	83,000	107,000	124,000	155,000	45,100	86,100	60,700	991,000
1929-30	103,000	78,000	97,800	90,400	89,400	89,200	73,600	70,100	53,400	47,100	41,200	46,300	862,000
1931-32	71,300	60,700	97,800	58,000	82,800	94,700	66,000	90,400	179,000	69,500	87,200	63,100	1,021,000
1932-33	68,900	50,600	45,400	68,200	50,600	100,000	75,000	89,200	48,000	69,500	78,700	63,100	807,000
1933-34	62,800	68,970	78,700	64,560	61,040	66,410	69,130	57,470	52,370	44,540	52,890	59,290	738,200
1934-35	78,030	80,730	43,530	46,600	84,580	73,550	94,330	131,000	163,000	89,400	92,030	82,080	1,058,000
1935-36	84,670	83,370	62,180	42,370	48,800	182,700	69,050	64,650	54,580	35,770	41,150	48,480	817,800
1936-37	50,880	48,460	49,560	18,140	57,230	144,600	66,400	71,880	81,980	52,310	45,640	71,950	759,000
1937-38	68,560	41,660	47,110	74,400	58,770	90,390	64,470	134,400	84,620	109,500	38,110	50,480	843,300
1938-39	54,830	57,220	92,160	54,190	65,410	80,350	54,600	62,020	74,880	41,390	34,500	31,310	709,600
1939-40	50,410	62,880	62,810	35,540	78,920	95,810	79,290	83,120	76,050	23,400	28,950	39,010	665,000
1940-41	61,020	54,460	48,710	63,510	41,970	80,350	64,470	50,460	95,740	41,870	27,140	53,900	759,200
1941-42	54,570	44,850	55,740	53,210	51,030	93,080	64,430	86,720	118,700	37,620	53,390	94,900	808,200
1942-43	65,610	76,890	41,880	39,230	58,550	74,160	69,440	52,190	111,200	55,310	37,160	55,310	782,000
1943-44	57,880	61,400	53,630	61,980	85,610	95,070	118,800	105,300	85,510	56,430	37,610	47,080	821,800
1944-45	63,510	61,690	46,610	63,790	60,520	64,810	74,980	92,790	134,500	52,420	52,140	47,480	889,600
1945-46	58,380	53,840	40,580	74,120	71,920	77,240	55,280	56,540	70,090	43,110	30,040	58,480	889,600
1946-47	109,900	67,520	58,200	60,990	65,360	83,350	84,000	59,630	292,300	73,870	35,900	47,380	1,037,000
1947-48	54,660	67,880	65,470	60,580	92,070	151,300	61,450	51,360	96,140	69,390	82,810	39,390	851,200
1948-49	51,710	61,980	52,660	48,160	59,940	125,200	94,600	79,520	118,900	45,460	42,690	70,420	845,700
1949-50	66,630	59,880	49,720	42,860	66,510	88,900	75,850	92,290	56,950	109,900	77,300	58,870	845,700
1950-51	73,570	58,810	56,020	56,560	76,740	77,280	82,410	122,100	98,280	83,970	69,710	77,230	932,700
1951-52	72,600	72,030	43,610	68,720	86,420	97,190	76,890	81,370	40,340	39,550	36,160	39,450	754,300
North Loup River at Brewster													
1944-45	21,170	20,240	18,190	22,180	20,830	27,670	19,540	20,350	17,000	15,220	16,810	10,720	239,600
1945-46	24,130	23,590	23,710	22,410	19,540	23,540	27,130	19,980	27,860	19,790	17,080	18,900	267,700
1946-47	18,730	21,650	23,080	19,140	22,470	20,310	20,060	20,430	19,740	18,620	17,690	17,290	239,200
1947-48	19,380	20,690	18,130	18,300	22,870	37,920	20,420	28,950	27,190	19,100	19,100	19,380	282,400
1948-49	23,050	21,940	19,790	22,470	25,240	26,580	25,590	28,350	21,340	22,140	21,380	22,410	280,300
1949-50	23,060	22,610	22,450	20,760	23,230	24,710	24,290	35,070	44,530	29,390	30,310	31,510	331,800

North Loup River at Taylor

1896-97	26,510	27,050	20,340	25,790	32,420	26,920	25,620	25,280	19,590	18,180	22,600	345,200
1897-98	23,720	26,230	22,630	28,230	38,140	39,550	38,040	26,150	25,150	20,920	24,470	291,700
1898-99	21,360	29,610	29,810	22,310	31,970	25,920	24,080	16,190	16,190	17,300	17,620	287,000
1899-40	18,160	25,100	24,760	32,980	35,480	24,070	18,420	16,930	9,050	10,740	11,890	292,000
1940-41	25,060	29,100	45,370	31,660	31,660	30,520	32,880	18,150	15,100	11,540	17,030	392,500
1941-42	25,770	25,940	31,270	26,930	32,040	30,480	48,090	28,890	16,550	16,830	26,330	332,500
1942-43	20,760	25,390	26,770	32,210	32,210	29,590	22,400	24,940	13,520	9,670	18,580	389,300
1943-44	24,210	26,720	29,400	32,420	37,030	38,540	35,880	38,590	22,920	12,580	17,840	329,800
1944-45	24,460	28,580	30,820	28,840	31,940	35,200	26,660	33,910	22,920	18,370	18,930	326,800
1945-46	35,430	25,380	29,710	28,600	38,770	25,380	24,080	17,460	13,860	10,650	20,840	289,100
1946-47	21,450	29,370	29,490	28,620	35,170	27,090	26,500	40,850	23,550	11,860	18,510	345,000
1947-48	19,840	25,580	22,830	28,620	27,130	37,130	21,110	21,010	14,660	20,200	15,190	276,600
1948-49	26,940	25,250	22,530	27,150	46,040	39,430	34,520	26,240	19,590	18,470	22,030	328,500
1949-50	28,710	26,950	25,280	31,950	34,520	37,510	37,510	24,030	26,110	27,460	26,890	349,600
1950-51	32,960	29,140	36,420	38,520	42,510	43,280	39,790	51,210	35,180	32,130	39,590	402,000
1951-52	28,180	29,140	36,420	38,520	42,510	43,280	39,790	21,930	13,910	17,740	15,900	364,300

North Loup River at Burwell

1896-97	44,080	45,800	34,340	42,670	54,380	43,890	45,080	40,070	34,550	35,350	39,330	582,300
1937-38	42,150	40,400	35,180	34,250	55,480	59,190	60,010	45,420	40,710	36,400	39,020	

Calamus River near Harrop

1931-32	16,300	13,500	13,500	13,600	15,100							
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Calamus River near Burwell

1940-41	14,840	14,970	15,100	12,840	15,830	15,530	15,520	14,830	13,530	12,650	14,750	176,000
1941-42	16,230	15,360	14,820	14,650	17,750	16,720	19,110	15,960	14,740	14,160	16,010	189,800
1942-43	16,920	16,800	14,240	15,680	21,450	17,220	16,580	18,140	14,740	14,440	14,780	196,600
1943-44	15,780	15,740	16,390	15,320	17,830	18,170	17,990	18,080	15,470	14,130	14,170	195,100
1944-45	15,780	14,900	16,400	15,870	16,040	16,400	16,070	16,790	14,640	14,640	14,430	188,100
1945-46	15,430	15,430	17,080	14,960	17,680	14,490	15,380	13,410	13,660	13,310	14,680	180,800
1946-47	18,190	16,850	16,470	15,960	16,080	16,820	15,000	21,660	15,600	15,380	14,630	199,000
1947-48	15,720	15,840	16,200	16,880	16,530	15,630	15,700	15,210	13,960	14,870	13,960	186,500
1948-49	15,130	17,010	15,850	16,420	22,530	22,150	18,750	19,460	15,950	17,080	16,410	211,000
1949-50	17,530	16,770	15,450	16,280	20,760	21,290	18,520	18,250	16,370	18,490	18,810	218,900
1950-51	18,670	17,930	16,400	16,560	18,780	19,920	22,940	22,940	19,450	22,850	23,390	241,100
1951-52	22,440	21,060	23,550	22,560	23,520	23,520	26,810	17,990	17,810	18,460	16,870	253,800

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska—Continued

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
North Loup River at Ord													
1936-37			43,430	33,080	43,180	57,020	47,050	48,480	40,500	39,060	37,480	43,450	
1937-38			39,770	38,400	39,070	63,970	57,880	64,580	48,020	43,080	37,460	43,600	563,900
1951-52	46,210	41,860								29,100	39,680	34,640	
North Loup River at Scotia													
1936-37			46,510	32,820	43,090	62,410	47,250	47,080	43,750	39,810	35,390	40,990	
1937-38			40,140	41,550	42,130	69,730	56,230	71,100	54,790	50,230	38,990	44,820	600,600
1938-39			50,990	58,190	32,360	59,270	46,230	45,950	51,490	25,380	30,080	36,260	525,700
1939-40			45,990	34,830	46,900	64,710	45,690	37,870	46,870	18,470	20,450	20,450	472,500
1940-41			50,990	49,650	50,110	64,840	54,890	42,630	42,180	24,090	14,410	38,370	508,500
1941-42			49,290	39,190	28,850	46,070	52,780	82,440	73,250	27,890	25,480	54,340	583,700
1942-43			45,160	38,140	48,950	50,530	54,720	41,120	53,080	34,010	14,500	38,740	514,100
1943-44			42,080	50,620	52,050	56,320	66,660	80,460	66,310	37,550	20,760	34,700	584,400
1944-45			43,200	53,410	50,990	58,590	53,410	75,970	69,240	47,150	30,570	33,710	611,600
1945-46			33,560	54,030	52,420	62,170	49,800	42,750	38,450	21,670	15,250	42,980	501,500
1946-47			48,750	51,330	54,110	59,320	59,800	45,730	124,600	41,870	18,750	35,200	665,800
1947-48			60,300	47,420	65,970	69,510	47,870	38,420	60,010	34,510	50,130	28,960	596,800
1948-49			47,600	46,990	48,810	89,570	77,970	60,010	63,570	34,510	32,110	44,800	640,800
1949-50			44,360	46,350	47,790	77,990	64,350	73,110	44,970	96,220	66,450	47,380	709,200
1950-51			54,870	49,490	55,070	59,210	65,130	81,850	85,390	66,950	66,450	73,720	769,700
1951-52	65,120	58,970	50,370	60,620	78,450	70,510	73,770	76,010	37,420	25,190	33,320	34,490	664,400
Davis Creek near Cotesfield													
1948-49			122	65	375	831	311	520	1,300	116	209	137	
1949-50	86	136								4,060	307	100	7,050
1950-51	285	145	184	114	218	204	268	857	1,050	1,330	1,050	1,110	6,860
1951-52	180	188	178	205	119	842	238	203	108	135	43	26	2,460
North Loup River near Cotesfield													
1950-51	60,120	55,570	54,510	49,770	55,150	60,070	64,650	83,170	85,730	70,450	77,500	72,380	789,100
1951-52	65,580	59,380	51,850	59,590	79,680	77,550	73,710	75,750	38,470	24,750	37,180	34,620	678,100

North Loup River near St. Paul

1927-28	57,400	43,000	41,600	104,000	75,000	70,200	57,900	42,600	46,900	728,000
1928-29	55,700	40,600	38,500	60,900	58,700	84,200	43,000	47,000	46,700	723,000
1929-30	66,000	60,900	80,000	67,400	61,900	56,000	48,700	43,200	43,000	693,000
1930-31	63,000	57,400	61,700	78,700	68,900	68,000	48,700	43,500	43,900	743,000
1931-32	54,500	52,400	52,700	58,900	57,900	68,000	53,800	51,000	42,700	623,000
1932-33	45,700	46,400	39,500	64,600	61,300	75,800	53,800	45,000	45,350	623,500
1933-34	45,700	50,640	46,120	48,410	47,210	43,240	30,760	38,660	41,750	702,900
1934-35	48,880	33,910	39,230	55,040	58,720	89,660	50,750	40,650	41,750	536,900
1935-36	47,600	49,470	37,400	159,290	47,210	89,660	28,810	33,240	36,330	632,300
1936-37	49,500	42,300	42,310	78,830	48,580	59,160	40,960	36,200	41,170	542,800
1937-38	43,100	38,480	45,170	41,810	51,290	52,110	28,810	36,200	41,170	517,900
1938-39	41,650	53,900	63,360	36,940	48,580	63,520	40,960	27,940	39,260	636,600
1939-40	34,950	48,540	31,810	71,800	51,890	46,650	23,960	24,840	29,080	550,800
1940-41	35,020	46,970	45,880	67,900	46,850	50,440	15,490	17,780	19,420	484,700
1941-42	46,920	48,400	49,220	67,900	46,850	50,440	25,420	13,000	42,150	538,900
1942-43	45,350	48,830	35,620	65,980	55,390	91,600	25,420	30,290	58,240	636,600
1943-44	37,100	46,810	51,130	65,420	49,590	77,740	28,810	30,290	39,730	638,000
1944-45	48,300	46,550	56,130	62,090	53,450	86,210	41,590	14,660	38,720	634,900
1945-46	47,440	39,130	51,130	63,730	74,340	71,760	40,650	23,660	32,980	638,000
1946-47	71,740	37,350	50,200	60,260	54,670	77,080	57,310	14,610	45,540	516,000
1947-48	43,870	59,080	51,850	64,660	64,660	47,720	25,280	17,660	34,620	708,600
1948-49	40,830	45,060	46,650	65,360	79,490	69,310	39,760	70,170	27,730	659,300
1949-50	52,460	44,110	39,780	85,530	50,540	72,360	36,700	32,660	44,210	723,000
1950-51	61,400	46,170	40,700	104,600	87,680	63,750	103,000	55,450	48,300	817,200
1951-52	65,060	53,570	60,750	87,680	65,680	85,300	75,180	84,970	78,610	723,000
				86,910	73,690	76,170	27,120	35,750	35,250	693,100

Spring Creek at Cushing

1948-49	264	247	733	1,310	426	2,340	458	545	384	14,410
1949-50	582	269	295	1,598	1,880	2,010	8,320	865	263	14,060
1950-51	500	467	889	889	1,600	481	1,280	2,182	1,133	6,220
1951-52										

Cedar River near Spalding

1944-45	7,580	7,210	6,510	5,650	8,170	9,760	8,470	6,760	5,950	81,330
1945-46	11,240	10,270	6,100	7,320	7,320	7,250	6,950	6,620	6,480	122,700
1946-47	7,330	7,820	7,380	8,770	10,890	30,940	8,980	6,420	7,570	81,330
1947-48	6,480	6,790	7,480	8,980	7,550	7,790	6,450	6,550	6,480	90,760
1948-49	7,460	7,540	7,690	11,350	17,700	10,640	6,750	6,750	7,170	103,800
1949-50	12,040	7,920	7,960	10,930	12,360	11,060	11,940	11,300	10,450	121,200
1950-51	12,470	10,160	10,080	11,810	13,260	12,790	15,900	15,900	15,540	146,100
1951-52				15,840	14,040	8,060	8,080	7,700	6,810	133,500

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska—Continued

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
Cedar River near Fullerton													
1931-32	11,300	11,500	14,800	9,590	12,100	18,500	13,000	12,200	20,100	9,080	6,660	11,380	144,400
1940-41	10,130	9,650	10,460	11,310	13,330	15,060	15,530	14,300	17,610	7,920	7,900	10,270	124,800
1941-42	11,340	10,240	8,010	10,170	8,300	14,270	10,640	12,300	13,410	7,920	7,900	8,730	171,100
1942-43	8,860	9,690	9,370	8,690	23,210	10,960	11,940	17,420	40,920	14,460	7,160	9,810	156,400
1943-44	9,290	10,070	9,230	11,070	13,750	12,330	18,530	21,810	18,900	12,100	9,650	8,030	147,600
1944-45	10,580	11,060	10,840	12,180	10,730	14,850	13,070	15,520	19,230	12,710	8,900	8,030	147,600
1945-46	10,060	10,160	8,070	11,920	13,150	13,890	10,480	18,600	18,990	10,880	8,760	12,950	147,600
1946-47	18,240	15,760	10,140	10,640	14,380	15,290	17,210	20,660	85,470	18,370	9,060	9,220	244,400
1947-48	10,440	12,270	12,300	11,840	38,310	18,300	11,690	11,270	21,700	16,080	20,180	8,770	193,200
1948-49	9,950	11,350	11,210	8,430	8,930	20,340	26,260	17,600	20,240	11,070	10,290	11,370	167,000
1949-50	11,760	11,320	9,030	8,780	11,370	21,290	16,920	20,540	18,940	84,530	20,700	14,520	250,000
1950-51	16,820	13,830	12,210	11,890	11,560	19,910	22,040	30,300	25,280	20,410	24,660	24,900	233,800
1951-52	17,500	16,200	13,040	15,270	26,490	26,300	19,700	19,730	12,920	11,370	12,000	10,270	200,800
Loup River power canal near Genoa													
1936-37	33,440	32,530	5,800	7,340	4,610	6,790	7,520	8,330	11,060	23,570	22,620	21,000	423,200
1937-38	35,250	30,220	27,030	29,690	31,600	38,570	37,430	39,460	31,770	39,900	42,260	39,270	471,100
1938-39	65,180	81,860	52,320	49,960	25,670	31,040	31,940	48,800	46,270	44,000	53,140	59,160	760,300
1939-40	91,320	77,230	77,230	77,780	92,180	108,500	82,010	92,310	79,700	42,100	52,860	104,700	1,105,000
1941-42	122,400	108,900	79,860	81,960	52,680	100,200	116,500	115,100	131,000	71,180	71,470	108,900	1,135,000
1942-43	108,400	108,200	89,040	81,030	97,510	68,740	98,900	96,210	105,900	92,350	48,940	83,920	1,077,000
1943-44	95,170	110,600	77,160	83,310	74,890	94,510	166,400	125,700	130,900	94,100	57,850	87,990	1,198,000
1944-45	109,100	102,800	38,640	81,020	60,320	110,500	130,500	117,500	137,400	107,300	83,120	76,900	1,185,000
1945-46	107,400	101,300	62,570	106,000	85,750	140,900	103,400	104,900	94,690	75,070	48,680	108,800	1,189,000
1946-47	149,900	138,100	84,730	85,240	87,020	107,200	134,300	119,700	126,900	123,900	55,120	84,810	1,297,000
1947-48	105,200	117,400	72,290	52,020	39,950	88,320	160,700	97,350	118,400	104,000	180,000	71,620	1,094,000
1948-49	101,500	98,430	78,390	79,110	85,510	121,200	160,700	160,300	154,700	98,240	80,410	114,600	1,328,000
1949-50	126,600	125,100	46,650	71,540	103,200	92,030	145,700	182,000	112,400	142,500	123,200	117,800	1,346,000
1950-51	132,600	84,040	76,400	93,560	79,850	71,240	136,400	166,400	153,600	141,600	136,700	157,100	1,415,000
1951-52	156,300	73,640	64,960	97,900	75,960	70,530	116,700	143,600	87,280	71,830	75,280	76,460	1,110,000

Loup River near Genoa

1927-28	140,000	171,000	86,100	89,200	303,000	261,000	240,000	200,000	162,000	106,000	116,000	1,990,000
1928-29	148,000	92,000	57,900	92,200	173,000	227,000	269,000	262,000	105,000	165,000	152,000	1,980,000
1929-30	185,000	147,000	188,000	180,000	174,000	161,000	163,000	140,000	110,000	95,900	90,400	1,800,000
1931-32	2,460	8,070	23,430	48,620	63,370	51,390	87,380	44,450	10,800	5,440	3,560	440,700
1943-44	3,280	10,560	56,460	43,980	49,910	14,030	90,280	118,800	28,240	6,080	6,450	464,500
1944-45	3,020	14,100	14,110	20,110	35,800	4,730	17,450	42,960	4,580	2,580	12,480	191,900
1946-47	57,460	11,420	40,820	18,100	68,500	31,640	9,570	438,200	21,860	7,310	5,160	786,800
1947-48	3,790	18,880	64,260	78,840	174,000	5,640	3,280	76,080	22,690	60,940	4,960	710,500
1948-49	3,890	28,680	14,110	21,620	162,000	57,500	14,880	85,130	3,130	3,050	14,460	439,500
1949-50	3,790	3,320	47,790	19,280	17,960	9,500	33,900	17,340	281,300	37,000	5,940	607,500
1950-51	22,580	43,120	43,550	18,080	107,000	40,010	96,920	17,940	36,300	31,440	15,820	585,400
1951-52	5,030	77,300	33,390	31,870	159,100	81,020	36,730	5,040	3,460	6,860	1,820	570,700

Beaver Creek at Loretto

1944-45	2,800	2,500	2,510	3,260	4,620	4,030	7,530	13,140	3,620	2,180	2,060	52,440
1945-46	2,550	2,800	2,800	2,830	4,860	2,690	7,460	3,720	1,780	1,010	2,300	24,460
1946-47	2,450	2,240	3,260	2,240	4,860	3,690	3,690	12,820	2,720	1,760	1,770	24,700
1947-48	2,430	3,260	3,260	3,260	5,870	3,480	3,100	3,240	5,740	4,680	2,000	58,300
1948-49	2,530	3,140	3,460	3,090	12,770	11,860	6,620	6,680	3,670	2,210	2,620	62,300
1949-50	2,030	3,030	3,020	2,260	3,140	11,860	6,210	12,270	16,800	2,070	3,660	72,300
1950-51	4,970	3,510	3,610	2,640	11,690	6,000	10,710	6,020	6,410	9,340	6,720	78,250
1951-52	3,860	4,220	4,300	4,400	5,430	9,490	9,210	3,400	2,780	4,260	2,490	64,400

Beaver Creek at Genoa

1940-41	2,710	2,830	4,270	4,400	9,300	9,780	8,340	9,300	4,610	2,440	7,470	74,270
1941-42	4,150	4,380	4,670	4,540	9,400	8,240	6,350	6,350	5,670	6,410	10,640	90,260
1942-43	4,010	4,290	4,600	4,170	11,700	5,050	6,140	24,720	7,650	3,090	2,760	86,980
1943-44	3,500	3,850	3,650	4,420	6,950	6,140	6,180	26,950	6,670	7,420	4,840	96,070
1944-45	4,180	4,410	4,360	4,680	9,250	6,840	7,920	19,260	10,730	3,980	3,010	84,040
1945-46	3,870	4,130	3,430	3,570	6,770	4,760	7,200	19,260	3,010	2,670	4,670	56,600
1946-47	8,630	6,640	5,360	4,860	9,660	9,430	7,200	40,900	6,030	2,930	3,020	115,200
1947-48	3,590	4,740	4,540	4,860	10,100	5,580	5,320	10,560	10,560	10,950	3,510	102,600
1948-49	3,710	4,580	4,970	4,340	17,640	16,490	11,650	28,250	5,960	7,060	5,390	107,600
1949-50	4,750	4,780	4,550	3,860	17,400	16,390	11,650	28,250	76,720	12,190	5,690	179,800
1950-51	7,080	5,430	5,490	5,490	24,430	14,790	15,810	11,930	10,260	20,160	12,800	138,700
1951-52	7,040	6,780	6,190	5,730	13,800	12,810	11,730	6,890	5,350	8,470	4,660	99,530

TABLE 2.—Monthly and annual discharge, in acre-feet, of streams in the Loup River drainage basin, Nebraska—Continued

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1900-01							193,626	144,250	206,300	98,934	84,668	169,765	
1901-02	137,716	138,842				143,385	143,385	198,334	193,375	348,530	293,115	191,487	
1902-03	185,116	143,859				239,623	239,623	251,177	189,699	211,180	330,373	164,410	
1903-04	171,919	203,544											
1905-06								282,000	172,000	171,000	192,000	155,000	
1906-07	202,000	165,000											
1911-12	151,000	161,000					564,000	319,000	226,000	124,000	137,000	165,000	
1912-13	134,000	156,900					259,000	267,000	167,000	136,000	121,000	121,000	
1913-14	1913-14	129,000					151,000	192,000					
1914-15	136,000		114,000	139,000	183,000	172,000	338,000	212,000	374,000	338,000	291,000	287,000	2,643,000
1930-31					183,000	170,000	162,000	154,000	132,000	111,000	95,300	94,000	918,000
1933-34	138,300	150,800	176,800	116,800	122,500	148,100	163,400	111,800	112,100	76,000	97,680	139,000	1,553,000
1934-35	154,300	143,200	93,120	91,670	180,700	150,600	163,400	111,800	112,100	76,000	97,680	139,000	2,294,000
1935-36	123,200	151,100	131,200	83,220	87,810	419,700	266,100	292,100	450,500	172,900	146,100	153,200	1,599,000
1936-37	120,600	128,800	150,500	50,040	107,700	169,400	143,900	184,300	114,900	66,290	85,170	99,650	1,589,000
1937-38	106,600	98,020	79,760	73,370	75,250	192,300	130,700	160,300	188,700	134,600	78,940	107,600	1,380,000
1938-39	85,860	93,940	124,400	119,200	62,700	192,300	122,000	190,700	150,300	139,900	44,500	107,600	1,380,000
1939-40	25,460	31,900	54,890	34,290	74,680	197,300	119,400	145,000	114,000	53,880	29,610	10,660	1,151,000
1940-41	13,790	32,030	33,610	59,520	117,400	94,130	53,610	23,640	117,100	5,120	6,950	4,510	629,400
1941-42	15,220	17,040	30,330	56,040	61,410	120,300	34,300	47,320	69,230	34,350	4,990	15,640	556,300
1942-43	11,530	13,500	17,620	9,100	68,640	66,320	53,180	78,830	137,900	18,170	16,870	79,180	655,000
1943-44	6,630	12,060	26,890	53,910	107,100	74,370	82,990	18,350	176,500	60,290	6,170	7,510	508,700
1944-45	9,980	25,750	52,240	52,820	57,290	72,820	27,380	138,900	59,150	31,750	19,850	13,360	628,000
1945-46	9,620	23,410	29,790	23,820	77,850	57,290	27,380	62,930	140,900	59,350	14,250	11,040	591,500
1946-47	83,590	31,700	43,980	25,600	59,420	78,200	13,490	37,310	77,230	9,360	6,790	22,930	343,200
1947-48	10,140	25,400	54,900	82,020	189,100	233,200	50,680	29,710	498,270	42,630	12,930	10,460	826,700
1948-49	9,130	27,440	58,940	15,650	27,510	205,500	18,330	14,810	82,420	38,200	68,000	10,210	896,200
1949-50	11,460	11,860	54,290	23,680	25,050	139,900	19,620	37,820	102,700	14,070	13,130	23,220	603,400
1950-51	26,130	49,900	50,900	23,460	77,160	138,900	62,670	104,200	98,100	343,700	62,810	14,780	808,300
1951-52	16,670	79,820	44,690	38,170	134,800	163,700	94,410	60,490	14,650	15,190	19,830	8,930	785,500

Loup River at Columbus

however, about 87 percent of the surface contributes direct overland runoff to stream discharge. This runoff, consisting of rainfall and snowmelt, reaches the streams at irregular intervals and produces a less uniform rate of discharge. For example, during the 3 water years 1950-52, the variation in annual discharge of Oak Creek near Dannebrog, Davis Creek near Cotesfield, and Spring Creek at Cushing was 126, 84, and 177 percent, respectively, of the average annual discharge during the same period. Stream discharge at most other stations in the loess plains and hills part of the basin has a wide variation because the discharge is derived largely from overland runoff and, in addition, is regulated or is affected by electric-power developments, surface diversions and ground-water withdrawals for irrigation, and return flow from irrigated areas.

The sum of the discharges of Middle Loup River at Walworth, North Loup River at Taylor, Calamus River near Burwell, and Cedar River near Spalding is virtually equal to total runoff from the Sand Hills part of the Loup River drainage basin. (See fig. 12.) Similarly, the sum of the discharges of the Loup River power canal near Genoa and Loup River at Columbus is virtually equal to total runoff from the basin. Runoff from the loess plains and hills part of the area is determined by computing the difference between total runoff from the Sand Hills part of the basin and total runoff from the entire basin. As shown in table 3, the runoff from the loess plains and hills part of the basin is less than from the Sand Hills part, even though precipitation on the loess plains and hills part is greater. Doubtless the greater moisture-storing capacity of the cultivated loessial soils and consequent greater water loss through evapotranspiration accounts for the smaller proportion of precipitation reaching the streams by either overland or subterranean routes.

TABLE 3.—Runoff from the Sand Hills part and the loess plains and hills part of the Loup River drainage basin

Water year	Runoff							
	Sand Hills part of the basin				Loess plains and hills part of the basin			
	Acres-foot	Feet	Inches	Percent of precipitation	Acres-foot	Feet	Inches	Percent of precipitation
1948.....	1, 115, 000	0. 202	2. 42	12. 5	805, 900	0. 190	2. 28	10. 0
1949.....	1, 221, 000	. 227	2. 72	10. 9	710, 100	. 167	2. 01	7. 8
1950.....	1, 268, 000	. 241	2. 90	12. 1	886, 600	. 209	2. 51	10. 3
1951.....	1, 405, 000	. 273	3. 28	12. 0	794, 800	. 187	2. 25	8. 1
1952.....	1, 355, 000	. 263	3. 16	19. 0	446, 400	. 105	1. 26	7. 1

NATURAL VEGETATION

Except where cultivated crops are grown, native grass is the predominant vegetation. The main grasses are known locally as needle grass, bunch grass, long-leaved reed grass, and blowout grass. The grasses grow luxuriantly in the valleys where they are amply supplied with moisture, but on the higher sandhills they are thin and interspersed with small woody plants, such as the wildrose, sandcherry, soapweed, wild licorice, and prickly pear.

Trees, such as green ash, boxelder, cottonwood, willow, and hackberry, and shrubs, such as choke cherry and wild plum, thrive along the streams. Cottonwoods have been planted in many of the hay flats. The Nebraska National Forest (Bessey Division), which was established in 1902, lies between the Middle Loup and Dismal Rivers near their confluence. It is a typical sand-dune area that has been planted to conifers. The dark patches at the top of figure 8 are planted areas in the forest.

POPULATION

The population of the Loup River drainage basin is not known but probably is about 120,000. Broken Bow, with a population of 3,400 is the largest town; and Ord and Albion have populations greater than 2,000. Fullerton, St. Paul, Ravenna, Loup City, Burwell, and Genoa are the only other towns having more than 1,000 residents. The density of the rural population ranges from about 16 per square mile at the lower end of the basin to 1 per square mile at the upper end.

AGRICULTURE AND INDUSTRY

Livestock raising and general farming are the chief sources of income in the Loup River drainage basin. Milling of grain and generation of electricity are the only industries of economic importance.

In the Sand Hills part of the basin nearly all the land is used as pasture for beef cattle or for growing wild hay. The average size of ranches is about 2,000 acres. In the lower part of the basin, about half the land is cultivated and half is used for pasture or for growing hay. Corn is the principal crop, although oats, alfalfa, and wheat also are economically important. Hogs and beef cattle are the principal livestock in this part of the basin and are about of equal economic value. About three-fourths of the corn and other grain is fed to livestock on the farm where grown. The average size of farms in this part of the basin is about 320 acres.

Water is diverted from the Middle and North Loup Rivers for irrigation of valley lands. The Middle Loup Public Power and Irrigation District provides for irrigation of land on both sides of the

stream, from a few miles southeast of Sargent and continuing downstream for about 40 miles to a point about 8 miles southeast of Loup City. The Almeria Public Power and Irrigation District diverts water from the North Loup River near the Blaine-Loup County line for irrigation of valley land within Loup County. The North Loup Public Power and Irrigation District irrigates land on both sides of the stream from about 17 miles west of Burwell to near Scotia—a distance of about 45 miles. In many places, water for irrigation is pumped directly from streams. The U.S. Bureau of Reclamation has proposed construction of several reservoirs and irrigation of considerably more land, some of which is upland. In addition, it proposed diversion of water out of the Loup River drainage basin to irrigate land in the Platte River valley.

In 1952, when this reconnaissance was made, there were 352 irrigation wells in the Loup River drainage basin. Most of them were in the valleys and some were within the areas supplied by diverted river water.

In southwestern Howard County, water is diverted from the Middle Loup River into a canal which carries water to the Boelus powerplant and then discharges it into the South Loup River just above the point where the South Loup enters the Middle Loup. In eastern Nance County, about 6 miles southwest of Genoa, the Loup River Public Power District diverts water from the Loup River for generation of electricity at its powerplants near Monroe and near Columbus. There are onstream powerplants near Callaway on the South Loup River, near Sargent on the Middle Loup River, near Ericson, Spalding, and Fullerton on the Cedar River, and near St. Edward on Beaver Creek. The Bureau of Reclamation has made studies of several possible sites for additional hydroelectric powerplants.

GEOLOGY

Almost anywhere in the westernmost part of the Loup River drainage basin a hole drilled to bedrock of Cretaceous age would penetrate first the unconsolidated deposits of Quaternary age and then, in the order named, the following semiconsolidated deposits of Tertiary age: the Ogallala formation (Pliocene), the Hemingford group of Lugin (1938) and the Arikaree group (Miocene), and the White River group (Oligocene). At the lower end of the drainage basin, where the Loup River enters the Platte River valley, a hole drilled to bedrock would penetrate only deposits of Quaternary age before reaching strata of Cretaceous age. Obviously, therefore, the deposits of Tertiary age pinch out somewhere between the upper and lower ends of the basin. The combined thickness of the deposits of Quaternary and

Tertiary age at points where penetrated by test drilling is shown in figure 13.

The surface of the rocks of Cretaceous age is a buried peneplain which was produced by stream erosion early in the Tertiary period. Evidence obtained by drilling exploratory test holes and wells, data for which are on file in the offices of the Conservation and Survey Division of the University of Nebraska, indicates that this surface is 2,410 feet above sea level at its highest known point near the upper end of the Loup River drainage basin and that it may be as high as 2,862 feet in western Cherry County outside the basin. Although the surface is lowest, below 1,300 feet, at the extreme lower end of the Loup River drainage basin, it does not slope uniformly southeastward; test drilling has shown it to be almost as low at some points in eastern Cherry County as it is at the lower end of the drainage basin. (See fig. 13.)

The Cretaceous and older strata are warped into several broad flexures. (See fig. 14.) The axis of one anticline, the Siouxana arch, extends northeastward from central Hooker County; and the axis of another, the Chadron-Cambridge arch, crosses the drainage basin from northwestern McPherson County to central Sheridan County. Several synclinal axes extend into the drainage basin; one enters in central Buffalo County and disappears in southeastern Thomas County; another extends southeastward into the drainage basin for a short distance in east-central Cherry County; and a third crosses the lower end of the drainage basin.

Throughout nearly the entire Loup River drainage basin, the buried peneplain transects strata of only the marine Pierre shale of Late Cretaceous age (fig. 14). The maximum thickness of this formation within the basin is not known but possibly is as much as 2,000 feet in the western part. East of a north-northeastward-trending line through western Nance County, peneplanation completely removed the Pierre shale and exposed older formations, also of marine origin and of Late Cretaceous age. The formations thus truncated within the Loup River drainage basin include the Niobrara formation, which underlies the Pierre shale and is about 200 feet thick, the Carlile shale, about 150 feet thick, and possibly older Late Cretaceous strata. The importance of the Cretaceous formations as potential sources of water supply is considered negligible not only because ample supplies of ground water can be obtained from younger rocks, but also because the Cretaceous formations probably would not yield large supplies of water of good quality.

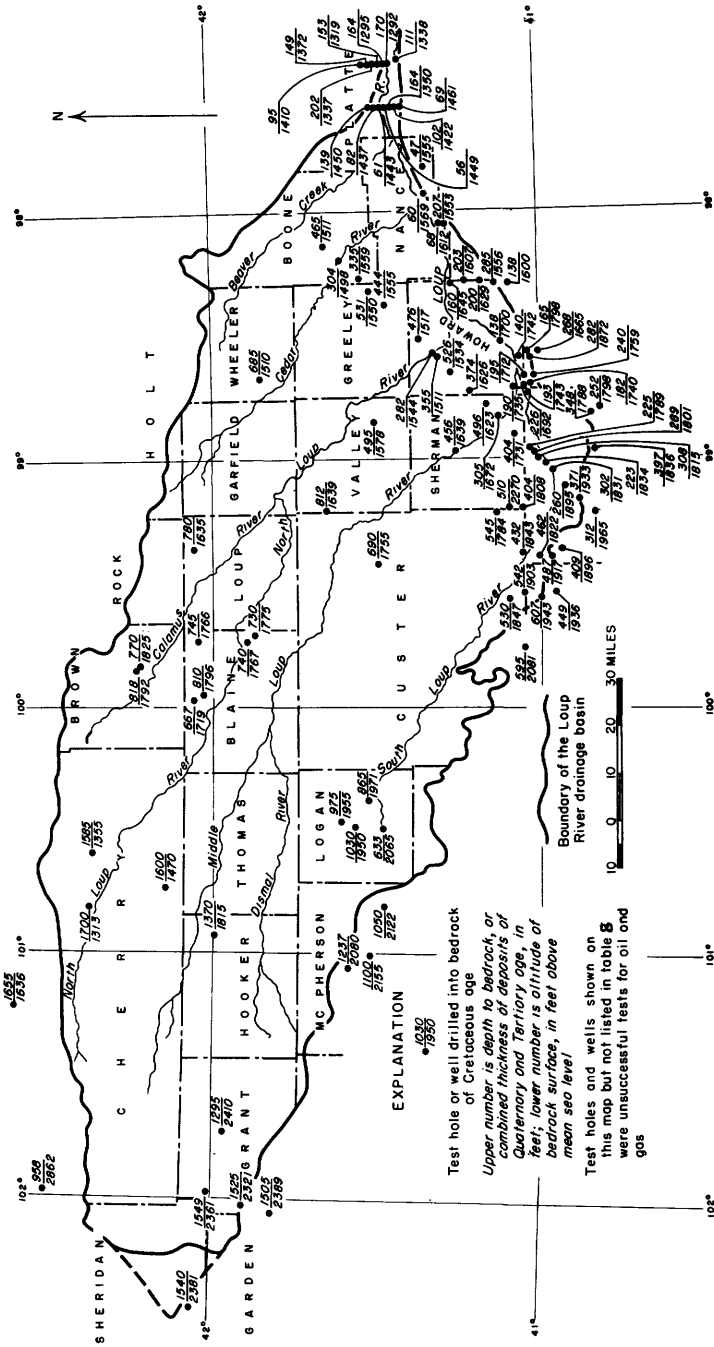


FIGURE 13.—Map showing depth to, and altitude of, the Cretaceous bedrock surface in the Loup River drainage basin.

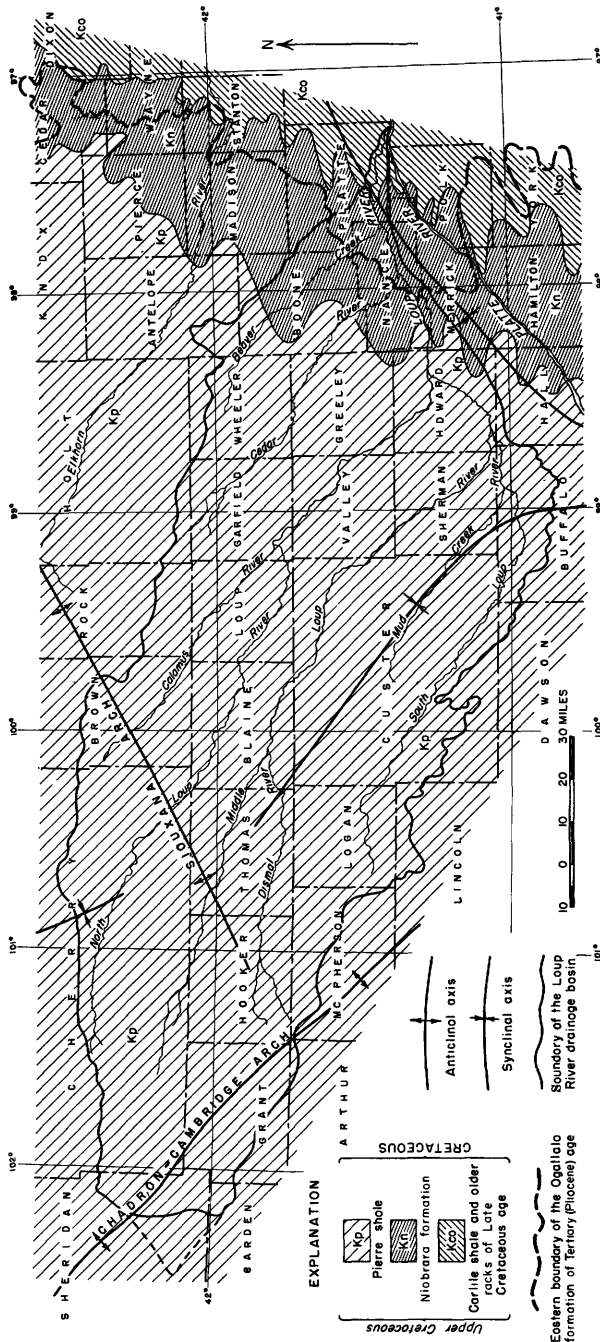


FIGURE 14.—Subsurface geologic map of the Cretaceous bedrock in the Loup River drainage basin, showing also the areal extent of the Ogallala formation of Tertiary (Pliocene) age.

TERTIARY SYSTEM

The eastward-thinning wedge of Tertiary deposits consists of rock fragments that were derived from the higher slopes and mountain ranges to the west and carried into the basin by the wind and by streams. Where these deposits are exposed outside the Loup River drainage basin, they have been subdivided, in ascending order, into the following formations: the Chadron formation and Brule clay of the White River group; the Gering, Monroe Creek, and Harrison sandstones of the Arikaree group; the Marsland and Sheep Creek formations (the Hemingford group of Lugn, 1938); and the Ogallala formation (the Ogallala group, as used by the Nebraska Geological Survey).

The Chadron formation of the White River group is composed principally of greenish to buff clay and silt; locally, at its base, it contains sandstone that was deposited in stream channels. Where exposed in Sioux and Dawes Counties, Nebr., the Chadron is as much as 100 feet thick, but its maximum thickness within the Loup River drainage basin is not known. Because the Brule clay rests on Cretaceous bedrock along the Niobrara River valley in northeastern Cherry County and northwestern Brown County, it is assumed that the Chadron formation thins eastward and disappears along a sinuous line somewhere west of Thomas County. The Brule clay, the younger formation of the White River group, is composed of pink sandy clay and channel sandstone in its lower part and of pink massive silty clay and thin layers of volcanic ash and sand in its upper part. The maximum thickness of the formation in Nebraska is about 600 feet, but within the Loup River drainage basin it probably is much less. The formation wedges out about halfway between the west and east ends of the basin, or somewhat east of the border of the Chadron formation. The White River group is of Oligocene age.

Streams flowing on the surface of the Brule clay excavated valleys and then filled them with deposits of both flat-bedded and crossbedded gray sand. Not only were the valleys completely filled but the divides between them eventually were buried beneath massive deposits of gray medium-fine sand. These deposits, now referred to as the Gering sandstone of the Arikaree group, were buried in turn by the Monroe Creek sandstone. The Monroe Creek consists in its lower part of massively bedded gray medium-grained sandstone containing "pipy" concretions and in its upper part of pinkish to buff sandy silt and thin layers of cemented concretions and scattered large concretions. Overlying the Monroe Creek are deposits of gray fine sand, the Harrison sandstone, which also contains "pipy" concretions in its lower part. West of the Loup River drainage basin, where these formations

of the Arikaree group are exposed, their aggregate thickness is between 400 and 500 feet. Because they thin to a featheredge in or near western Cherry and Grant Counties, only the westernmost part of the basin is underlain by the Arikaree group. This group is of early Miocene age.

After another period of erosion by streams, sedimentation was renewed. Beds of buff to reddish-brown and gray sand, the Marsland formation, were the first to be deposited, and these were followed by beds of the Sheep Creek formation, which consists of pinkish- to greenish-gray sandy clay and sand, volcanic ash, and pinkish- and brownish-gray clay. The Marsland and Sheep Creek formations have a combined thickness of about 500 feet where they crop out west of the basin, but their maximum thickness within the basin possibly is less. These two units wedge out to the east also, probably along a line fairly close to the featheredge of the Arikaree group. The Marsland and Sheep Creek are of late Miocene age.

Again deposition was interrupted, and streams draining the newly formed constructional plain eroded broad valleys into its surface. Later, the streams began to aggrade their valleys, eventually filling them with sand and burying even the intervalley uplands with layers of gravel, sand, silt, clay, and volcanic ash. Some of the layers later became indurated, forming so-called mortar beds. This mass of deposits, the Ogallala formation, referred to as the Ogallala group by the Nebraska Geological Survey, is about 400 feet thick at the west end of the basin. There it has been subdivided locally into the Valentine formation (Barbour and Cook, 1917) and the overlying Ash Hollow formation (Engelmann, 1876; Lugin, 1938). The Ogallala formation extends much farther east than do the older Tertiary deposits, reaching almost to the east end of the basin before it pinches out. (See fig. 14.) In the eastern part of the basin the deposits of the Ogallala generally are finer grained than in the west and have been referred to by Condra, Reed, and Gordon (1947) as the Seward formation. The Ogallala is of Pliocene age.

During the period of erosion that followed, the once fairly smooth surface of the Ogallala formation, as well as the surface of the truncated Cretaceous strata beyond the outer margin of the Ogallala, was incised by streams. A profile of the surface thus produced is shown on plate 2.

QUATERNARY SYSTEM

When the first of the Pleistocene continental glaciers (the Nebraskan ice sheet) invaded eastern Nebraska, the streams draining the land surface were dammed in their lower reaches by the ice. Ponding of water along the ice margin caused the streams to drop their

loads of sediment and aggrade the lower reaches of their valleys. These deposits which consist principally of sand and gravel and which have a maximum thickness of 170 feet or more, are referred to as the Holdrege formation. During the succeeding Aftonian interglacial stage, wind- and water-transported fine sand, silt, and clay accumulated in the valleys to a depth of 40 feet or a little more. These deposits, known as the Fullerton formation, completely mantled the Holdrege, lapping up onto the valley sides and extending farther upstream.

The second, or Kansan, ice sheet also invaded Nebraska, similarly damming drainage courses and causing the streams to aggrade their valleys to an even higher level with sand and gravel, now referred to as the Grand Island formation. The Sappa formation, which was deposited during the Yarmouth interglacial stage that followed, is similar to the Fullerton formation except that in some localities it contains a distinctive layer of volcanic ash—the Pearlette ash member. The Sappa is related to the Grand Island formation as is the Fullerton to the Holdrege.

Although the third continental ice sheet (Illinoian) did not reach Nebraska, the concurrent climatic change resulted in the deposition of a layer of sand and gravel, the Crete formation, in the valleys. The Crete generally is thinner than either the Holdrege or the Grand Island formation but is somewhat more extensive. After deposition of the Crete formation, the entire eastern part of the basin was buried beneath a 100-foot mantle of wind-deposited pinkish-brown silt and fine sand known as the Loveland loess. Possibly some of the sand that mantles the Ogallala formation in the Sand Hills part of the basin was deposited at the same time as was the Loveland, but, according to E. C. Reed (oral communication, 1957), the bulk of the dune sand may have accumulated concurrently with deposition of the later Peorian and Bignell loesses.

The fourth sheet of glacial ice (Wisconsin) barely invaded northeastern Nebraska. During this stage of glaciation, in which the ice sheet melted back and readvanced several times, the Todd Valley sand was deposited in valleys cut into the surface of the Loveland loess and the Peorian loess was deposited as another mantle over the eastern part of Nebraska. A fossil soil within the Peorian loess, similar to the fossil soil at the top of both the Loveland loess and the Peorian loess, is proof that deposition of the Peorian was interrupted at least once. The deposits which the Conservation and Survey Division of the University of Nebraska refers to as late Wisconsin sand and gravel may have been laid down during one such interruption. Another layer of loess, the Bignell, was deposited in late Wisconsin and Recent time

in scattered parts of the basin; it consists largely of reworked Peorian loess.

Because the dune sand in the Sand Hills region grades into the loess layer in the loess plains and hills region, the two must have been deposited at about the same time; the wind dropped the heavier sand first and carried the lighter silt and clay particles farther southeast. The dune sand on the south side of the Loup River in southeastern Howard County and in Merrick, Nance, and Platte Counties probably was derived from the sand and gravel deposits exposed along the Loup River.

Recent deposits in the Loup River drainage basin consist of surficial materials that have been reworked by wind and running water since the Wisconsin glacier melted back the last time. Only by their position can they be distinguished from the Pleistocene deposits from which they were derived.

GROUND WATER

The semiconsolidated deposits of Tertiary age, except for the relatively impermeable formations of the White River group, together with the unconsolidated deposits of Quaternary age constitute a tremendous ground-water reservoir. Because little subsurface information is available for much of the basin, the amount of water stored in the reservoir cannot be determined accurately. A conservative estimate—400 million acre-feet or 20 times the average annual precipitation—is obtained by assuming that the average thickness of saturated material is not less than 300 feet and that the average porosity of the material is 15 percent. Because the supply of ground water is distributed fairly uniformly, wells of moderately large to large discharge can be drilled almost everywhere in the basin. In some places in the loess plains and hills part of the basin, however, it is generally impossible to obtain a supply much greater than enough for domestic and livestock needs. In much of this part of the basin the Pleistocene deposits are the only likely source of ground-water supply because the underlying Tertiary rocks are too fine grained to yield water freely.

If the water in a well does not rise above the level at which it is struck—that is, stands at the same level as the top of the zone of saturation—the water is under water-table conditions. On the other hand, if the water in a well stands higher than the top of the zone of saturation, perhaps even flowing from the well at the land surface, the water is artesian. Artesian water is confined under pressure below a relatively impervious layer. In many places in the Loup River drainage basin, both artesian and nonartesian conditions exist within the ground-water reservoir, and in such places it is possible to have a shallow well that taps nonartesian water or a deeper well that taps

artesian water. In some places even the water in the uppermost part of the zone of saturation is artesian. Although most wells in the Loup River drainage basin tap water that is under water-table conditions or confined under only slight artesian head, flowing wells are common in parts of Grant, Cherry, and Brown Counties (pl. 1); none of them were visited during the investigation. Two of several flowing wells observed in T. 24 N., Rs. 14 and 15 W., Garfield County, had a flow of about 40 gpm (gallons per minute). Local residents reported that these wells tap saturated gravel overlain by blue clay 80 feet thick. Several other artesian wells are near Pibel Lake in Wheeler County; the flow from these wells is small and unsteady.

The top of the zone of saturation is within 250 feet of the land surface in all or nearly all the basin. In the Sand Hills part of the basin the water table is only a few feet below the floor of most of the closed basins; and in most of those basins occupied by lakes, the water table is continuous with the lake surface. In all the valleys where streamflow is perennial, the water table is continuous with the surface of the stream. Usually it is not possible to determine readily whether the water surface in any given well is at the same level as the top of the zone of saturation.

NATURAL RECHARGE AND DISCHARGE

Most of the sediments that constitute the ground-water reservoir were laid down by water and so were saturated when first deposited. However, the water that originally occupied the pore spaces has long since percolated out and has been replaced by infiltrating precipitation. Precipitation is the only significant source of recharge to the ground-water reservoir beneath the basin. Underflow is the source of some recharge along the south boundary of the drainage basin from McPherson County to Buffalo County, but the amount is small compared to the total received from precipitation.

The capacity of the soil to hold and to transmit water downward determines how much of the precipitation will pass through the soil and recharge the underlying reservoir. Because sandy soils generally hold less water and are much more permeable than loessial soils, the proportion of rainfall reaching the zone of saturation in the Sand Hills part of the basin is somewhat greater than in the loess plains and hills part. Direct determinations of the amount of recharge to an aquifer ordinarily are not possible without conducting highly complex and detailed studies; however, if discharge from a ground-water reservoir for a given period is assumed to balance recharge to the reservoir during that period, the amount of recharge may be determined indirectly by measuring the discharge.

In the Sand Hills part of the basin, ground water is discharged principally by seepage into streams and by evapotranspiration. The amount of streamflow originating as ground-water discharge in the Sand Hills region during water years 1948-52 indicates that the average annual rate of recharge is about 2.9 inches, plus whatever ground water is discharged by evaporation and transpiration. Because water evaporated from the myriad of lakes in the Sand Hills region is replaced by seepage from the ground-water reservoir and because the water table is so close to the land surface in many places that hay meadows are subirrigated, ground-water discharge by evapotranspiration may equal or exceed that by seepage into streams. Tolstead (1942) reported that the water table in a wet meadow in Cherry County fell 2.78 feet from June 30 to September 1, 1938, as the result of evapotranspiration losses. Accordingly, the average annual recharge in the Sand Hills parts of the basin is estimated to be at least 5 inches per year.

During November, runoff from the loess plains and hills part of the basin consists almost wholly of ground-water discharge because, during that month, overland runoff generally is negligible, evapotranspiration losses are slight, and freezing is not a factor in reducing streamflow. Based on records of stream discharge during water years 1948-52, the average runoff during November is about 38,000 acre-feet. If this rate of ground-water contribution to streamflow remains constant throughout the year, ground-water discharge from the loess plains and hills part of the basin averages about 450,000 acre-feet per year. To produce this amount of discharge from the ground-water reservoir, recharge necessarily would average 1.2 inches per year.

In addition to the direct discharge of ground water into streams and lakes, a very small amount of water issues from springs and seeps not immediately adjacent to streams. Among the best known of these are the springs in Victoria Spring State Park in Custer County and the springs at the north end of Pibel Lake in Wheeler County. At both places the water table is shallow and the springs are of the simple gravity type. When visited in July 1952, the two springs in Victoria Springs State Park had a combined flow of about 1 gpm.

ARTIFICIAL RECHARGE AND DISCHARGE

The hydrologic regimen of the Loup River drainage basin has been modified locally by withdrawal of ground water through wells, irrigation of valley lands with water diverted from streams, impoundment of water behind dams, and diversion from streams for generation of electric power. Some such developments reduce the supply of ground water available for use, whereas others increase the available supply of ground water.

Throughout the rural part of the drainage basin, water for drinking, cooking, laundering, and sanitary use is obtained from wells. On the basis of the number of rural residents and a reasonable assumption of per capita use, about 3,500 acre-feet of ground water is estimated to be pumped each year for these purposes. Although a part of the water is used consumptively, a part of it infiltrates to the zone of saturation and is available for reuse.

Livestock drink water from streams, from natural and artificial ponds, and from watering tanks or troughs filled with water pumped from wells. An estimated 14,000 acre-feet of ground water is pumped each year for this purpose. Probably most of the water is used consumptively, although some overflows the water tanks and troughs and infiltrates again to the underground reservoir.

According to information obtained from a reconnaissance of the Loup River drainage basin and to data supplied by employees of the U.S. Soil Conservation Service, county agricultural extension agents, and residents of the basins, 352 irrigation wells had been drilled in the Loup River drainage basin by 1952 (fig. 15). The locations of these

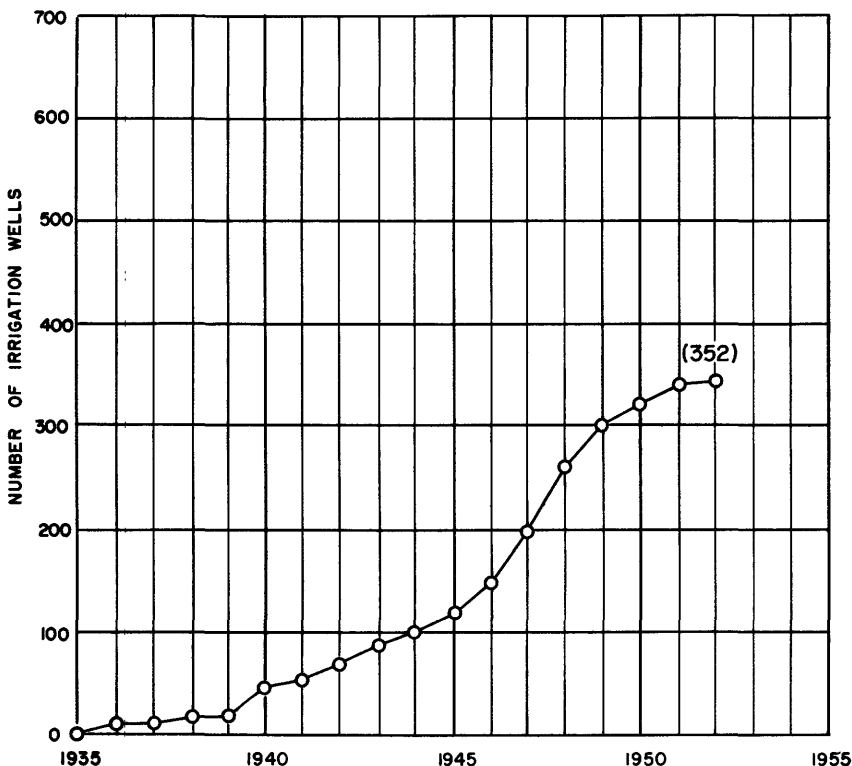


FIGURE 15.—Cumulative number of irrigation wells drilled in the Loup River drainage basin, 1935-52.

wells are shown on plate 1, and pertinent data on 115 of them, selected at random, are given in table 12. Most of the wells are in the valleys because there the pumping lift is not very great and most of the land is topographically suitable for irrigation. Available information indicates that the amount of land irrigated from a single well ranges from 20 to 260 acres and averages about 85 acres. Accordingly, about 30,000 acres in the basin is irrigated with water pumped from wells. The discharge from irrigation wells ranges from 200 to 1,800 gpm and averages about 830 gpm. In an average growing season irrigation wells are pumped a total of about 3 weeks and, thus, about 27,500 acre-feet of ground water per year is used for irrigation. How much of the applied irrigation water infiltrates below the reach of roots and rejoins the zone of saturation is not known but is estimated to be at least a tenth.

About 48,500 acres of land in the valleys of the Middle and North Loup Rivers is irrigated from the principal canals. Of the water diverted into these canals—a reported 115,700 acre-feet in the water year that ended September 30, 1952—probably as much as 40 percent evaporates or is utilized by crops, and the remainder eventually returns to the rivers. Although some of the return flow takes place by overland runoff, most of it returns by subsurface percolation.

The number of acres irrigated with water pumped from streams is not known. In Boone County surface water is pumped at 32 locations (fig. 16) to irrigate an aggregate of about 2,000 acres.

Ord, in Valley County, is the only town in the Loup River drainage basin that uses surface water for its public supply. All other towns having public-supply systems obtain water from wells, and the total pumpage is about 4,000 acre-feet per year. Data on all municipal wells are included in table 12, and additional information on selected municipal water supplies is given in table 4. The Chicago, Burlington & Quincy Railroad and local creameries are the principal industrial users of ground water not supplied from the municipal systems. An estimated 1,000 acre-feet of water per year is pumped for use by these industries.

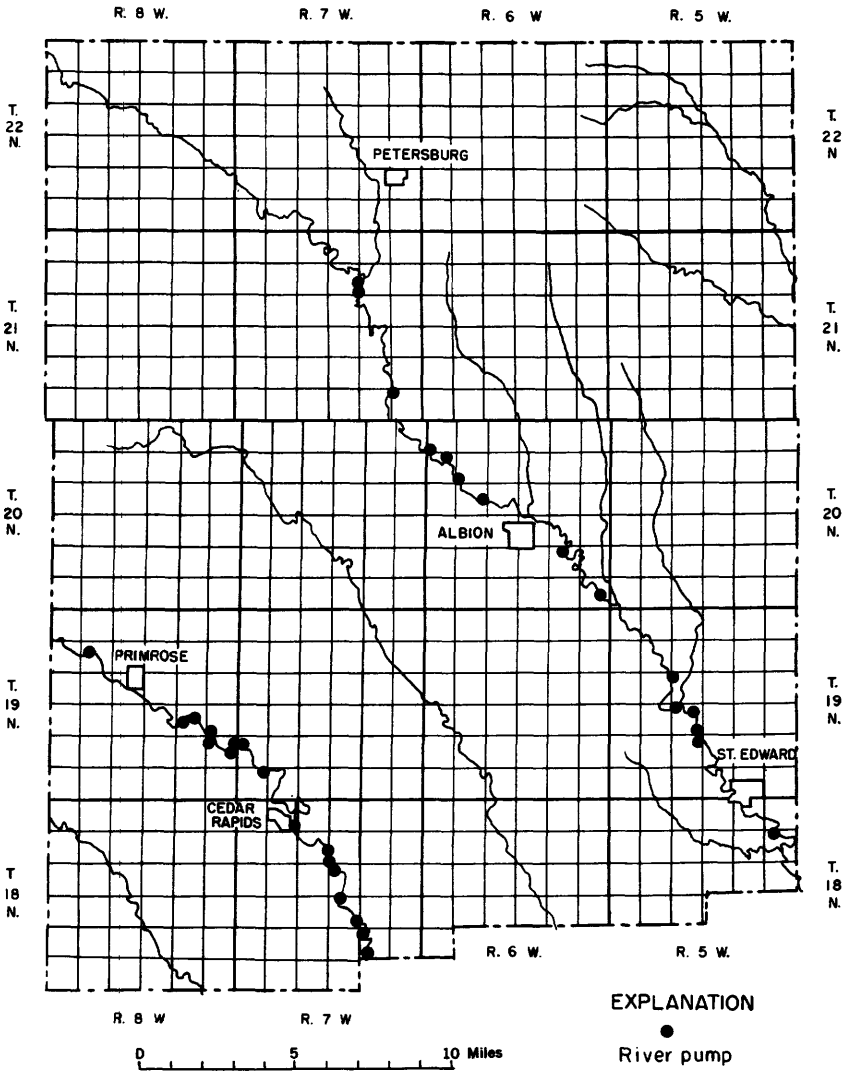


FIGURE 16.—Map of Boone County showing the locations at the Cedar River (lower left) and Beaver Creek (center) where surface water is pumped for irrigation.

TABLE 4.—Data on selected municipal water supplies in the Loup River drainage basin

City or town	Number of wells	Storage capacity (gallons)	Average daily pumpage (gallons)	Remarks
Boone County				
Albion.....	2	67,000	200,000	Water treated for taste and odor; chlorinated occasionally.
Cedar Rapids.....	7	-----	60,000	All wells interconnected to one piston pump. Information obtained for only one well.
Petersburg.....	2	-----	50,000	One well reserved for standby purposes. Both wells in firehouse.
Primrose.....	1	25,000	25,000	Well in building north of the town hall.
St. Edward.....	1	-----	50,000	Well in City Water Supply Building. Drawdown 18 feet after well is pumped 3 hours at 300 gpm.
Custer County				
Anselmo.....	2	50,000	75,000	Information obtained for only one well; other well is 50 feet east and is reserved for standby use.
Ansley.....	3	90,000	50,000	Drawdown in well 15-18-4dc is 15 feet when discharge is 300 gpm.
Arnold.....	2	80,000	200,000	Information obtained for only one well; other well is 50 feet south.
Broken Bow.....	5	350,000	400,000	Wells in city park, about 20 feet apart.
Callaway.....	2	50,000	200,000	
Mason City.....	1	30,000	25,000	Information obtained for only one well. Other well is about 15 feet south.
Merna.....	2	60,000	60,000	
Grant City				
Hyannis.....	2	90,000	180,000	
Greeley County				
Greeley.....	2	50,000	50,000	Wells pumped alternately.
Scotia.....	1	18,000	42,000	Well west of Community Building. Air-pressure storage tanks used.
Spalding.....	2	110,000	100,000	Information obtained for only one well.
Wolbach.....	2	43,000	43,000	
Hooker County				
Mullen.....	3	40,000	300,000	Water sample collected from well 24-32-20ab (city well 2). Well 24-32-20bd owned by Chicago, Burlington & Quincy Railroad and leased to town.
Howard County				
Boelus.....	1	-----	7,000	Occasionally water has an odor. Drawdown 19 feet when well was test-pumped at 350 gpm.
Dannebrog.....	1	50,000	25,000	
Elba.....	1	35,000	12,000	
Farwell.....	1	25,000	20,000	New well of larger capacity being constructed.
Logan County				
Stapleton.....	1	50,000	50,000	New well to be constructed.

TABLE 4.—Data on selected municipal water supplies in the Loup River drainage basin—Continued

City or town	Number of wells	Storage capacity (gallons)	Average daily pumpage (gallons)	Remarks
Merrick County				
Palmer.....	2	-----	75,000	Information obtained for only one well; other well is 5 blocks east and is reserved for standby use.
Nance County				
Belgrade.....	1	-----	120,000	Information obtained for only one well.
Fullerton.....	9	-----	235,000	
Genoa.....	2	-----	125,000	
Sherman County				
Litchfield.....	2	50,000	50,000	Information obtained for only one well; other well is in same city block.
Thomas County				
Thedford.....	1	9,000	100,000	
Valley County				
North Loup.....	2	60,000	45,000	Well 18-13-26dd reserved for standby use.
Wheeler County				
Erierson.....	1	33,000	45,000	

Apparently the canals conveying water from the Middle Loup River to the Boelus powerplant and from the Loup River to the powerplants at Monroe and Columbus are not sources of appreciable recharge to the ground-water reservoir. Unlike the irrigation canals, the power canals carry water the year round, and they have become effectively sealed by the settling of silt and clay. Hydrographs of the water level in two wells close to Lake Babcock, a regulatory reservoir near the Columbus powerplant, show that seepage from the reservoir caused a large rise of the water table when the canals first carried water in 1937 but that within a few years the water table began to decline and in 1952 was not appreciably higher than before the canal became operative. (See fig. 17.)

MOVEMENT

Once water infiltrates to the zone of saturation its direction of movement becomes nearly horizontal. Unless intercepted by a discharging well, the water continues its lateral movement until dis-

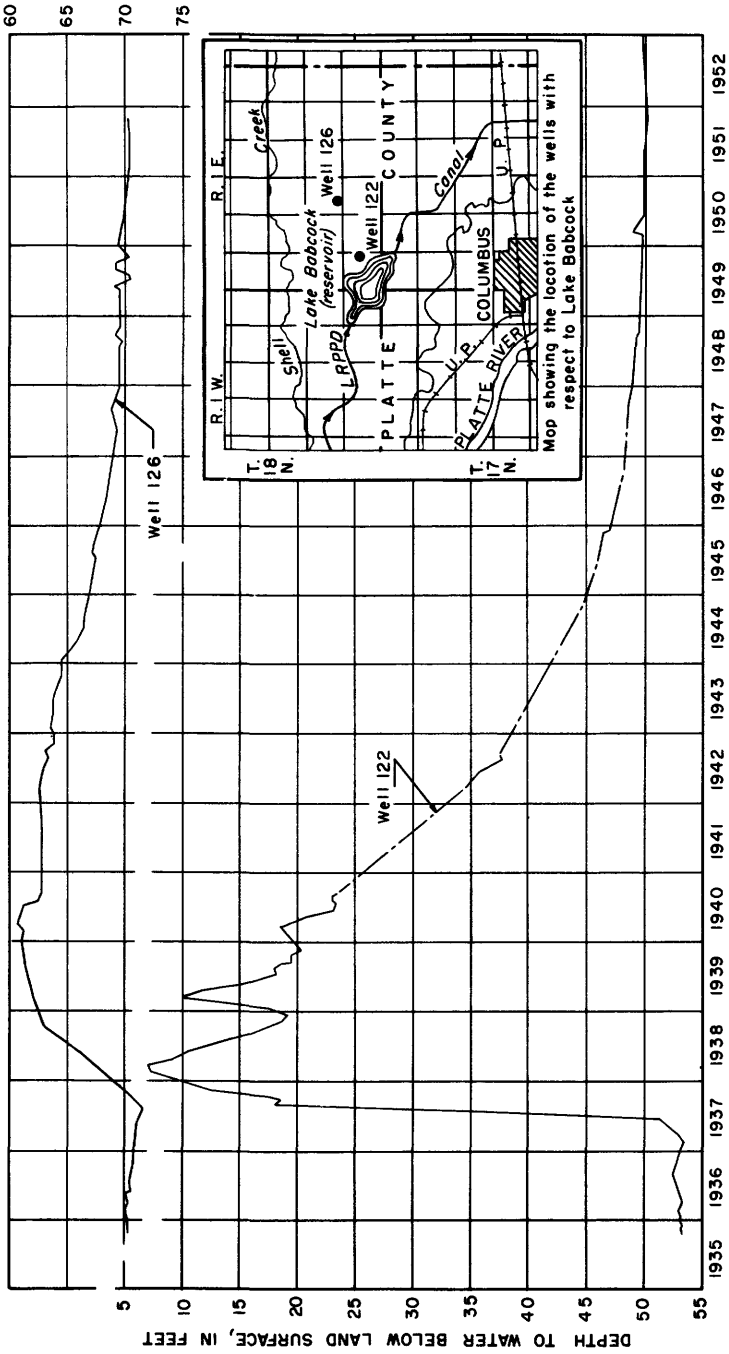


FIGURE 17.—Hydrographs for wells 122 (A18-1-31ad) and 126 (A18-1-28cd) of the Loup River Public Power District.

charged by natural processes. The rate of movement is governed by the permeability of the material through which the water moves and by the steepness of the hydraulic gradient. As the permeability of water-bearing material in the Loup River drainage basin has not been determined, the rate of ground-water movement is unknown. However, the average rate of movement is estimated to be no more than a few feet per day.

The steepness of the hydraulic gradient and the direction of ground-water movement in the Loup River drainage basin can be determined from plate 1, which shows the configuration of the water table. The hydraulic gradient ranges from about 6 to 40 feet per mile and averages a little less than 9 feet per mile. The general direction of ground-water movement in the western part of the basin is eastward and in the eastern part is southeastward. However, because ground water discharges into the streams, the direction of natural ground-water movement locally may be southwest, south, southeast, east, northeast, or north. In the triangular area adjoining the west end of the Loup River drainage basin, ground water moves westward and northwestward toward a tributary of the Niobrara River.

Pumping a well creates a steeper than natural hydraulic gradient toward the well on all sides, diverting ground water from its normal path, and causing it to percolate toward the well at an accelerated rate. When a well is pumped, the steepness of the hydraulic gradient toward it and the area in which water is diverted from its normal path are governed by the capacity of the aquifer to transmit water and by the rate at which water is discharged from the well.

WATER-LEVEL FLUCTUATIONS

Fluctuations of the water levels in wells reflect changes in the amount of ground water in storage. During periods of rising water level the increment to storage exceeds discharge from storage, and during periods of falling water level the reverse is true. Unlike that of water stored in a surface reservoir, the surface of stored ground water may rise in some parts of an area and at the same time fall in other parts. Therefore, significant net changes in ground-water storage are impossible to detect unless water-level changes are recorded at points scattered somewhat uniformly throughout the area.

As part of the State-Federal program of ground-water studies in Nebraska, water-level measurements have been made at irregular intervals in 18 wells in the Loup River drainage basin since the late 1930's. Measurements have been made in an additional 17 wells as part of the Missouri River basin development program, which began

in 1946. The measurements made in all these wells are reproduced in table 11. Although the measurements show that seasonal fluctuations have occurred, they do not indicate any significant upward or downward trends in water levels during the period of record.

CHEMICAL QUALITY OF THE WATER

BY RUSSELL H. LANGFORD

As part of the investigation of the ground-water resources of the Loup River drainage basin, studies were made to determine the chemical quality of the water and to evaluate the suitability of the water for irrigation and for domestic use. Some chemical quality data were available as a result of previous investigations in the area (Brown, 1955; Connor, 1951; Schreurs, 1956; and Sniegocki, 1955). An additional 20 samples were collected and analyzed in 1952 to augment data obtained during the previous investigations. The locations of wells, springs, streams, and lakes for which data are available are shown on figure 18, and the chemical analyses of the water are given in tables 5 and 6.

The chemical analyses were made by methods usually used in water chemistry (Am. Public Health Assoc., 1955). Concentrations of dissolved constituents are given in parts per million; a part per million is a unit for expressing concentration by weight, usually as grams of constituent per million grams of solution. Concentrations of iron and manganese in analyses of ground water represent the amounts of these constituents both in solution and in suspension at the time the sample was collected, except when footnoted "in solution when analyzed." Concentrations of iron in analyses of surface water represent the amounts of iron in solution at time of analysis. In tables 5 and 6, concentrations of dissolved solids represent residue on evaporation at 180°C, and specific conductance values are expressed in reciprocal ohms per centimeter times 10⁶ and are referred to as micromhos at 25°C.

CHEMICAL CHARACTERISTICS OF THE WATER

The streams in the Loup River basin are fed by ground water, and the chemical quality of the water in the streams during periods of relatively low flow (table 5) is similar to the quality of the ground water (table 6). Because the chemical characteristics of both surface and ground waters in the Loup River drainage basin are uniform, no attempt was made to correlate the type of water with the water-bearing source. However, all samples of ground water are probably from sands and gravels of either Pleistocene or Tertiary age. Almost with-

TABLE 5.—Chemical analyses of water from streams during periods of low flow and from lakes in the Loup River drainage basin

[Results in parts per million except as indicated]

Location	Date of collection	Discharge (cfs)	Silica (SiO ₂)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Boron (B)	Dissolved solids	Hardness as CaCO ₃	Non-carbonate hardness as CaCO ₃	Percent sodium	Specific conductance (micro-mhos at 25°C)	pH
Frye Lake, 1 mile northeast of Hyannis.	1952 Sept. 10	-----	21	0.08	28	33	53	36	1 410	19	7.5	1.4	2.2	0.28	438	205	0	31	654	8.5
Middle Loup River at Dunning.	do.	‡ 347	57	.27	23	3.5	7.8	5.8	106	4.0	.5	.2	1.2	.03	160	72	0	18	188	8.1
Dismal River at Dunning.	do.	294	54	.25	22	2.2	7.2	4.8	96	2.0	1.0	.2	.8	.01	148	64	0	18	170	7.8
South Loup River at Piessanton.	1950 Oct. 24	-----	46	.10	55	7.9	10	7.3	224	15	3.5	.0	3.0	.00	278	170	0	11	373	8.0
Mud Creek at Ravena.	Oct. 28	-----	50	.10	95	18	15	13	390	30	7.0	.2	1.3	.10	428	310	0	9	611	8.0
South Loup River at St. Michael.	1949 Sept. 22	‡ 168	46	.02	59	8.9	17	17	238	17	3.4	.2	3.8	-----	284	184	0	17	394	7.5
Middle Loup River at St. Paul.	Oct. 6	906	51	.02	34	4.2	14	14	144	8.0	2.5	.4	1.7	-----	197	103	0	23	253	7.7
North Loup River near Burwell.	1952 Sept. 9	276	58	.14	26	3.9	8.5	6.0	117	4.0	1.0	.3	1.1	.02	170	81	0	17	204	7.9
Calamus River near Burwell.	do.	‡ 267	51	.10	18	2.2	6.6	4.4	83	2.0	1.0	.2	.9	.01	130	54	0	20	144	7.7
North Loup River near St. Paul.	1949 Oct. 6	730	53	.02	28	3.1	10	10	119	3.0	1.5	.4	1.5	-----	175	83	0	21	205	8.2
Cedar River near Spalding.	1947 Aug. 27	42	47	.13	26	6.8	5.4	5.4	117	7.4	.0	.2	.7	.14	165	93	0	11	204	8.2
Beaver Creek at Loretto.	1949 Sept. 27	39	38	.08	31	5.4	7.6	7.6	136	1.6	1.4	.2	.8	-----	158	100	0	14	274	7.7

1 Includes equivalent of 13 ppm of carbonate (CO₃).

‡ Daily mean discharge.

TABLE 6.—Chemical analyses of ground water in the Loup River drainage basin

[Results in parts per million except as indicated]

Well or test hole	County	Depth of well (feet)	Date of collection	Temperature (°F)	Silica (SiO ₂)	Total iron (Fe)	Total manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO ₃)	Carbonate (CO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Boron (B)	Dissolved solids	Hardness as CaCO ₃	Noncarbonate hardness as CaCO ₃	Percent sodium	Specific conductance (micromhos at 25° C)	pH
11-16-35ad	Buffalo	183	9-6-50	50	0.08	0	---	81	9.2	7.6	5.7	292	0	11	6.5	0.0	3.0	0.10	330	240	1	6	464	5
12-13-20eb	do	207	8-31-50	54	0.05	---	---	64	8.4	9.6	8.0	236	0	12	2.0	0.0	8.9	0.00	314	104	0	9	403	7.4
14-5dd	do	235	8-30-50	54	0.03	---	---	88	12	10	6.1	332	0	18	4.0	0.0	1.9	0.00	374	268	0	7	515	7.5
15-25cb	do	96	8-9-50	50	0.05	---	---	71	11	11	6.2	276	0	21	4.0	0.0	6	0.00	334	222	0	9	440	7.4
16-35ad2	do	119	9-12-50	48	0.92	2.7	1.06	89	13	11	6.6	332	6	19	9.0	0.0	5	0.00	400	276	4	8	522	7.5
13-11-6bd	Howard	80	10-9-49	54	4.4	---	---	60	10	16	4.8	234	6	8	11	0.2	2.9	0.30	304	191	0	15	416	8.2
11db1	do	85	2-2-50	54	52	3.2	1.39	124	15	12	9.1	396	6	72	13	0.0	1.1	0.30	516	371	46	6	722	7.7
12-29ab1	do	31	11-10-49	56	45	0.5	1.07	92	8.5	11	4.7	226	15	32	12	0.2	3.4	0.17	388	265	55	8	527	8.5
13-5dd	Sherman	35	10-9-49	56	40	5.0	---	55	9.2	7.9	5.2	212	10	11	10	0.0	7.0	0.30	436	326	16	3	621	8.3
13cc	do	78	9-1-49	55	46	0.2	---	114	10	5.0	11	341	18	1	16	0.0	2.0	0.30	402	292	25	8	583	7.7
17-36bc	Custer	126	10-27-50	43	4.0	---	---	100	10	12	7.5	326	0	18	25	0.0	4	0.00	402	292	25	8	583	7.7
14-10-3ca2	Howard	55	12-1-43	55	---	---	---	88	16	32	---	300	0	50	13	0.0	4	0.09	396	286	406	20	628	8.3
30ba	do	32	10-18-49	55	41	0.8	---	200	47	40	24	313	18	182	49	3	31.4	0.10	070	693	406	11	450	8.3
11-6ba	do	115	8-15-49	54	58	0.4	0.8	36	9.4	9.4	7.4	189	0	4	3.2	0.0	8.9	0.30	228	129	0	13	303	8.0
14-3ca2	Sherman	38	10-9-49	53	41	9.2	---	81	14	13	17	201	15	74	18	0.0	3	0.23	222	260	64	9	555	8.4
15-6-2bb	Nance	18.5	6-2-51	49	46	1.4	---	33	3.8	6.1	5.0	115	0	11	2.5	0.0	12	0.05	188	98	4	11	236	7.7
8-17dd	Merrick	14.0	6-2-51	48	35	---	---	66	9.6	16	6.1	249	0	42	3.0	0.0	9	0.09	311	204	0	14	450	7.7
7dd	do	21.0	6-2-51	50	43	---	---	47	6.4	6.4	5.0	180	0	16	1.5	0.0	3	0.11	10	204	0	14	450	7.7
11-10bc	Howard	79	11-30-43	---	---	---	---	81	13	16	---	327	0	11	4	0.0	6.4	0.06	292	256	0	9	307	7.5
13-27ab	Sherman	150	7-21-49	58	0.5	0.5	0.5	11	17.4	12	11	174	0	18	24	0.0	6.4	0.06	311	144	0	12	511	7.6
14-18bd1	do	116	10-18-49	55	53	2.8	1.05	59	15	22	12	239	0	54	17	0.0	3.2	0.44	282	256	0	12	511	7.6
18-9ba1	Custer	100	9-9-52	55	57	2.6	0.00	63	8.0	9.0	6.3	230	0	16	3.0	0.0	6.5	0.31	368	209	11	13	378	8.1
23-11ba1	do	194	9-9-52	54	50	1.1	0.00	44	4.6	9.3	4.8	172	0	2	2.0	0.0	8.4	0.03	286	154	13	18	505	7.8
16-3-5aa	Merrick	14.0	6-4-51	50	28	---	---	30	3.4	20	4.2	86	0	19	5	0.0	2.2	0.11	132	129	0	13	303	7.6
7dd	do	10.6	6-4-51	50	28	---	---	30	3.4	20	4.2	86	0	19	5	0.0	2.2	0.11	132	129	0	13	303	7.6
5-21cc	Nance	14.0	6-2-51	49	17	---	---	49	4.7	4.4	5.2	104	0	26	3.0	0.0	3.5	0.02	218	100	15	23	183	6.9
16-12bc	Sherman	124	8-29-49	54	44	---	---	90	11	12	10	348	0	5	1.0	0.0	3.3	0.28	188	142	0	8	293	7.8
A17-1-20bc	Platte	100	2-20-51	54	35	---	---	87	14	35	13	314	0	73	29	0.0	3.3	0.20	367	270	0	6	551	8.0
17-4-27ad	do	13.5	6-4-51	50	29	1.9	1.1	148	10	14	14	148	0	41	7.0	0.0	2.8	0.10	289	124	16	21	690	7.4
17-4-24ca1	Nance	30	12-29-49	54	36	2.3	1.05	91	13	23	11	331	0	53	7.5	0.0	2.8	0.20	428	281	10	15	698	7.3
36aa	do	11.0	6-4-51	50	26	5.5	---	51	7.5	17	9.3	186	0	44	6.5	0.0	3	0.05	267	158	10	18	389	7.0

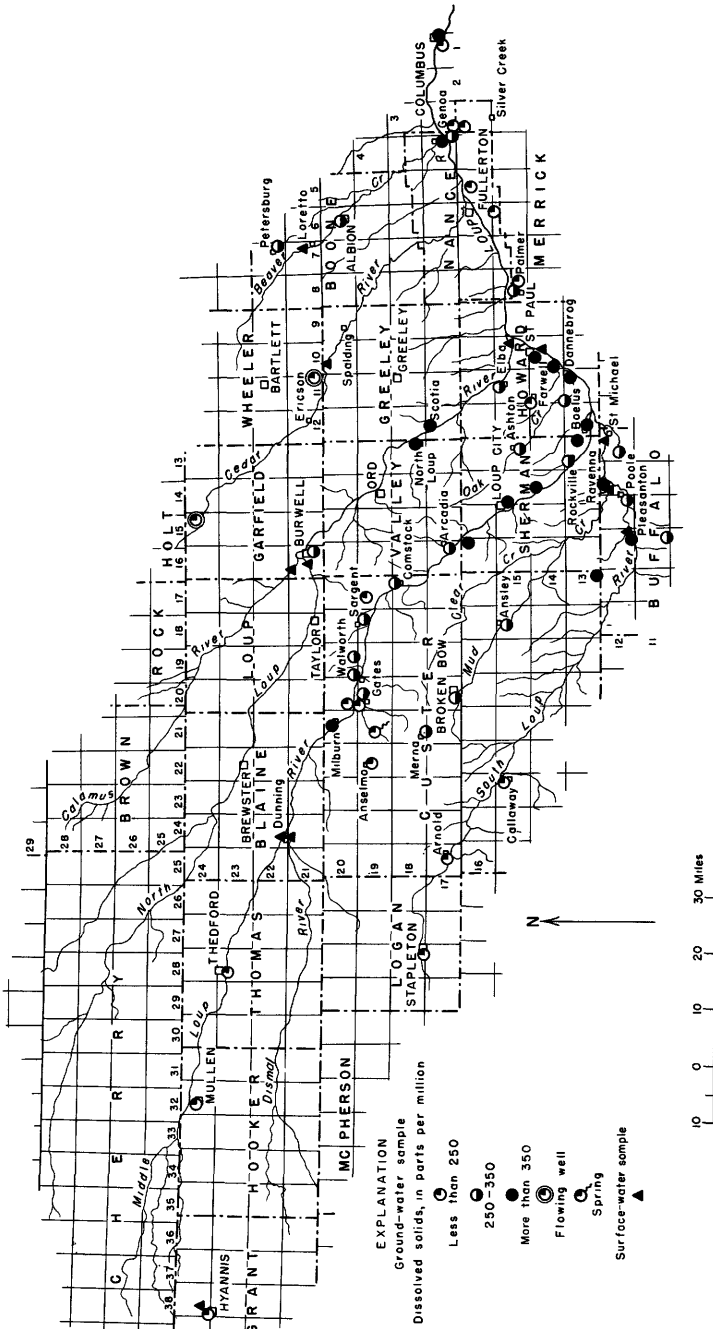


FIGURE 18.—Map of the Loup River drainage basin showing the location of sampling points and the concentration of dissolved solids in the ground water.

out exception, the analyses show that the water is of the calcium bicarbonate type and has high concentrations of silica and low concentrations of sodium (table 7).

TABLE 7.—*Maximum, minimum, and average concentrations of some of the constituents of ground and surface water*¹

[Concentrations are given in parts per million, except as indicated]

Constituent	Maximum	Minimum	Average
Silica (SiO ₂)	58	17	47
Bicarbonate and carbonate as HCO ₃	444	77	218
Boron (B)	.44	.00	.12
Dissolved solids	538	118	280
Hardness as CaCO ₃	395	47	176
Percent sodium	31	3	14
Specific conductance (micromhos at 25°C)	859	127	391

¹ The analyses of water from wells 20-21-10bc and 14-10-30ba were omitted from this tabulation because the water probably was contaminated. They are plotted on figure 19, however.

The similarity in the chemical characteristics of the surface and ground waters can be seen more clearly in figure 19, in which the water is classified according to type. The plots represent the percentage concentrations of the various groups of ions in the water. Percentages were calculated from concentrations in equivalents per million and were based on the sum of either the cations or the anions. The ions are grouped into the strong bases—sodium and potassium; the weak bases—calcium and magnesium; the strong acids—sulfate, chloride, fluoride, and nitrate; and the weak acids—carbonate and bicarbonate. Nearly all the analyses plotted in the shaded part of the figure. The position of the shaded area in the left part of the diamond illustrates that most water in the area is of the calcium bicarbonate type. About two-thirds of the points plotted in the lower part of the shaded area. Most of the points in the upper part of the shaded area represent water from wells in the bottom lands of the lower Middle Loup and lower Loup River valleys.

The analyses of three samples did not conform with the majority. Water from wells 20-21-10bc and 14-10-30ba contained high percentages of chloride and nitrate (fig. 19), perhaps as a result of contamination of the water by surface drainage. The plot representing the sample from Frye Lake near Hyannis shows the effect of concentration by evaporation of the lake water, a phenomenon that is discussed by F. H. Rainwater (Bradley, 1956) in connection with similar lakes in southern Sheridan County, Nebr.

The water in the Sand Hills part of the basin generally is softer than that in the southeastern part of the basin, except in the area south

of the Loup River between St. Paul and Columbus where samples were collected from shallow wells in June 1951 after a period of heavy precipitation. Rainwater states that water from these shallow wells probably was diluted by recharge from the precipitation (Sniegocki, 1955).

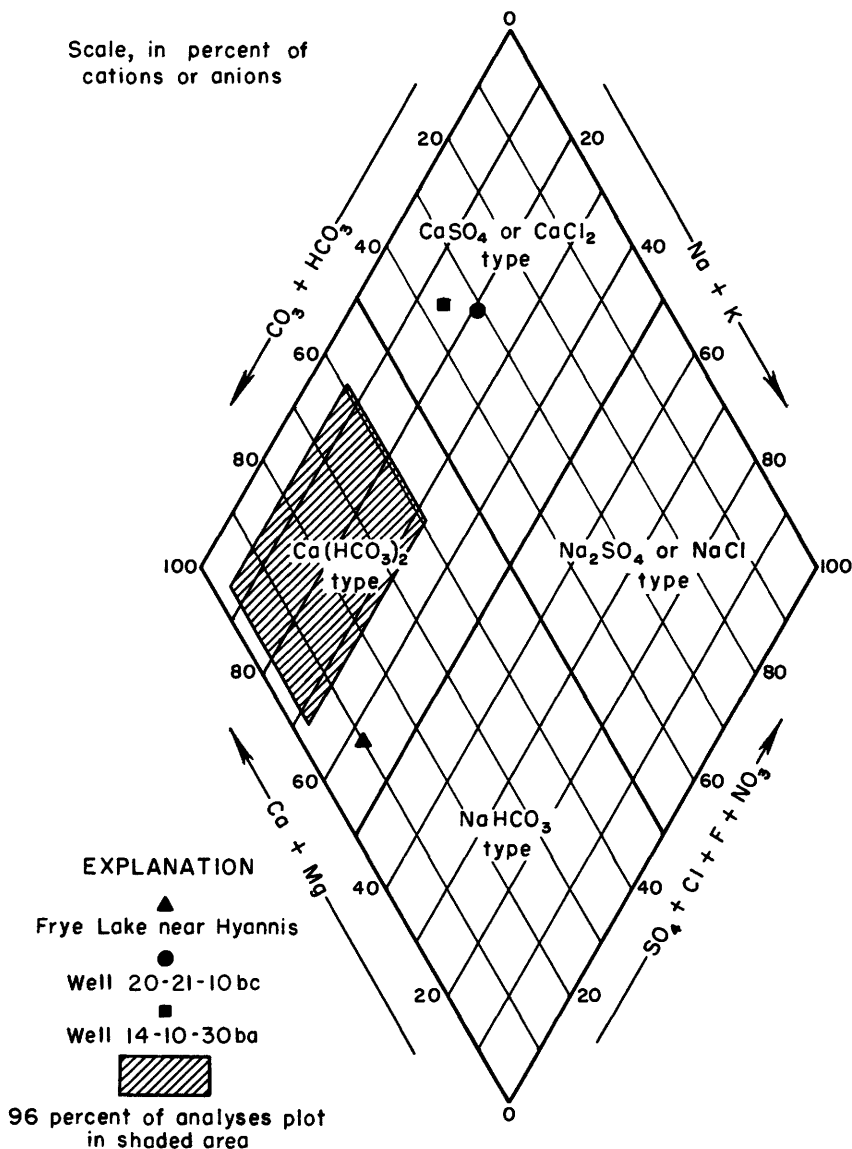


FIGURE 19.—Chemical classification of waters in the Loup River drainage basin.

Generally, the concentration of dissolved solids increases in the direction of ground-water movement, which is southeastward. (See fig. 18.) The increase in concentration, however, does not result from proportional increases in each of the constituents. The relations of cations and alkalinity to total concentrations are shown in figure 20. In this illustration, total concentration is considered to be the sum of the equivalents per million of all the ionized constituents. Alkalinity is caused principally by carbonates and bicarbonates, although in the Loup River drainage basin water contains appreciable silica which may contribute to the alkalinity. In figure 20 the alkalinity is plotted as carbonate plus bicarbonate. The plots of alkalinity have been ad-

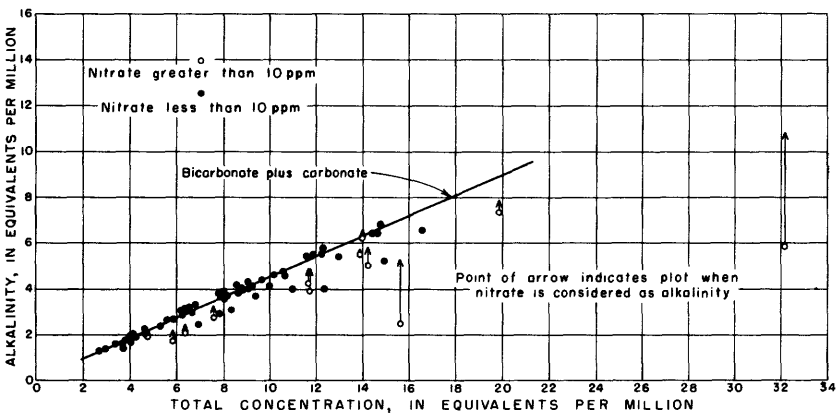
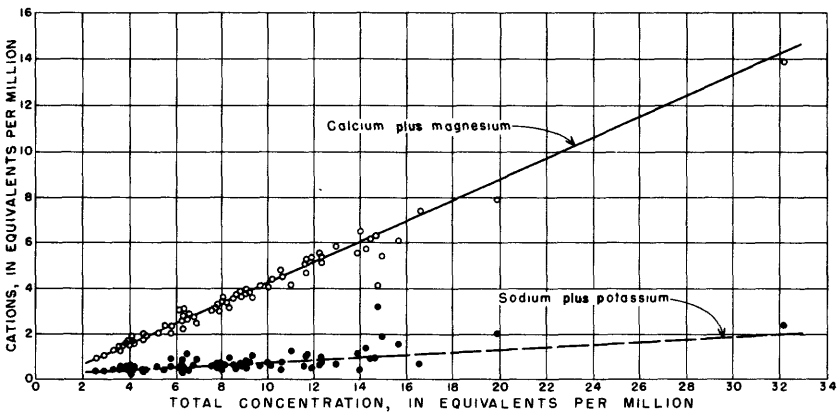


FIGURE 20.—Relation of cations and alkalinity to total concentration, Loup River drainage basin.

justed for those analyses that show a nitrate concentration greater than 10 ppm. (See arrows, fig. 20.) Rainwater (Sniegocki, 1955) explains this method for adjusting the alkalinity when nitrate concentration is high. The slopes of the curves in figure 20 show that an increase in total concentration is due mainly to an increase in calcium and magnesium salts rather than in sodium and potassium salts. The slopes of the calcium plus magnesium curve and the alkalinity curve are each about 0.45. This fact indicates that about 90 percent of the total ionic concentration consists of alkaline salts of calcium and magnesium and that calcium plus magnesium and alkalinity increase in stoichiometric proportion. Thus, the increase in concentration of ground water in transit can be attributed principally to the solution of calcium and magnesium carbonates. The slope of the sodium plus potassium curve in figure 20 indicates that sodium and potassium salts are less abundant soluble constituents of the water-bearing sources.

The percentage by weight of silica in the dissolved solids decreases in the general direction of ground-water movement. Water in the Sand Hills part of the basin had appreciably higher silica concentrations than water in the loess plains and hills part of the basin. Connor (1951, p. 9) states, "A noticeable downward trend in the percentage of silica in ground water sampled between Dunning and St. Paul was also observed in the surface water."

SUITABILITY OF THE WATER FOR IRRIGATION

The rating of water for irrigation depends not only on the dissolved constituents in the water but also on the drainage characteristics of the land, the permeability of the soil, the expected reactions in the soil solution, the amount of water to be applied, and the type of crops to be grown.

Wilcox (1948) rates water for irrigation with respect to the total concentration and percent sodium, assuming "average conditions as related to soil, permeability, drainage, quantity of water used, climate, and crops." Water sampled in the Loup River drainage basin, when classified by the method described by Wilcox, rates excellent to good, with the exception of ground water in the vicinity of three wells, which rates good to permissible.

Eaton (1950) discusses the effect on the soil of high concentrations of carbonates and bicarbonates in irrigation water. He defines "residual sodium carbonate" as the residue of carbonate paired with sodium in equivalents per million after evaporation and plant uptake of water have resulted in the precipitation of calcium and magnesium carbonates. Thus, even though an irrigation water initially has a low percent sodium, if carbonate and bicarbonate exceed calcium and

magnesium, the percent sodium and the pH could increase as the water is subjected to evaporation and plant uptake. Wilcox (1952, p. 3) states that waters having more than 2.5 epm (equivalents per million) of residual sodium carbonate are not suitable for irrigation, waters having 1.25 to 2.5 epm are marginal, and those having less than 1.25 epm are probably safe. About 60 percent of the water sampled had some residual sodium carbonate; however, the maximum was only 0.52 epm except for the sample from Frye Lake near Hyannis, which had 2.30 epm.

Boron is toxic to many plants. Wilcox (1952, p. 3) states, "In a general way, if the boron concentration * * * is less than 1 part per million no serious injury will occur even to the more sensitive plants." The highest boron concentration in water sampled was 0.44 ppm, which is well below the limit for the more sensitive crops.

Both surface and ground water in the Loup River drainage basin should not present any serious problems if used for irrigation, providing that drainage is adequate.

SUITABILITY OF THE WATER FOR DOMESTIC USE

The United States Public Health Service (1946) has set standards for the chemical characteristics of drinking and culinary water used on public and other carriers subject to Federal quarantine regulations. These standards are useful in evaluating the suitability of water for domestic use and are shown, in part, below :

<i>Constituent</i>	<i>Recommended maximum concentration (ppm)</i>
Iron and manganese-----	0.3
Magnesium -----	125
Sulfate -----	250
Chloride -----	250
Fluoride -----	¹ 1.5
Dissolved solids-----	² 500

¹ Maximum allowable.

² 1,000 ppm permitted when water of better quality is not available.

Except for excess iron in some samples, most of the water is satisfactory according to the above standards.

Although a limit on the concentration of nitrate is not included in the standards, nitrate when present in high concentrations may be an indication of contamination of ground water. A limit of 44 ppm has been recommended for water used in infant feeding (Maxcy, 1950). Water from two wells used for domestic purposes in the area contained nitrate greatly in excess of 44 ppm and should not be used for drinking.

Generally, water having a hardness of less than about 60 ppm is considered to be soft, whereas that having a hardness of more than

about 200 ppm is considered to be very hard. Softening is desirable for most uses of very hard water. In the report area the degree of hardness of the water ranged from soft in the Sand Hills part of the basin to very hard in the southeastern part of the basin.

CONCLUSIONS

Evidence indicates that large quantities of water feasibly could be pumped from wells in the Sand Hills part of the basin. However, barring a progressive decrease in precipitation or a general change in the agricultural economy of that part of the Loup River drainage basin, ground-water withdrawals there are not likely to increase substantially. Because high production of hay would no longer be possible if the water table were lowered below the reach of meadow grasses, a wide-spread lowering of the water table, such as would attend large-scale pumping from the ground-water reservoir, would adversely affect the feed supply required for cattle raising. At present, therefore, the ground-water resources of the Sand Hills probably could not be utilized to better advantage within that part of the basin; only if the ground water now discharged into streams could not be used effectively outside the Sand Hills would development of ground water within the Sand Hills seem economically advantageous.

In 1952 not all the loess plains and hills part of the basin had been test drilled; and, until it is, its ground-water potential will remain unknown. However, the test drilling already done shows that, although the yielding capacity of the ground-water reservoir is not uniform, at least some extensive tracts are underlain by material capable of yielding large quantities of water to wells. Exploratory test drilling should be done at the site of each proposed large-discharge well to determine whether the aquifer at that point is sufficiently thick and permeable to transmit the desired quantity of water.

Even if the ground-water resources of the loess plains and hills part of the basin were eventually developed to the maximum capacity of the reservoir to yield on a sustained basis, the supply of surface water probably would not be reduced to less than about 70 percent of the present supply. As pointed out by the U.S. Bureau of Reclamation (1951), there exist many opportunities to use the available surface water to irrigate farmland and generate hydroelectric power within the Loup River drainage basin and also to supplement the supply in water-short areas in the Platte River valley in Buffalo County and eastward.

The chemical characteristics of the water in the Loup River drainage basin are very uniform. Analyses of samples collected during 1943-52 indicate that the water is of the calcium bicarbonate type

and has a high silica content and a low percent sodium. In general, the concentration of dissolved salts in the ground water increases in the direction of ground-water movement. Calcium and magnesium bicarbonates account for about 90 percent of the increase in the ionized constituents. Water in the Sand Hills part of the basin is softer and has higher concentrations of silica than water in the southeastern part.

The water is suitable for irrigation because of its low concentration of dissolved solids, boron, and sodium and low residual sodium carbonate. Although in some parts of the basin the ground water is very hard and locally has a high iron or nitrate content, it is considered to be suitable for most domestic uses.

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BASIC DATA

Table 8.—Summary of published logs of test holes drilled in the Loup River drainage basin by the Conservation and Survey Division, University of Nebraska, in cooperation with the U. S. Geological Survey

[Logs obtainable from Conserv. and Survey Division, Univ. Nebraska]

Test hole	Altitude of land surface (feet)	Water surface		Thick-ness of saturated Pleistocene deposits penetrated (feet)	Top of Ogallala formation		Thick-ness of Ogallala formation penetrated (feet)	Depth of test hole (feet)	
		Date of measurement	Depth be-low land surface (feet)		Altitude (feet)	Depth be-low land surface (feet)			Altitude (feet)
BOONE COUNTY									
18- 8- 8bc.....	1,894	May 19, 1947	40.4	1,853.6	167	207	1,687	128	340
19- 7- 5aa.....	1,976	May 21, 1947	181	1,795	249	430	1,546	35	500
8-24bc.....	1,802	May 9, 1947	9.0	1,793.0	103	112	1,690	182	320
27cc.....	1,879	May 12, 1947	79.7	1,799.3	118	198	1,681	162	360
21- 7-23ca.....	1,821	Nov. 1, 1944	8	1,813	86	94	1,727	15	109
23cb.....	1,868	.....do.....	22	1,846	18	.....	.....	0	40
23db.....	1,800	.....do.....	2.4	1,797.6	51.6	54	1,746	85	139
24cb.....	1,832	Oct. 31, 1944	39	1,793	100	.....	.....	0	139
BUFFALO COUNTY									
11-16-15da.....	2,155	July 17, 1947	30.3	2,124.7	47.7	78	2,077	182	310
31da.....	2,304	.....do.....	143.1	2,160.9	0	138	2,166	233	400
12-15-12ba.....	2,014	July 8, 1947	6.4	2,007.6	61.6	68	1,946	157	270
14ab.....	2,090	July 10, 1947	72.0	2,018.0	55.0	127	1,963	162	360
22ab.....	2,123	July 11, 1947	91.8	2,031.2	20.2	112	2,011	196	340
28bd.....	2,057	July 15, 1947	6.3	2,050.7	40.7	47	2,010	176	260
31dd.....	2,133	July 14, 1947	66.1	2,066.9	73.9	140	1,993	162	330
18- 5ab.....	2,218	Sept. 14, 1948	8.6	2,209.4	62.4	71	2,147	269	340
17dd.....	2,284	Sept. 13, 1948	32.6	2,251.4	42.4	75	2,209	387	480
32ad.....	2,404	Sept. 10, 1948	127.8	2,276.2	33.2	161	2,243	326	510
CUSTER COUNTY									

13-19-31dc.....	2,445	Sept. 17, 1948	101.7	2,343.3	15.3	117	2,328	343	550
21-32cc.....	2,676	Oct. 6, 1948	210.4	2,465.6	107.6	318	2,358	277	645

GARFIELD COUNTY

21-16-11dd.....	2,177	Sept. 26, 1943	23.7	2,153.3	32.3	56	2,121	81	137
14da.....do.....	2,143	.....do.....	6.6	2,136.4	8.4	15	2,128	135	150
28aa.....	2,186	Oct. 23, 1943	13.6	2,172.4	106.4+	.....	.....	0	120

GREELEY COUNTY

17-9-5cd.....	1,997	May 26, 1947	102.2	1,894.8	18	120	1,877	224	460
10-23ca.....	1,954	May 27, 1947	78.9	1,875.1	0	67	1,887	63	130
12-5dd.....	1,909	Oct. 31, 1943	6.7	1,902.3	48.3	55	1,854	65	120
8cb.....	1,936	Nov. 8, 1943	14.2	1,921.8	55.8	70	1,866	30	100
34bb.....	2,023	Aug. 3, 1944	Dry	1,914.0-	0	99	1,824	10	109
34bc.....	1,900	Aug. 2, 1944	24.1	1,875.9	4.9	29	1,871	60	89
18-9-23cc.....	2,081	May 23, 1947	184.9	1,896.1	141	326	1,756	205	540
12-18cd.....	1,974	Oct. 31, 1943	30.8	1,943.2	0	26	1,948	104	130
33ca.....	1,960	Oct. 23, 1943	41.6	1,918.4	66.4	108	1,852	162	270
20-10-5ba.....	1,980	Nov. 9, 1944	24.6	1,955.4	74.4	.....	.....	0	99
5bd.....	1,932	.....do.....	6.8	1,925.2	55.2	62	1,870	37	99
5cb.....	1,935do.....	9	1,926	44	53	1,882	46	99

HALL COUNTY

12-12-2ab.....	1,997	Aug. 19, 1944	Dry	1,928.0	69
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HOWARD COUNTY

13-9-1aa.....	1,841	July 25, 1951	23.2	1,817.8	300
24aa.....	1,805	July 24, 1951	3.0	1,802.0	175
10-7cc.....	1,837	July 6, 1931	4.8	1,832.2	.....	.....	.....	.....	134
19ab.....	1,881	Aug. 5, 1944	4.9	1,876.1	37.1	42	1,839	67	109
29ab.....	1,890	July 15, 1931	12.2	1,877.8	.....	.....	.....	.....	167

Table 8.—Summary of published logs of test holes drilled in the Loup River drainage basin by the Conservation and Survey Division, University of Nebraska, in cooperation with the U. S. Geological Survey—Continued

Test hole	Altitude of land surface (feet)	Water surface		Thickness of saturated Pleistocene deposits penetrated (feet)	Top of Ogallala formation		Thickness of Ogallala formation penetrated (feet)	Depth of test hole (feet)	
		Date of measurement	Depth below land surface (feet)		Altitude (feet)	Depth below land surface (feet)			Altitude (feet)
HOWARD COUNTY—Continued									
13-10-32dd	1,931	Aug. 5, 1944	23.3	1,907.7	75.7	99	1,832	40	139
11- 4cc	1,929	.....	.....	.....	0	94	1,835	45	139
8da	1,901	Aug. 8, 1944	35.2	1,865.8	31.8	67	1,834	72	139
8dd	1,914	Aug. 10, 1944	47.5	1,866.5	45.5	93	1,821	26	119
12bc	1,838	Aug. 5, 1944	10.1	1,827.9	20.9	31	1,807	107	139
12-24ca	.....	Aug. 12, 1944	20.4	.....	28.6+	49+	.....	0	49
25ba	1,923	.....do.....	37.7	1,885.3	0	19	1,904	90	109
25db	1,900	.....do.....	20.8	1,879.2	0	19	1,881	80	99
36aa	1,900	Aug. 16, 1944	9.2	1,890.8	19.8	29	1,871	40	69
36dd	1,904	.....do.....	.0	.....	0	71	1,833	28?	99
14-10- 4cd	1,814	July 24, 1944	22.1	1,791.9	15.9	38	1,776	66	104
9da	1,797	July 25, 1944	8.2	1,788.8	7.8	16	1,781	123	139
22aa	1,799	July 26, 1944	5.3	1,793.7	37.7	43	1,756	96	139
26ab	1,845	July 27, 1944	21.5	1,823.5	28.5	50	1,795	69	119
12- 6da	2,000	June 25, 1947	24.1	1,975.9	86.9	111	1,889	263	430
15- 9- 5ac	1,789	Aug. 28, 1944	42.7	1,756.3	23.3	66	1,733	43	109
6da	1,782	.....do.....	27.5	1,754.5	0	27	1,755	52	79
9aa	1,785	Aug. 30, 1944	33.5	1,751.5	13.5	47	1,738	32	79
9da	1,743	Aug. 28, 1944	6.1	1,736.9	30.9	37	1,706	42	79
16da	1,764	Aug. 30, 1944	11.7	1,752.3	4.3	16	1,748	23	39
21aa	1,788	.....do.....	18.9	1,769.1	23.1	42	1,746	17	59
24aa	1,738	July 20, 1951	5.0	1,733.0	29.0	34	1,704	146	180
10- 9dc	1,845	Oct. 31, 1943	61.6	1,783.4	0	58	1,787	82	140
16ad	1,800	July 18, 1944	28.9	1,771.1	3.1	32	1,768	107	139

Table 8.—Summary of published logs of test holes drilled in the Loup River drainage basin by the Conservation and Survey Division, University of Nebraska, in cooperation with the U. S. Geological Survey—Continued

Test hole	Altitude of land surface (feet)	Water surface		Thickness of saturated Pleistocene deposits penetrated (feet)	Top of Ogallala formation		Thickness of Ogallala formation penetrated (feet)	Depth of test hole (feet)
		Date of measurement	Depth below land surface (feet)		Depth below land surface (feet)	Altitude (feet)		
PLATTE COUNTY—Continued								
17- 2- 7dd.....	1,505	July 20, 1942	5.8	1,499.2	50.2	.....	0	90
18dd.....	1,514	.....do.....	12.5	1,501.5	151.5	.....	0	170
19dd.....	1,524	.....do.....	20.4	1,503.6	81.6	.....	0	130
31aa.....	1,530	.....do.....	15.6	1,514.4	53.4	.....	0	100
18- 1-23bc.....	1,505	July 8, 1942	7.3	1,497.7	87.7	.....	0	110
27dd.....	1,521	.....do.....	49.5	1,471.5	99.5	.....	0	160
35cc.....	1,539	.....do.....	74.6	1,464.4	127.4	.....	0	230
2-29cc.....	1,589	July 20, 1942	62.4	1,526.6	76.6	.....	0	150
31dd.....	1,519	.....do.....	13.2	1,505.8	68.8	.....	0	100
SHERMAN COUNTY								
13-13- 5ab.....	2,086	.....	.....	.....	.....	59	2,027	40
5ca.....	1,977	July 1, 1947	8.1	1,968.9	8.9	17	1,960	288
5cb1.....	1,979	Aug. 2, 1944	10.7	1,968.3	22.3	33	1,946	26
5cb2.....	1,973	Sept. 2, 1944	6.7	1,966.3	27.3	34	1,939	45
7ab.....	1,969	Sept. 7, 1944	4.8	1,964.2	42.2	47	1,922	2
7ca.....	1,987	.....do.....	18.7	1,968.3	73.3	92	1,895	7
7cc.....	2,096	.....do.....	100+	1,996-	.....	.....	.....	0
24da.....	1,982	Sept. 25, 1944	26.4	1,955.6	8	34	1,948	83
26da.....	1,951	.....do.....	15	1,936	50	65	1,867	28
34aa.....	2,048	.....	.....	.....	.....	104	1,944	30
14-23cc.....	2,135	Sept. 17, 1947	133.5	2,001.5	11.5	145	1,990	259
15-28cd.....	2,087	Oct. 24, 1944	28.2	2,058.8	62.8	91	1,996	8

BASIC DATA

28da.....	2,076	Oct. 24, 1944	23.6	2,052.4	58.4	82	1,994	4	86
32ad.....	2,096	.....do.....	30.8	2,065.2	69.2	100	1,996	9	109
14-13-22dd.....	2,119	July 1, 1947	133.0	1,986	31.0	162	1,955	332	510
14- 2cd.....	2,081	Sept. 9, 1944	.....	.....	.....	102	1,979	37	139
6ab.....	2,069	Sept. 23, 1944	21.3	2,047.7	4.7	26	2,043	33	59
10ac.....	2,026	Sept. 7, 1944	7.7	2,018.3	34.3	42	1,984	27	69
16aa.....	2,009	.....do.....	3.8	2,005.2	30.2	34	1,975	45	79
17da.....	2,033	Sept. 23, 1944	11	2,022.0	37.0	48	1,985	21	69
16-21cc.....	2,173	Oct. 23, 1944	49.5	2,123.5	73.5	123	2,050	16	139
23ca.....	2,161	.....do.....	44.3	2,116.7	52.7	97	2,064	12	109
23cc.....	2,149	.....do.....	33.2	2,115.8	69.8	103	2,046	10	113
28bc.....	2,166	.....do.....	.....	.....	.....	87	2,079	2	89
36ab.....	2,129	.....do.....	43.8	2,085.2	20.2+	.....	.....	0	64
36cc.....	2,099	.....do.....	17.7	2,081.3	50.3	68	2,031	1	69
15-13-34aa.....	2,033	Oct. 2, 1944	31.8	2,001.2	34.2	66	1,967	39	105
36bb.....	2,023	.....do.....	22	2,001	17+	.....	.....	0	39
14-28bb.....	2,077	Sept. 23, 1944	36.7	2,040.3	33.3	70	2,007	19	89
28db.....	2,042	.....do.....	6.7	2,035.3	27.3	34	2,008	25	59
32cb.....	2,043	.....do.....	6.1	2,036.9	70.9	77	1,966	42	119
15-12aa.....	2,094	Oct. 7, 1944	29.4	2,064.6	31.6	61	2,033	13	74
12cc.....	2,069	.....do.....	1	2,068	46	67	2,022	52	99
14cd.....	2,093	Oct. 2, 1944	18.9	2,074.1	48.1	47	2,026	72	139
16-15- 5bb.....	2,139	Oct. 12, 1944	12.7	2,126.3	33.3	46	2,093	43	89
16dd.....	2,120	Oct. 7, 1944	16	2,104	47	63	2,057	1	64
28bb.....	2,105	Oct. 10, 1944	10.2	2,094.8	51.8	62	2,043	77	139
29dc.....	2,124	.....do.....	17.5	2,106.5	22.5	40	2,084	54	94
16-16-12aa.....	2,125	Oct. 12, 1944	1.7	2,123.3	37.3	.....	.....	0	39
12cd.....	2,166	.....do.....	31.3	2,134.7	13.7	45	2,121	44	89

VALLEY COUNTY

17-14- 1ad.....	2,049	Oct. 9, 1943	23.7	2,025.3	26.3	50	1,999	100	150
12ab.....	2,060	.....do.....	24.6	2,035.4	25.4	50	2,010	80	130

Table 8.—Summary of published logs of test holes drilled in the Loup River drainage basin by the Conservation and Survey Division, University of Nebraska, in cooperation with the U. S. Geological Survey—Continued

Test hole	Altitude of land surface (feet)	Water surface			Thick-ness of saturated Pleistocene deposits penetrated (feet)	Top of Ogallala formation		Thick-ness of Ogallala formation penetrated (feet)	Depth of test hole (feet)
		Date of measurement	Depth be-low land surface (feet)	Altitude (feet)		Depth be-low land surface (feet)	Altitude (feet)		
VALLEY COUNTY—Continued									
18-13-3ca.....	2,013	Oct. 2, 1943	31.2	1,951.8	18.8	50	1,963	80	130
24cd.....	1,959	Oct. 14, 1943	11	1,948	41.8	53	1,906	97	150
26ca.....	1,972	.....do.....	11.2	1,960.8	50.8	62	1,910	88	150
31cb.....	2,069	Oct. 9, 1943	46.8	2,022.2	8.2	55	2,014	65	120
15-2dd.....	2,120	Oct. 5, 1943	12.2	2,107.8	50.8	63	2,057	60	123
14cb.....	2,174	.....dd.....	39.2	2,134.8	53.8	93	2,081	87	180
19-13-25cc.....	1,996	Oct. 16, 1943	16.0	1,980.0	42.0	58	1,938	242	300
35cc.....	1,987	Oct. 2, 1943	9.0	1,978.0	71.0	.....	.....	0	80
14-4ba.....	2,071	Sept. 15, 1943	26.7	2,044.3	55.3	82	1,989	18	100
8aa.....	2,047	Sept. 14, 1943	13.6	2,033.4	73.4	87	1,960	23	110
8dc.....	2,058	Sept. 13, 1943	13.1	2,044.9	29.9	43	2,013	47	90
19aa.....	2,090	.....do.....	33.1	2,056.9	16.9	50	2,040	310	360
22dc.....	2,015	Sept. 30, 1943	5.8	2,009.2	64.2	.....	.....	0	70
31bb.....	2,098	Oct. 5, 1943	14.7	2,053.3	73.3	88	2,010	102	190
15-3bb.....	2,152	Sept. 20, 1943	15	2,137	99	114	2,038	6	120
20-14-34cb.....	2,142	Sept. 18, 1943	75	2,067	22	97	2,045	1	98
15-10da.....	2,116	Sept. 23, 1943	11.6	2,104.4	45.4	57	2,059	49	106
14da.....	2,102	Sept. 25, 1943	10	2,092	27	37	2,065	93	130
22ac.....	2,130	Oct. 16, 1943	30.4	2,099.6	19.6	.....	.....	0	50
22da.....	2,111	.....do.....	19.6	2,091.4	30.4	50	2,061	73	123
27cd.....	2,138	Sept. 20, 1943	40.8	2,097.2	66.2	.....	.....	0	107
WHEELER COUNTY									
21-10-32dc.....	1,993	Nov. 8, 1944	31.7	1,961.3	107.3	.....	.....	0	139

Table 9.—Summary of published logs of test holes drilled in the Loup River drainage basin by the Spelts, Cunningham, and Mevis Oil Exploration Co.

[Logs from Schreurs (1956)]

Test hole	Altitude of land surface (feet)	Thick-ness of Pleistocene deposits (feet)	Altitude of top of Ogallala formation (feet)	Thick-ness of Ogallala formation (feet)	Thick-ness of Cretaceous rocks penetrated (feet)	Depth of test hole (feet)
BUFFALO COUNTY						
12-13- 1cc.....	1,936	115	1,821	78	379	572
HALL COUNTY						
12-11- 5dd.....	1,963	155	1,808	10	315	480
21bb.....	1,933	205	1,728	63	143	411
12- 3bb.....	1,907	88	1,819	107	.....	.....
6ab.....	1,920	62	1,858	166	227	455
8bb.....	1,922	128	1,794	54	295	477
12dd.....	1,963	176	1,787	109	192	477
15bb.....	1,999	180	1,819	60	272	512
HOWARD COUNTY						
13-11-30dd.....	1,895	83	1,812	77	220	380
32cc.....	1,922	105	1,817	50	673	828
33bb.....	1,882	75	1,807	65	210	350
12-20dd.....	1,925	93	1,832	97	690	880
26bb.....	1,893	25	1,868	135	285	445
26cc.....	1,916	75	1,841	103	319	422
31bb.....	1,930	62	1,868	123	315	500
31cd.....	1,931	62	1,869	113	345	520
34bb.....	1,906	57	1,849	98	285	440
35aa.....	1,892	39	1,853	141	265	445
SHERMAN COUNTY						
13-13-19dd.....	2,074	153	1,921	177	286	616
20aa.....	1,968	67	1,901	155	308	530
22ca.....	1,946	72	1,874	130	288	490
24cc.....	1,934	20	1,914	165	314	499
24dd.....	1,941	38	1,903	162	510	710
29dd.....	2,056	148	1,908	167	303	618
35dd.....	2,063	154	1,909	156	338	648
14-24cc.....	2,100	106	1,994	256	308	670
25dd.....	2,110	135	1,975	237	318	690

72 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin

Material	Thickness (feet)	Depth (feet)
GRANT COUNTY		
Well 23-39- 6ab		
[Chicago, Burlington & Quincy Railroad Co. 12-in. diameter well 1 at Hyannis. Drilled in 1922]		
Sand, fine.....	63	63
Sand, coarse.....	2	65
Sand, coarse; contains clay	5	70
Sand, coarse.....	6	76
Sand, fine.....	11	87
Sand, coarse.....	5	92
Sand, fine.....	3.3	95.3
Well 24-36-20bc		
[Chicago, Burlington & Quincy Railroad Co. well at Whitman. Drilled in 1918]		
Quicksand, water-bearing.....	118	118
HALL COUNTY		
Test hole 12- 9- 5bb		
[Surface altitude, 1,865 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	2	2
Clay.....	6	8
Sand and gravel.....	72	80
Clay, yellow	14	94
Caliche.....	6	100
Clay, yellow	37	137
Shale, blue to gray.....	8	145
Shale, dark-gray	93	238
Lime, chalky, shaly, speckled light-gray	7	245
Test hole 12-10- 4ab		
[Surface altitude, 1,906 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil, sandy.....	3	3
Clay, yellow.....	3	6
Sand and gravel	97	103
Caliche	37	140
Gravel.....	5	145
Clay, yellow.....	11	156
Shale, blue to gray	168	324
Lime, chalky, shaly, speckled light-gray.....	16	340

Table 10.—*Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued*

Material	Thickness (feet)	Depth (feet)
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HALL COUNTY—Continued

Test hole 12-10- 7bb

[Surface altitude, 1,924 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Sand.....	5	5
Clay, buff to yellow.....	12	17
Sand and gravel.....	126	143
Caliche; contains sand.....	22	165
Clay, yellow; contains dark streaks.....	35	200
Shale, blue to gray.....	50	250
Shale, dark-gray to black.....	52	302
Shale, dark-gray to black; contains fossil fragments.....	49	351
Lime, light-gray; contains some gray to buff, shaly chalky lime.....	19	370

Test hole 12-10-11dd

[Surface altitude, 1,870 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	2	2
Sand.....	3	5
Clay, yellow.....	13	18
Sand and gravel.....	52	70
Clay, blue.....	40	110
Clay, yellow.....	5	115
Caliche.....	17	132
Clay, yellow.....	18	150
Shale, blue to gray.....	10	160
Shale, dark-gray.....	86	246
Lime, chalky, shaly, speckled light-gray.....	24	270

Test hole 12-10-18aa

[Surface altitude, 1,906 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Sand, fine.....	7	7
Clay, sandy, yellow.....	15	22
Sand and gravel.....	15	37
Clay, blue.....	13	50
Sand and gravel.....	50	100
Clay, green.....	7	107
Caliche.....	8	115
Sand and gravel.....	70	185
Clay, yellow.....	25	210
Shale, blue to gray.....	60	270
Shale, dark-gray to black.....	38	308
Lime, chalky, shaly, speckled light-gray.....	12	320

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued

Material	Thickness (feet)	Depth (feet)
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HALL COUNTY—Continued

Test hole 12-11-13bb

[Surface altitude, 1,916 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	5	5
Sand and gravel.....	83	88
Clay, yellow.....	22	110
Sand and gravel.....	24	134
Caliche.....	21	155
Sand and gravel.....	13	168
Clay, sandy, yellow.....	92	260
Shale, blue to gray.....	20	280
Shale, dark-gray.....	91	371
Lime, chalky, shaly, speckled light-gray.....	29	400

Test hole 12-11-14cc

[Surface altitude, 1,911 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	1	1
Clay.....	30	31
Sand and gravel.....	39	70
Caliche; contains sand.....	135	205
Gravel.....	15	220
Clay, sandy, yellow to light-gray.....	82	302
Shale, blue to gray.....	57	359
Lime, chalky, shaly, speckled light-gray.....	12	371

Test hole 12-12-32bb

[Surface altitude, 1,924 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	3	3
Sand.....	35	38
Gravel; contains clay.....	17	55
Clay, sticky, yellow.....	107	162
Shale, sticky, blue.....	28	190
Shale, gray.....	110	300
Shale, dark-gray to black.....	30	330
Hard streak, probably dolomitic lime.....	100	430
Shale, dark-gray to black.....	43	473
Lime, chalky, shaly, light-gray.....	7	480
Lime, chalky, shaly, speckled light-gray.....	20	500

HOOKER COUNTY

Well 24-32-20ab

[Chicago, Burlington & Quincy Railroad Co. 6-in diameter well at Mullen. Depth to water, 96 ft. Drilled in 1938]

Old well pit.....	12	12
Clay, hard; contains gypsum and sandstone.....	96	108
Sand, fine.....	56	164
Sand and gravel, coarse.....	12	176

Table 10.—*Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued*

Material	Thickness (feet)	Depth (feet)
HOWARD COUNTY		
Test hole 13-10- 7dc		
[Surface altitude, 1,839 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	1	1
Sand and gravel.....	42	43
Caliche; contains green sandy clay.....	67	110
Clay, yellow.....	42	152
Shale, blue to gray.....	115	267
Hard streak.....	4	271
Shale, gray; contains hard streak at 274.5 ft.....	15	286
Hard streak.....	1	287
Shale, gray.....	59	346
Lime, chalky, shaly, speckled light-gray.....	34	380

Test hole 13-10-16aa

[Surface altitude, 1,891 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Sand and gravel.....	100	100
Clay, yellow.....	24	124
Caliche, sandy.....	56	180
Clay, yellow.....	13	193
Shale, blue to gray.....	19	212
Shale, dark-gray.....	28	240
Shale, dark-gray to black.....	135	375
Lime, chalky, shaly, speckled light-gray.....	15	390

Test hole 13-10-25aa

[Surface altitude, 1,891 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	4	4
Clay, sandy.....	13	17
Sand and gravel.....	141	158
Caliche.....	9	167
Clay, blue.....	11	178
Clay, yellow.....	2	180
Shale, blue to gray.....	10	190
Shale, dark-gray.....	33	223
Hard streaks.....	1	224
Lime, chalky, shaly, speckled light-gray.....	86	310

76 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued

Material	Thickness (feet)	Depth (feet)
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HOWARD COUNTY—Continued

Test hole 13-10-31dd

[Surface altitude, 1,924 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Sand, fine.....	27	27
Clay, yellow	17	44
Sand and gravel.....	46	90
Clay.....	5	95
Sand and gravel.....	21	116
Clay, green.....	4	120
Caliche, sandy	40	160
Sand and gravel.....	5	165
Caliche.....	15	180
Shale, blue to gray.....	60	240
Shale, gray to black	115	355
Lime, chalky, shaly, speckled light-gray	25	380
Lime, shaly, speckled light-gray; contains more shale than above.....	50	430
Lime, chalky, shaly, speckled dark-gray	120	550
Lime, chalky, shaly, speckled light-gray; contains streaks of dark-gray shale.....	160	710
Lime, chalky, shaly, speckled light-gray	68	778
Shale, sticky, waxy, black	16	794

Test hole 13-10-32aa

[Surface altitude, 1,933 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Sand, fine.....	22	22
Clay, buff to yellow.....	15	37
Sand and gravel.....	93	130
Caliche; contains sand.....	72	202
Shale, blue to gray.....	58	260
Shale, dark-gray to black.....	36	296
Hard streak.....	44	340
Shale, dark-gray; contains fossil shell fragments.....	28	368
Lime, chalky, shaly, speckled light-gray to buff.....	12	380

Test hole 13-11- 3cc

[Surface altitude, 1,944 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	2	2
Clay, yellow	124	126
Sand and gravel.....	4	130
Caliche.....	8	138
Clay, yellow	68	206
Caliche.....	29	235
Clay, yellow	11	246
Shale, blue to gray.....	199	445
Lime, chalky, shaly, speckled light-gray	15	460

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued

Material	Thickness (feet)	Depth (feet)
HOWARD COUNTY—Continued		
Test hole 13-11-18aa		
[Surface altitude, 1,965.6 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	5	5
Clay, yellow.....	99	104
Clay and caliche.....	161	265
Clay, yellow.....	25	290
Shale, light-gray; contains hard streaks.....	50	340
Shale, dark-gray.....	5	345
Shale, black.....	55	400
Shale, dark-gray; contains chalk.....	20	420
Chalk; contains some dark-gray shale.....	50	470
Shale, dark-gray, and chalk.....	16	486
Shale, limy, speckled light-gray.....	24	510

Test hole 13-11-19dd

[Surface altitude, 1,917 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Clay.....	25	25
Clay, sandy.....	45	70
Clay, sandy; contains caliche.....	22	92
Clay, chalky, green and white.....	13	105
Sandstone and caliche.....	60	165
Clay, sticky, yellow; contains white caliche.....	35	200
Clay, blue and yellow.....	20	220
Shale, light bluish-gray.....	80	300
Shale, dark-gray.....	75	375
Lime, chalky, shaly, light-gray.....	25	400
Lime, chalky, shaly, speckled light-gray.....	22	422
Lime, chalky, shaly, speckled, darker than above.....	55	477
Shale, calcareous, speckled light-gray.....	223	700
Shale, calcareous, speckled gray.....	12	712
Shale, calcareous, speckled gray; contains fossil fragments.....	71	783
Shale, calcareous, speckled, more chalky, gray.....	9	792
Shale, argillaceous, black.....	13	805

Test hole 13-11-22bb

[Surface altitude, 1,989 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	4	4
Clay, yellow.....	126	130
Caliche; contains clay.....	50	180
Shale, sandy, hard, green.....	45	225
Caliche; contains light-colored shale.....	6	231
Clay, yellow.....	9	240
Shale, gray.....	90	330
Shale, light-gray; contains streaks of chalk.....	20	350
Shale, dark-gray to black.....	40	390
Shale, gray; contains light-colored streaks.....	30	420
Shale, gray; contains streaks of chalk.....	35	455
Shale, dark-gray.....	55	510
Shale, dark-gray; contains chalk.....	5	515
Shale, limy, speckled light-gray.....	35	550

78 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued

Material	Thickness (feet)	Depth (feet)
HOWARD COUNTY—Continued		
Test hole 13-11-34ad		
[Surface altitude, 1,900 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Sand and very coarse gravel.....	100	100
Caliche, tan to light-green.....	55	155
Shale, blue to gray.....	45	200
Shale, dark-gray; contains many fossil shells.....	125	325
Lime, chalky, shaly, speckled light-gray.....	25	350
Test hole 13-11-34bb		
[Surface altitude, 1,881 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	2	2
Sand, fine, buff to gray.....	73	75
Sandstone, hard; contains lenses of lime and shale.....	30	105
Gravel; contains clay.....	2	107
Sand, fine.....	20	127
Caliche.....	43	170
Shale, gray.....	12	182
Shale, dark-gray to black.....	66	248
Shale, dark-gray; contains hard streaks.....	2	250
Shale, dark-gray; contains shell fragments.....	55	305
Shale, black; contains some chalk.....	5	310
Shale, dark-gray.....	20	330
Shale, chalky, limy, speckled white, light-gray.....	30	360
Test hole 13-11-35dd		
[Surface altitude, 1,953 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Sand and gravel.....	188	188
Clay, gray.....	14	202
Clay, yellow.....	13	215
Shale, dark-gray.....	182	397
Lime, chalky, shaly, speckled light-gray.....	33	430
Test hole 13-12-13cc		
[Surface altitude, 2,000 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	3	3
Clay, sticky, grayish-buff.....	92	95
Clay; contains caliche.....	90	185
Sandstone; contains caliche.....	76	261
Sandstone, quartzitic, hard.....	6	267
Clay, sticky, hard, white; contains caliche streaks.....	55	322
Shale, sticky, gray.....	28	350
Shale, dark-gray to black.....	153	503
Lime, chalky, shaly, speckled light-gray.....	47	550

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued

Material	Thickness (feet)	Depth (feet)
SHERMAN COUNTY		
Test hole 13-13- 4cc		
[Surface altitude, 1,989 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Sand.....	50	50
Sand and gravel.....	20	70
Sand and porous caliche.....	20	90
Sand, fine, light.....	20	110
Sand and gravel.....	10	120
Caliche, porous, buff.....	120	240
Clay; contains buff porous caliche.....	40	280
Clay, buff.....	30	310
Sand, coarse, clear.....	5	315
Shale, light-gray.....	25	340
Shale, medium-gray.....	20	360
Shale, dark-gray.....	62	422
Shale, black.....	22	444
Shale, black; contains a few thin buff streaks.....	110	554
Lime, chalky, shaly, speckled grayish-buff.....	31	585
Test hole 13-13- 6cc		
[Surface altitude, 1,995 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	3	3
Clay, sandy.....	24	27
Sand, gray.....	58	85
Caliche, hard; contains cemented sand.....	205	290
Clay, yellow.....	27	317
Shale, blue to gray.....	73	390
Shale, black.....	176	566
Lime, shaly, chalky, speckled light-gray to buff.....	16	582
Test hole 13-13-12dd		
[Surface altitude, 2,068 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]		
Soil.....	5	5
Clay, silty, buff to brown.....	145	150
Clay, silty, buff; contains weathered chalky clay.....	50	200
Clay, chalky.....	150	350
Shale, calcareous, greenish-buff.....	40	390
Shale, calcareous, gray and buff.....	30	420
Shale, light-gray; contains bands of dark-gray shale.....	40	460
Shale, argillaceous, dark-gray.....	10	470
Shale, buff and dark-gray.....	20	490
Shale, light-gray.....	32	522
Shale, dark-gray to black.....	11	533
Shale, dark-gray to black; contains fragments of fossils.....	111	644

Table 10.—Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued

Material	Thickness (feet)	Depth (feet)
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SHERMAN COUNTY—Continued

Test hole 13-13-14cc

[Surface altitude, 1,954 ft. Drilled by Spelts, Cunningham, and Mevis Oil Exploration Co. in 1941]

Soil.....	3	3
Sand.....	9	12
Clay, sandy.....	23	35
Clay and caliche.....	30	65
Sand.....	13	78
Sandstone and caliche.....	77	155
Sand.....	33	188
Sand and caliche.....	27	215
Clay and caliche.....	30	245
Clay, yellow and gray.....	20	265
Clay, blue and yellow.....	10	275
Shale, sticky, bluish-gray.....	25	300
Shale, light bluish-gray.....	10	310
Shale, bluish-gray.....	30	340
Shale, dark-gray to black.....	135	475
Lime, chalky, shaly, light-gray.....	15	490
Lime, chalky, shaly, speckled light-gray.....	30	520

THOMAS COUNTY

Well 23-28- 9cb

[Chicago, Burlington & Quincy Railroad Co. well at Thedford, Depth to water, 8 ft; water-level drawdown, 8 ft. Drilled in 1927]

Soil, sandy.....	1	1
Soil, black.....	1	2
Sand and gravel, dry.....	10	12
Sand and gravel, water-bearing.....	18	30
Clay, yellow.....	.5	30.5
Sand and gravel, water-bearing.....	11.5	42

Well 24-30-19ab1

[Chicago, Burlington & Quincy Railroad Co. well 50 ft west of storage tank at Seneca, Drilled in 1945]

Sand, fine.....	20	20
Gravel, fine.....	7	27
Sand, fine.....	41	68
Sandstone.....	12	80
Sandstone, soft.....	100	180
Sand, firm; contains some water.....	6	186
Sandstone, soft.....	50	236
Sand, fine; contains some water.....	4	240
Sandstone, soft.....	20	260
Sand, fine, water-bearing.....	60	320
Sand, fine.....	87	407
Sand and some fine gravel.....	17	424

Table 10.—*Previously unpublished logs of test holes and wells in the Loup River drainage basin—Continued*

Material	Thickness (feet)	Depth (feet)
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THOMAS COUNTY—Continued

Well 24-30-19ab2

[Chicago, Burlington & Quincy Railroad Co. well at Seneca. Drilled in 1918]

Sand, fine.....	9	9
Vegetation, rotted.....	.5	9.5
Gravel, coarse, clean.....	12	21.5
Clay, light-yellow.....	.5	22
Clay, heavy, greenish-yellow.....	.3	22.3

Well 24-30-19ab3

[Chicago, Burlington & Quincy Railroad Co. well at Seneca. Depth to water, 10.4 ft.
Drilled in 1921]

Sand, fine.....	7.8	7.8
Vegetation, rotted.....	.5	8.3
Sand and gravel, coarse, clean.....	12	20.3
Clay, light-yellow.....	.5	20.8
Clay, heavy, greenish-yellow.....	.7	21.5
Sand and gravel.....	1.4	22.9
Sandstone.....	5	27.9
Sand and gravel, coarse.....	7	34.9
Sandstone, hard.....	.5	35.4
Sand, fine.....	.5	35.9
Sand and gravel.....	4.5	40.4

Well 24-30-19ab4

[Chicago, Burlington & Quincy Railroad Co. well at Seneca. Depth to water, 9.5 ft]

Sand, fine.....	9	9
Vegetation, rotted.....	.5	9.5
Gravel, coarse, clean.....	12	21.5
Clay, light-yellow.....	.5	22
Clay, heavy, greenish-yellow.....	.3	22.3
Sand, fine.....	.5	22.8
Sandstone, soft.....	3	25.8
Sand and gravel, coarse.....	6	31.8
Sand, fine.....	6.5	38.3
Sandstone.....	.5	38.8
Sand, coarse.....	1	39.8
Sand, very fine.....	48.6	88.4
Sandstone.....	.5	88.9
Sand, very fine.....	35.2	124.1
Sandstone.....	.8	124.9
Sand, very fine.....	24.3	149.2

82 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 11.—Measurements of the water level in wells, in feet below land surface

Date	Water level	Date	Water level	Date	Water level
BLAINE COUNTY					
22-24-33ca					
Jan. 7, 1935.....	3.64	Sept. 28, 1944.....	4.90	Mar. 25, 1948.....	3.20
Feb. 27, 1935.....	3.57	Oct. 29, 1944.....	4.50	May 1, 1948.....	3.88
Apr. 20, 1935.....	3.27	Nov. 28, 1944.....	4.14	May 26, 1948.....	4.28
June 8, 1935.....	2.44	Dec. 29, 1944.....	4.12	June 3, 1948.....	4.27
July 15, 1935.....	3.87	Jan. 29, 1945.....	4.20	June 16, 1948.....	4.55
Aug. 16, 1935.....	4.79	Feb. 26, 1945.....	3.80	June 30, 1948.....	3.92
Sept. 16, 1935.....	4.39	Mar. 29, 1945.....	3.80	July 13, 1948.....	4.46
Oct. 23, 1935.....	4.17	Apr. 28, 1945.....	3.38	July 27, 1948.....	4.55
Nov. 26, 1935.....	3.83	May 29, 1945.....	3.80	Aug. 11, 1948.....	4.13
Dec. 30, 1935.....	3.69	June 28, 1945.....	3.28	Aug. 24, 1948.....	4.39
Jan. 18, 1936.....	3.62	July 28, 1945.....	4.31	Sept. 2, 1948.....	4.72
Mar. 27, 1936.....	3.12	Aug. 17, 1945.....	4.54	Sept. 21, 1948.....	4.86
June 3, 1936.....	3.50	Aug. 29, 1945.....	4.46	Oct. 5, 1948.....	4.83
July 21, 1936.....	4.96	Sept. 28, 1945.....	4.60	Oct. 19, 1948.....	4.76
Aug. 26, 1936.....	5.02	Oct. 29, 1945.....	4.43	Oct. 21, 1948.....	4.73
Nov. 24, 1936.....	4.10	Jan. 8, 1946.....	3.81	Nov. 2, 1948.....	4.54
Apr. 2, 1937.....	3.80	Jan. 29, 1946.....	3.77	Apr. 4, 1949.....	1.17
June 17, 1937.....	3.71	Feb. 27, 1946.....	3.60	May 13, 1949.....	2.55
Aug. 10, 1937.....	5.12	Mar. 29, 1946.....	3.12	May 17, 1949.....	2.44
Oct. 15, 1937.....	4.57	Apr. 4, 1946.....	3.39	May 31, 1949.....	1.16
June 24, 1938.....	3.59	Apr. 26, 1946.....	3.91	June 8, 1949.....	1.27
Oct. 24, 1938.....	4.15	Apr. 29, 1946.....	3.58	June 13, 1949.....	1.96
June 9, 1939.....	3.07	May 14, 1946.....	4.05	June 28, 1949.....	3.13
Dec. 2, 1939.....	4.06	May 22, 1946.....	4.10	July 15, 1949.....	3.68
Apr. 2, 1940.....	3.37	June 3, 1946.....	4.04	July 28, 1949.....	4.21
July 23, 1940.....	3.70	June 24, 1946.....	4.67	Aug. 9, 1949.....	4.64
Nov. 4, 1940.....	4.44	July 2, 1946.....	5.00	Aug. 23, 1949.....	4.34
Oct. 21, 1941.....	4.18	Aug. 4, 1946.....	5.60	Sept. 7, 1949.....	3.85
Aug. 25, 1942.....	4.80	Aug. 15, 1946.....	5.49	Sept. 16, 1949.....	3.84
Aug. 29, 1942.....	4.80	Sept. 1, 1946.....	2.30	Sept. 19, 1949.....	4.03
Sept. 28, 1942.....	4.08	Oct. 1, 1946.....	4.42	Oct. 5, 1949.....	4.21
Oct. 29, 1942.....	4.08	Oct. 14, 1946.....	2.36	Oct. 18, 1949.....	3.62
Nov. 2, 1942.....	4.02	Oct. 30, 1946.....	3.67	Nov. 15, 1949.....	3.40
Nov. 29, 1942.....	3.95	Dec. 3, 1946.....	3.08	Nov. 24, 1949.....	3.52
Dec. 29, 1942.....	3.83	Dec. 24, 1946.....	3.38	Nov. 30, 1949.....	3.52
Jan. 29, 1943.....	3.78	Jan. 11, 1947.....	3.22	Dec. 14, 1949.....	3.46
Feb. 26, 1943.....	3.57	Feb. 20, 1947.....	3.00	Dec. 28, 1949.....	3.47
Mar. 29, 1943.....	3.49	Apr. 1, 1947.....	3.23	Jan. 11, 1950.....	3.43
Apr. 28, 1943.....	4.48	Apr. 24, 1947.....	3.03	Jan. 23, 1950.....	3.31
May 29, 1943.....	3.94	May 6, 1947.....	3.40	Feb. 6, 1950.....	3.22
June 28, 1943.....	4.50	June 2, 1947.....	3.48	Feb. 23, 1950.....	2.89
July 29, 1943.....	4.60	July 1, 1947.....	2.74	Mar. 8, 1950.....	1.04
Aug. 29, 1943.....	4.70	Aug. 26, 1947.....	4.68	Apr. 4, 1950.....	2.30
Sept. 28, 1943.....	4.81	Aug. 29, 1947.....	4.82	May 4, 1950.....	2.89
Oct. 29, 1943.....	4.53	Sept. 3, 1947.....	4.76	June 15, 1950.....	2.68
Nov. 28, 1943.....	4.19	Sept. 9, 1947.....	4.80	July 12, 1950.....	4.24
Dec. 29, 1943.....	4.11	Sept. 15, 1947.....	4.39	Aug. 14, 1950.....	4.06
Jan. 29, 1944.....	3.90	Sept. 29, 1947.....	4.54	Aug. 23, 1950.....	4.27
Feb. 27, 1944.....	3.92	Oct. 7, 1947.....	4.58	Sept. 6, 1950.....	4.00
Mar. 29, 1944.....	3.20	Oct. 14, 1947.....	4.58	Sept. 20, 1950.....	3.58
Apr. 28, 1944.....	2.69	Oct. 28, 1947.....	4.39	Oct. 6, 1950.....	3.69
May 29, 1944.....	3.39	Nov. 13, 1947.....	3.01	Oct. 16, 1950.....	3.91
June 28, 1944.....	3.90	Dec. 3, 1947.....	3.64	Oct. 18, 1950.....	3.96
July 29, 1944.....	4.96	Dec. 23, 1947.....	3.55	Nov. 16, 1950.....	3.89
Aug. 17, 1944.....	4.95	Jan. 6, 1948.....	3.50	Dec. 13, 1950.....	3.66
Aug. 29, 1944.....	4.78	Feb. 19, 1948.....	3.45	Dec. 18, 1950.....	3.59

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
BLAINE COUNTY—Continued					
22-24-33ca—Continued					
Dec. 26, 1950.....	3.64	July 25, 1951.....	3.55	Apr. 2, 1952.....	3.08
Jan. 25, 1951.....	3.73	Aug. 8, 1951.....	6.97	Apr. 16, 1952.....	3.35
Feb. 2, 1951.....	3.87	Aug. 22, 1951.....	4.21	Apr. 29, 1952.....	3.40
Feb. 7, 1951.....	3.72	Sept. 4, 1951.....	3.28	May 12, 1952.....	3.48
Feb. 19, 1951.....	3.44	Sept. 6, 1951.....	3.80	May 28, 1952.....	2.16
Feb. 22, 1951.....	3.45	Sept. 20, 1951.....	3.97	June 12, 1952.....	3.56
Mar. 7, 1951.....	3.13	Oct. 2, 1951.....	4.15	June 26, 1952.....	4.16
Mar. 13, 1951.....	3.35	Oct. 16, 1951.....	4.32	July 9, 1952.....	4.62
Mar. 22, 1951.....	3.32	Oct. 30, 1951.....	4.12	July 23, 1952.....	4.93
Apr. 3, 1951.....	3.20	Oct. 31, 1951.....	4.10	Aug. 5, 1952.....	4.88
Apr. 17, 1951.....	3.34	Nov. 14, 1951.....	4.07	Aug. 19, 1952.....	4.85
Apr. 18, 1951.....	3.40	Nov. 28, 1951.....	4.07	Sept. 17, 1952.....	5.25
Apr. 25, 1951.....	2.80	Dec. 12, 1951.....	4.03	Sept. 23, 1952.....	5.27
Apr. 26, 1951.....	3.03	Dec. 27, 1951.....	3.83	Oct. 2, 1952.....	5.05
May 2, 1951.....	2.95	Jan. 9, 1952.....	3.69	Oct. 15, 1952.....	4.90
May 22, 1951.....	1.55	Jan. 23, 1952.....	3.32	Oct. 28, 1952.....	4.70
May 23, 1951.....	1.81	Feb. 4, 1952.....	3.10	Nov. 12, 1952.....	4.60
May 29, 1951.....	2.47	Feb. 20, 1952.....	3.22	Nov. 25, 1952.....	4.45
June 10, 1951.....	2.20	Mar. 5, 1952.....	3.48	Dec. 12, 1952.....	4.34
June 28, 1951.....	2.81	Mar. 17, 1952.....	2.60	Dec. 24, 1952.....	4.28
July 10, 1951.....	3.13				

BOONE COUNTY

18- 7- 4ca

Mar. 26, 1937.....	14.33	Sept. 28, 1948.....	14.39	May 29, 1950.....	13.18
June 10, 1937.....	14.75	Apr. 28, 1949.....	12.79	June 21, 1950.....	13.31
Oct. 10, 1937.....	14.84	June 8, 1949.....	12.65	July 24, 1950.....	10.82
July 10, 1938.....	14.69	July 5, 1949.....	13.03	Aug. 21, 1950.....	14.33
Oct. 14, 1938.....	15.16	Aug. 4, 1949.....	13.83	Oct. 23, 1950.....	13.35
May 26, 1938.....	15.00	Sept. 20, 1949.....	13.66	Dec. 29, 1950.....	13.44
Nov. 24, 1939.....	15.08	Nov. 1, 1949.....	13.89	Feb. 19, 1951.....	13.40
Mar. 23, 1940.....	14.64	Nov. 30, 1949.....	14.02	May 8, 1951.....	12.81
July 13, 1940.....	14.88	Jan. 5, 1950.....	13.94	Aug. 13, 1951.....	12.66
Oct. 26, 1940.....	15.17	Feb. 6, 1950.....	13.79	Dec. 27, 1951.....	12.78
Oct. 14, 1941.....	14.99	Feb. 27, 1950.....	13.27	Aug. 12, 1952.....	11.88
Oct. 31, 1942.....	15.02	Mar. 30, 1950.....	13.43	Oct. 28, 1952.....	13.25
Apr. 22, 1948.....	14.38	Apr. 27, 1950.....	13.73		

18- 7- 5ad

Feb. 14, 1935.....	5.79	Nov. 8, 1936.....	5.93	Sept. 29, 1948.....	5.82
Apr. 12, 1935.....	5.69	Mar. 26, 1937.....	5.20	Apr. 28, 1949.....	4.35
May 29, 1935.....	5.30	June 10, 1937.....	6.05	June 8, 1949.....	4.43
July 8, 1935.....	5.76	Oct. 10, 1937.....	5.95	July 5, 1949.....	4.87
Aug. 6, 1935.....	6.33	July 10, 1938.....	5.63	Aug. 4, 1949.....	5.49
Sept. 9, 1935.....	5.84	Oct. 14, 1938.....	6.11	Sept. 20, 1949.....	5.13
Oct. 12, 1935.....	6.20	May 26, 1939.....	6.00	Nov. 1, 1949.....	4.96
Nov. 18, 1935.....	5.96	Nov. 24, 1939.....	5.94	Nov. 30, 1949.....	5.04
Dec. 20, 1935.....	5.98	Mar. 23, 1940.....	5.42	Jan. 5, 1950.....	4.76
Jan. 9, 1936.....	5.82	July 13, 1940.....	5.69	Feb. 3, 1950.....	4.28
Mar. 21, 1936.....	5.39	Oct. 26, 1940.....	6.11	Feb. 27, 1950.....	4.29
May 26, 1936.....	5.92	Oct. 14, 1941.....	5.77	Mar. 30, 1950.....	3.24
July 11, 1936.....	5.86	Oct. 31, 1942.....	6.04	Apr. 27, 1950.....	4.77
Aug. 19, 1936.....	6.14	Apr. 22, 1948.....	5.70	May 29, 1950.....	4.21

84 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
BOONE COUNTY—Continued					
18- 7- 5ad—Continued					
June 21, 1950.....	4.66	Dec. 29, 1950....	4.31	Aug. 13, 1951.....	3.93
July 26, 1950.....	2.14	Feb. 19, 1951....	4.47	Dec. 27, 1951.....	3.16
Aug. 21, 1950.....	4.51	May 8, 1951....	3.40	Oct. 28, 1952.....	3.75
Oct. 23, 1950.....	5.74				
21- 7-26ca					
Mar. 26, 1937.....	17.69	Oct. 30, 1942....	18.31	Apr. 26, 1950.....	16.30
June 9, 1937.....	18.45	Apr. 21, 1948....	17.20	May 23, 1950.....	16.13
Oct. 10, 1937.....	20.76	Sept. 29, 1948....	19.72	June 22, 1950.....	16.30
July 10, 1938.....	19.69	Apr. 27, 1949....	14.89	July 25, 1950.....	14.26
Oct. 14, 1938.....	21.07	Nov. 4, 1949....	14.97	Aug. 22, 1950.....	14.13
May 26, 1939.....	18.96	Dec. 5, 1949....	16.92	Oct. 24, 1950.....	14.92
Nov. 23, 1939.....	19.95	Jan. 10, 1950....	16.96	Jan. 2, 1951.....	15.27
Mar. 23, 1940.....	18.83	Feb. 9, 1950....	16.82	Feb. 20, 1951.....	15.53
July 13, 1940.....	Dry	Mar. 2, 1950....	16.81	May 4, 1951.....	14.51
Oct. 26, 1940.....	Dry	Mar. 28, 1950....	16.27	Dec. 27, 1951.....	14.27
Oct. 14, 1941.....	Dry				
CHERRY COUNTY					
25-31-18ac					
Jan. 15, 1948.....	98.67	July 14, 1948....	102.26	Sept. 7, 1948.....	102.43
May 26, 1948.....	102.05	July 28, 1948....	102.18	Sept. 21, 1948.....	102.49
June 15, 1948.....	102.22	Aug. 11, 1948....	102.27	Oct. 19, 1948.....	102.66
July 1, 1948.....	102.26	Aug. 24, 1948....	102.28		
25-31-31bb					
Jan. 5, 1948.....	148.87	Aug. 11, 1948....	149.55	Sept. 20, 1948.....	149.65
July 1, 1948.....	149.54	Aug. 24, 1948....	149.56	Oct. 7, 1948.....	149.40
July 28, 1948.....	149.48	Sept. 7, 1948....	149.34	Oct. 19, 1948.....	149.56
GRANT COUNTY					
24-36-30bb					
Jan. 5, 1935.....	4.61	Oct. 24, 1938....	5.64	Mar. 25, 1948.....	5.04
Feb. 26, 1935.....	4.40	June 9, 1939....	4.93	June 30, 1948.....	5.54
Apr. 20, 1935.....	4.14	Dec. 2, 1939....	5.85	Sept. 2, 1948.....	6.18
June 8, 1935.....	3.59	Apr. 2, 1940....	5.46	Oct. 19, 1948.....	6.06
July 15, 1935.....	4.38	July 22, 1940....	6.62	May 13, 1949.....	4.87
Aug. 15, 1935.....	5.07	Nov. 4, 1940....	6.48	June 8, 1949.....	4.36
Sept. 16, 1935.....	5.03	Oct. 21, 1941....	6.44	July 15, 1949.....	5.41
Oct. 23, 1935.....	5.05	Nov. 13, 1942....	5.76	Sept. 16, 1949.....	5.55
Nov. 26, 1935.....	4.85	Apr. 4, 1946....	5.17	Nov. 25, 1949.....	5.36
Dec. 30, 1935.....	4.70	May 22, 1946....	5.25	Jan. 23, 1950.....	5.12
Jan. 18, 1936.....	4.63	June 24, 1946....	5.48	Apr. 3, 1950.....	4.70
Mar. 27, 1936.....	4.20	Aug. 15, 1946....	6.28	Aug. 14, 1950.....	4.25
June 3, 1936.....	4.44	Sept. 2, 1946....	6.15	Oct. 16, 1950.....	4.95
Aug. 27, 1936.....	5.73	Oct. 14, 1946....	5.84	Dec. 18, 1950.....	4.81
Nov. 24, 1936.....	5.38	Dec. 24, 1946....	5.59	Feb. 19, 1951.....	4.65
Apr. 2, 1937.....	3.68	Jan. 11, 1947....	5.47	Apr. 17, 1951.....	4.51
June 17, 1937.....	5.02	Apr. 24, 1947....	5.15	June 7, 1951.....	4.10
Aug. 10, 1937.....	5.88	Aug. 23, 1947....	5.97	Sept. 4, 1951.....	4.30
Oct. 15, 1937.....	5.80	Oct. 28, 1947....	5.90	June 30, 1952.....	4.38
June 24, 1938.....	4.86				

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
GRANT COUNTY—Continued					
24-40-36bb					
Jan. 5, 1935.....	12.80	Oct. 24, 1938.....	13.38	Aug. 29, 1947.....	13.99
Feb. 26, 1935.....	12.84	June 9, 1939.....	12.97	Oct. 28, 1947.....	14.02
Apr. 20, 1935.....	12.71	Dec. 2, 1939.....	13.84	Mar. 25, 1948.....	13.85
June 8, 1935.....	12.32	Apr. 2, 1940.....	13.76	June 30, 1948.....	13.89
July 15, 1935.....	12.41	July 22, 1940.....	14.10	Sept. 2, 1948.....	14.18
Aug. 15, 1935.....	12.62	Nov. 4, 1940.....	13.27	Oct. 19, 1948.....	14.26
Sept. 16, 1935.....	12.87	Oct. 21, 1941.....	13.31	May 13, 1949.....	13.52
Oct. 23, 1935.....	12.86	Nov. 13, 1942.....	13.27	June 8, 1949.....	13.48
Nov. 26, 1935.....	12.90	Aug. 17, 1944.....	13.53	July 14, 1949.....	13.42
Dec. 30, 1935.....	12.91	Aug. 17, 1945.....	13.70	Sept. 16, 1949.....	13.85
Jan. 18, 1936.....	12.91	Apr. 4, 1946.....	13.82	Nov. 25, 1949.....	13.87
Mar. 27, 1936.....	12.78	Apr. 26, 1946.....	13.94	Jan. 23, 1950.....	13.85
June 3, 1936.....	12.81	May 22, 1946.....	13.89	Apr. 3, 1950.....	13.88
July 21, 1936.....	13.10	June 24, 1946.....	13.95	Aug. 14, 1950.....	14.06
Aug. 27, 1936.....	13.29	Aug. 15, 1946.....	14.08	Oct. 16, 1950.....	14.12
Nov. 24, 1936.....	13.37	Aug. 28, 1946.....	13.83	Dec. 18, 1950.....	14.17
Apr. 2, 1937.....	13.30	Sept. 2, 1946.....	13.88	Feb. 19, 1951.....	13.21
June 17, 1937.....	13.38	Oct. 14, 1946.....	14.01	Apr. 17, 1951.....	14.19
Aug. 10, 1937.....	13.69	Dec. 24, 1946.....	14.08	June 7, 1951.....	13.90
Oct. 15, 1937.....	13.26	Jan. 11, 1947.....	14.02	June 30, 1952.....	12.79
June 24, 1938.....	12.98	Apr. 24, 1947.....	14.05		
GREELEY COUNTY					
17-10-10cb					
Nov. 15, 1935.....	14.67	July 12, 1938.....	15.40	Apr. 28, 1949.....	14.27
Dec. 23, 1935.....	14.62	Oct. 20, 1938.....	16.08	May 29, 1950.....	14.10
Jan. 12, 1936.....	14.56	June 3, 1939.....	15.62	June 21, 1950.....	14.06
Mar. 24, 1936.....	14.28	Nov. 27, 1939.....	16.29	July 24, 1950.....	13.34
Nov. 6, 1936.....	15.22	Mar. 27, 1940.....	16.25	Aug. 21, 1950.....	13.11
Mar. 29, 1937.....	15.09	July 17, 1940.....	16.09	Oct. 23, 1950.....	13.72
June 13, 1937.....	15.04	Oct. 29, 1940.....	16.72	Dec. 29, 1950.....	13.49
Aug. 8, 1937.....	15.46	Oct. 17, 1941.....	16.96	Feb. 19, 1951.....	13.70
Oct. 12, 1937.....	15.84	Oct. 31, 1942.....	17.17	May 8, 1951.....	13.65
20- 9-20cc					
Feb. 21, 1935.....	1.85	Aug. 8, 1937.....	3.00	Sept. 20, 1949.....	2.81
Apr. 16, 1935.....	2.11	Oct. 12, 1937.....	2.58	Nov. 1, 1949.....	2.43
June 3, 1935.....	2.11	July 12, 1938.....	2.47	Nov. 30, 1949.....	2.32
July 11, 1935.....	2.35	Oct. 20, 1938.....	2.53	Jan. 5, 1950.....	2.14
Aug. 9, 1935.....	3.27	June 3, 1939.....	2.18	Feb. 6, 1950.....	1.63
Sept. 11, 1935.....	2.55	Nov. 27, 1939.....	2.18	Feb. 27, 1950.....	1.85
Oct. 16, 1935.....	2.67	Mar. 27, 1940.....	1.81	Mar. 30, 1950.....	1.35
Nov. 20, 1935.....	1.30	July 17, 1940.....	3.06	Apr. 27, 1950.....	2.03
Dec. 23, 1935.....	2.19	Oct. 29, 1940.....	2.03	May 29, 1950.....	1.44
Jan. 12, 1936.....	1.71	Oct. 17, 1941.....	2.20	June 21, 1950.....	1.80
Mar. 24, 1936.....	1.78	Oct. 31, 1942.....	2.04	July 24, 1950.....	1.40
May 30, 1936.....	2.60	Apr. 22, 1948.....	2.24	Aug. 21, 1950.....	1.88
July 16, 1936.....	3.26	Sept. 29, 1948.....	2.78	Oct. 23, 1950.....	2.04
Sept. 14, 1936.....	3.11	Apr. 28, 1949.....	1.93	Dec. 29, 1950.....	1.63
Nov. 6, 1936.....	2.47	June 8, 1949.....	1.79	Feb. 19, 1951.....	1.60
Mar. 29, 1937.....	1.80	July 5, 1949.....	2.22	May 8, 1951.....	1.78
June 13, 1937.....	2.59	Aug. 3, 1949.....	3.35	Aug. 12, 1952.....	2.64

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
GREELEY COUNTY—Continued					
20- 9-20db					
Nov. 6, 1936.....	9.97	Oct. 17, 1941.....	9.26	Feb. 27, 1950.....	9.02
Mar. 29, 1937.....	7.50	Apr. 22, 1948.....	8.80	Mar. 30, 1950.....	7.52
June 12, 1937.....	8.24	Sept. 29, 1948.....	9.15	Apr. 27, 1950.....	8.36
Aug. 8, 1937.....	8.77	Apr. 29, 1949.....	7.56	May 29, 1950.....	8.65
Oct. 12, 1937.....	9.13	June 8, 1949.....	8.07	June 21, 1950.....	8.37
July 12, 1938.....	8.44	July 5, 1949.....	7.79	July 24, 1950.....	6.85
Oct. 20, 1938.....	8.98	Aug. 4, 1949.....	9.04	Aug. 21, 1950.....	7.88
June 2, 1939.....	7.72	Sept. 22, 1949.....	8.97	Oct. 23, 1950.....	8.26
Nov. 27, 1939.....	9.37	Nov. 1, 1949.....	9.10	Dec. 29, 1950.....	8.43
Mar. 27, 1940.....	7.88	Nov. 30, 1949.....	9.17	Feb. 19, 1951.....	8.47
July 17, 1940.....	9.12	Jan. 5, 1950.....	9.11	May 8, 1951.....	7.54
Oct. 29, 1940.....	9.02	Feb. 6, 1950.....	9.06	Aug. 12, 1952.....	9.84
HOOKER COUNTY					
24-31-17cd					
May 24, 1948.....	15.40	Sept. 20, 1948.....	15.29	Oct. 16, 1950.....	15.28
July 1, 1948.....	15.33	Oct. 11, 1948.....	15.26	Dec. 18, 1950.....	15.32
July 14, 1948.....	15.30	Oct. 22, 1948.....	15.32	Feb. 19, 1951.....	15.26
July 27, 1948.....	15.32	Sept. 19, 1949.....	15.34	Apr. 17, 1951.....	15.12
Aug. 10, 1948.....	15.32	Aug. 14, 1950.....	15.33	Sept. 4, 1951.....	15.46
Aug. 23, 1948.....	15.30	Oct. 4, 1950.....	15.31	June 30, 1952.....	14.80
Sept. 6, 1948.....	15.28				
24-31-18cb					
May 26, 1948.....	32.68	Sept. 6, 1948.....	32.73	Oct. 16, 1950.....	32.62
June 15, 1948.....	32.71	Sept. 20, 1948.....	32.66	Dec. 18, 1950.....	32.66
July 1, 1948.....	32.69	Oct. 11, 1948.....	32.62	Feb. 19, 1951.....	32.64
July 14, 1948.....	32.68	Oct. 19, 1948.....	32.75	Apr. 17, 1951.....	32.52
July 27, 1948.....	32.68	Aug. 14, 1950.....	32.67	Sept. 4, 1951.....	32.71
Aug. 10, 1948.....	32.67	Oct. 5, 1950.....	32.51	June 30, 1952.....	33.26
Aug. 23, 1948.....	32.68				
24-31-18dd					
May 24, 1948.....	16.30	Aug. 10, 1948.....	16.97	Oct. 11, 1948.....	16.97
July 1, 1948.....	16.95	Aug. 23, 1948.....	16.92	Oct. 19, 1948.....	17.05
July 14, 1948.....	16.95	Sept. 6, 1948.....	16.98	Sept. 19, 1949.....	17.11
July 27, 1948.....	16.98	Sept. 20, 1948.....	17.00	Oct. 5, 1950.....	17.09
24-31-21aa					
May 24, 1948.....	4.80	Sept. 20, 1948.....	4.88	Oct. 16, 1950.....	4.91
July 1, 1948.....	4.85	Oct. 11, 1948.....	4.84	Dec. 18, 1950.....	4.88
July 14, 1948.....	4.86	Oct. 19, 1948.....	4.86	Feb. 19, 1951.....	4.83
July 27, 1948.....	4.89	Sept. 19, 1949.....	4.97	Apr. 17, 1951.....	4.71
Aug. 11, 1948.....	4.89	Aug. 14, 1950.....	4.82	Sept. 4, 1951.....	4.40
Aug. 23, 1948.....	4.87	Oct. 4, 1950.....	4.90	June 30, 1952.....	4.19
Sept. 6, 1948.....	4.87				

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
HOOKER COUNTY—Continued					
24-35-23dd					
Jan. 5, 1935.....	11.70	Oct. 24, 1938.....	16.20	Aug. 29, 1947.....	20.49
Feb. 26, 1935.....	12.17	June 9, 1939.....	16.83	Oct. 28, 1947.....	20.51
Apr. 20, 1935.....	12.53	Dec. 2, 1939.....	17.25	Mar. 25, 1948.....	20.40
June 8, 1935.....	.19	Apr. 2, 1940.....	17.72	June 30, 1948.....	20.73
July 15, 1935.....	5.62	July 22, 1940.....	17.91	Sept. 2, 1948.....	20.72
Aug. 15, 1935.....	8.84	Nov. 4, 1940.....	17.18	Oct. 19, 1948.....	20.84
Sept. 16, 1935.....	10.11	Oct. 21, 1941.....	18.93	May 13, 1949.....	20.87
Oct. 23, 1935.....	10.98	Nov. 13, 1942.....	15.74	June 8, 1949.....	19.70
Nov. 26, 1935.....	11.53	Aug. 17, 1944.....	18.94	July 15, 1949.....	19.21
Dec. 30, 1935.....	11.97	Aug. 17, 1945.....	19.50	Sept. 16, 1949.....	20.02
Jan. 18, 1936.....	12.18	Apr. 4, 1946.....	19.55	Nov. 23, 1949.....	20.46
Mar. 27, 1936.....	12.79	Apr. 28, 1946.....	20.00	Jan. 23, 1950.....	20.55
June 3, 1936.....	9.56	May 22, 1946.....	19.98	Apr. 3, 1950.....	20.61
July 21, 1936.....	11.82	June 24, 1946.....	20.17	Aug. 14, 1950.....	20.42
Aug. 27, 1936.....	12.49	Aug. 15, 1946.....	20.07	Oct. 16, 1950.....	20.63
Nov. 24, 1936.....	13.35	Sept. 2, 1946.....	20.10	Dec. 18, 1950.....	20.61
Apr. 2, 1937.....	14.19	Oct. 14, 1946.....	20.16	Feb. 19, 1951.....	19.70
June 17, 1937.....	14.60	Dec. 24, 1946.....	20.28	Apr. 17, 1951.....	19.90
Aug. 10, 1937.....	14.87	Jan. 11, 1947.....	20.26	Sept. 4, 1951.....	10.30
Oct. 15, 1937.....	15.14	Apr. 24, 1947.....	20.46	June 30, 1952.....	6.70
June 24, 1938.....	15.61				

LOUP COUNTY

21-18-22aa

Oct. 15, 1935.....	4.78	July 12, 1938.....	4.82	Oct. 5, 1950.....	4.20
Nov. 20, 1935.....	4.47	Oct. 20, 1938.....	4.89	Nov. 1, 1950.....	4.06
Dec. 22, 1935.....	4.33	June 2, 1939.....	4.50	Jan. 5, 1951.....	3.98
Jan. 11, 1936.....	4.16	Nov. 25, 1939.....	4.62	Mar. 7, 1951.....	3.67
Mar. 23, 1936.....	3.79	Mar. 26, 1940.....	4.17	Apr. 26, 1951.....	3.73
May 29, 1936.....	4.24	July 16, 1940.....	5.31	July 10, 1951.....	4.15
July 15, 1936.....	5.25	Oct. 28, 1940.....	4.77	Sept. 21, 1951.....	3.96
Sept. 15, 1936.....	5.14	Oct. 16, 1941.....	4.59	Nov. 29, 1951.....	4.08
Nov. 5, 1936.....	4.67	Nov. 11, 1942.....	4.67	Feb. 15, 1952.....	3.54
Mar. 28, 1937.....	3.97	Mar. 27, 1948.....	3.93	Apr. 15, 1952.....	3.81
June 12, 1937.....	4.50	Aug. 24, 1950.....	4.50	July 22, 1952.....	5.04
Oct. 11, 1937.....	4.88				

21-18-27ba

Aug. 31, 1950.....	5.08	Mar. 7, 1951.....	3.39	Nov. 29, 1951.....	3.60
Oct. 5, 1950.....	5.12	Apr. 26, 1951.....	3.63	Feb. 15, 1952.....	4.22
Nov. 1, 1950.....	1.43	July 10, 1951.....	3.13	Apr. 15, 1952.....	4.63
Jan. 5, 1951.....	2.52	Sept. 21, 1951.....	2.98	July 22, 1952.....	5.20

MERRICK COUNTY

15- 8-17dd

Aug. 4, 1950.....	2.19	Oct. 2, 1950.....	2.84	Nov. 27, 1950.....	2.94
Aug. 29, 1950.....	3.08	Oct. 31, 1950.....	3.30	Jan. 4, 1951.....	2.84

88 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
MERRICK COUNTY—Continued					
15- 8-27dd					
Aug. 4, 1950.....	1.37	Oct. 2, 1950....	2.74	Nov. 29, 1950....	3.05
Aug. 29, 1950.....	2.72	Oct. 31, 1950....	3.48		
16- 3- 5aa					
Aug. 3, 1950.....	3.80	Oct. 9, 1950....	4.33	Nov. 30, 1950....	4.75
Aug. 25, 1950.....	4.33	Nov. 2, 1950....	4.49		
16- 3- 7dd					
Aug. 11, 1947.....	4.45	Sept. 2, 1949....	4.85	Jan. 31, 1951.....	5.29
Sept. 4, 1947.....	4.94	Nov. 7, 1949....	4.01	Feb. 21, 1951.....	5.25
Nov. 11, 1947.....	4.97	Jan. 11, 1950....	5.07	Mar. 26, 1951.....	3.99
Jan. 13, 1948.....	4.40	Mar. 10, 1950....	4.59	Apr. 26, 1951.....	3.08
Mar. 18, 1948.....	3.67	May 4, 1950.....	4.15	May 28, 1951.....	3.34
May 8, 1948.....	2.94	May 26, 1950....	3.68	July 26, 1951.....	3.57
July 13, 1948.....	3.75	June 23, 1950....	4.23	Aug. 24, 1951.....	3.90
Sept. 2, 1948.....	4.20	Aug. 3, 1950.....	4.33	Sept. 25, 1951....	4.14
Nov. 2, 1948.....	4.89	Aug. 23, 1950....	4.39	Oct. 23, 1951....	3.79
Jan. 4, 1949.....	3.86	Oct. 9, 1950....	4.66	Nov. 23, 1951....	4.02
May 8, 1949.....	3.49	Nov. 2, 1950....	4.95	Dec. 27, 1951....	4.00
Apr. 15, 1949.....	.79	Nov. 30, 1950....	4.98	Jan. 24, 1952....	3.72
July 12, 1949.....	3.58	Jan. 5, 1951....	5.19	May 29, 1952....	1.12
NANCE COUNTY					
15- 6- 2bb					
Nov. 4, 1949.....	4.08	July 28, 1950....	1.78	Feb. 21, 1951.....	2.75
Nov. 29, 1949.....	4.05	July 31, 1950....	1.89	Apr. 26, 1951.....	1.08
Jan. 6, 1950.....	4.26	Aug. 28, 1950....	2.25	May 28, 1951.....	1.65
Feb. 6, 1950.....	4.14	Sept. 5, 1950....	3.01	July 26, 1951....	2.50
Mar. 3, 1950.....	2.48	Oct. 4, 1950....	1.96	Aug. 24, 1951....	2.14
Mar. 28, 1950....	1.07	Oct. 25, 1950....	2.99	Sept. 25, 1951....	2.29
Apr. 12, 1950....	2.09	Oct. 30, 1950....	3.08	Oct. 23, 1951....	2.09
Apr. 28, 1950....	2.35	Nov. 27, 1950....	2.83	Nov. 23, 1951....	2.09
May 24, 1950....	2.18	Nov. 28, 1950....	2.80	Dec. 26, 1951....	2.04
June 23, 1950....	3.21	Dec. 27, 1950....	2.91	Jan. 24, 1952....	1.94
June 27, 1950....	3.35	Jan. 31, 1951....	3.39		
16- 5-21cc					
Aug. 1, 1950.....	6.09	Jan. 30, 1951....	8.22	Sept. 25, 1951....	7.41
Aug. 28, 1950....	6.70	Feb. 21, 1951....	8.26	Oct. 23, 1951....	7.76
Oct. 5, 1950.....	7.07	Mar. 30, 1951....	7.97	Nov. 23, 1951....	7.94
Nov. 1, 1950.....	7.36	Apr. 26, 1951....	7.52	Dec. 26, 1951....	8.18
Nov. 30, 1950....	7.81	May 28, 1951....	7.54	Jan. 24, 1952....	8.12
Jan. 4, 1951.....	8.11	Aug. 24, 1951....	7.20		
17- 4-36aa					
Nov. 6, 1935.....	5.80	Jan. 27, 1936....	5.50	Apr. 26, 1949....	2.93
Nov. 19, 1935....	5.90	Feb. 26, 1936....	5.30	June 6, 1949....	2.73
Dec. 4, 1935.....	5.70	Mar. 25, 1936....	4.90	July 6, 1949....	2.57
Dec. 17, 1935....	5.40	June 15, 1936....	5.50	Aug. 8, 1949....	4.47
Dec. 30, 1935....	5.50	May 18, 1948....	4.11	Sept. 21, 1949....	4.35
Jan. 13, 1936....	5.40	Sept. 28, 1948....	5.15	Nov. 4, 1949....	4.63

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
NANCE COUNTY—Continued					
17- 4-36aa—Continued					
Dec. 2, 1949.....	4.85	Apr. 12, 1950....	3.60	Aug. 25, 1950....	4.66
Jan. 10, 1950.....	4.89	Apr. 24, 1950....	4.06	Oct. 6, 1950....	5.11
Feb. 8, 1950.....	4.77	May 24, 1950....	3.84	Nov. 2, 1950....	5.21
Mar. 3, 1950.....	4.24	June 23, 1950....	4.39	Nov. 28, 1950....	5.17
Mar. 29, 1950.....	3.48	July 26, 1950....	3.12	Nov. 20, 1952....	5.14

PLATTE COUNTY

A18- 1-28cd

Nov. 1, 1935.....	69.80	June 26, 1940.....	60.40	Feb. 28, 1946....	63.00
Nov. 13, 1935.....	69.40	July 20, 1940.....	61.70	Mar. 28, 1946....	63.10
Dec. 2, 1935.....	69.50	Aug. 14, 1940.....	62.20	Apr. 30, 1946....	68.30
Dec. 16, 1935.....	70.20	Mar. 18, 1942.....	62.20	May 27, 1946....	68.30
Dec. 28, 1935.....	69.50	Apr. 13, 1942.....	62.20	June 28, 1946....	68.10
Jan. 15, 1936.....	69.60	May 20, 1942.....	62.40	July 27, 1946....	68.40
Jan. 31, 1936.....	69.50	June 11, 1942.....	62.40	Aug. 28, 1946....	68.50
Mar. 16, 1936.....	69.50	July 21, 1942.....	62.70	Sept. 27, 1946....	68.70
Apr. 2, 1936.....	69.70	Aug. 19, 1942.....	63.10	Oct. 28, 1946....	68.80
June 16, 1936.....	69.80	Sept. 29, 1942.....	62.80	Dec. 27, 1946....	68.80
Oct. 9, 1936.....	69.84	Oct. 23, 1942.....	63.20	Jan. 27, 1947....	69.10
Feb. 5, 1937.....	70.25	Nov. 20, 1942.....	63.30	June 26, 1947....	69.00
Feb. 25, 1937.....	70.39	Dec. 16, 1942.....	63.50	Aug. 27, 1947....	68.90
Apr. 10, 1937.....	70.51	Jan. 6, 1943.....	63.40	Sept. 26, 1947....	69.00
June 11, 1937.....	70.60	Feb. 8, 1943.....	63.30	Nov. 29, 1947....	69.20
July 30, 1937.....	70.73	Mar. 16, 1943.....	63.70	Dec. 30, 1947....	69.30
Oct. 5, 1937.....	70.17	Apr. 22, 1943.....	64.00	Jan. 28, 1948....	69.30
Nov. 30, 1937.....	69.00	May 28, 1943.....	64.10	Mar. 29, 1948....	69.30
Jan. 3, 1938.....	68.35	June 28, 1943.....	64.20	Apr. 28, 1948....	69.40
Feb. 9, 1938.....	67.35	Aug. 28, 1943.....	64.40	May 28, 1948....	69.40
Mar. 23, 1938.....	66.35	Sept. 28, 1943.....	64.70	July 31, 1948....	69.50
Apr. 26, 1938.....	65.58	Oct. 28, 1943.....	64.70	Aug. 28, 1948....	69.60
May 25, 1938.....	64.95	Nov. 27, 1943.....	65.00	Oct. 30, 1948....	69.40
June 15, 1938.....	64.50	Dec. 28, 1943.....	65.10	Nov. 30, 1948....	69.60
July 19, 1938.....	63.80	Feb. 28, 1944.....	65.90	Jan. 29, 1949....	69.70
Aug. 11, 1938.....	63.37	Mar. 28, 1944.....	66.10	Feb. 26, 1949....	69.70
Sept. 7, 1938.....	62.95	Apr. 28, 1944.....	66.20	Mar. 31, 1949....	69.80
Oct. 11, 1938.....	62.50	May 27, 1944.....	66.30	Apr. 29, 1949....	69.49
Nov. 25, 1938.....	62.06	June 28, 1944.....	66.40	May 28, 1949....	69.40
Dec. 14, 1938.....	61.95	Aug. 28, 1944.....	66.50	June 30, 1949....	70.50
Jan. 19, 1939.....	61.64	Sept. 28, 1944.....	66.60	July 30, 1949....	70.50
Feb. 14, 1939.....	61.47	Oct. 28, 1944.....	66.70	Aug. 29, 1949....	69.50
Mar. 9, 1939.....	61.36	Nov. 28, 1944.....	66.80	Sept. 30, 1949....	69.50
Apr. 10, 1939.....	61.20	Dec. 28, 1944.....	66.90	Oct. 31, 1949....	70.50
May 17, 1939.....	60.91	Jan. 27, 1945.....	67.10	Dec. 28, 1949....	69.70
June 7, 1939.....	61.01	Feb. 28, 1945.....	67.20	Jan. 28, 1950....	69.80
July 14, 1939.....	60.73	Mar. 28, 1945.....	67.20	Feb. 28, 1950....	69.90
Aug. 22, 1939.....	60.62	Apr. 28, 1945.....	67.40	Mar. 21, 1950....	69.90
Sept. 12, 1939.....	60.58	May 28, 1945.....	67.40	May 27, 1950....	70.00
Oct. 17, 1939.....	60.47	June 28, 1945.....	67.60	June 29, 1950....	70.00
Nov. 14, 1939.....	60.46	July 27, 1945.....	67.40	July 31, 1950....	70.10
Dec. 19, 1939.....	60.50	Aug. 28, 1945.....	67.40	Aug. 29, 1950....	70.10
Feb. 21, 1940.....	60.50	Sept. 29, 1945.....	67.70	Sept. 30, 1950....	70.00
Mar. 27, 1940.....	60.30	Oct. 29, 1945.....	67.70	Oct. 25, 1950....	69.88
Apr. 24, 1940.....	60.30	Nov. 28, 1945.....	67.80	Oct. 30, 1950....	70.10
May 24, 1940.....	60.50	Jan. 28, 1946.....	67.90	Nov. 28, 1950....	69.96

90 GEOLOGY AND GROUND WATER, LOUP RIVER DRAINAGE BASIN

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
PLATTE COUNTY—Continued					
A18- 1-28cd—Continued					
Dec. 27, 1950.....	69.98	July 26, 1951.....	70.21	Feb. 25, 1952.....	70.36
Jan. 29, 1951.....	69.76	Sept. 25, 1951.....	70.32	Mar. 24, 1952.....	70.45
Feb. 21, 1951.....	70.08	Oct. 23, 1951.....	70.31	May 2, 1952.....	70.44
Mar. 26, 1951.....	69.99	Nov. 23, 1951.....	70.34	May 29, 1952.....	70.32
Apr. 26, 1951.....	70.09	Dec. 24, 1951.....	70.26	Oct. 20, 1952.....	70.18
July 3, 1951.....	70.27	Jan. 24, 1952.....	70.32		

17- 1-27ad

Sept. 27, 1949.....	5.52	June 27, 1950.....	5.41	Mar. 26, 1951.....	4.11
Nov. 7, 1949.....	5.73	July 26, 1950.....	4.60	Apr. 26, 1951.....	4.07
Dec. 2, 1949.....	5.77	Aug. 23, 1950.....	5.38	May 28, 1951.....	4.60
Jan. 9, 1950.....	5.22	Aug. 28, 1950.....	5.39	July 26, 1951.....	4.88
Feb. 8, 1950.....	5.12	Oct. 10, 1950.....	5.66	Aug. 24, 1951.....	4.50
Mar. 3, 1950.....	4.46	Oct. 25, 1950.....	5.80	Sept. 25, 1951.....	5.12
Mar. 29, 1950.....	3.31	Nov. 28, 1950.....	5.52	Oct. 23, 1951.....	5.11
Apr. 11, 1950.....	4.79	Dec. 27, 1950.....	5.21	Nov. 23, 1951.....	5.04
Apr. 24, 1950.....	5.09	Jan. 29, 1951.....	5.28	Dec. 27, 1951.....	4.83
May 26, 1950.....	4.83	Feb. 21, 1951.....	4.91	Jan. 24, 1952.....	4.43
June 23, 1950.....	4.26				

SHERIDAN COUNTY

24-41-34da

Dec. 18, 1934.....	6.78	Oct. 24, 1938.....	7.98	June 6, 1947.....	8.04
Jan. 5, 1935.....	6.72	June 9, 1939.....	7.30	Aug. 29, 1947.....	8.59
Feb. 26, 1935.....	6.56	Dec. 2, 1939.....	8.68	Oct. 28, 1947.....	8.68
Apr. 20, 1935.....	6.25	Apr. 2, 1940.....	8.17	Mar. 25, 1948.....	7.93
June 8, 1935.....	5.52	July 22, 1940.....	9.09	June 30, 1948.....	7.53
July 15, 1935.....	6.00	Nov. 4, 1940.....	9.35	Sept. 2, 1948.....	8.73
Aug. 15, 1935.....	6.64	Oct. 21, 1941.....	9.37	Oct. 19, 1948.....	8.77
Sept. 16, 1935.....	6.83	Nov. 13, 1942.....	8.25	May 13, 1949.....	7.66
Oct. 23, 1935.....	7.00	Aug. 17, 1944.....	8.30	June 8, 1949.....	7.52
Nov. 26, 1935.....	6.87	Aug. 17, 1945.....	8.17	July 15, 1949.....	7.98
Dec. 30, 1935.....	6.77	Mar. 1, 1946.....	8.10	Sept. 16, 1949.....	8.34
Jan. 18, 1936.....	6.73	Mar. 22, 1946.....	9.88	Nov. 25, 1949.....	8.19
Mar. 27, 1936.....	6.38	Apr. 4, 1946.....	7.85	Jan. 23, 1950.....	8.09
June 3, 1936.....	6.41	May 14, 1946.....	8.03	Apr. 3, 1950.....	7.31
July 21, 1936.....	7.53	Aug. 15, 1946.....	8.94	Aug. 14, 1950.....	8.36
Aug. 27, 1936.....	7.92	Sept. 2, 1946.....	8.85	Oct. 16, 1950.....	8.41
Nov. 24, 1936.....	7.81	Oct. 14, 1946.....	8.54	Dec. 18, 1950.....	8.36
Apr. 2, 1937.....	7.29	Nov. 15, 1946.....	8.44	Feb. 19, 1951.....	8.29
June 17, 1937.....	7.59	Dec. 18, 1946.....	8.41	Apr. 17, 1951.....	8.24
Aug. 10, 1937.....	8.47	Jan. 21, 1947.....	8.35	June 7, 1951.....	7.78
Oct. 15, 1937.....	8.53	Feb. 19, 1947.....	8.24	Sept. 4, 1951.....	7.21
June 24, 1938.....	7.23	Apr. 29, 1947.....	8.03	June 30, 1952.....	6.80

24-42-27ba

Mar. 28, 1946.....	12.50	Nov. 15, 1946.....	13.12	Aug. 29, 1947.....	13.10
Apr. 4, 1946.....	12.19	Dec. 18, 1946.....	13.23	Oct. 28, 1947.....	12.99
May 14, 1946.....	12.33	Jan. 21, 1947.....	13.27	June 30, 1948.....	12.94
June 24, 1946.....	12.38	Feb. 20, 1947.....	13.26	Sept. 2, 1948.....	13.05
Aug. 15, 1946.....	12.37	Apr. 29, 1947.....	13.21	Oct. 19, 1948.....	13.01
Oct. 14, 1946.....	13.13	June 6, 1947.....	13.18	May 13, 1949.....	12.94

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
SHERIDAN COUNTY—Continued					
24-42-27ba—Continued					
June 8, 1949.....	12.52	Aug. 14, 1950.....	13.24	Apr. 17, 1951.....	13.45
July 15, 1949.....	12.84	Oct. 16, 1950.....	13.28	June 7, 1951.....	13.40
Nov. 25, 1949.....	13.05	Dec. 18, 1950.....	13.34	Sept. 4, 1951.....	13.02
Jan. 23, 1950.....	13.07	Feb. 19, 1951.....	13.30	June 30, 1952.....	12.71
Apr. 3, 1950.....	13.12				
24-43-15da					
May 22, 1940.....	7.36	Oct. 19, 1946.....	6.78	June 8, 1949.....	5.66
July 22, 1940.....	7.90	Nov. 15, 1946.....	6.66	July 15, 1949.....	6.32
Nov. 4, 1940.....	8.08	Dec. 18, 1946.....	6.64	Sept. 16, 1949.....	6.53
Oct. 20, 1941.....	7.86	Jan. 21, 1947.....	6.70	Nov. 25, 1949.....	6.35
Nov. 13, 1942.....	6.23	Feb. 20, 1947.....	6.78	Jan. 23, 1950.....	6.39
Aug. 17, 1944.....	6.95	Apr. 29, 1947.....	6.70	Apr. 3, 1950.....	6.14
Aug. 17, 1945.....	6.52	June 6, 1947.....	6.52	Aug. 14, 1950.....	6.68
Mar. 1, 1946.....	6.26	Aug. 29, 1947.....	6.96	Oct. 16, 1950.....	6.73
Mar. 22, 1946.....	6.01	Oct. 28, 1947.....	6.82	Dec. 18, 1950.....	6.73
Apr. 4, 1946.....	5.97	Mar. 25, 1948.....	6.45	Feb. 19, 1951.....	6.74
May 14, 1946.....	6.16	June 30, 1948.....	6.78	Apr. 17, 1951.....	6.76
June 24, 1946.....	6.35	Sept. 2, 1948.....	7.14	June 7, 1951.....	6.75
Aug. 15, 1946.....	6.94	Oct. 19, 1948.....	7.01	Sept. 4, 1951.....	6.58
Sept. 2, 1946.....	7.00	May 13, 1949.....	5.78	June 30, 1952.....	6.41
24-44-14da					
Apr. 4, 1946.....	4.05	Aug. 29, 1947.....	6.09	Apr. 3, 1950.....	3.80
May 14, 1946.....	4.42	Oct. 28, 1947.....	5.51	Aug. 14, 1950.....	5.79
Aug. 15, 1946.....	6.18	June 30, 1948.....	5.13	Oct. 16, 1950.....	5.18
Oct. 14, 1946.....	5.26	Sept. 2, 1948.....	6.05	Dec. 18, 1950.....	4.77
Nov. 15, 1946.....	4.86	Oct. 19, 1948.....	5.68	Feb. 19, 1951.....	4.54
Dec. 18, 1946.....	4.76	May 11, 1949.....	3.94	Apr. 17, 1951.....	4.33
Jan. 21, 1947.....	4.73	July 15, 1949.....	4.62	June 7, 1951.....	4.42
Feb. 20, 1947.....	4.42	Sept. 16, 1949.....	5.24	Sept. 5, 1951.....	3.71
Apr. 29, 1947.....	4.31	Nov. 25, 1949.....	4.66	June 30, 1952.....	4.77
June 6, 1947.....	4.09	Jan. 23, 1950.....	4.49		
24-44-18bb					
Apr. 4, 1946.....	4.30	Aug. 29, 1947.....	4.71	Apr. 3, 1950.....	4.49
May 14, 1946.....	4.25	Oct. 28, 1947.....	4.72	Aug. 14, 1950.....	5.33
Aug. 15, 1946.....	5.50	June 30, 1948.....	4.79	Oct. 16, 1950.....	5.23
Oct. 14, 1946.....	5.13	Sept. 2, 1948.....	5.31	Dec. 18, 1950.....	5.24
Nov. 15, 1946.....	5.04	Oct. 19, 1948.....	5.19	Feb. 19, 1951.....	5.20
Dec. 18, 1946.....	5.03	May 11, 1949.....	3.80	Apr. 17, 1951.....	5.19
Jan. 21, 1947.....	5.04	July 15, 1949.....	4.11	June 21, 1951.....	4.93
Feb. 20, 1947.....	4.87	Sept. 16, 1949.....	4.77	Sept. 5, 1951.....	4.41
Apr. 29, 1947.....	4.78	Nov. 25, 1949.....	4.73	June 30, 1952.....	4.61
June 6, 1947.....	4.54	Jan. 23, 1950.....	4.74		
24-45- 8dd					
Nov. 26, 1935.....	3.06	July 21, 1936.....	4.25	Oct. 15, 1937.....	3.15
Dec. 30, 1935.....	2.91	Aug. 27, 1936.....	4.50	June 10, 1938.....	2.22
Jan. 18, 1936.....	2.83	Nov. 24, 1936.....	3.72	June 24, 1938.....	2.45
Mar. 27, 1936.....	2.40	Apr. 2, 1937.....	2.92	Oct. 24, 1938.....	3.22
June 3, 1936.....	2.36	Aug. 10, 1937.....	4.13	June 9, 1939.....	2.67

Table 11.—Measurements of the water level in wells, in feet below land surface—Con.

Date	Water level	Date	Water level	Date	Water level
SHERIDAN COUNTY—Continued					
24-45- 8dd—Continued					
Dec. 2, 1939.....	3.98	Nov. 15, 1946....	1.91	July 12, 1949.....	0.97
Apr. 2, 1940.....	3.36	Dec. 18, 1946....	2.04	Sept. 13, 1949.....	2.15
July 22, 1940.....	4.65	Jan. 21, 1947....	2.00	Nov. 23, 1949.....	1.94
Nov. 4, 1940.....	3.97	Apr. 29, 1947....	1.75	Aug. 14, 1950.....	2.95
Oct. 21, 1941.....	4.23	June 6, 1947....	1.35	Oct. 16, 1950.....	2.75
Nov. 15, 1942.....	1.85	Aug. 29, 1947....	3.00	Dec. 18, 1950.....	2.42
May 14, 1946.....	.96	Oct. 28, 1947....	2.34	Feb. 19, 1951.....	2.32
June 24, 1946.....	1.47	Sept. 2, 1948....	3.28	Apr. 17, 1951.....	2.18
Aug. 15, 1946.....	3.29	Oct. 19, 1948....	2.91	Sept. 5, 1951.....	.88
Sept. 2, 1946.....	2.20	May 11, 1949....	1.13	June 30, 1952.....	1.77
Oct. 14, 1946.....	2.23				
24-46-10cb					
Apr. 4, 1946.....	2.26	June 6, 1947....	6.82	Nov. 23, 1949.....	6.03
May 14, 1946.....	6.15	Aug. 29, 1947....	7.04	Jan. 24, 1950.....	5.90
June 24, 1946.....	6.69	Oct. 28, 1947....	6.97	Apr. 5, 1950.....	5.75
Aug. 15, 1946.....	7.35	Mar. 25, 1948....	6.32	Aug. 14, 1950.....	6.35
Oct. 14, 1946.....	7.31	July 1, 1948....	6.46	Oct. 16, 1950.....	6.33
Nov. 15, 1946.....	7.12	Sept. 2, 1948....	6.90	Dec. 18, 1950.....	6.30
Dec. 18, 1946.....	7.00	Oct. 19, 1948....	6.86	Feb. 19, 1951.....	6.29
Jan. 21, 1947.....	6.97	May 11, 1949....	5.92	Apr. 18, 1951.....	6.18
Feb. 20, 1947.....	6.92	July 14, 1949....	5.67	Sept. 5, 1951.....	6.39
Apr. 29, 1947.....	6.75	Sept. 13, 1949....	6.14	June 30, 1952.....	5.72
THOMAS COUNTY					
24-30-20ab					
Dec. 19, 1934.....	2.52	June 24, 1938....	2.65	Apr. 24, 1947.....	2.83
Jan. 7, 1935.....	2.60	Oct. 24, 1938....	2.78	Aug. 29, 1947.....	2.57
Feb. 26, 1935.....	2.55	June 9, 1939....	2.60	Oct. 28, 1947.....	2.73
Apr. 20, 1935.....	2.46	Dec. 2, 1939....	2.66	Mar. 25, 1948.....	2.67
June 8, 1935.....	2.52	Apr. 2, 1940....	2.46	June 30, 1948.....	2.92
July 15, 1935.....	2.87	July 23, 1940....	2.90	Sept. 2, 1948.....	2.95
Aug. 15, 1935.....	3.07	Nov. 4, 1940....	2.56	Oct. 19, 1948.....	2.78
Sept. 16, 1935.....	2.75	Oct. 21, 1941....	2.79	July 15, 1949.....	2.91
Oct. 23, 1935.....	2.94	Nov. 12, 1942....	2.68	Sept. 16, 1949.....	2.84
Nov. 26, 1935.....	2.70	Aug. 17, 1944....	2.89	Nov. 23, 1949.....	2.76
Dec. 30, 1935.....	2.48	Aug. 17, 1945....	2.90	Jan. 23, 1950.....	2.54
Jan. 18, 1936.....	2.54	Apr. 4, 1946....	2.71	Apr. 3, 1950.....	2.55
Mar. 27, 1936.....	2.33	Apr. 26, 1946....	3.12	Aug. 14, 1950.....	2.68
June 3, 1936.....	2.56	May 22, 1946....	2.87	Oct. 16, 1950.....	2.77
July 21, 1936.....	3.01	June 24, 1946....	3.04	Dec. 18, 1950.....	2.57
Aug. 26, 1936.....	3.02	Aug. 15, 1946....	3.04	Feb. 19, 1951.....	2.51
Nov. 24, 1936.....	2.54	Sept. 2, 1946....	2.86	Apr. 17, 1951.....	2.87
Apr. 2, 1937.....	2.38	Oct. 14, 1946....	2.70	June 7, 1951.....	2.42
June 17, 1937.....	2.71	Dec. 24, 1946....	2.64	Sept. 4, 1951.....	1.57
Aug. 10, 1937.....	2.92	Jan. 11, 1947....	2.52	June 30, 1952.....	2.74
Oct. 15, 1937.....	2.83				

Table 12.—Record of wells and springs in Loup River basin

Well number: See text for explanation of well-numbering system.
 Type of well: B, bored; Dn, driven; Dr, drilled; Du, dug; J, jetted; Sp, spring.
 Depth of well: Measured depths are given in feet and tenths below land surface; reported depths are given in feet only.
 Type of casing: C, concrete; GI, galvanized iron; I, iron; P, pipe; S, steel.
 Type of pump: C, centrifugal; Cy, cylinder; N, none; P, piston; T, turbine.
 Type of power: D, diesel; E, electric; F, natural flow; G, stationary

gasoline engine; H, hand; N, none; T, tractor; W, wind.
 Use of water: D, domestic; I, irrigation; In, industrial; N, none; O, observation of water-level fluctuations; P, public supply; R, railroad; S, stock.
 Measuring point: Epb, edge of pump base; Hpb, hole in pump base; Ldp, lower edge of discharge pipe; Ls, land surface; Tca, top of casing; Tpi, top of pipe; Tpl, top of platform.
 Depth to water: Measured depths are given in feet and hundredths; reported depths are given in feet only.

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Distance above or below land surface	Altitude above or below mean sea level (feet)			
22-24-33ca	University of Nebraska.....	1934	Dn	12.7	1	P	N	N	O	Tpi	1.4	2,615	5.13	12-16-34

BLAINE COUNTY

BOONE COUNTY

18-5-6cd	.....	.....	Dr	177.0	3	P	Cy	H	S	Tca	2.0	1,840	140.75	5-20-52
12cc	Fay Smith.....	1944	Dr	65.0	18	GI	T	E	I	Hpb	.5	1,660	13.15	1-2-51
7-4ca	University of Nebraska.....	1936	Dn	22.3	1	P	N	N	O	Tpi	2.9	1,767	16.34	12-29-50
5ad	do.....	1935	Dn	14.3	1	P	N	N	O	Tpi	1.7	1,758	6.01	12-29-50
5ca	City of Cedar Rapids.....	1926	Dr	90.0	3	S	P	E	P	Ls	0	.....	15	5-28-52
14bb	A. Klefner.....	1944	Dr	250	18	GI	T	G	I	Hpb	0	1,800	57.10	12-29-50
19-5-4ac	C. Choat.....	1945	Dr	142.0	22	C	T	T	I	Hpb	0	1,753	64.44	1-2-51
6aa	Carl Olson.....	1946	Dr	.....	18	.....	T	E	I	Hpb	.5	1,746	42.08	1-2-51
7cd	R. C. Maricle.....	1943	Dr	147.0	18	GI	T	E	I	Hpb	1.0	1,755	45.73	1-2-51
16db	Elmer Choat.....	1944	Dr	129.0	22	C	T	E	I	Hpb	0	1,695	23.87	1-2-51

Table 12.—Record of wells and springs in Loup River basin—Continued

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Distance above or below land surface	Altitude above mean sea level (feet)	De-scription		
19- 5 27dc	Louis Gasper.....	1945	Dr	65.0	18	GI	T	T	I	Hpb	0.5	1,674	14.07	1- 2-51
28cd	Lawrence Bryan.....	1945	Dr	147.0	18	GI	T	E	I	Hpb	1.0	1,709	34.04	1- 2-51
35cd	City of St. Edward.....	.....	Dr	110	30	C	T	E	P	Ls	0	.....	20	5-22-52
7- 13aa	Henry Vette.....	1949	Dr	179.0	18	GI	T	G	I	Hpb	0	1,848	86.52	5-21-52
24ba	Roy Bert.....	.....	Dr	194.0	3	P	N	N	N	Ls	0	.....	168.95	5-20-52
30aa	Roy Green.....	1941	Dr	98.0	18	GI	T	T	I	Hpb	.5	1,791	24.39	12-29-50
31cc	Wm. Brown.....	1941	Dr	96.0	18	GI	T	G	I	Hpb	0	1,812	36.41	12-29-50
8- 9bb	H. Curring.....	1945	Dr	160.0	18	GI	T	T	I	Hpb	0	1,893	68.99	12-29-50
14db	John West.....	1943	Dr	100.0	24	GI	T	T	I	Hpb	.5	1,819	25.88	12-29-50
16aa	City of Primrose.....	.....	Dr	60	6	S	T	E	P	Ls	0	1,824	20	5-28-52
16cc	C. J. Dresch, Jr.....	1944	Dr	165	18	GI	T	G	I	Hpb	0	1,856	44.45	12-29-50
20- 5-20bd	.....	.....	Dr	112.0	2	P	N	N	S	Tpi	2.0	1,776	65.59	5-26-52
6- 6dc	.....	.....	Dr	78.0	3	P	Cy	W	S	Tpi	4.0	1,836	71.13	1- 2-51
22ba1	City of Albion.....	1935	Dr	98	18	C	T	E	P	Ls	0	.....	14	5-22-52
22ba2	.....do.....	1946	Dr	99	18	S	T	D	P	Ls	0	.....	14	5-22-52
23bb	W. W. Redler.....	1947	Dr	100.0	22	GI	T	T	I	Hpb	0	1,763	30.44	1- 2-51
35ba	Lawrence Thompson.....	1943	Dr	154.0	18	GI	T	E	I	Hpb	1.0	1,773	50.65	1- 2-51
21- 6- 8aa	.....	.....	Dr	198.0	3	P	Cy	H	N	O	2.0	2,031	169.25	5-26-52
7-26ca	University of Nebraska.....	1936	Dr	24.2	3	GI	N	Tca	O	Tca	1.9	1,827	17.17	1- 2-51
22- 7-25bd2	City of Petersburg.....	1925	Dr	126	8	S	T	E	P	Ls	0	1,898	50	5-26-52

BOONE COUNTY—Continued

BUFFALO COUNTY

11-16-35ad	Ray Cruise.....	1947	Dr	183	18	S	T	G	I	Hpb	1.0	2,287	153.66	8-27-51
12-13-20cb	Irvin Urwiller.....	1950	Dr	207	18	.....	T	G	I	Hpb	.5	2,031	26.01	8-20-51
14-5dd	City of Ravenna.....	1940	.....	235	18	C	T	E	P	.....	.....	.....	45	7-15-40
15-25cb	Bert Standage.....	1945	.....	96	3	.....	Cy	E	D	Epb	.5	2,039	16.80	8-10-50
16-35ad1	Raymond Hand.....	1935	Du	24.0	12	GH	Cy	H	N	Tpl	0	2,080	6.42	8-27-51
35ad2	Village of Pleasanton.....	.....	.....	119	18	S	T	E	P	.....	.....	.....	.....	.....

CHERRY COUNTY

25-31-18ac	U. S. Bur. Reclamation.....	1948	Dr	139.0	1 1/4	I	N	N	O	Tpi	0	3,204	102.66	10-19-48
31bb	.....do.....	1948	Dr	163.0	1 1/4	I	N	N	O	Tpi	.....	3,223	149.56	10-19-48

CUSTER COUNTY

13-17-36bc	A. W. Tatum, A.....	.....	.....	126	3	P	Cy	W	D,S	Tpi	1.0	2,288	110.17	10-27-50
19-15ba	G. L. Morgan.....	1948	Dr	.....	18	.....	T	T	I	Ls	0	.....	90	8-6-52
14-17-2cb	Ross Douglas.....	.....	Dr	81.0	18	.....	T	T	I	Hpb	0	.....	28.86	8-5-52
5bb	City of Mason City.....	1947	Dr	162	10	.....	T	E	P	Ls	0	2,257	40	8-7-52
15-17-1ad	Glen Smith.....	1940	Dr	122	24	GH	T	T	I	Hpb	0	2,222	21.48	11-6-50
12ab	Maurice Lowry.....	1936	Du	100	24	GH	T	T	I	Ls	0	.....	20	8-5-52
34aa	Otha Lovitt.....	.....	Dr	120.0	18	GH	T	T	I	Hpb	1.0	.....	36.11	8-5-52
18-4ba	C. I. Sherbeck.....	.....	Dr	102	18	GH	T	E	I	Ls	0	.....	35	8-7-52
4dc	City of Ansley.....	1938	Dr	140	10	S	T	E	P	Ls	0	2,304	25	8-7-52
7da	E. A. Nelson.....	1947	Dr	100	.....	.....	T	T	I	Hpb	0	2,355	51.84	8-7-52
9ba1	City of Ansley.....	1946	Dr	110	8	S	T	E	P	Ls	0	2,304	25	8-7-52
9ba2	.....do.....	1948	Dr	100	8	S	T	E	P	Ls	0	2,304	25	8-7-52
14bb	Raymond Shepardson.....	1946	Dr	125	.....	.....	T	T	I	Ls	0	.....	30	8-7-52
14ca	Melvin Clinger.....	1950	Dr	95	18	S	T	T	I	Ls	0	.....	30	8-7-52
15cc	Mathew Reed.....	.....	Dr	.....	18	.....	T	T	I	Hpb	0	.....	29.56	8-7-52
35ca	Frank Reed.....	.....	Dr	.....	18	GH	T	T	I	Hpb	0	.....	36.38	8-7-52
22-8bb	Harlan Van Cleave.....	1945	Dr	135	18	GH	T	G	I	Ls	0	.....	27	8-6-52
31da	Ralph Benjamin.....	1951	Dr	180	18	GH	T	G	I	Ls	0	2,647	115	8-2-52
23-11ba1	City of Callaway.....	1921	Dr	194	10	P	T	E	P	Ls	0	2,552	11	8-6-52
11ba2	.....do.....	1904	Dr	190	4	P	T	E	P	Ls	0	2,552	11	8-6-52

Table 12.—Record of wells and springs in Loup River basin—Continued

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Distance above or below land surface	Altitude above mean sea level (feet)	De-scription		
15-23-13bc	Roy Bryson.....	.....	.....	.....	.....	.....	T	T	I	Hpb	0	2,566	30.22	8-13-52
24-14bc	Henry Bonde.....	.....	Dr	186.0	18	GI	T	G	I	Hpb	0	2,714	122.35	8- 6-52
16-17- 2ab	Arthur Armstrong.....	1940	Dr	200	18	GI	T	G	I	Ls	0	.....	80	7-29-52
5cb	Hubert Mills.....	1951	Dr	.....	18	GI	T	E	I	Ls	0	.....	15	7-24-52
9ac	Ralph Porter.....	1944	Dr	83	18	GI	T	T	I	Ls	0	.....	35	7-23-52
9dc	A. J. Pester.....	1938	Dr	83	20	GI	T	E	I	Ls	0	.....	40	7-23-52
26ad	Fred Mills.....	1940	Dr	.....	18	GI	T	T	I	Ls	0	.....	35	8- 5-52
18- 2ab	Jess Casteel.....	1936	Du	120	24	GI	T	G	I	Ldp	4.8	.....	28.12	7-24-52
2dd	Alpha Casteel.....	1943	Dr	86.0	18	S	T	T	I	Ls	0	.....	14.70	7-24-52
3ba	Marshall Casteel.....	1938	Dr	113.0	24	GI	T	T	I	Hpb	1.0	2,327	11.20	7-24-52
19- 6ab	Leonard Anderson.....	1949	Dr	126	18	GI	T	G	I	Hpb	0	.....	31.5	8- 1-52
8da	Bill Gunther.....	1938	Dr	125	.....	.....	T	G	I	Ls	0	.....	45	8- 1-52
20aa	O. H. Taibot.....	1940	Dr	.....	18	GI	T	G	I	Hpb	0	.....	43.02	8- 7-52
20-10dc	Arthur Haumont.....	.....	Dr	.....	24	GI	T	T	I	Hpb	0	.....	29.22	8- 1-52
23-17dc	Johnson.....	1952	Dr	208.0	18	S	.....	.....	I	Tca	0	.....	22.86	8- 6-52
17-17-25dc	Donald Holeman.....	1945	Dr	120	20	GI	T	G	I	Hpb	0	.....	47.82	7-30-52
25dd	.....do.....	1948	Dr	120	20	GI	T	G	I	Ls	0	.....	48	7-30-52
26db	Gerald Pierson.....	1951	Dr	225	18	GI	T	G	I	Ls	0	.....	80	7-30-52
31cc	Miles Lee.....	.....	.....	130	.....	.....	T	E	I	Ls	0	.....	19	2-23-49
36cc	G. F. Dean.....	1940	Dr	197	18	GI	T	T	I	Ls	0	.....	80	7-29-52

CUSTER COUNTY—Continued

BASIC DATA

36dd	.....do.....	1946	Dr	205	18	GI	T	G	I	Ls	0	.....	80	7-29-52
18-21cc	Donald Samp.....	1948	Dr	200	18	I	T	E	I	Ls	0	.....	11	7-29-52
27cb	Charles Brown.....	1948	Dr	207	18	S	T	E	I	Ls	0	2,332	11	7-29-52
36cb	Rex Cooley.....	1940	Dr	.....	18	.....	T	E	I	Ls	0	.....	29	7-29-52
20-32ad1	City of Broken Bow.....	1940	Dr	140	10	S	T	E	P	Ls	0	.....	16	7-22-52
32ad2	.....do.....	1935	Dr	165	8	S	T	E	P	Ls	0	2,475	16	7-22-52
33cb1	.....do.....	1940	Dr	156	12	S	T	E	P	Ls	0	2,470	30	7-22-52
33cb2	.....do.....	1949	Dr	140	18	GI	T	E	P	Ls	0	2,480	33	7-22-52
33cc1	Charles Sargent.....	.....	Dr	145	18	GI	T	E	I	Ls	0	2,480	30	7-22-52
33cc2	City of Broken Bow.....	1932	Dr	161	8	S	T	E	P	Ls	0	2,475	24	7-22-52
21-13db	Merritt Winchester.....	1947	Dr	125	18	GI	T	G	I	Ls	0	.....	75	7-31-52
24-7ca	Lawrence Wahl.....	.....	Dr	175.0	18	GI	T	G	I	Hpb	0	2,787	114.95	7-31-52
30ca	Robert Shaw.....	1949	Dr	.....	18	GI	T	E	I	Ls	0	.....	20	7-31-52
25-28aa1	City of Arnold.....	1928	Dr	140	6	S	T	E	P	Ls	0	2,700	12	7-23-52
28aa2	.....do.....	.....	Dr	140	4	S	C	E	P	Ls	0	2,700	12	7-23-52
18-17-2db	City of Comstock.....	1927	Dr	180	8	GI	T	E	P	.....	0	2,457	30	10-17-49
18-15ab	Clive Tobias.....	1947	Dr	174	18	GI	T	G	I	Ls	0	2,659	108	7-21-52
21-32dc2	City of Merna.....	.....	Dr	180	12	GI	T	E	P	Ls	0	2,742	120	7-22-52
22-33bc	Cecil Jacquot.....	1938	Dr	220	14	S	T	E	I	Ls	0	2,336	140	7-22-52
19-17-9ca	P. E. Probert.....	1948	Dr	170	18	GI	T	G	I	Hpb	1.0	.....	69.69	11-1-50
18-3dd1	City of Sargent.....	1936	Dr	90	24	GI	T	E	P	Ls	0	.....	12.14	2-8-50
3dd2	.....do.....	1936	Dr	90	24	C	T	E	P	Ls	0	.....	14.15	2-8-50
31dc	Floyd Slagle.....	1947	Dr	130	18	GI	T	G	I	Ls	0	.....	105	7-30-52
19-28da	Berent Ottun.....	1952	Dr	128	18	GI	T	G	I	Ls	0	.....	91	7-30-52
33cb	Milton Collins.....	1945	Dr	162	18	GI	T	G	I	Ls	0	.....	96	7-30-52
20-5cb	John Jacobsen.....	1942	Dr	112	18	GI	T	G	I	Tpl	1.0	2,448	16.96	11-2-50
9aa	Oscar Swick.....	1948	Dr	80	18	GI	T	G	I	Hpb	0	2,427	16.52	11-2-50
21-15dc	.....do.....	.....	Dr	155	18	GI	T	T	I	Hpb	0	2,567	39.12	7-17-52
16cd	Carl Knoell.....	1940	Dr	110	24	I	T	G	I	Ls	0	2,531	20	7-22-52
17ab	Charles Sargent.....	.....	.....	140	16	GI	T	T	I	Ls	0	2,550	22	7-17-52
20aa	Victoria Springs State Park.....	.....	Sp	.....	.....	.....	.....	.....	.....	.....	0	.....	.....	.....
22aa	Harold Kepler.....	1952	Dr	160	18	GI	T	I	Ls	Ls	0	2,565	38	7-17-52
22-16cb2	City of Anselmo.....	1927	Dr	150	4	GI	T	E	P	Ls	0	2,605	30	7-17-52
16db	Frank Lewis.....	1950	Dr	130	18	GI	T	I	Hpb	Ls	0	2,600	29.77	7-21-52

Table 12.—Record of wells and springs in Loup River basin—Continued

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Distance above or below land surface	Altitude above mean sea level (feet)	De-scription		
CUSTER COUNTY—Continued														
13-22-17ad	Chicago, Burlington & Quincy Railroad.....	1927	Dr	100	6	P	Cy	D	R	Ls	0	2,606	30	7-17-52
17dd	Dominic Rolli.....	.....	Dr	135	18	GI	T	E	I	Hpb	0	2,613	22.9	7-21-52
20ac	Frank Lewis.....	1950	Dr	130	18	GI	T	T	I	Ls	0	2,612	23	7-21-52
21ab	.....do.....	1950	Dr	130	18	GI	T	T	I	Hpb	0	2,596	33.95	7-17-52
22bc	James Lindly.....	.....	Dr	137	24	GI	T	E	I	Ls	0	2,596	35	7-17-52
20-19-31cb	E. E. Stone.....	1949	Dr	110	18	GI	T	T	I	Tpl	1.0	2,409	33.08	11- 2-50
34ab	Ray Johnson.....	1948	Dr	122	18	GI	T	G	I	Hpb	0	2,399	52.68	11-12-50
20-30aa	Ted Holmes.....	1948	Dr	77	18	GI	T	G	I	Tpl	0	2,446	32.27	10-10-50
21-10bc	A. C. Turner.....	1949	Dr	30	6	GI	Cy	W	D	Tca	1.0	2,478	22.09	10-30-50
GARFIELD COUNTY														
21-13-32cd	George Lavbildoll.....	.....	.....	191	18	GI	T	G	I	Hpb	0	.....	119.40	10-26-50
15-19aa	Henry Bonzoli.....	.....	.....	.....	.....	.....	T	G	I	Hpb	1.0	.....	16.04	10-25-50
20dd	Charles Meyer.....	.....	.....	.....	.....	.....	T	T	I	Tca	1.0	.....	26.26	10-25-50*
16-11dd	M. L. Kenselmeyer.....	1948	Dr	55	18	GI	T	G	I	Tca	1.0	.....	25.00	10-24-50
12cc	.....do.....	1949	Dr	80	18	GI	T	G	I	Hpb	2.0	.....	38.75	10-24-50
13ad	Emma Janicek.....	1944	Dr	.....	18	GI	T	G	I	Hpb	0	.....	48.49	10-24-50
14cb	Frank Smalik.....	1949	Dr	154	18	GI	T	G	I	Hpb	2.0	.....	25.82	10-24-50
15da	Lawrence Fransen.....	1949	Dr	64	18	GI	T	T	I	Tca	0	.....	9.03	10- 5-50
21dc	Elsie Donner.....	1949	Dr	71	18	GI	T	G	I	Hpb	1.0	.....	6.19	10-25-50
23bd1	City of Burwell.....	1929	Dr	50	30	S	T	E	P	Ls	0	2,176	18	8-18-52

23bd2	.....do.....	1936	Dr	50	30	S	T	E	P	Ls	0	2,176	18	8-18-52
23bd3	.....do.....	.....	Dr	78	24	C	T	E	P	Ls	0	.....	35	11-29-43
24-15-15dd	.....do.....	1952	Dr	140	1 1/4		.....	F	.....	.....	.....	.....	.....	.....

GRANT COUNTY

23-38-5bd	City of Hyannis.....	1947	Dr	120	.....	.....	T	E	P	Ls	0	.....	15	8-19-52
6ad	.....do.....	1932	Dr	160	.....	.....	T	E	P	Ls	0	.....	30	8-19-52
24-36-30bb	U. S. Geol. Survey.....	1934	Dn	15.4	1	P	N	N	O	Tpi	1.2	3,600	5.91	12-18-34
40-36bb	.....do.....	1934	Dn	20.9	1	P	N	N	O	Tpi	4.2	3,840	13.87	12-18-34

GREILEY COUNTY

17-9-31ba	City of Wolbach.....	.....	Dr	90	.....	C	T	E	P	Ls	0	.....	50	6-2-52
10-10cb	U. S. Geol. Survey.....	1935	B	20.0	3	GI	N	N	O	Tca	.9	.....	14.39	12-29-50
12-9ba	City of Scotia.....	1932	Dr	73	36	S	T	E	P	Ls	0	1,940	23	6-4-52
18-11-12ac	Town of Greeley.....	1938	Dr	255	10	S	T	E	P	Ls	0	.....	32	6-4-52
12db	.....do.....	1943	Dr	255	10	S	T	E	P	Ls	0	.....	32	6-4-52
31cc	Conrad Hermsmeyer.....	1941	Dr	220	18	GI	T	D	I	Hpb	0	2,025	65.45	6-4-52
19-9-12db	.....do.....	.....	.....	.....	.....	.....	T	G	I	Hpb	0	1,878	37.58	12-29-50
20-9-20cc	U. S. Geol. Survey.....	1935	Dn	16.3	1	P	N	N	O	Tpi	1.4	1,882	3.03	12-29-50
20db	.....do.....	1936	B	19.5	3	GI	N	N	O	Tca	2.2	1,883	10.63	12-29-50
21bd	City of Spalding.....	1946	Dr	150	24	S	T	E	P	Ls	0	.....	18	6-3-52
21ca	.....do.....	.....	Dr	120	24	S	T	E	P	Ls	0	.....	25	6-3-52
30ca	Alvin Gilray.....	1947	Dr	168.0	18	GI	T	G	I	Hpb	2.0	1,962	68.98	12-29-50
34aa	E. Haggerty.....	1943	Dr	158.0	24	GI	T	G	I	Hpb	.5	1,882	32.79	12-29-50
10-14ab	Albert Glaser.....	1944	Dr	90.0	18	GI	T	G	I	Hpb	.5	1,921	10.00	12-29-50

HOOKE COUNTY

24-31-17cd	U. S. Bur. Reclamation.....	.....	Dr	20.9	1 1/4	I	N	N	O	Tpi	0.9	3,010	16.82	12-18-50
18cb	.....do.....	.....	Dr	41.6	1 1/4	I	N	N	O	Tpi	1.0	3,050	33.66	12-18-50
18dd	.....do.....	.....	Dr	21	1 1/4	I	N	N	O	Tpi	1.0	3,030	18.09	10-5-50
21aa	.....do.....	.....	Dr	11.6	1 1/4	I	N	N	O	Tpi	2.2	2,990	7.08	12-18-50
32-20ab	City of Mullen.....	1934	Dr	180	8	P	T	E	P	Ls	0	.....	40	8-19-52

Table 12.—Record of wells and springs in Loup River basin—Continued

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Distance above or below land surface (feet)	Altitude above mean sea level (feet)	De-scription		
20ad	.....do.....	1949	Dr	180	8	P	T	E	P	Ls	0	.....	40	8-19-52
20bd	.....do.....	1915	Dr	180	8	P	T	E	P	Ls	0	.....	40	8-19-52
35-23gd	University of Nebraska.....	1934	Dn	22.6	1	P	N	N	O	Tpi	1.8	3,440	13.34	12-18-34

HOOVER COUNTY—Continued

HOWARD COUNTY

13-11-6bd	J. C. Peterson.....	1900	Dr	80	6	GI	Cy	W	D ₁ S	Tpl	1.0	1,955	49.61	10-13-50
11ac	City of Dannebrog.....	1939	Dr	54	18	C	T	E	P	Ls	0	.....	30	5-6-52
11db1	.....do.....	1934	Dr	85	18	GI	T	E	P	Ls	2.2	.....	19.00	2-2-50
12-29ab1	City of Boelus.....	1935	Dr	31.5	12	GI	T	E	P	Hpb	1.0	.....	10.24	11-10-49
29ab2	.....do.....	1934	Dr	31.5	18	S	T	E	P	Hpb	0	.....	9.02	5-6-52
14-9-3bb	George Zuehelke.....	1950	Dr	106	18	GI	T	T	I	Hpb	0	1,850	11.47	4-30-52
3cb	Ray Bahensky.....	1949	Dr	107	18	GI	T	T	I	Hpb	0	1,855	14.36	4-30-52
10-3ca1	City of St. Paul.....	1948	Dr	50	18	S	C	E	P	Ls	.....	.....	14	5-8-52
3ca2	.....do.....	.....	Dr	55	28	S	T	E	P	Ls	.....	.....	12	12-1-43
30ba	Ivan McCrackin.....	1935	Dr	32	4	GI	Cy	W	D	Tca	.5	1,853	14.88	4-3-50
11-3bc	.....	.....	.....	.....	2	P	N	N	N	Tpi	-4.0	1,992	106.88	4-5-52
6ba1	Chicago, Burlington & Quincy Railroad.....	1937	Dr	115	12	GI	T	E	R	Hpb	2.0	.....	32.81	8-15-49
6ba2	City of Farwell.....	1938	Dr	142	8	S	T	E	P	Ls	0	.....	29	5-6-52
27ba	U. S. Bur. Reclamation.....	1952	J	31	3 ¹ / ₄	P	N	N	N	Tpi	1.5	1,910	16.65	4-5-52
12-1aa	.....	.....	.....	31	5	GI	N	N	N	Tca	1.0	1,960	20.71	4-6-52

	1952	J	$\frac{3}{2}$	P	N	N	N	N	N	N	Tpi	1,935	8.30	4- 7-52
12dd	U. S. Bur. Reclamation.....	Dr	79.0	18	GI	T	E	I	Hpb	0	1,795	21.07	5- 2-52		
15-10-34db	Joseph Zavitka.....	.....	85	5	GI	Cy	H	D,S	Tca	0	1,906	32.34	4- 6-52	
11- 5cc	R. Spillnek.....	.....	53	6	GI	N	N	N	Tca	1.0	1,845	33.03	4- 6-52	
10ac	City of Elba.....	1936	79	8	S	T	E	P	.....	.....	.....	28	11-30-43
10bc	
15ba	Elba Cemetery.....	.....	83	5	GI	Cy	H	D,S	Tca	1.0	1,893	66.29	4- 5-52	
27aa	A. S. Naprstek.....	.....	120	6	GI	Cy	W	S	Hpb	0	1,922	67.90	4- 5-52	
12-33aa	.....	Du	32	60	.....	N	N	N	Tpi	0	1,993	30.68	4- 7-52
16- 9-10ad	Cyril Havlik.....	.....	260	3	S	Cy	H	N	Tpi	4.0	2,000	175.35	5- 2-52	
10-21cc	.....	Dr	101	8	GI	N	N	S	Tca	1.0	1,970	90.20	5- 2-52	
11-19cb1	Ray Parker.....	1947	96	18	GI	N	N	I	Tca	0	1,905	41.59	12-29-50		
19cb2	.....	Dr	95	18	GI	T	T	I	Hpb	0	1,880	33.36	5- 5-52	

LOGAN COUNTY

18-20-35cd	City of Stapleton.....	1938	Dr	153	8	P	T	E	P	Ls	0	2,890	18	8-13-52
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LOUP COUNTY

21-17-32dc	Louis Bohy.....	18	T	G	I <th>Hpb</th> <th>0.5</th> <th>.....</th> <th>23.74</th> <th>8-30-50</th>	Hpb	0.5	23.74	8-30-50
18-18cd	Arthur Coleman.....	1945	Dr	131	18	GI	G	I	Hpb	1.0	15.36	8-29-51
20bd	Charles Ford.....	1946	Dr	115	18	GI	G	I	Hpb	.5	.....	28.79	11- 1-50
22aa	University of Nebraska.....	1935	Dn	15.2	1	P	N	O	Tpi	.8	.....	4.86	11- 1-50
26cc	.....	.....	.....	18	GI	T	G	I	Hpb	0	.....	25.91	11- 1-50
27ba	North Loup Public Power and Irrigation District.....	.....	Dn	6.3	1 $\frac{1}{4}$	GI	N	O	Tpi	1.0	.....	5.12	10- 5-50
35ba	Lester Stekel.....	.....	.....	.....	.....	.....	G	I	Hpb	0	.....	33.59	9-24-51
19- 4bc	Wm. Strong.....	1930	Dr	22.0	1 $\frac{1}{4}$	P	N	N	Tpi	1.5	.....	10.41	1-17-51
13db	S. Ferguson.....	1930	Dr	132.0	18	GI	T	G	Hpb	1.0	.....	17.79	11- 1-50
22-20-24db	Oscar Anderson.....	1945	Dr	.....	18	GI	T	G	Hpb	1.0	.....	19.80	1-17-51

MERRICK COUNTY

15- 8-17dd	U. S. Geol. Survey.....	1950	J	14.0	GI <th>N <th>O <th>Tpi <th>1.0</th> <th>1,718</th> <th>3.84</th> <th>1- 4-51</th> </th></th></th>	N <th>O <th>Tpi <th>1.0</th> <th>1,718</th> <th>3.84</th> <th>1- 4-51</th> </th></th>	O <th>Tpi <th>1.0</th> <th>1,718</th> <th>3.84</th> <th>1- 4-51</th> </th>	Tpi <th>1.0</th> <th>1,718</th> <th>3.84</th> <th>1- 4-51</th>	1.0	1,718	3.84	1- 4-51
27dddo.....	1950	J	21.0 <td>$\frac{7}{4}$</td> <td>GI</td> <th>N</th>	$\frac{7}{4}$	GI	N	O <th>Tpi <th>1.5</th> <th>1,740</th> <th>4.55</th> <th>11-29-50</th> </th>	Tpi <th>1.5</th> <th>1,740</th> <th>4.55</th> <th>11-29-50</th>	1.5	1,740	4.55	11-29-50

Table 12.—Record of wells and springs in Loup River basin—Continued

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Distance above or below (-) land surface (feet)	Altitude above mean sea level (feet)	Definition		
MERRICK COUNTY—Continued														
15- 8-32cd	City of Palmer.....	1952	Dr	95	18	GI	T	E	P	Ls	0	.....	20	1- 9-53
16- 3- 5aa	U. S. Geol. Survey.....	1950	J	14.0	$\frac{3}{4}$	GI	N	N	O	Tpi	1.0	1,566	5.75	11-30-50
7dd	.....do.....	1947	Dr	10.6	$1\frac{1}{4}$	GI	N	N	O	Tpi	1.0	.....	2.12	5-29-52
NANCE COUNTY														
15- 6- 2bb	U. S. Geol. Survey.....	1951	J	18.5	$\frac{3}{4}$	GI	N	N	O	Tpi	1.0	1,663	3.83	11-27-50
16- 5-21cc	.....do.....	1950	J	14.0	$\frac{3}{4}$	GI	N	N	O	Tpi	1.5	.....	9.61	1- 4-51
6-11db	City of Fullerton.....	1904	Du	50	18	C	C	E	P	Ls	0	.....	25	5-14-52
7- 6aa	.....	.....	Dr	191.0	3	P	N	N	N	Tca	4.0	1,900	145.04	5-13-52
14ca	.....	.....	Dr	270.0	3	P	Cy	H	N	Tca	0	1,840	123.44	5-13-52
17- 4-24ca1	City of Genos.....	1947	Dr	30	18	GI	T	E	P	Ls	0	.....	20	5-14-52
24ca2	.....do.....	1950	Du	40	18	S	T	E	P	Ls	0	.....	20	5-14-52
36aa	Loup River Public Power District.....	1935	Dn	11.0	$1\frac{1}{4}$	P	N	N	O	Tpi	2.0	1,557	7.17	11-28-50
5-20bb	.....	.....	Dr	78.0	3	P	N	N	N	Tca	2.0	1,680	14.44	5-12-52
6- 3ad	.....	.....	Dr	154.0	3	P	N	N	N	Tca	2.0	1,800	89.95	5-12-52
7- 1dc	City of Belgrade.....	.....	Du	40.5	14	S	T	E	P	Ls	0	.....	10	5-14-52
8-15bb	.....	.....	Dr,Dn	74.0	3	P	Cy	W	N	Tca	0	1,795	17.64	5-12-52
18- 4-19ab	Homer Petersen.....	1935	Dr	142.0	4	GI	Cy	H	S	Tpi	1.5	1,635	12.34	1- 2-51
5-33da	.....	.....	Dr	164.0	3	P	N	N	N	Tca	2.0	1,800	146.22	5-12-52

PLATTE COUNTY

A17- 1-20bc	City of Columbus.....	1941	Dr	100	24	.....	T	E	P	LS	.....	16.00	11- 7-41
A18- 1-28cd	Loup River Public Power District.....	1935	Dr	98.6	2	P	N	N	O	Tpi	0.5	1,512	5-29-52
31ad	.....do.....	1935	Dr	84.0	2	P	N	N	O	Tpi	.....	1,507	11-14-35
17- 1-27ad	.....do.....	1935	Dn,B	13.5	1 1/4	P	N	N	O	Tpi	3.0	.....	8.52 9-27-49

SHERIDAN COUNTY

24-41-34da	U. S. Geol. Survey.....	1934	Dn	13.2	1	P	N	N	O	Tpi	1.0	3,876	9.36 12-18-50
42-27ba	.....do.....	1946	Dn	18.2	1 1/4	P	N	N	O	Tpi	1.0	3,922	14.34 12-18-50
43-15da	University of Nebraska.....	1940	Dn	21	1 1/4	P	N	N	O	Tpi	1.8	3,917	8.55 6- 7-51
44-14da	.....do.....	1946	Dn	10.8	1 1/4	P	N	N	O	Tpi	1.5	3,879	5.92 6- 7-51
18bb	.....do.....	1946	Dn	12.3	1 1/4	P	N	N	O	Tpi	1.0	3,881	5.93 6- 7-51
45- 8dd	.....do.....	1935	Dn	11.5	1	P	N	N	O	Tpi	2.0	3,878	4.42 12-18-50
46-10cb	U. S. Geol. Survey.....	1946	Dn	12	1 1/4	P	N	N	O	Tpi	1.0	3,905	7.30 12-18-50
25-45-32ad	J. Herrian.....	1930	Dr	79	4	.....	N	N	N	Tca	1.3	.....	34.42 12-18-50

SHERMAN COUNTY

13-13- 5dd	Rockville Ball Club.....	.....	.....	35	4	.....	Cy	.....	.....	Tpi	3.0	.....	26.61 10- 9-49
13cc	John Siefert.....	1935	.....	78	4	GH	Cy	W	S	Hpb	0	1,995	53.59 11- 7-50
14-14- 3cc2	Bill Coutan.....	.....	.....	38	4	GH	Cy	W	S	Hpb	0	.....	11.15 10- 9-49
15-26aa	.....do.....	.....	Dr	139	5	GH	N	N	N	Tca	1.0	2,190	109.63 6- 5-52
16-28ac2	City of Litchfield.....	1949	Dr	109	14	S	T	E	P	LS	0	.....	44 6- 5-52
28db	Chicago, Burlington & Quincy Railroad.....	1908	Dr	.....	.....	.....	Cy	G	R	LS	.....	.....	45 6- 5-52
15-13-27ab	City of Ashton.....	.....	Dr	150	12	GH	T	E	P	.....	.....	.....	.....
14-18bd1	City of Loup City.....	1922	Dr	116	18	C	T	E	P	.....	.....	.....	13.00 10-18-49
16- 7aa	M. Reiter.....	.....	Dr	.....	.....	GH	T	T	I	Epb	.5	2,218	27.05 11- 6-50
7ab	Darrel Packer.....	.....	Dr	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
16-14-28aa	Earl Keefer.....	1947	Dr	160	18	S	T	G	I	Hpb	1.0	2,160	85.42 6-11-52
16-12bc	Edward Chotkoski.....	1948	Dr	124	18	GH	T	T	I	Hpb	2.0	2,186	37.35 11- 7-50
21aa	.....do.....	.....	Dr	213.0	3	P	N	N	N	Tca	0	2,392	199.13 6- 5-52

Table 12.—Record of wells and springs in Loup River basin—Continued

Well	Owner or user	Year drilled	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Type of pump	Type of power	Use of water	Measuring point			Depth to water level below measuring point (feet)	Date of measurement
										Description	Distance above or below land surface (feet)	Altitude above mean sea level (feet)		
THOMAS COUNTY														
23-28-9ca	City of Theoford.....	1942	Dr	.....	.....	.....	T	E	P	Ls	0	.....	15	8-19-52
24-30-20ab	University of Nebraska.....	1934	Dn	12.6	1	P	N	N	O	Tpi	2.5	2,950	4.92	6-7-51
VALLEY COUNTY														
17-16-26ba	City of Arcadia.....	1936	Dr	81	12	GI	T	E	P	.....	.....	.....	7	10-17-49
30bc	Les Bly.....	1946	Dr	180	18	GI	T	T	I	Ls	0	.....	64	7-30-52
18-13-25cc	City of North Loup.....	.....	Dr	93	10	I	T	E	P	Ls	0	1,957	20	11-29-43
26dd	.....do.....	1914	Dr	87	12	S	T	E	P	Ls	0	1,957	10	7-10-52
33bc	W. N. Vogeler.....	1949	Dr	257	18	GI	T	G	I	Hpb	1.0	2,020	36	7-9-52
15-11ba	William Hansen.....	1948	Dr	150	18	GI	T	G	I	Hpb	.5	2,156	32.81	7-9-52
12bb	Emil Kokes.....	1948	Dr	120	18	GI	T	G	I	Hpb	1.0	2,145	31.84	7-1-48
19-14-6dc	Archie Geweke.....	1940	Dr	98	30	C	T	T	I	Ls	.....	2,085	36	7-8-52
36ba	Edward Penas.....	1947	Dr	155	18	GI	T	T	I	Ls	0	2,030	33	7-9-52
20-15-3bab	Floyd Wozniak.....	1948	Dr	122.0	18	C	T	G	I	Hpb	0	2,153	61.45	7-8-52
WHEELER COUNTY														
21-11-25dd	State of Nebraska.....	.....	.....	97	2	P	N	F	N	.....	.....	.....	.....	.....
12-23bb	City of Ericson.....	1937	Dr	87	6	S	T	E	P	Ls	0	.....	5	11-7-52

INDEX

	Page		Page
Acknowledgments	5	Dissolved solids	55, 57, 59
Agriculture	32-33	Drainage, principal streams	16
Alkalinity, defined	57	Dune sand	39, 40
ground water	57, 58	Electricity, generation	31, 33, 42
Almeria Public Power and Irrigation District	7, 33	Evapotranspiration	12, 31, 42
Analyses of water, chemical	51-53	Fluoride	55, 59
methods	50	Fossil soils	39
Anticlinal	34, 36	Fullerton formation, lithologic char- acter	39
Arikaree group, age	33, 38	Gering sandstone	37
formations	37-38	Glaciation	38-39
thickness	38	Grand Island formation, lithologic character	39
Artesian conditions, defined	40	Ground water, artificial recharge and discharge	42-47
Artesian wells	40-41	chemical analyses	52-53
Ash Hollow formation	38	discharge	41, 42, 43
Beaver Creek, course	16	dissolved solids	50, 54, 55-59
discharge	29	fluctuations of water table	47, 48, 49-50
Bibliography	61-62	movement	47, 49
Bicarbonate	55, 57, 58	potential development	40
Bignell loess	39	recharge, canal leakage	47, 48
Blowouts, defined	12	precipitation	41
Boelus power canal, course	33	pumpage from wells	43, 44
discharge	22	underflow	41
seepage losses	47	relation to surface water	41, 50
Boron	55, 59	sampling points	54, pl. 1
Brule clay	37	storage	40, 49
Calamus River, course	16	use	43-44
discharge	25, 31	Hardness of water	55-56, 59-60
Calcium	55, 57, 58	Harrison sandstone	37
Canals	7, 17, 44, 47	Hemingford group, age	33
Carbonate	55, 57, 58	formations	37, 38
Carlisle shale, distribution	36	thickness	38
thickness	34	Holdrege formation, lithologic char- acter and thickness	39
Cattle raising	32, 60	Illinoian ice sheet	39
Cedar River, course	16	Industry	32, 33
discharge	27, 28, 31	Introduction	1-5
Chadron-Cambridge arch	34	Investigation, previous	2-4
Chadron formation	37	purpose and scope	1-2
Chemical quality of the water, by R. H. Langford	50-60	Iron	59
Chloride	55, 59	Irrigation, source of ground-water recharge	44
Climate	6-12	suitability of water	58-59
Closed basins area	5, 49	use of surface water	32-33, 44, 45
Conclusions	60-61	wells	33, 43-44
Consumers Public Power District	7	Kansan ice sheet	39
Cretaceous system, description	34-36		
water supply	34		
Crete formation, lithologic character	39		
Davis Creek, discharge	26, 31		
Dismal River, course	16		
discharge	16, 18, 19, 20		

	Page		Page
Lakes, chemical quality	51, 55	Recent deposits	40
occurrence	12	Residual sodium carbonate, defined	58
relation to water table	41	Runoff	16-31, 42, 44
Langford, R. H., Chemical quality of the water	50-60	Sappa formation	39
Late Wisconsin sand and gravel	39	Sheep Creek formation, age and litho- logic character	38
Loess, defined	12	Silica	55, 57, 58
deposition	39, 40	Siouxana arch	34, 36
Loess plains and hills	12, 15	Sodium	55, 57, 58
Loup River, course	16	South Loup River, course	16
discharge	29, 30, 31	discharge	27, 31
Loup River power canal, course	33	Specific conductance, defined	50
discharge	28, 31	ground water	52-53, 55
source of recharge	47	surface water	51, 55
Loup River Public Power District	7, 33	Spring Creek, discharge	27, 31
Loveland loess	39	Springs	42
Magnesium	55, 57, 58, 59	Structural geology	34
Manganese	59	Sulfate	55, 58
Marshes, occurrence	12	Surface water, chemical analyses	51
Marsland formation, age and litho- logic character	38	discharge	16, 18
Middle Loup River, course	16	measurements	19-30
discharge	16, 18, 19, 20, 21, 22, 24, 31	dissolved solids	55
Middle Loup Public Power and Irriga- tion District	7, 32-33	uses	32-33
Monroe Creek sandstone	37	Synclines	34, 36
Mud Creek, discharge	23	Temperature	11-12
Nebraskan ice sheet	38	Tertiary system, description	37-38
Nebraska National Forest	13, 32	water supply	40
Newton Irrigation District	7	Test holes, location	4, pl. 1
Niobrara formation, distribution	34, 36	logs, State-Federal program	64-70
thickness	34	other	71, 72-81
Nitrate	55, 57, 58, 59	numbering system	5, 6
North Loup Public Power and Irriga- tion District	7, 33	Todd Valley sand	39
North Loup River, course	16	Topography	4, 12-16
discharge	24, 25, 26, 31	Underflow, source of ground-water recharge	41
Oak Creek, discharge	23, 31	U.S. Public Health Service, drinking- water standards	59
Ogallala formation, age	33, 38	Valentine formation	38
distribution	36, 38	Vegetation	32
lithologic character and thick- ness	38	Water loss	12
Pearlette ash member, Sappa forma- tion	39	Water table, configuration	49, pl. 1
Peneplain, topography	34	depth to	41, 42
Peorian loess	39, 40	Water-table conditions, defined	40
Percent sodium	58-59	Wells, artesian	40-41
pH	59	domestic and stock	43, 59
Pierre shale, distribution	34, 36	industrial supply	44
thickness	34	irrigation	33, 43-44
Population	32	location	pl. 1
Potassium	55, 57, 58	numbering system	5, 6
Precipitation, amount	5-6, 8-11	public supply	44, 46-47
percentage in runoff	31	water-level fluctuations	4
source of ground-water recharge	41		42, 47, 48, 49-50
Public water supplies	44, 46-47	White River group, age	33
Quaternary system, description	38-40	formations	37
water supply	40	Wisconsin ice sheet	39
		Yarmouth interglacial stage	39