UNITED STATES DEPARTMENT OF THE INTERIOR J. A. Krug, Secretary

GEOLOGICAL SURVEY W. E. Wrather, Director

CIRCULAR 19 August, 1948

OGRESS REPORT ON THE GROUND-WATER HYDROLOGY OF THE REPUBLICAN AND FRENCHMAN RIVER VALLEYS

By

Herbert A. Waite and Others

WITH A SECTION ON THE CHEMICAL QUALITY OF THE GROUND WATER

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PROGRESS REPORT ON THE GROUND-WATER HYDROLOGY OF THE REPUBLICAN AND FRENCHMAN RIVER VALLEYS IN NEBRASKA

By Herbert A. Waite and others

ABSTRACT

This report is based on current investigations of the ground-water resources of the Republican and Frenchman River Valleys in Nebraska and includes data gathered to December 31, 1947. These studies were started late in 1945 as a part of a program of ground-water investigations now in progress in connection with the Missouri River Basin development plan. Studies to date have consisted principally of periodic observations of water-table fluctuations at selected observation wells, of collection of samples of ground water for chemical analysis, and of collection of data concerning the municipal water supplies in the valley. In addition to the data thus obtained, this report includes a brief description of the geology of the area based on earlier investigations, a map of the valleys showing the locations of observation wells and contours on the water table, a table of well records, and hydrographs of water-level fluctuations in 10 observation wells with records extending back to 1934. A section on the chemical quality of ground water in the valley, prepared by the Quality of Water Division of the Geological Survey, and chemical analyses of samples of ground water are also included. This report is preliminary in nature and is expected to be followed at a later date by a more comprehensive report.

INTRODUCTION

The area covered in this report includes the valley floor of the Republican River throughout its entire course within the State of Nebraska and the valley floor of the Frenchman River from Wauneta, Nebraska to its confluence with the Republican River at Culbertson, Nebraska. The Republican River follows an easterly course across southern

Nebraska, entering the State at its southwest corner, flowing essentially parallel to and within 21 miles of its southern border, and leaving at about the midpoint of the Nebraska-Kansas State line. (See fig. 1.) The valley ranges in width from about half a mile to 2 miles. The total area covered in this study is approximately 450 square miles.

For fuller discussions of the geologic and ground-water conditions in the Republican River Valley than appear in this preliminary report the reader is referred to the following publications:

> Condra, G. E., Geology and water resources of the Republican River Valley and adjacent areas, Nebraska: U. S. Geol. Survey Water-Supply Paper 216, 1907.
>
> Waite, H. A., Reed, E. C., and Jones, D. S., Jr., Ground water in the Republican River Basin in Nebraska: Nebraska Water Resources Survey Water-Supply Paper 1, Conservation and Survey Division, Univ. Nebraska, 1946. Comprised of four parts, Part I covering Nuckolls, Webster, Franklin, and Harlan Counties, Part II covering Furnas County, Part III covering Redwillow and Frontier Counties, and Part IV covering Hitchcock, Hayes, Dundy, and Chase Counties.

The 1946 report was prepared through the joint efforts of the Conservation and Survey Division of the University of Nebraska, the United States Geological Survey, and the Bureau of Irrigation, Water Power, and Drainage of the Nebraska Department of Roads and Irrigation. It includes records of test holes, county maps showing contours drawn on the top of the impervious bedrock floor, thicknesses of the water-saturated sand and gravel formations in the bottom-land and terrace regions, and geologic profile sections in each county based on test-drilling information.

An unpublished report by R. C. Cady, entitled Geology and ground-water resources of the Republican Valley in the southern half of Franklin,

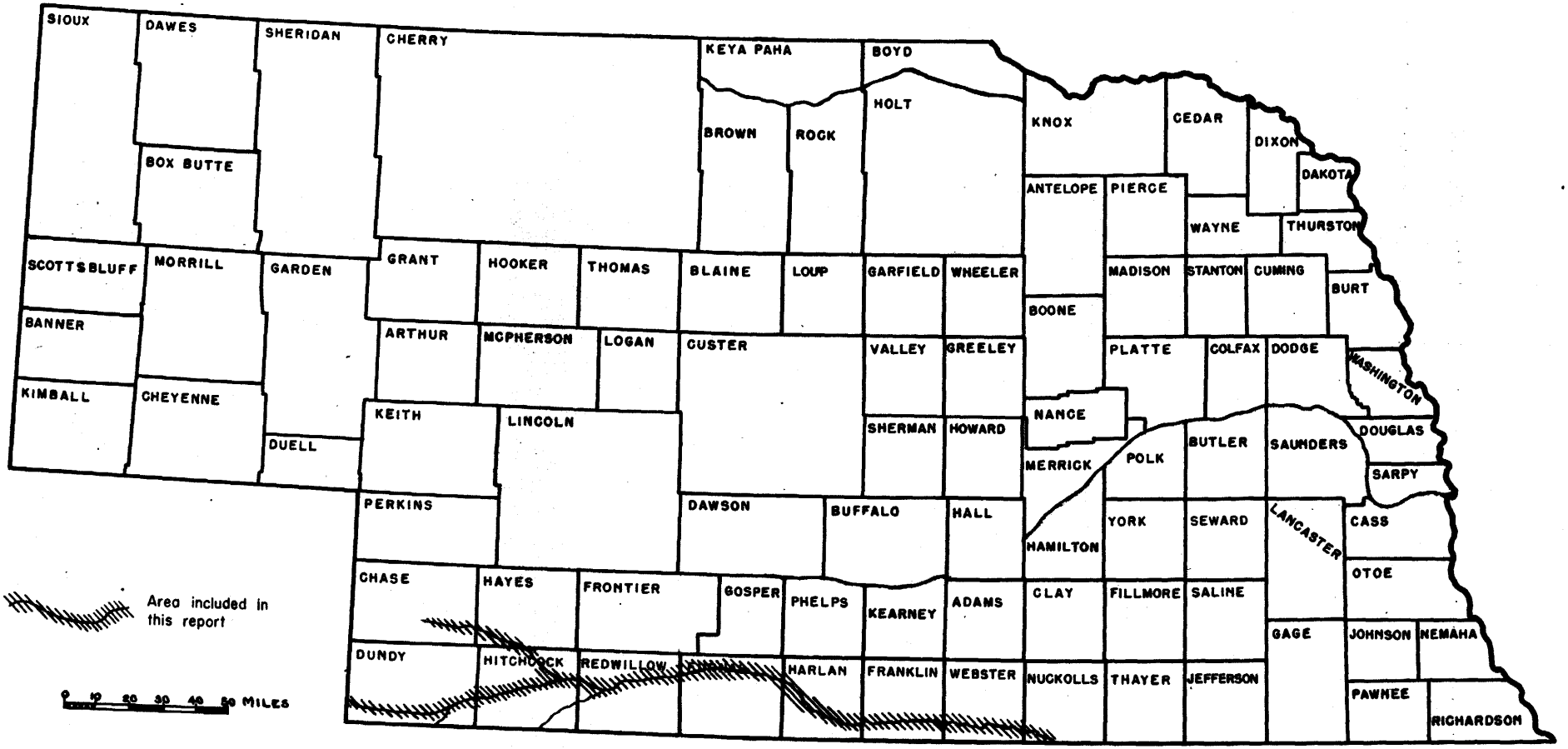

Figure 1.– Map of Nebraska showing area covered by this report

Webster, and Nuckolls Counties, Nebraska, has been drawn upon to some extent in the preparation of this report.

The present investigation, which was begun late in 1945, augments the studies referred to above and to date has consisted of the following:

1. Periodic measurements of the depth to water in observation wells located throughout the area.

2. The construction of hydrographs showing water levels in observation wells having long periods of record.

3. The construction of a preliminary water-table contour map.

4. The collection of water samples from representative wells for chemical analysis by the Quality of Water Division of the United States Geological Survey.

5. An inventory of the public-supply wells of the principal towns in the valley.

ACKNOWLEDGMENTS

The investigation in the Republican River Valley was carried on under the general supervision of O. E. Meinzer, Geologist in Charge of the Division of Ground Water of the Geological Survey until his retirement on December 1, 1946; since that date the work has been under the general supervision of A. N. Sayre. The investigation was under the direct supervision of George H. Taylor, Regional Engineer, Ground Water, in charge of ground-water investigations in the Missouri River Basin.

Dr. G. E. Condra, State Geologist and Director of the Conservation and Survey Division of the University of Nebraska, and E. C. Reed,

Assistant State Geologist, reviewed the manuscript report and gave many helpful suggestions, especially relating to the geology of the area. Special acknowledgment is due Dr. Condra for making available a co-operatively owned Failing Model 30 drilling rig for drilling test holes.

Acknowledgment is made to the following personnel of the Lincoln office of the Division of Ground Water for their active participation in the field work and later in the preparation of the report: Ray Bentall, W. Kenneth Bach, Howard F. Haworth, Graham D. Jones, Charles F. Keech, Raymond L. Schreurs, Ferd G. Schnittker, Mervin F. Sunyoke, Raymond L. Stribic, Otto E. Toppenberg and Andrew P. Wach. Mr. Schnittker made most of the measurements of water level in observation wells in the Republican and Frenchman River Valleys, serviced three automatic water-stage recorders periodically, collected water samples for chemical analysis, and made an inventory of the municipal water supplies in the valleys. Messrs. Haworth, Sunyoke, Jones, and Schnittker installed three 8-inch observation wells in the valleys and equipped each with a continuous recorder. A total of 103 observation wells, 1¼ inches in diameter, were installed by Messrs. Schnittker, Sunyoke, Schreurs, Jones, and Bentall.

The water-table contour map, together with many other parts of this report, were prepared by Mr. Bentall. The section of municipal supplies was prepared by Mr. Bach, and the well tables by Mr. Toppenberg. The hydrographs were prepared by Messrs. Jones and Schreurs. The water-level records were prepared by Messrs. Toppenberg, Schreurs, and Bach. Illustrations were drafted by Messrs. Stribic and Wach.

Study of the chemical character of ground water in the Republican and Frenchman River Valleys in Nebraska was under the general direction of S. K. Love, Chief of the Quality of Water Division, and under the immediate supervision of Paul C. Benedict, District Engineer in charge of quality of water studies in the Missouri River Basin.

Of the total number of 34 well water analyses presented in this report, 12 were made in 1936 and 1939 by M. D. Foster and F. H. Davis as a part of a report by R. C. Cady.[1] The analytical work on the 22 samples collected in 1947 was done by J. G. Connor, L. L. Thatcher, W. M. Barr, and J. F. Bonebright.

Acknowledgment is also due the many residents of the area who readily gave permission for the measurement of their wells and who supplied helpful information.

GEOLOGY AND GROUND-WATER CONDITIONS

Throughout its course in Nebraska, the Republican River meanders from one side of its valley floor to the other. The length of the valley in Nebraska is 227 miles, but the length of the river in the same distance is 289 miles. In this length the altitude of the river surface drops from 3,337 feet to 1,529 feet, indicating an average gradient of about 6 feet to the mile. The river bed increases in width from about 275 feet at a point 1 mile below the confluence of the North and South Forks

1 Cady, R. C., Geology and ground-water resources of the Republican Valley in the southern half of Franklin, Webster, and Nuckolls Counties, Nebraska (unpublished report).

in Dundy County to about 375 feet where it leaves the State, and in the same distance the valley floor widens from 1.1 miles to 2.0 miles. The Arikaree River, which joins the North Fork of the Republican River at Haigler in Dundy County, and the Frenchman River, which enters the Republican River at Culbertson in Hitchcock County, are two of the principal tributaries. The average discharge of the Republican River at Max, in Dundy County, is 189 second-feet (15-year period); at Culbertson, in Hitchcock County, it is 235 second-feet (12-year period); near Bloomington, in Franklin County, it is 670 second-feet (14-year period); and near Hardy, in Nuckolls County it is 771 second-feet (11-year period).[2] Although the flow of the river may be greatly reduced during the summer months, the river bed becomes completely dry only occasionally.

The uplands both north and south of the Republican Valley are mantled by unconsolidated materials, such as silty clay (loess), dune sand, and sand and gravel, all of which were deposited in comparatively late geologic time. The sands and gravels, where present, underlie the finer-textured deposits. In the upland area they are restricted to the north side of the river and, except for thin and scattered deposits, extent westward no farther than Redwillow County. In a test hole 5 miles north of Red Cloud this sand and gravel zone is as much as 150 feet thick.

In general, the walls of the Republican Valley are abrupt, especially on the south side, and are notched at frequent intervals by the narrow

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2 Surface water supply of the United States, Part 6, Missouri River Basin: U. S. Geol. Survey Water-Supply Paper 976, pp. 376-379, 1943.

canyons of tributary streams. Except for the north side of the river between the mouth of the Frenchman River and eastern Webster County, the valley walls generally consist of bedrock, in many places mantled by unconsolidated materials, which are continuous from the upland surface down the slopes of the valley walls to the floor of the valley. The bedrock formations that crop out in the area and are exposed in bluffs and quarries are as follows:

Tertiary	Ogallala formation.
Unconformity.	
Cretaceous	Pierre shale.
	Niobrara formation.
	Carlile shale.

The Ogallala formation has a maximum thickness of about 400 feet in western Dundy County and thins eastward. It comprises a series of hard and soft beds consisting of limy sandstone and siltstone interbedded with sands, some gravel, and some clay. In certain zones the beds are cemented by silica and are very dense. The coarser unconsolidated deposits are relatively permeable and where such deposits occur below the water table they yield water to wells tapping them. The Ogallala formation crops out along the valley walls both north and south of the river in Dundy, Hitchcock, Hayes, Redwillow, and Furnas Counties. Farther east, in Harlan and Franklin Counties, it is present below the mantle rock of the uplands south of the valley and crops out high on the valley walls. Only thin scattered deposits remain under the uplands in southwestern Webster County, and none are known to occur in Nuckolls County.

The Pierre shale is dark-gray to black and westward it thickens to about 1,500 feet in western Dundy County. The Pierre shale is practically impervious and yields water to wells only where it is jointed or fractured. Where water is present in the Pierre shale it is usually strongly mineralized, containing considerable amounts of sodium and potassium salts, largely sulphates. The Pierre shale crops out continuously beneath the Ogallala formation in Dundy and Hitchcock Counties, but its occurrence in Redwillow County is restricted to the western part of the county, where only the lowest part was preserved from erosion in pre-Ogallala times. The lowest part crops out also in eastern Furnas County and in central Harlan County, but east of the latter area it is entirely absent.

The Niobrara formation, which underlies the Pierre shale, consists predominantly of chalky shale in its upper and middle parts and of chalky limestone in its lower part. Its total thickness increases westward from about 400 feet in central Harlan County to about 600 feet in western Dundy County. The Niobrara is relatively impermeable and does not yield water to wells except where it is jointed or fractured. The Niobrara formation does not crop out in Dundy, Hitchcock, Hayes, and Redwillow Counties. It is present at relatively shallow depths in the eastern part of this area, but its depth increases westward to 1,000 feet or more. It crops out along the sides of the valley in Furnas, Harlan, Franklin, and Webster Counties and in western Nuckolls County. It has been completely removed by erosion in eastern Nuckolls County, where older rocks are either exposed or are immediately below the mantle rock cover.

The Carlile shale underlies the Niobrara formation. It consists predominantly of a dark-gray to black shale with some chalky layers in its lower part and locally a thin sandstone at its top. The upper sandstone member is known to yield water in some places. The aggregate thickness of the Carlile shale is about 250 feet. In the Republican Valley area in Nebraska its exposures and outcrop are limited to eastern Nuckolls County. Westward it occurs at increasingly greater depths.

The floor of the Republican Valley is underlain by a buried channel filled with water-bearing sands and gravels of Pleistocene and Recent age. These alluvial materials range in thickness from a very thin layer up to about 75 feet, the greater thicknesses being generally restricted to the center of the present valley and not necessarily underlying the present course of the river. The water-laid alluvial materials within the valley are confined within bedrock walls as far downstream as the western part of Redwillow County. Still farther downstream the sand and gravel of the valley alluvium in some places are continuous with the sand and gravel deposits that occur as mantle rock under the capping loess on the uplands north of the valley. Where the alluvial sands and gravels in the valley are sufficiently thick, they yield water freely to wells. Irrigation wells are common along the entire valley within a narrow band coinciding with the maximum thickness of alluvial fill.

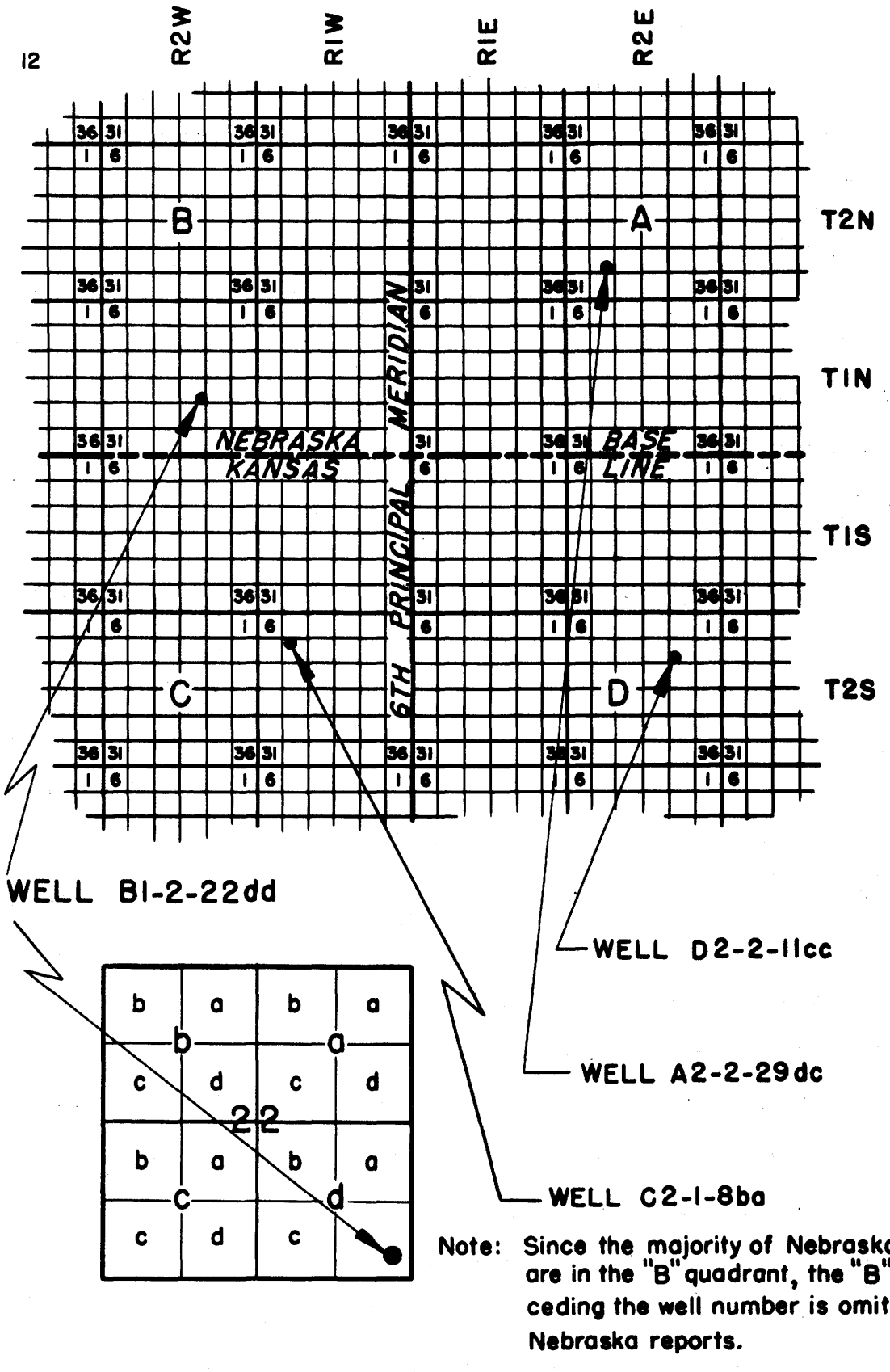
WELL-NUMBERING SYSTEM

The well numbers used in this report show the location of each well

according to General Land Office surveys of the area. These numbers are assigned in accordance with the following formula: Township, range, section, quarter section, and 40-acre tract within the quarter section. When two or more wells are located within a 40-acre tract, the wells are numbered serially according to the order in which they were visited. The quarter section and 40-acre tracts are designated a, b, c, and d in a counterclockwise direction, beginning in the northeast quarter. (See fig. 2).

FLUCTUATIONS OF THE WATER TABLE

Periodic measurements of the depth to water in observation wells in the Republican and Frenchman River Valleys began in 1934 as a part of the State-wide program of water-level measurements. This program has been supported cooperatively by the United States Geological Survey and the Conservation and Survey Division of the University of Nebraska. When the present studies began, late in 1945, the water levels in 19 observation wells were being measured in the area covered by this report. In the course of the present studies 161 wells have been added to the water-level observation program; of these, 103 are wells installed by the United States Geological Survey for observation purposes only and the remainder are selected, privately owned wells in which the water level can readily be measured. Of the 103 wells installed by the Geological Survey, three are 8 inches in diameter and are equipped with automatic water-stage recorders; the remaining wells are constructed of 1¼-inch iron pipe fitted



Note: Since the majority of Nebraska wells are in the "B" quadrant, the "B" preceding the well number is omitted in Nebraska reports.

Figure 2.– Sketch showing system of well identification

at the bottom end with a screened sand point. A fourth recorder was installed December 15, 1947 on a privately owned well with a 6-inch diameter. A summary of the number of observation wells in each county is shown in table 1, and the locations of these wells are shown on plate 1 (in pocket). Measurements of the depth to water below land surface in all observation wells are given in table 2. Pertinent data concerning each well are presented by table 3.

Hydrographs showing the water level in 10 of the observation wells with a period of record extending over at least 8 years are shown by figure 3. No significant net changes of water level during the period of record are to be noted in these hydrographs except in four wells, 2-18-33cd (Harlan County), 3-27-8ac (Redwillow County), 1-38-20bc (Dundy County), and 1-38-21cb (Dundy County), in which the water levels have risen 6.0, 2.1, 2.1, 2.8 feet, respectively.

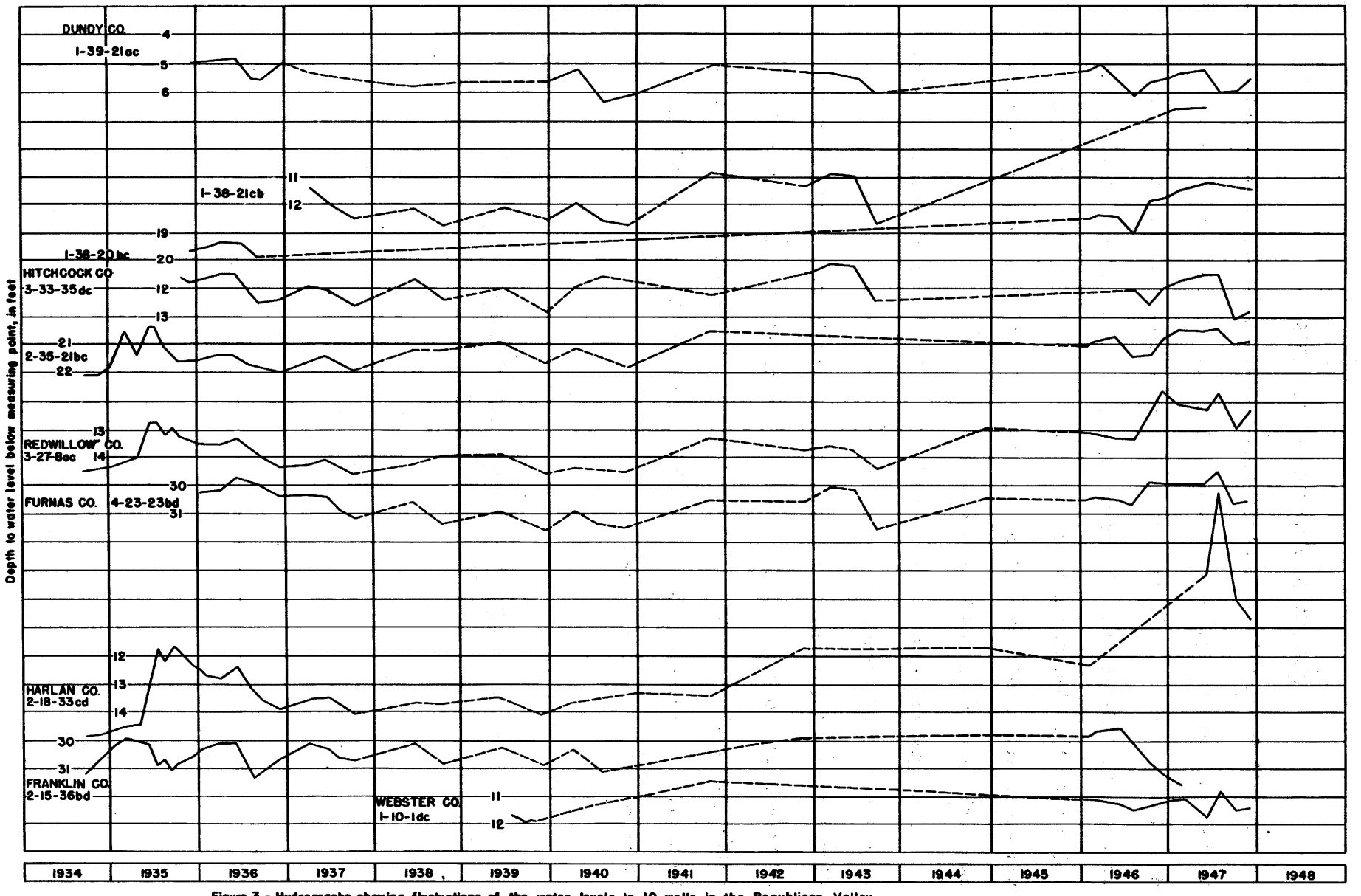


Figure 3.— Hydrographs showing fluctuations of the water levels in 10 wells in the Republican Valley.

Table 1.--Summary of observation wells by counties

County	Number of State-wide wells incorporated into this study	Number of privately owned wells added during this study	Number of wells installed for this study	Total
NEBRASKA				
Chase	1	--	1	2
Dundy	3	7	14	24
Franklin	2	8	8	18
Furnas	2	12	9	23
Harlan	2	6	3	11
Hayes	0	1	3	4
Hitchcock	1	7	11	19
Nuckolls	0	3	32	35
Redwillow	2	13	7	22
Webster	6	1	15	22
KANSAS				
Jewell	--	--	4	4
Republic	--	--	2	2
Total	19	58	109	186

Table 2.--Water-level measurements in wells

Chase County

5-36-7ba

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
May 29, 1946	16.05	Dec. 16, 1946	15.80	July 30, 1947	16.02
Aug. 15	16.39	Feb. 27, 1947	15.72	Oct. 8	15.98
Oct. 24	15.80	June 7	16.02	Dec. 5	15.92

5-36-11dc

Water level, in feet below land-surface datum

Feb. 6, 1946	62.64	Oct. 24, 1946	62.57	Feb. 27, 1947	62.46
May 28	62.65	Dec. 16	62.53	June 7	Destroyed
Aug. 15	63.27				

Dundy County

1-37-7ab

Water level, in feet below land-surface datum

Feb. 5, 1946	61.20	Dec. 15, 1946	61.61	July 30, 1947	60.82
Mar. 19	61.05	Feb. 27, 1947	61.08	Oct. 8	61.15
Oct. 21	61.88	June 7	60.92	Dec. 4	61.00

1-37-16dd

Water level, in feet below land-surface datum

Oct. 21, 1946	39.02	Feb. 26, 1947	38.59	Oct. 8, 1947	38.54
Dec. 15	38.77	June 6	38.55	Dec. 4	38.34

1-37-19ba

Water level, in feet below land-surface datum

Aug. 16, 1946	12.45	Feb. 26, 1947	9.23	Oct. 8, 1947	14.25
Oct. 21	11.67	June 6	9.56	Dec. 4	11.05
Dec. 15	9.45	July 30	11.65		

1-37-31cd

Water level, in feet below land-surface datum

Aug. 16, 1946	4.29	Feb. 26, 1947	4.00	Oct. 8, 1947	5.85
Oct. 21	4.04	June 7	3.75	Dec. 4	5.19
Dec. 15	3.78	July 30	4.88		

Table 2.--Water-level measurements in wells--Continued

Dundy County--Continued

1-38-20bc

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Feb. 6, 1946	17.02	Aug. 16, 1946	17.61	Feb. 26, 1947	15.98
Mar. 19	16.87	Oct. 23	16.39	June 6	15.83
June 11	16.91	Dec. 15	16.30	Dec. 1	16.01

1-38-21cb

Water level, in feet below land-surface datum					
Feb. 27, 1947	5.57	June 6, 1947	5.53	July 30, 1947	Destroyed

1-38-25bd

Water level, in feet below land-surface datum					
Feb. 5, 1946	12.32	Oct. 23, 1946	12.93	July 30, 1947	12.97
Mar. 19	13.10	Dec. 15	12.26	Oct. 8	13.90
June 11	12.40	Feb. 26, 1947	12.32	Dec. 4	13.43
Aug. 16	13.09	June 6	12.33		

1-38-29ad

Water level, in feet below land-surface datum					
Aug. 16, 1946	9.00	Feb. 26, 1947	7.94	Oct. 8, 1947	8.85
Oct. 23	8.55	June 6	8.00	Dec. 4	8.52
Dec. 15	8.01	July 30	8.77		

1-39-21ac

Water level, in feet below land-surface datum					
Feb. 6, 1946	5.18	Oct. 23, 1946	5.59	July 30, 1947	5.93
Mar. 19	5.00	Dec. 15	5.42	Oct. 8	5.90
June 11	5.46	Feb. 26, 1947	5.24	Dec. 4	5.50
Aug. 16	6.09	June 6	5.17		

1-39-22cc

Water level, in feet below land-surface datum					
Mar. 20, 1946	11.52	Dec. 15, 1946	11.46	July 30, 1947	12.32
June 11	11.43	Feb. 26, 1947	11.43	Oct. 8	12.72
Aug. 16	13.02	June 6	11.30	Dec. 4	12.18
Oct. 23	12.25				

Table 2.--Water-level measurements in wells--Continued

Dundy County--Continued

1-39-26aa

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
July 12, 1946	25.59	Dec. 15, 1946	25.64	July 30, 1947	25.56
Aug. 16	25.98	Feb. 26, 1947	25.22	Oct. 8	26.37
Oct. 22	26.12	June 6	25.19	Dec. 4	26.02

1-39-30bb

Water level, in feet below land-surface datum					
Aug. 16, 1946	12.92	Feb. 26, 1947	11.72	Oct. 8, 1947	13.12
Oct. 23	12.94	June 6	11.82	Dec. 4	12.70
Dec. 15	12.30	July 30	12.43		

1-40-20cb

Water level, in feet below land-surface datum					
Aug. 16, 1946	3.71	Feb. 26, 1947	2.62	Oct. 8, 1947	4.37
Oct. 23	2.89	June 6	1.80	Dec. 4	3.79
Dec. 15	2.49	July 30	3.80		

1-40-24cd

Water level, in feet below land-surface datum					
Aug. 16, 1946	9.35	Feb. 26, 1947	8.36	Oct. 8, 1947	9.79
Oct. 23	8.91	July 30	8.98	Dec. 4	9.61
Dec. 15	8.52				

1-40-27ab

Water level, in feet below land-surface datum					
Feb. 6, 1946	19.08	Oct. 23, 1946	19.50	July 30, 1947	19.20
Mar. 19	18.99	Dec. 15	18.10	Oct. 8	20.75
June 11	18.66	Feb. 26, 1947	18.95	Dec. 4	20.05
Aug. 16	20.87	June 6	18.88		

1-40-29bb

Lowest daily water level in feet below land-surface datum, 1946[a]

Day	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		12.09	12.10		12.42	12.57	12.53	12.39
2		12.08	12.11		12.43	12.57	12.53	12.38
3		12.07	12.12		12.44	12.58	12.54	12.37
4		12.07	12.13		12.44	12.58	12.54	12.37
5		12.06	12.13		12.45		12.53	12.37
6		12.05	12.10		12.47		12.52	12.36
7		12.05	12.06		12.47		12.52	12.35
8		12.05	12.04		12.48		12.52	12.34
9		12.05	12.03		12.48		12.52	12.34
10		12.05	12.02	12.22	12.48		12.52	12.33
11		12.06	12.02	12.23	12.49		12.51	12.32
12		12.06	12.01	12.24	12.49		12.51	12.32
13		12.06	12.00	12.25	12.50		12.51	12.32
14		12.06	12.00	12.27	12.50		12.50	12.32
15		12.06	12.00	12.27	12.50		12.50	12.32
16		12.06	12.00	12.28	12.52		12.50	12.32
17		12.06	12.00	12.29	12.52		12.50	12.32
18		12.07	12.00	12.30	12.53		12.49	12.31
19		12.07		12.32	12.53		12.48	12.30
20		12.07		12.33	12.54		12.48	12.30
21	12.24	12.07		12.34	12.54		12.46	12.30
22	12.20	12.06		12.35	12.54		12.45	12.29
23	12.17	12.05		12.37	12.55	12.55	12.45	12.29
24	12.15	12.05		12.37	12.55	12.54	12.43	12.28
25	12.15	12.06		12.38	12.55	12.54	12.43	12.28
26	12.14	12.06		12.39	12.56	12.54	12.42	12.28
27	12.13	12.07		12.41	12.56	12.54	12.42	12.27
28	12.11	12.08		12.42	12.57	12.54	12.41	12.27
29	12.10	12.08		12.42	12.57	12.54	12.41	12.27
30	12.10	12.09		12.42	12.57	12.54	12.39	12.27
31	12.10			12.42		12.54		12.27

a From recording gage charts.

1-40-29bb--Continued

Lowest daily water level in feet below land-surface datum, 1947[a]

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.28	12.22	12.13	12.09	12.05		11.67	11.91	12.23	12.54	12.63	12.54
2	12.28	12.21	12.13	12.08	12.05		11.67	11.92	12.24	12.55	12.63	12.53
3	12.27	12.21	12.13	12.08	12.04		11.67	11.94	12.25	12.56	12.62	12.53
4	12.27	12.21	12.13	12.08	12.05		11.68	11.95	12.26	12.57	12.62	12.53
5	12.27	12.21	12.13	12.08	12.05		11.69	11.96	12.27	12.58	12.62	12.53
6	12.27	12.21	12.13	12.08	12.06	9.79	11.70	11.97	12.28	12.58	12.62	12.53
7	12.27	12.21	12.12	12.08	12.06	10.50	11.70	11.98	12.29	12.59	12.62	12.53
8	12.27	12.21	12.12	12.08	12.06	11.80	11.70	11.99	12.30	12.59	12.62	12.53
9	12.26	12.20	12.13	12.08	12.06	11.97	11.70	12.00	12.31	12.60	12.61	12.53
10	12.26	12.20	12.13	12.08	12.06	11.97	11.70	12.01	12.32	12.61	12.61	12.53
11	12.25	12.20	12.12	12.08	12.06	11.95	11.73	12.02	12.33	12.61	12.61	12.53
12	12.25	12.20	12.12	12.08	12.06	11.93	11.75	12.03	12.34	12.62	12.60	12.53
13	12.24	12.20	12.12	12.08	12.06	11.91	11.75	12.04	12.35	12.62	12.60	12.53
14	12.24	12.20	12.13	12.09	12.06	11.90	11.76	12.05	12.36	12.62	12.60	12.53
15	12.24	12.20	12.13	12.08	12.06	11.85	11.77	12.06	12.37	12.63	12.60	12.53
16	12.24	12.20	12.12	12.08	12.06	11.85	11.77	12.07	12.38	12.63	12.60	12.53
17	12.24	12.20	12.12	12.08	12.05	11.85	11.78	12.08	12.39	12.63	12.60	12.53
18	12.23	12.20	12.12	12.08	12.05	11.83	11.79	12.09	12.40	12.64	12.59	12.53
19	12.23	12.20	12.12	12.08	12.04	11.81	11.84	12.10	12.41	12.64	12.59	12.53
20	12.23	12.20	12.11	12.08	12.04	11.80	11.88	12.11	12.42	12.64	12.58	12.52
21	12.23	12.20	12.11	12.08	12.04	11.77	11.89	12.12	12.43	12.64	12.58	12.52
22	12.23	12.20	12.10	12.08	12.04	11.74	11.91	12.13	12.44	12.64	12.58	12.52
23	12.23	12.20	12.10	12.08	12.04	11.72	11.92	12.14	12.45	12.65	12.57	12.52
24	12.22	12.20	12.10	12.08	12.04	11.70	11.92	12.15	12.46	12.65	12.57	12.52
25	12.22	12.20	12.10	12.07	12.04	11.69	11.88	12.16	12.47	12.64	12.56	12.52
26	12.22	12.13	12.10	12.07	12.05	11.69	11.88	12.17	12.48	12.64	12.56	12.51
27	12.22	12.13	12.10	12.07	b	11.69	11.88	12.18	12.49	12.64	12.56	12.51
28	12.22	12.13	12.10	12.06		11.68	11.88	12.19	12.50	12.63	12.55	12.51
29	12.22		12.10	12.06		11.68	11.88	12.20	12.51	12.63	12.55	12.50
30	12.22		12.09	12.05		11.67	11.88	12.21	12.52	12.63	12.55	12.50
31	12.22		12.09				11.90	12.22			12.54	12.50

a. From recording gage charts.
b Flash flood no record.

Table 2.--Water-level measurements in wells--Continued

Dundy County--Continued

1-41-20dd

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Aug. 16, 1946	4.26	Feb. 26, 1947	2.69	Oct. 8, 1947	3.45
Oct. 23	2.78	June 6	2.58	Dec. 4	2.67
Dec. 15	2.71	July 30	3.64		

1-41-27ca

Water level, in feet below land-surface datum					
Aug. 16, 1946	5.70	Feb. 26, 1947	3.96	July 30	4.89
Oct. 23	4.40	June 6	4.12	Oct. 8	4.77
Dec. 15, 1946	4.05				

1-42-10cd

Water level, in feet below land-surface datum					
Aug. 16, 1946	6.01	Feb. 26, 1947	3.41	Oct. 8, 1947	6.79
Oct. 23	4.26	June 6	4.06	Dec. 4	5.05
Dec. 15	3.53	July 30	4.34		

1-42-13bb

Water level, in feet below land-surface datum					
Aug. 16, 1946	5.62	Feb. 26, 1947	3.71	Oct. 8	4.80
Oct. 22	4.48	June 6	4.14	Dec. 4	4.21
Dec. 15	3.85	July 30	4.78		

1-42-36aa

Water level, in feet below land-surface datum					
Aug. 16, 1946	10.77	Feb. 26, 1947	11.16	Oct. 8, 1947	10.02
Oct. 23	9.88	June 6	11.21	Dec. 4	9.90
Dec. 15	10.43	July 30	10.90		

2-36-24ca

Water level, in feet below land-surface datum					
Aug. 16, 1946	14.34	Feb. 27, 1947	14.28	Oct. 8, 1947	15.09
Oct. 21	14.29	June 7	14.29	Dec. 5	15.24
Dec. 16	14.42	July 30	14.49		

Table 2.--Water-level measurements in wells--Continued

Dundy County--Continued

2-36-29ac

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Feb. 4, 1946	21.80	Oct. 21, 1946	21.98	July 30, 1947	21.72
Mar. 19	21.68	Dec. 15	21.71	Oct. 8	22.35
June 11	21.65	Feb. 27, 1947	21.48	Dec. 5	22.29
Aug. 16	22.94	June 7	21.32		

2-36-31bc

Water level, in feet below land-surface datum					
Aug. 16, 1946	22.35	Feb. 27, 1947	21.62	Oct. 8, 1947	22.48
Oct. 21	22.45	June 7	21.47	Dec. 5	22.24
Dec. 15	22.00	July 30	21.80		

Franklin County

1-13-1cc

Water level, in feet below land-surface datum					
Mar. 7, 1946	6.76	Oct. 26, 1946	4.59	June 10, 1947	4.27
June 12	7.19	Dec. 18	4.75	Dec. 16	8.18
Aug. 12	7.36	Mar. 1, 1947	5.15		

1-13-2bc

Water level, in feet below land-surface datum					
Mar. 7, 1946	9.08	Dec. 18, 1947	8.09	Aug. 2, 1947	7.14
June 12	9.07	Mar. 1, 1947	8.19	Oct. 11	8.88
Aug. 12	9.15	June 10	8.10	Dec. 1	8.77
Oct. 26	7.12				

1-13-3ca

Water level, in feet below land-surface datum					
Mar. 7, 1946	8.18	Oct. 26, 1946	4.48	June 10, 1947	6.92
June 12	7.97	Dec. 18	6.80	Aug. 2	6.50
Aug. 12	8.35	Mar. 1, 1947	7.08	Dec. 16	8.52

1-13-4cb

Water level, in feet below land-surface datum					
Feb. 13, 1946	11.93	Oct. 26, 1946	10.48	Aug. 2, 1947	10.13
Mar. 7	11.90	Dec. 18	10.54	Oct. 11	12.97
June 12	11.74	Mar. 1, 1947	11.11	Dec. 1	12.28
Aug. 12	12.72	June 10	10.52		

Table 2.--Water-level measurements in wells--Continued

Franklin County--Continued

1-13-7bb

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Mar. 7, 1946	5.48	Dec. 18, 1946	3.96	Aug. 2, 1947	4.58
June 12	5.79	Mar. 1, 1947	4.45	Oct. 9	6.34
Aug. 12	6.26	June 10	3.51	Dec. 1	5.78
Oct. 26	2.56				

1-14-2cb

Water level, in feet below land-surface datum					
Feb. 13, 1946	10.15	Dec. 18, 1946	5.70	Aug. 2, 1947	6.42
Mar. 7	10.13	Mar. 1, 1947	6.74	Oct. 9	9.72
June 12	10.14	June 10	6.62	Dec. 1	9.50
Oct. 26	6.33				

1-14-3ba

Water level, in feet below land-surface datum					
Feb. 28, 1946	5.06	Oct. 27, 1946	0.91	Aug. 1, 1947	3.02
Mar. 7	5.04	Dec. 18,	1.96	Oct. 9	5.73
June 12	4.63	June 10, 1947	3.10	Dec.	5.57
Aug. 13	5.94				

1-14-6bc

Water level, in feet below land-surface datum					
Feb. 14, 1946	8.57	Dec. 18, 1946	5.48	Aug. 1, 1947	5.69
Mar. 7	8.43	Mar. 1, 1947	6.25	Oct. 9	8.80
June 14	5.74	June 10	6.11	Dec. 1	8.87
Oct. 27	5.34				

1-14-7bb1

Water level, in feet below land-surface datum					
Mar. 7, 1946	3.30	Dec. 18, 1946	1.68	Aug. 1, 1947	3.30
June 12	3.72	Mar. 1, 1947	2.25	Oct. 9	5.26
Aug. 12	4.17	June 10	2.18	Dec. 1	4.85
Oct. 27	0.70				

Table 2.--Water-level measurements in wells--Continued

Franklin County--Continued

1-14-7bb2

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Feb. 14, 1946	5.18	Oct. 27, 1946	3.45	Aug. 1, 1947	5.15
Mar. 7	6.10	Dec. 18	4.42	Oct. 9	7.52
June 12	5.98	Mar. 1, 1947	4.55	Dec. 1	7.42
Aug. 12	6.28	June 10	4.57		

1-15-5ca

Water level, in feet below land-surface datum

June 13, 1946	4.49	Dec. 18, 1946	2.93	June 9, 1947	3.08
Aug. 13	5.75	Feb. 28, 1947	3.29	Dec. 1	6.24
Oct. 26	0.62				

1-15-8cb

Water level, in feet below land-surface datum

Feb. 14, 1946	10.78	Oct. 26, 1946	8.93	Aug. 1, 1947	9.34
Mar. 7	10.90	Dec. 18	9.98	Oct. 9	11.57
June 13	11.12	Feb. 28, 1947	9.91	Dec. 1	11.16
Aug. 13	11.74	June 9	9.24		

1-16-9bc

Water level, in feet below land-surface datum

Feb. 19, 1946	12.70	Oct. 26, 1946	10.25	Aug. 1, 1947	10.95
Mar. 7	13.68	Dec. 7	11.59	Oct. 9	13.43
June 13	13.62	Feb. 28, 1947	12.38	Dec. 1	13.65
Aug. 13	12.88	June 9	12.42		

1-16-10bd

Water level, in feet below land-surface datum

June 14, 1946	3.90	Dec. 17, 1946	1.36	Aug. 1, 1947	2.85
Aug. 13	5.19	Feb. 28, 1947	1.86	Oct. 9	4.92
Oct. 26	0.70	June 9	2.30	Dec. 1	4.97

1-16-14ab

Water level, in feet below land-surface datum

Feb. 14, 1946	40.10	Oct. 26, 1946	37.40	Aug. 1, 1947	37.82
Mar. 7	40.20	Dec. 17	38.29	Oct. 9	39.49
June 13	40.02	Feb. 28, 1947	38.69	Dec. 1	40.63
Aug. 13	42.41	June 9	38.70		

Table 2.--Water-level measurements in wells--Continued

Franklin County--Continued

2-13-31ad

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Mar. 8, 1946	54.80	Mar. 1, 1947	53.86	Oct. 11, 1947	53.10
Oct. 26	53.81	June 10	53.89	Dec. 1	54.08
Dec. 18	53.73	Aug. 2	53.14		

2-13-32dd

Water level, in feet below land-surface datum

Mar. 7, 1946	7.32	Dec. 18, 1946	5.59	Aug. 2, 1947	5.58
June 12	7.85	Mar. 1, 1947	2.77	Oct. 11	8.79
Aug. 12	8.44	June 10	5.64	Dec. 1	8.45
Oct. 26	4.50				

2-15-36bd

Water level, in feet below land-surface datum

Feb. 13, 1946	27.73	Aug. 13, 1946	28.04	Feb. 28, 1947	29.48
Mar. 7	27.57	Oct. 26	26.67	June 10	Destroyed
June 14	27.49	Dec. 18	29.04		

Furnas County

3-21-2cc

Water level, in feet below land-surface datum

June 13, 1946	8.57	Dec. 17, 1946	7.85	July 31, 1947	8.50
Aug. 13	8.98	Feb. 28, 1947	7.94	Oct. 9	10.32
Oct. 25	6.47	June 9	8.14	Dec. 7	10.17

3-21-9bd

Water level, in feet below land-surface datum

Mar. 22, 1946	14.75	Feb. 28, 1947	15.40	Aug. 1, 1947	Destroyed
Dec. 17	13.82	June 9	15.48		

3-21-12dc

Water level, in feet below land-surface datum

June 13, 1946	5.22	Dec. 17, 1946	3.94	Oct. 9, 1947	6.70
Aug. 13	6.35	Feb. 28, 1947	3.97	Dec. 2	5.92
Oct. 25	3.40	June 9	3.74		

Table 2.--Water-level measurements in wells--Continued

Furnas County--Continued

3-22-2ba

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
June 12, 1946	7.44	Dec. 17, 1946	5.35	July 28, 1947	4.78
Aug. 13	7.63	Feb. 24, 1947	6.07	Oct. 6	7.95
Oct. 25	4.89	June 5	4.97	Dec. 3	8.49

3-25-4bb

Lowest daily water level in feet below land-surface datum, 1946
(From recording gage charts)

Day	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.25	5.95		6.99	7.35	4.79	4.26
2		5.27	5.95		7.01	7.36	4.80	4.26
3		5.29	5.95		7.02	7.37	4.81	4.27
4		5.32	5.95		7.04		4.83	4.28
5		5.34	5.95		7.06		4.84	4.28
6		5.37	5.95		7.08		4.84	4.28
7		5.40	5.95		7.09		4.82	4.28
8		5.42	5.95		7.10		4.76	4.28
9		5.50	5.95		7.11		4.75	4.29
10		5.57	5.95		7.12		4.68	4.29
11		5.60	5.95		7.13		4.60	4.30
12		5.62	5.97		7.15		4.58	4.30
13		5.64	5.98		7.15		4.57	4.31
14		5.65	5.98	6.50	7.17		4.54	4.32
15		5.67	5.97	6.52	7.18		4.50	4.32
16		5.75	5.82	6.55	7.20			4.33
17		5.82	5.78	6.60	7.23			4.33
18	6.77	5.85	5.78	6.65	7.24			4.42
19	6.71	5.85	5.78	6.69	7.25			4.44
20	6.72	5.86	5.79	6.73	7.25			4.46
21	6.72	5.87	5.79	6.77	7.26	4.65		4.48
22	6.69	5.87	5.79	6.80	7.27	4.67		4.48
23	6.67	5.89	5.79	6.83	7.27	4.68		4.51
24	6.36	5.90	5.80	6.85	7.29	4.68	4.16	4.52
25	6.30	5.92	5.80	6.87	7.30	4.70	4.18	4.53
26	6.29	5.93	5.81	6.90	7.31	4.72	4.20	4.54
27	5.99	5.94	5.82	6.92	7.32	4.73	4.22	4.55
28	5.99	5.95		6.93	7.33	4.74	4.23	4.55
29	5.87	5.95		6.95	7.34	4.75	4.24	4.56
30	5.48	5.95		6.96	7.34	4.77	4.25	4.58
31	5.24			6.97		4.78		4.61

Table 2.--Water-level measurements in wells--Continued

Furnas County--Continued

3-25-4bb--Continued

Lowest daily water level in feet below land-surface datum, 1947
(From recording gage charts)

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.65	4.83	4.57	4.44		4.84	4.58	4.77	6.05	6.53	6.71	6.46
2	4.67	4.82	4.59	4.46		4.84	4.64	4.83	6.09	6.53	6.70	6.45
3	4.69	4.82	4.62	4.47		4.86	4.71	4.89	6.14	6.54	6.70	6.45
4	4.72	4.82	4.64	4.49	4.55	4.87	4.77	4.95	6.18	6.54	6.70	6.45
5	4.75	4.82	4.65	4.50	4.62	4.88	4.83	5.01	6.22	6.55	6.69	6.45
6	4.77	4.82	4.66	4.50	4.65	4.88	4.89	5.06	6.25	6.55	6.67	6.44
7	4.78	4.77	4.67	4.50	4.68	4.88	4.95	5.11	6.29	6.56	6.65	6.44
8	4.79	4.75	4.67	4.52	4.70	4.89	5.02	5.16	6.34	6.56	6.63	6.43
9	4.80	4.73	4.68	4.54	4.72	4.89	5.09	5.20	6.37	6.57	6.62	6.43
10	4.81	4.73	4.68	4.54	4.75	4.90	5.09	5.25	6.40	6.58	6.62	6.42
11	4.81	4.73	4.68	4.37	4.77	4.92	4.91	5.30	6.42	6.59	6.61	6.40
12	4.81	4.74	4.67	4.25	4.78	4.88	4.78	5.34	6.43	6.59	6.60	6.39
13	4.81	4.74	4.63	4.22	4.79	4.77	4.62	5.38	6.43	6.60	6.59	6.39
14	4.81	4.73	4.58	4.22	4.80	4.76	4.52	5.41	6.43	6.60	6.57	6.39
15	4.81	4.68	4.45	4.21	4.82	4.76	4.51	5.43	6.44	6.62	6.56	6.38
16	4.81	4.63	4.43	4.21	4.82	4.76	4.51	5.45	6.44	6.63	6.56	6.37
17	4.82	4.58	4.41	4.22	4.84	4.76	4.52	5.58	6.45	6.65	6.56	6.37
18	4.82	4.55	4.38	4.23	4.85	4.77	4.52	5.51	6.45	6.67	6.55	6.36
19	4.83	4.55	4.36	4.23	4.85	4.78	4.53	5.54	6.46	6.68	6.55	6.35
20	4.83	4.55	4.34	4.24	4.83	4.78	4.53	5.58	6.47	6.70	6.54	6.34
21	4.84	4.55	4.33	4.25	4.80	a4.78	4.54	5.63	6.49	6.70	6.53	6.33
22	4.84	4.55	4.32	4.27	4.80	4.22	4.55	5.67	6.50	6.70	6.52	6.33
23	4.85	4.54	4.32	4.28	4.80	4.12	4.54	5.71	6.50	6.71	6.50	6.32
24	4.85	4.54	4.32	4.31	4.80	4 17	4.53	5.75	6.51	6.71	6.49	6.31
25	4.85	4.53	4.34	4.32	4.80	4.24	4.52	5.79	6.52	6.71	6.49	6.30
26	4.85	4.55	4.35	4.26	4.80	4.29	4.52	5.82	6.52	6.71	6.48	6.29
27	4.85	4.55	4.35		4.80	4.35	4.54	5.86	6.52	6.72	6.47	6.27
28	4.85	4.56	4.38		4.80	4.41	4.55	5.90	6.52	6.72	6.49	6.25
29	4.84		4.38		4.80	4.47	4.56	5.94	6.52	6.71	6.47	6.23
30	4.83		4.40		4.80	4.52	4.64	5.98	6.52	6.71	6.46	6.22
31	4.83		4.42		4.81		4.72	6.01		6.71		6.20

a The recorder was disturbed by a flash flood on June 21, 1947 and was not readjusted until July 22, 1947. Readings for this period are interpolated.

Table 2.--Water-level measurements in wells--Continued

Furnas County--Continued

4-21-32cc

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Mar. 22, 1946	14.66	Dec. 17, 1946	13.03	July 31, 1947	11.87
June 13	15.70	Feb. 28, 1947	13.29	Oct. 9	14.35
Aug. 13	16.74	June 9	13.18	Dec. 1	13.82
Oct. 25	12.64				

4-22-25cc

Water level, in feet below land-surface datum

Feb. 1, 1946	11.22	Dec. 17, 1946	8.29	July 31, 1947	8.78
Mar. 18	11.10	Feb. 28, 1947	8.62	Oct. 9	11.62
Aug. 13	11.50	June 9	8.52	Dec. 2	11.91
Oct. 25	8.77				

4-22-29ad

Water level, in feet below land-surface datum

Mar. 18, 1946	17.39	Dec. 18, 1946	15.94	July 31, 1947	13.64
June 12	17.33	Feb. 28, 1947	15.62	Oct. 9	14.73
Aug. 13	17.60	June 9	15.29	Dec. 2	15.47
Oct. 25	16.07				

4-22-32dd

Water level, in feet below land-surface datum

Mar. 22, 1946	9.05	Dec. 17, 1946	8.31	July 28, 1947	7.55
June 12	10.22	Feb. 24, 1947	8.42	Oct. 6	11.48
Aug. 13	10.81	June 5	8.50	Dec. 3	10.69
Oct. 25	7.71				

4-22-34ba

Water level, in feet below land-surface datum

Feb. 1, 1946	14.39	Dec. 17, 1946	13.02	July 31, 1947	12.22
Mar. 18	14.12	Feb. 28, 1947	13.13	Oct. 9	14.77
June 12	14.36	June 9	12.90	Dec. 1	14.56
Oct. 25	12.79				

Table 2.--Water-level measurements in wells--Continued

Furnas County--Continued

4-23-20ab

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Jan. 31, 1946	27.76	Oct. 25, 1946	28.02	July 31, 1947	25.29
Mar. 18	27.69	Dec. 11	26.42	Oct. 9	27.84
June 12	27.66	Feb. 28, 1947	26.04	Dec. 6	27.19
Aug. 14	31.28	June 9	25.95		

4-23-23bd

Water level, in feet below land-surface datum					
Feb. 1, 1946	29.79	Dec. 17, 1946	29.14	July 31, 1947	28.72
Mar. 18	29.68	Feb. 28, 1947	29.15	Oct. 9	29.89
June 12	29.75	June 9	29.15	Dec. 3	29.82
Aug. 13	29.14				

4-23-27dd

Water level, in feet below land-surface datum					
Feb. 8, 1946	10.05	Oct. 25, 1946	9.90	July 28, 1947	8.08
Mar. 18	10.83	Dec. 17	9.11	Oct. 6	10.45
June 12	11.31	Feb. 24, 1947	9.29	Dec. 3	10.82
Aug. 13	11.65	June 5	9.37		

4-23-30cc

Water level, in feet below land-surface datum					
Jan. 31, 1946	52.37	Dec. 17, 1946	52.50	July 28, 1947	51.97
Mar. 18	52.29	Feb. 24, 1947	52.25	Oct. 6	53.30
June 12	52.45	June 5	51.84	Dec. 3	52.95
Oct. 25	52.80				

4-23-36aa

Water level, in feet below land-surface datum					
Jan. 31, 1946	19.57	Oct. 25, 1946	18.00	July 28, 1947	17.06
Mar. 18	20.33	Dec. 17	17.43	Oct. 6	19.94
June 12	20.34	Feb. 24, 1947	18.05	Dec. 3	20.46
Aug. 13	23.17	June 5	18.18		

Table 2.--Water-level measurements in wells--Continued

Furnas County--Continued

4-24-13cd

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Jan. 31, 1946	19.06	Oct. 25, 1946	18.82	July 31, 1947	15.24
Mar. 18	19.03	Dec. 11	17.90	Oct. 9	16.69
June 12	19.26	Feb. 28, 1947	17.68	Dec. 6	17.39
Aug. 14	19.73	June 9	17.50		

4-24-15cc

Water level, in feet below land-surface datum

Feb. 8, 1946	12.83	Oct. 25, 1946	12.60	July 31, 1947	10.82
Mar. 18	13.69	Dec. 11	12.15	Oct. 9	12.89
June 12	13.44	Feb. 28, 1947	12.56	Dec. 6	13.48
Aug. 14	14.20	June 9	12.47		

4-24-19cc

Water level, in feet below land-surface datum

Feb. 1, 1946	12.77	Oct. 25, 1946	10.90	June 9, 1947	11.85
Mar. 20	14.50	Dec. 11	11.02	Oct. 9	12.64
June 12	15.05	Feb. 28, 1947	11.64	Dec. 6	12.24

4-24-22dd

Water level, in feet below land-surface datum

June 12, 1946	5.67	Dec. 17, 1946	5.32	June 5, 1947	5.22
Aug. 14	6.78	Feb. 24, 1947	5.02	Dec. 16	6.10
Oct. 25	5.00				

4-24-29cd

Water level, in feet below land-surface datum

Jan. 31, 1946	20.94	Oct. 25, 1946	21.22	July 28, 1947	20.38
Mar. 20	20.75	Dec. 17	20.85	Oct. 6	22.02
June 12	21.15	Feb. 24, 1947	20.49	Dec. 1	21.57
Aug. 14	23.57	June 5	20.44		

Table 2.--Water-level measurements in wells--Continued

Furnas County--Continued

4-25-32cd

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Feb. 8, 1946	5.57	Oct. 25, 1946	3.66	July 28, 1947	4.78
Mar. 20	5.10	Dec. 17	4.27	Oct. 6	6.58
June 12	4.99	Feb. 24, 1947	4.20	Dec. 3	5.95
Aug. 14	6.37	June 5	4.84		

4-25-34ad

Water level, in feet below land-surface datum

Jan. 31, 1946	17.76	Dec. 17, 1946	15.18	July 28, 1947	14.32
Mar. 20	17.22	Feb. 24, 1947	15.22	Oct. 6	17.72
June 12	16.95	June 5	15.45	Dec. 3	17.47
Oct. 25	15.52				

Harlan County

1-17-1da

Water level, in feet below land-surface datum

Mar. 7, 1946	6.42	Dec. 17, 1946	4.56	Aug. 1, 1947	5.21
June 13	6.54	Feb. 28, 1947	5.06	Oct. 9	7.79
Aug. 13	7.57	June 9	5.40	Dec. 1	7.07
Oct. 25	1.95				

1-17-12da

Water level, in feet below land-surface datum

Feb. 14, 1946	17.35	Oct. 26, 1946	12.71	Aug. 1, 1947	13.70
Mar. 7	17.29	Dec. 17	13.53	Oct. 9	16.52
June 13	16.94	Feb. 28, 1947	13.99	Dec. 1	17.02
Aug. 13	20.28	June 9	15.36		

2-19-5cb

Water level, in feet below land-surface datum

Mar. 22, 1946	21.20	Dec. 17, 1946	20.32	Aug. 1, 1947	20.38
June 13	22.95	Feb. 28, 1947	20.36	Oct. 9	22.00
Aug. 13	24.19	June 9	20.52	Dec. 1	21.30
Oct. 25	20.62				

Table 2.--Water-level measurements in wells--Continued

Harlan County--Continued

2-19-17da

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Mar. 21, 1946	21.89	Dec. 17, 1946	19.11	Aug. 1, 1947	18.60
June 13	22.10	Feb. 28, 1947	19.30	Oct. 9	20.36
Aug. 13	22.20	June 9	19.51	Dec. 1	20.80
Oct. 25	19.07				

2-19-28dd

Water level, in feet below land-surface datum					
June 13, 1946	8.93	Feb. 28, 1947	7.99	Oct. 9, 1947	9.71
Aug. 13	9.37	June 9	7.37	Dec. 1	9.43
Dec. 17	6.82	Aug. 1	7.71		

2-19-34bc

Water level, in feet below land-surface datum					
Mar. 21, 1946	20.86	Dec. 17, 1946	20.69	Oct. 9, 1947	21.95
June 13	22.30	Feb. 28, 1947	20.49	Dec. 1	21.37
Aug. 13	23.70	June 9	20.15		

3-20-7ab

Water level, in feet below land-surface datum					
Mar. 22, 1946	30.55	Dec. 17, 1946	30.08	Aug. 1, 1947	29.56
June 13	30.51	Feb. 28, 1947	30.00	Oct. 9	30.36
Aug. 13	32.00	June 9	29.77	Dec. 1	30.02
Oct. 25	30.26				

3-20-16bb

Water level, in feet below land-surface datum					
June 13, 1946	7.49	Dec. 17, 1946	6.00	Aug. 1, 1947	5.66
Aug. 13	9.44	Feb. 28, 1947	6.53	Oct. 9	8.68
Oct. 25	3.95	June 9	4.52	Dec. 1	8.15

3-20-18ca

Water level, in feet below land-surface datum					
Mar. 22, 1946	15.86	Oct. 25, 1946	14.18	June 9, 1947	13.40
June 13	14.75	Dec. 17	13.60	Oct. 9	14.33
Aug. 13	16.56	Feb. 28, 1947	13.60	Dec. 2	14.65

Table 2.--Water-level measurements in wells--Continued

Harlan County--Continued

3-20-22dd

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
June 13, 1946	25.95	Dec. 17, 1946	24.79	Aug. 1, 1947	24.20
Aug. 13	26.29	Feb. 28, 1947	24.75	Oct. 9	25.99
Oct. 25	24.91	June 9	24.41	Dec. 2	25.42

3-20-25cc

Water level, in feet below land-surface datum					
June 13, 1946	15.25	Dec. 17, 1946	11.56	Aug. 1, 1947	10.22
Aug. 13	16.16	Feb. 28, 1947	11.92	Oct. 9	13.40
Oct. 25	11.73	June 9	11.90	Dec. 2	13.96

Hayes County

5-33-30cb

Water level, in feet below land-surface datum					
Feb. 6, 1946	19.17	Oct. 24, 1946	18.84	July 30, 1947	19.48
Mar. 19	18.88	Dec. 16	18.71	Oct. 8	19.65
May 29	19.11	Feb. 27, 1947	19.16	Dec. 5	19.21
Aug. 15	20.00	June 7	19.51		

5-33-31dc

Water level, in feet below land-surface datum					
Feb. 6, 1946	13.34	Dec. 16, 1946	13.41	July 30, 1947	13.97
May 29	11.64	Feb. 27, 1947	13.50	Oct. 8	14.82
Aug. 15	13.05	June 7	13.85	Dec. 5	13.39
Oct. 24	13.50				

5-34-30ba

Water level, in feet below land-surface datum					
May 29, 1946	11.00	Dec. 16, 1946	10.81	July 30, 1947	11.09
Aug. 15	11.47	Feb. 27, 1947	10.62	Oct. 8	11.30
Oct. 24	10.55	June 7	10.96	Dec. 5	11.19

Table 2.--Water-level measurements in wells--Continued

Hayes County--Continued

5-35-17da

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1946	9.18	Feb. 27, 1947	8.38	Oct. 8, 1947	9.00
Oct. 24	8.22	June 7	8.65	Dec. 5	8.75
Dec. 16	8.35	July 30	8.88		

Hitchcock County

2-33-2aa

Water level, in feet below land-surface datum

Feb. 4, 1946	9.76	Oct. 23, 1946	10.73	June 7, 1947	9.79
Mar. 19	9.69	Dec. 16	10.24	July 30	10.12
June 11	9.99	Feb. 27, 1947	9.91	Dec. 5	11.00

2-33-6cb

Water level, in feet below land-surface datum

Aug. 16, 1946	10.45	Feb. 27, 1947	9.83	Oct. 8, 1947	11.19
Oct. 23	10.45	June 7	9.80	Dec. 5	10.52
Dec. 16	10.22	July 30	10.15		

2-33-10ab

Water level, in feet below land-surface datum

Aug. 15, 1946	8.01	Feb. 24, 1947	7.10	Oct. 6, 1947	8.60
Oct. 21	7.79	June 5	7.10	Dec. 3	7.87
Dec. 11	7.45	July 28	7.60		

2-34-8da

Water level, in feet below land-surface datum

Feb. 4, 1946	18.94	Dec. 16, 1946	19.37	July 30, 1947	18.47
May 19	18.88	Feb. 27, 1947	19.24	Oct. 8	20.22
Aug. 16	20.02	June 7	19.03	Dec. 5	19.77
Oct. 23	19.80				

Table 2.--Water-level measurements in wells--Continued

Hitchcock County--Continued

2-34-11dc

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1946	10.82	Feb. 26, 1947	10.81	Oct. 6, 1947	10.62
Oct. 21	10.80	June 6	10.45	Dec. 4	11.35
Dec. 11	10.75	July 30	10.10		

2-35-13bb

Water level, in feet below land-surface datum					
Aug. 16, 1946	13.55	Feb. 26, 1947	14.32	Oct. 8, 1947	14.84
Oct. 21	15.16	June 6	15.74	Dec. 5	15.48
Dec. 16	15.30	July 30	13.88		

2-35-21bc

Water level, in feet below land-surface datum					
Feb. 4, 1946	20.72	Oct. 21, 1946	20.39	July 30, 1947	20.10
Mar. 19	20.60	Dec. 16	20.50	Oct. 8	20.69
June 11	20.42	Feb. 27, 1947	20.15	Dec. 5	20.53
Aug. 16	21.19	June 7	20.19		

2-35-24aa

Water level, in feet below land-surface datum					
Aug. 16, 1946	6.08	Feb. 26, 1947	4.61	Oct. 8, 1947	8.77
Oct. 21	5.43	June 6	4.50	Dec. 4	5.84
Dec. 11	4.73	July 30	4.97		

3-31-14bc

Water level, in feet below land-surface datum					
June 11, 1946	15.51	Dec. 16, 1946	14.15	July 30, 1947	14.81
Aug. 15	15.88	Feb. 27, 1947	14.59	Oct. 8	a/11.82
Oct. 24	13.70	June 9	14.67	Dec. 5	14.37

3-31-15cc

Water level, in feet below land-surface datum					
Feb. 2, 1946	7.88	Aug. 14, 1946	8.26	Feb. 24, 1947	7.09
Mar. 17	7.94	Oct. 21	7.09	June 5	Destroyed
June 11	7.78	Dec. 11	7.16		

a/ Rise probably due to seepage from an irrigation canal.

Table 2.--Water-level measurements in wells--Continued

Hitchcock County--Continued

3-31-17cd

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1946	8.78	Dec. 11, 1946	7.48	June 5, 1947	7.45
Oct. 21	7.52	Feb. 24, 1947	7.42	Dec. 3	7.79

3-31-20da

Water level, in feet below land-surface datum					
June 11, 1946	8.19	Dec. 11, 1946	7.85	July 28, 1947	6.58
Aug. 15	8.40	Feb. 24, 1947	7.79	Oct. 6	7.92
Oct. 21	8.32	June 5	7.45	Dec. 3	8.20

3-32-11bb

Water level, in feet below land-surface datum					
May 29, 1946	13.20	Dec. 16, 1946	13.33	July 30, 1947	13.39
Aug. 15	14.00	Feb. 27, 1947	13.29	Oct. 8	13.80
Oct. 24	13.26	June 7	13.74	Dec. 5	13.30

3-32-12cc

Water level, in feet below land-surface datum					
Feb. 5, 1946	21.89	Dec. 16, 1946	21.43	July 30, 1947	21.47
Mar. 19	21.97	Feb. 27, 1947	21.64	Oct. 8	21.82
May 28	21.68	June 7	21.95	Dec. 5	21.36
Oct. 24	21.20				

3-32-26dd

Water level, in feet below land-surface datum					
Feb. 1, 1946	28.54	Oct. 21, 1946	28.63	July 28, 1947	27.40
May 19	28.30	Dec. 11	28.05	Oct. 6	28.80
June 11	28.76	Feb. 24, 1947	28.00	Dec. 3	28.58
Aug. 14	29.30	June 5	27.85		

3-32-31aa

Water level, in feet below land-surface datum					
Aug. 15, 1946	6.74	Feb. 27, 1947	5.78	Oct. 8, 1947	7.31
Oct. 23	6.18	June 7	5.87	Dec. 5	6.98
Dec. 16	5.92	July 30	6.07		

Table 2.--Water-level measurements in wells--Continued

Hitchcock County--Continued

3-33-35dc

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1946	10.54	Feb. 27, 1947	10.22	Oct. 8, 1947	11.60
Oct. 23	11.05	June 7	9.97	Dec. 5	11.35
Dec. 16	11.53	July 30	10.00		

4-33-8bb

Water level, in feet below land-surface datum					
Feb. 6, 1946	55.04	Oct. 24, 1946	55.25	July 30, 1947	55.00
Mar. 19	54.95	Dec. 16	55.18	Oct. 8	55.74
May 29	55.26	Feb. 27, 1947	54.85	Dec. 5	55.32
Aug. 15	55.74	June 7	55.14		

4-33-23ad

Water level, in feet below land-surface datum					
Aug. 15, 1946	13.82	Feb. 27, 1947	12.55	Oct. 8, 1947	13.56
Oct. 24	12.62	June 7	13.05	Dec. 5	12.84
Dec. 16	11.55	July 30	12.90		

Nuckolls County

1-5-31cb

Water level, in feet below land-surface datum					
Oct. 13, 1947	19.82	Nov. 14, 1947	19.78		

1-5-31cc

Water level, in feet below land-surface datum					
Feb. 28, 1946	3.95	Oct. 27, 1946	1.42	Aug. 2, 1947	a/4.17
Mar. 8	3.98	Dec. 18	1.14	Oct. 13	6.07
June 10	4.19	Mar. 1, 1947	2.11	Nov. 14	5.59
Aug. 12	4.08	June 10	0.66	Dec. 15	5.38

a/ Area drained.

Table 2.--Water-level measurements in wells--Continued

Nuckolls County--Continued

1-6-30dd

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Feb. 19, 1946	33.50	Nov. 14, 1947	33.12	Dec. 23, 1947	33.15
Mar. 8	33.50	Dec. 15	a/33.18	24	33.15
June 10	33.43	16	33.17	25	33.15
Aug. 12	33.48	17	33.16	26	33.14
Oct. 27	33.52	18	33.16	27	33.14
Dec. 18	33.42	19	33.16	28	33.13
Mar. 1, 1947	33.60	20	33.17	29	33.12
June 10	33.36	21	33.17	30	33.14
Aug. 2	33.25	22	33.15	31	33.15
Oct. 13	33.19				

1-6-31cc

Water level, in feet below land-surface datum					
Oct. 13, 1947	9.69	Nov. 14, 1947	10.23	Dec. 16, 1947	10.47

1-6-33cb

Water level, in feet below land-surface datum					
Oct. 13, 1947	5.02	Nov. 14, 1947	4.91	Dec. 16, 1947	5.02

1-6-33cc

Water level, in feet below land-surface datum					
Oct. 13, 1947	11.90	Nov. 14, 1947	12.41	Dec. 16, 1947	12.64

1-6-35cb

Water level, in feet below land-surface datum					
Oct. 13, 1947	13.70	Nov. 14, 1947	13.60	Dec. 16, 1947	13.61

1-6-35cc

Water level, in feet below land-surface datum					
Feb. 28, 1946	11.56	Oct. 27, 1946	10.98	Aug. 2, 1947	10.15
Mar. 8	11.60	Dec. 18	9.83	Oct. 13	13.35
June 10	12.83	Mar. 1, 1947	10.59	Nov. 14	13.23
Aug. 12	12.82	June 10	10.31	Dec. 16	13.39

a/ Automatic recorder installed Dec. 15, 1947. Lowest daily water level in feet below land-surface datum Dec. 15, 1947 to Dec. 31, 1947 taken from recorder charts.

Table 2.--Water-level measurements in wells--Continued

Nuckolls County--Continued

1-7-19cb

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Feb. 28, 1946	8.66	Oct. 27, 1946	9.20	Aug. 2, 1947	7.30
Mar. 8	8.48	Dec. 18	8.25	Oct. 13	10.36
June 10	9.15	Mar. 1, 1947	8.36	Nov. 13	10.75
Aug. 12	9.16	June 10	8.28	Dec. 15	10.92

1-7-19dd

Water level, in feet below land-surface datum					
Oct. 13, 1947	7.77	Nov. 13, 1947	7.49	Dec. 15, 1947	6.82

1-7-27cb

Water level, in feet below land-surface datum					
Oct. 13, 1947	20.59	Nov. 13, 1947	20.58	Dec. 15, 1947	20.56

1-7-31da

Water level, in feet below land-surface datum					
Oct. 13, 1947	10.64	Nov. 13, 1947	10.92	Dec. 16, 1947	10.97

1-7-32bb

Water level, in feet below land-surface datum					
Oct. 13, 1947	4.59	Nov. 13, 1947	4.29	Dec. 16, 1947	3.66

1-7-33ad

Water level, in feet below land-surface datum					
Oct. 13, 1947	6.22	Nov. 13, 1947	6.31	Dec. 16, 1947	6.10

1-7-33dd

Water level, in feet below land-surface datum					
Oct. 13, 1947	9.39	Nov. 13, 1947	9.33	Dec. 16, 1947	9.08

Table 2.--Water-level measurements in wells--Continued

Nuckolls County--Continued

1-7-34bb

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Feb. 28, 1946	5.39	Oct. 27, 1946	3.69	Aug. 2, 1947	4.98
Mar. 8	5.25	Dec. 18	3.61	Oct. 13	7.40
June 10	6.06	Mar. 1, 1947	3.84	Nov. 13	7.05
Aug. 12	7.04	June 10	3.89	Dec. 16	6.38

1-7-35da

Water level, in feet below land-surface datum					
Feb. 28, 1946	8.57	Dec. 18, 1946	7.84	Oct. 13, 1947	7.32
June 10	8.70	Mar. 1, 1947	8.06	Nov. 14	7.61
Aug. 12	8.46	June 10	7.78	Dec. 16	8.05
Oct. 27	8.24	Aug. 2	5.55		

1-7-36da

Water level, in feet below land-surface datum					
Oct. 13, 1947	10.00	Nov. 14, 1947	10.75	Dec. 16, 1947	11.20

1-8-7bb

Water level, in feet below land-surface datum					
Oct. 13, 1947	6.96	Nov. 13, 1947	6.28		

1-8-7dd

Water level, in feet below land-surface datum					
Feb. 28, 1946	3.77	Oct. 27, 1946	1.73	Aug. 2, 1947	4.59
Mar. 8	2.97	Dec. 18	2.43	Oct. 13	6.17
June 10	5.20	Mar. 1, 1947	3.05	Nov. 13	5.86
Aug. 12	5.66	June 10	1.36	Dec. 15	5.57

1-8-14cb

Water level, in feet below land-surface datum					
Oct. 13, 1947	15.82	Nov. 13, 1947	15.98	Dec. 15, 1947	15.57

1-8-17aa

Water level, in feet below land-surface datum					
Oct. 13, 1947	6.53	Nov. 13, 1947	6.49	Dec. 15, 1947	5.53

Table 2.--Water-level measurements in wells--Continued

Nuckolls County--Continued

1-8-17da

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Oct. 13, 1947	7.51	Nov. 13, 1947	7.57	Dec. 15, 1947	7.21

1-8-18cc

Water level, in feet below land-surface datum

Oct. 13, 1947	12.87	Nov. 13, 1947	13.12	Dec. 15, 1947	13.20

1-8-21cb

Water level, in feet below land-surface datum

Oct. 13, 1947	12.41	Nov. 13, 1947	12.41	Dec. 15, 1947	12.22

1-8-21dc

Water level, in feet below land-surface datum

Feb. 12, 1946	27.24	Dec. 18, 1946	26.09	Oct. 13, 1947	27.69
Mar. 8	27.25	Mar. 1, 1947	26.02	Nov. 13	27.84
June 10	27.61	June 10	24.92	Dec. 15	28.19
Oct. 27	27.20	Aug. 2	24.52		

1-8-22ab

Water level, in feet below land-surface datum

Feb. 12, 1946	2.44	Oct. 27, 1946	2.39	Aug. 2, 1947	3.95
Mar. 8	3.70	Dec. 18	3.37	Oct. 13	5.56
June 10	4.06	Mar. 1, 1947	4.71	Nov. 13	5.06
Aug. 12	4.66	June 10	2.70	Dec. 15	4.83

1-8-22da

Water level, in feet below land-surface datum

Oct. 13, 1947	10.05	Nov. 13, 1947	9.75	Dec. 15, 1947	9.37

1-8-22dd

Water level, in feet below land-surface datum

Oct. 13, 1947	8.41	Nov. 13, 1947	8.45	Dec. 15, 1947	8.50

Table 2.--Water-level measurements in wells--Continued

Nuckolls County--Continued

1-8-25aa

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Oct. 13, 1947	6.64	Nov. 13, 1947	6.75	Dec. 15, 1947	6.64

1-8-25ad

Water level, in feet below land-surface datum

Oct. 13, 1947	10.50	Nov. 13, 1947	10.25	Dec. 15, 1947	9.88

1-8-36aa

Water level, in feet below land-surface datum

Oct. 13, 1947	12.17	Nov. 13, 1947	11.94	Dec. 16, 1947	11.42

Redwillow County

2-29-4aa

Water level, in feet below land-surface datum

June 12, 1946	10.49	Dec. 17, 1946	8.93	July 31, 1947	9.40
Aug. 14	10.99	Feb. 27, 1947	9.12	Oct. 9	11.46
Oct. 25	8.90	June 9	9.20	Dec. 6	10.84

2-29-5ab

Water level, in feet below land-surface datum

Jan. 29, 1946	18.12	Dec. 17, 1946	16.35	July 31, 1947	18.15
Mar. 20	18.20	Feb. 27, 1947	16.65	Oct. 9	19.35
Aug. 12	19.80	June 9	17.18	Dec. 6	18.57
Oct. 25	16.73				

2-30-1aa

Water level, in feet below land-surface datum

June 12, 1946	10.03	Dec. 17, 1946	8.51	July 31, 1947	9.65
Aug. 14	11.19	Feb. 27, 1947	8.78	Oct. 9	11.31
Oct. 24	8.17	June 9	9.02	Dec. 6	10.38

2-30-12ad

Water level, in feet below land-surface datum

Jan. 29, 1946	30.38	Oct. 24, 1946	28.72	July 31, 1947	29.62
Mar. 20	30.65	Dec. 17	29.10	Oct. 9	28.91
June 12	30.81	Feb. 27, 1947	29.32	Dec. 6	28.09
Aug. 14	29.38	June 9	29.53		

Table 2.--Water-level measurements in wells--Continued

Redwillow County--Continued

3-26-5bb

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Jan. 30, 1946	44.30	Dec. 11, 1946	44.67	July 31, 1947	47.77
Mar. 20	43.87	Feb. 28, 1947	43.85	Oct. 9	47.40
June 12	43.60	June 9	43.32	Dec. 6	45.26
Oct. 25	45.87				

3-26-9cb

Water level, in feet below land-surface datum					
Jan. 30, 1946	16.73	Oct. 25, 1946	16.63	July 28, 1947	15.35
Mar. 20	16.58	Dec. 17	16.25	Oct. 6	16.50
June 12	16.80	Feb. 24, 1947	16.08	Dec. 3	16.69
Aug. 14	17.02	June 5	16.02		

3-26-11bb

Water level, in feet below land-surface datum					
June 12, 1946	8.62	Dec. 17, 1946	9.35	July 28, 1947	7.92
Aug. 14	9.08	Feb. 24, 1947	8.22	Oct. 6	9.42
Oct. 25	8.40	June 5	8.33	Dec. 3	9.30

3-27-7dc

Water level, in feet below land-surface datum					
Jan. 30, 1946	9.20	Oct. 21, 1946	7.55	July 31, 1947	8.23
Mar. 20	8.99	Dec. 11	7.18	Oct. 9	10.11
June 12	9.48	Feb. 28, 1947	7.90	Dec. 6	10.15
Aug. 14	9.62	June 9	8.02		

3-27-8ac

Water level, in feet below land-surface datum					
Mar. 20, 1946	12.09	Dec. 11, 1946	10.52	July 31, 1947	10.54
June 12	12.20	Feb. 28, 1947	11.05	Oct. 9	11.90
Aug. 14	12.17	June 9	11.21	Dec. 6	11.21
Oct. 21	9.21				

Table 2.--Water-level measurements in wells--Continued

Redwillow County--Continued

3-27-11aa

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
June 12, 1946	7.15	Dec. 11, 1946	4.26	July 31, 1947	6.20
Aug. 14	7.50	Feb. 28, 1947	5.79	Oct. 9	8.06
Oct. 21	3.73	June 9	6.07	Dec. 6	7.90

3-27-11cd

Water level, in feet below land-surface datum					
Jan. 30, 1946	16.39	Oct. 25, 1946	16.44	July 28, 1947	16.69
Mar. 20	16.60	Dec. 17	16.57	Oct. 6	17.60
June 12	16.99	Feb. 24, 1947	16.52	Dec. 3	16.99
Aug. 14	17.61	June 5	16.57		

3-27-17cb

Water level, in feet below land-surface datum					
Jan. 30, 1946	16.39	Oct. 25, 1946	16.44	July 28, 1947	16.69
Mar. 20	16.60	Dec. 17	16.57	Oct. 6	17.60
June 12	16.99	Feb. 24, 1947	16.52	Dec. 3	16.99
Aug. 14	17.61	June 5	16.57		

3-27-17cb

Water level, in feet below land-surface datum					
Feb. 8, 1946	9.10	Aug. 14, 1946	9.95	Feb. 24, 1947	9.00
Mar. 19	9.08	Oct. 25	8.31	June 5	9.35
June 12	9.42	Dec. 17	9.27		

3-28-17da

Water level, in feet below land-surface datum					
Feb. 8, 1946	10.79	Oct. 21, 1946	9.83	July 28, 1947	9.53
Mar. 19	10.54	Dec. 17	9.85	Oct. 6	10.85
June 12	11.16	Feb. 24, 1947	9.95	Dec. 3	10.35
Aug. 14	11.68	June 5	10.35		

3-28-20bb

Water level, in feet below land-surface datum					
Jan. 30, 1946	11.42	Oct. 21, 1946	9.32	July 28, 1947	10.18
Mar. 20	10.22	Dec. 17	9.27	Oct. 6	11.62
June 12	10.72	Feb. 24, 1947	9.39	Dec. 3	11.36
Aug. 14	10.86	June 5	9.77		

Table 2.--Water-level measurements in wells--Continued

Redwillow County--Continued

3-28-21cd

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Jan. 30, 1946	8.56	Dec. 17, 1946	8.94	July 28, 1947	9.14
Mar. 20	8.56	Feb. 24, 1947	8.89	Oct. 6	9.73
June 12	8.88	June 5	9.05	Dec. 3	9.32
Oct. 21	9.04				

3-29-32db

Water level, in feet below land-surface datum					
Feb. 6, 1946	5.59	Oct. 25, 1946	4.72	July 31, 1947	6.01
Mar. 20	5.46	Dec. 17	4.83	Oct. 9	7.45
June 12	6.69	Feb. 27, 1947	5.06	Dec. 5	6.56
Aug. 14	7.10	June 9	5.13		

3-29-35da

Water level, in feet below land-surface datum					
Jan. 29, 1946	19.53	Oct. 25, 1946	18.69	July 31, 1947	17.92
Mar. 20	19.39	Dec. 17	18.12	Oct. 9	18.59
June 12	19.48	Feb. 27, 1947	18.28	Dec. 6	18.53
Aug. 14	19.42	June 9	18.39		

3-30-19bb

Water level, in feet below land-surface datum					
Feb. 2, 1946	6.90	Oct. 24, 1946	6.95	July 30, 1947	7.32
Mar. 20	6.88	Dec. 16	6.99	Oct. 8	7.83
June 11	7.54	Feb. 27, 1947	6.90	Dec. 5	7.41
Aug. 14	9.66	June 9	6.88		

3-30-26bc

Water level, in feet below land-surface datum					
Feb. 4, 1946	8.05	Oct. 21, 1946	8.34	July 28, 1947	8.75
Mar. 20	8.32	Dec. 11	8.28	Oct. 6	10.14
June 12	8.96	Feb. 24, 1947	8.13	Dec. 3	8.79
Aug. 14	9.66	June 5	8.49		

Table 2.--Water-level measurements in wells--Continued

Redwillow County--Continued

3-30-29aa

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
June 12, 1946	4.00	Dec. 16, 1946	3.17	July 31, 1947	3.18
Aug. 14	4.45	Feb. 27, 1947	3.35	Oct. 9	5.06
Oct. 24	3.08	June 9	3.25	Dec. 5	4.35

3-30-34bb

Water level, in feet below land-surface datum

Feb. 2, 1946	13.30	Oct. 24, 1946	12.34	July 31, 1947	13.28
Mar. 20	13.27	Dec. 17	12.49	Oct. 9	14.45
June 12	13.82	Feb. 27, 1947	12.75	Dec. 5	13.75
Aug. 14	14.48	June 9	13.01		

4-26-34db

Water level, in feet below land-surface datum

Feb. 1, 1946	20.88	Dec. 11, 1946	19.96	July 31, 1947	19.65
Mar. 20	20.69	Feb. 28, 1947	20.10	Oct. 9	21.10
June 12	20.65	June 9	19.97	Dec. 6	21.05
Oct. 25	20.63				

Webster County

1-9-9cb

Water level, in feet below land-surface datum

Oct. 13, 1947	6.37	Nov. 13, 1947	6.47	Dec. 15, 1947	6.34

1-9-9cc

Water level, in feet below land-surface datum

Oct. 13, 1947	7.56	Nov. 13, 1947	7.66	Dec. 15, 1947	5.68

1-9-11cb

Water level, in feet below land-surface datum

Feb. 28, 1946	3.89	Oct. 27, 1946	2.54	Aug. 2, 1947	3.33
Mar. 8	3.72	Dec. 18	2.50	Oct. 13	5.23
June 10	4.00	Mar. 1, 1947	2.89	Nov. 13	5.47
Aug. 12	5.24	June 10	2.05	Dec. 15	4.84

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

1-9-13ad

Water level, in feet below land-surface datum

Date	Water level	Date	Water level	Date	Water level
Feb. 28, 1946	8.18	Oct. 27, 1946	5.50	Aug. 2, 1947	6.90
Mar. 8	8.10	Dec. 18	6.82	Oct. 13	9.38
June 10	8.56	Mar. 1, 1947	6.91	Nov. 13	9.24
Aug. 12	9.07	June 10	6.90	Dec. 15	8.95

1-9-14bb

Water level, in feet below land-surface datum

Oct. 13, 1947	8.47	Nov. 13, 1947	8.35	Dec. 15, 1947	7.97

1-9-14bc

Water level, in feet below land-surface datum

Oct. 13, 1947	12.55	Nov. 13, 1947	12.13	Dec. 15, 1947	11.71

1-9-9cb

Water level, in feet below land-surface datum

Oct. 13, 1947	6.37	Nov. 13, 1947	6.47	Dec. 15, 1947	6.34

1-9-9cc

Water level, in feet below land-surface datum

Oct. 13, 1947	7.56	Nov. 13, 1947	7.66	Dec. 15, 1947	5.68

1-9-11cb

Water level, in feet below land-surface datum

Feb. 28, 1946	3.89	Oct. 27, 1946	2.54	Aug. 2, 1947	3.33
Mar. 8	3.72	Dec. 18	2.50	Oct. 13	5.23
June 10	4.00	Mar. 1, 1947	2.89	Nov. 13	5.47
Aug. 12	5.24	June 10	2.05	Dec. 15	4.84

1-9-13ad

Water level, in feet below land-surface datum

Feb. 28, 1946	8.18	Oct. 27, 1946	5.50	Aug. 2, 1947	6.90
Mar. 8	8.10	Dec. 18	6.82	Oct. 13	9.38
June 10	8.56	Mar. 1, 1947	6.91	Nov. 13	9.24
Aug. 12	9.07	June 10	6.90	Dec. 15	8.95

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

1-9-14bb

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Oct. 13, 1947	8.47	Nov. 13, 1947	8.35	Dec. 15, 1947	7.97

1-9-14bc

Water level, in feet below land-surface datum					
Oct. 13, 1947	12.55	Nov. 13, 1947	12.13	Dec. 15, 1947	11.71

1-9-16bc

Water level, in feet below land-surface datum					
Feb. 13, 1946	10.86	Dec. 18, 1946	10.14	Oct. 13, 1947	11.79
Mar. 8	11.83	Mar. 1, 1947	10.12	Nov. 13	12.08
June 10	11.39	June 10	8.30	Dec. 15	12.23
Oct. 27	11.47	Aug. 2	8.57		

1-10-1dc1

Water level, in feet below land-surface datum					
Mar. 8, 1946	10.18	Dec. 18, 1946	10.19	Aug. 2, 1947	9.85
June 12	10.26	Mar. 1, 1947	10.09	Oct. 11	10.47
Aug. 12	10.52	June 10	10.75	Dec. 1	10.39
Oct. 27	10.33				

1-10-1dc2

Water level, in feet below land-surface datum					
Mar. 8, 1946	16.98	Oct. 27, 1946	17.16	June 10, 1947	16.30
June 12	16.98	Dec. 18	17.30	Aug. 2	Destroyed
Aug. 12	17.32	Mar. 1, 1947	17.95		

1-10-3ad

Water level, in feet below land-surface datum					
Mar. 8, 1946	9.42	Dec. 18, 1946	8.68	Aug. 2, 1947	8.22
June 10	9.87	Mar. 1, 1947	8.90	Oct. 11	9.64
Aug. 12	9.97	June 10	8.42	Dec. 1	9.50
Oct. 27	8.42				

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

1-10-9ad

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Mar. 8, 1946	16.34	Dec. 18, 1946	15.94	Aug. 2, 1947	15.60
June 10	17.20	Mar. 1, 1947	16.03	Oct. 11	17.27
Aug. 12	17.54	June 10	15.73	Dec. 1	17.74
Oct. 27	15.66				

1-11-1da

Water level, in feet below land-surface datum					
Mar. 8, 1946	9.05	Dec. 18, 1946	5.72	Aug. 2, 1947	6.10
June 10	9.33	Mar. 1, 1947	6.75	Oct. 11	9.00
Aug. 12	8.78	June 10	5.30	Dec. 1	9.50
Oct. 27	5.86				

1-11-5bc

Water level, in feet below land-surface datum					
Mar. 8, 1946	6.55	Dec. 18, 1946	2.64	Aug. 2, 1947	3.18
June 12	6.53	Mar. 1, 1947	3.92	Oct. 11	5.87
Aug. 12	5.92	June 10	3.58	Dec. 1	6.92
Oct. 27	2.69				

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

1-11-11ab

Lowest daily water level in feet below land-surface datum, 1946
(From recorder charts)

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1			8.90	7.81		8.20	5.33	4.65	4.88
2			8.91	7.84		8.16	5.33	4.63	4.89
3			8.91	7.87		8.11	5.32	4.55	4.96
4			8.91	7.88		8.17		4.48	4.96
5			8.91	7.90		5.70		4.41	4.98
6			8.92	7.93		5.70		4.63	4.99
7			8.93	6.05		4.43		4.52	5.00
8			8.95	5.87		4.22		4.57	5.01
9			8.95			4.22		4.56	5.09
10			8.98			4.22		3.94	5.13
11			9.00		7.80	4.35		3.89	5.13
12			9.00		7.81	4.45		3.90	5.16
13			9.01		7.82	4.43		3.83	5.21
14			9.02		7.85	4.43		3.82	5.25
15			9.03		7.88	4.43		3.90	5.25
16			9.05		7.92	4.43		4.13	5.27
17			9.10		7.94	4.42		4.20	5.36
18			8.99		7.97	4.42		4.20	5.45
19			7.52		8.00	4.42		4.28	5.47
20			7.39		8.02	4.42		4.28	5.53
21			7.35		8.04	4.53		4.38	5.56
22			7.42		8.05	4.53		4.43	5.56
23			7.48		8.07	4.62		4.43	5.61
24		8.86	7.55		8.08	4.72		4.47	5.63
25		8.88	7.61		8.09	4.80	4.52	4.53	5.60
26		8.88	7.67		8.10	5.05	4.65	4.63	5.60
27		8.88	7.70		8.12	5.08	4.71	4.71	5.65
28		8.88	7.77		8.12	5.14	4.74	4.74	5.70
29		8.91	7.75		8.13	5.20	4.75	4.74	5.74
30		8.89	7.80		8.15	5.27	4.75	4.82	5.84
31		8.89			8.17		4.70		6.00

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

1-11-11ab--Continued

Lowest daily water level in feet below land-surface datum, 1947
(From recorder charts)

Day	Jan.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.00	6.50	6.31		5.46		5.29	6.56		7.76	7.92
2	6.02	6.53	6.37		5.48		5.40	6.58		7.76	7.94
3	6.02	6.51	6.37	5.48	5.52		5.49	6.62		7.75	7.96
4	6.10	6.50	6.28	5.53	5.57		5.56	6.67		7.78	7.94
5	6.12	6.55	6.20	5.59	5.64		5.66	6.70		7.79	7.97
6	6.13	6.58	6.20	5.68	5.68		5.73	6.74		7.78	7.96
7	6.08	6.58	6.30	5.69	5.57		5.80	6.78		7.81	7.96
8	6.03	6.57	6.28	5.73	5.60		5.86	6.82		7.83	7.98
9	6.02	6.58	6.27	5.74	5.70		5.93	6.84		7.84	7.98
10	5.97	6.60		5.77	5.80		6.02	6.87	7.45	7.85	7.99
11	6.03	6.55		5.78	5.84		6.09	6.90	7.47	7.86	7.99
12	6.05	6.52		5.82	5.87		6.11	6.92	7.50	7.88	8.00
13	6.07	6.43		5.83	4.93		6.13	6.92	7.51	7.88	8.00
14	6.07	6.27		5.88	4.93		6.16	7.00	7.50	7.88	7.98
15	6.09	6.26		5.90	5.05		6.18	7.00	7.52	7.90	8.01
16	6.07	6.24		5.90	5.12		6.22	7.03	7.53	7.92	8.02
17	6.14	6.18		5.87	5.27		6.27	7.05	7.55	7.93	8.02
18	6.18	6.23		5.15	5.32		6.32	7.09	7.58	7.93	8.03
19	6.14	6.22		5.14	5.36		6.34	7.10	7.59	7.93	8.04
20	6.13	6.24		5.16	5.38		6.38	7.12	7.60	7.93	8.04
21	6.15	6.17		5.26	5.44	4.72	6.43	7.15	7.61	7.95	8.03
22	6.15	6.17		5.42	5.46	4.69	6.47		7.63	7.95	8.00
23	6.15	6.13		5.49b	5.38	4.57	6.52		7.65	7.94	8.02
24	6.17	6.12		5.54		4.64	6.54		7.67	7.91	8.02
25	6.17	6.23		5.63		4.69	6.43		7.68	7.93	8.03
26		6.28		5.65		4.78	6.15		7.68	7.94	8.00
27		6.26		5.65		4.87	6.15		7.69	7.96	7.99
28		6.30		5.66		4.96	6.23		7.70	7.96	7.99
29		6.28		5.45		5.05	6.31		7.71	7.98	7.94
30		6.34		5.36		5.15	6.39		7.72	7.98	7.98
31	a	6.28		5.38		5.22	6.48		7.75		7.98

a/ No record during February.
b/ Flash flood.

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

1-11-16aa

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Mar. 8, 1946	20.37	Dec. 18, 1946	19.95	Aug. 2, 1947	18.95
June 10	20.58	Mar. 1, 1947	19.59	Oct. 11	19.80
Aug. 12	21.25	June 10	19.05	Dec. 1	19.68
Oct. 27	20.45				

1-12-2bb

Water level, in feet below land-surface datum					
Mar. 7, 1946	5.45	Dec. 18, 1946	3.14	Aug. 2, 1947	3.12
June 12	6.00	Mar. 1, 1947	3.82	Oct. 11	5.57
Aug. 12	6.52	June 10	3.28	Dec. 1	6.04
Oct. 26	2.77				

1-12-4bb

Water level, in feet below land-surface datum					
Mar. 7, 1946	6.68	Dec. 18, 1946	3.54	Aug. 2, 1947	5.04
June 12	7.26	Mar. 1, 1947	4.14	Oct. 11	9.27
Aug. 12	8.17	June 10	3.64	Dec. 1	9.22
Oct. 27	3.10				

1-12-8aa

Water level, in feet below land-surface datum					
Mar. 7, 1946	4.06	Dec. 18, 1946	3.28	Aug. 2, 1947	3.70
June 12	4.29	Mar. 1, 1947	3.62	Oct. 11	5.91
Aug. 12	5.28	June 10	3.17	Dec. 1	5.20
Oct. 26	1.95				

2-9-24bd

Water level, in feet below land-surface datum					
Mar. 8, 1946	15.08	June 10, 1946	15.39	Aug. 12, 1946	15.78

2-10-36db

Water level, in feet below land-surface datum					
Feb. 12, 1946	28.07	Dec. 18, 1946	26.67	Aug. 2, 1947	26.80
Mar. 8	27.04	Mar. 1, 1947	26.79	Oct. 11	27.13
June 10	27.16	June 10	26.72	Dec. 1	27.04
Oct. 27	26.84				

Table 2.--Water-level measurements in wells--Continued

Webster County--Continued

2-12-34cd

Water level, in feet below land-surface datum					
Date	Water level	Date	Water level	Date	Water level
Mar. 7, 1946	17.68	Mar. 1, 1947	17.80	Aug. 2, 1947	17.38
Oct. 26	17.30	June 10,	17.45	Dec. 16	17.31
Dec. 18	17.82				

3-10-34cb

Water level, in feet below land-surface datum					
Feb. 13, 1946	34.43	Dec. 31, 1946	34.60		

C1-6-5da

Water level, in feet below land-surface datum					
Oct. 13, 1947	9.09	Nov. 14, 1947	9.37	Dec. 17, 1947	9.54

C1-6-5dd

Water level, in feet below land-surface datum					
Oct. 13, 1947	31.20	Nov. 14, 1947	31.23	Dec. 17, 1947	31.39

C1-7-1bb

Water level, in feet below land-surface datum					
Oct. 13, 1947	10.13	Nov. 14, 1947	10.39	Dec. 17, 1947	10.27

C1-7-2da

Water level, in feet below land-surface datum					
Oct. 13, 1947	7.00	Nov. 14, 1947	7.30	Dec. 17, 1947	7.44

Republic County

C1-5-7bb

Water level, in feet below land-surface datum					
Oct. 13, 1947	8.12	Nov. 14, 1947	8.48	Dec. 16, 1947	8.57

C1-5-7cb

Water level, in feet below land-surface datum					
Oct. 13, 1947	20.42	Nov. 14, 1947	20.47	Dec. 16, 1947	20.97

Table 3.—Records of observation wells in the Republican and Frenchman River Valleys, Nebraska

Well No. 1/	Owner or tenant	Driller	Year completed	Type of well 2/	Depth of well (feet) 3/	Diameter of well (inches)	Type of casing 4/	Method of lift		Use of water 7/	Measuring Point			Depth to water level below measuring point (feet) 9/
								Type of pump 5/	Kind of power 6/		Description	Distance above or below land surface (feet)	Height above mean sea level (feet) 8/	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Chase County													
5-36- 7ba	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	19.1	1¼	I	N	N	O	Top of well.	+0.7	—	16.42
11dc	John Redden	—	—	Dr	71.6	8	I	N	N	A,O	Top of platform.	+ .63	—	63.09
	Dundy County													
1-37- 7ab	Roy Lingo	Promer and Wakefield	1937	Dr	77	24	GI	T	G	I,O	Hole in base.	+3.0	—	64.08
16dd	Miles Jones	—	1945	Dr	—	24	GI	T	T	I,O	do.	.0	2,988	38.59
19ba	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	18.3	1¼	GI	N	N	O	Top of pipe.	+1.0	2,990	10.23
31cd	do.	do.	1946	Dn	12.5	1¼	GI	N	N	O	do.	+1.5	3,007	5.50
1-38-20bc	Ough	Don Wykof	—	Dr	26	6	GI	Cy	W	A,O	Top of casing.	+1.5	3,072	17.48
21cb	Univ. of Nebraska	Haworth and Bennett	1936	Dn	17.7	1	GI	N	N	O	do.	+3.0	3,042	8.57
25bd	Dave Jones	—	1936	Dr	10/42	24	GI	T	T	I,O	Edge of casing.	+1.0	2,996	13.32
29ad	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	22.2	1¼	GI	N	N	O	Top of casing.	+1.0	3,038	8.94
1-39-21ac	Louis Krutsinger	C. McGonigal	1927	Dr	15.5	6	GI	Cy	H	A,O	do.	.0	3,096	5.24
22cc	Dundy County	—	1940	Dr	21	4	GI	P	H	S,O	Side opening of casing.	+1.0	3,101	12.43
26aa	Pringle	—	—	Dr	39.4	6	GI	N	N	O	Top of casing.	+3.2	3,092	28.42
30bb	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	18.5	1¼	GI	N	N	O	do.	+1.0	3,141	12.72
1-40-20cb	do.	do.	1946	Dn	12.5	1¼	GI	N	N	O	do.	+1.0	3,194	3.62
24cd	do.	do.	1946	Dn	18	1¼	GI	N	N	O	do.	+1.0	3,139	9.36
11/ 26aa1	Lee Clegg	C. A. Robben	1942	Dr	80	16	--	T	G	I	—	—	—	—
27ab	Alvin Minton	do.	1945	Dr	94	16	I	T	G	I	Hole in base.	+1.5	3,182	20.45

1/ Well numbers in this table are based on well locations within the General Land Office survey of the area. In this system of numbering, the first number indicates the township, the second the range, and the third the section. The lower case letters which follow the second number indicate the position of the well within the section, the first letter indicating the quarter section and the second letter the quarter-quarter section. The letters a, b, c, and d, are applied in counter-clockwise direction beginning with a in the northeast quadrant in each case. The last numeral indicates the number of the well within the tract of land indicated by the last letter; no number is shown unless more than one well is located within that tract. The numbers of wells situated in Kansas are preceded by the letter C. (See fig. 2.)

2/ Dr, drilled; Dn, driven; Du, dug.

3/ All depths are measured depths unless otherwise noted.

4/ B, Brick; C, concrete; GI, galvanized iron; GS, galvanized steel; I, iron; R, rock; T, tile; W, wood.

5/ C, Horizontal centrifugal; Cy, cylinder; N, none; P, pitcher pump; T, turbine; VC, vertical centrifugal.

6/ E, Electric; G, gasoline; H, hand; N, none; T, tractor; W, windmill.

7/ A, Abandoned; D, domestic; I, irrigation; O, observation; S, stock.

8/ Altitudes are estimated from U. S. Geological Survey topographic map of the Republican Valley.

9/ All measurements made between Feb. 24 and Mar. 2, 1947.

10/ Reported.

11/ Well from which a water sample was taken for chemical analysis and which is not being currently used for water-level observation.

Table 3.--Records of observation wells in the Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Dundy County--Cont.														
1-40-29bb	U. S. Geol. Survey	Sunyoke and Jones	1946	Dr	21	8	GI	N	N	O	Top of casing.	+1.6	3,207	12.74
1-41-20dd	do.	Schreurs and Jones	1946	Dn	12.5	1¼	GI	N	N	O	Top of pipe.	+1.0	3,271	3.69
27ca	do.	do.	1946	Dn	12.6	1¼	GI	N	N	O	do.	+1.0	3,248	4.96
1-42-10cd	do.	do.	1946	Dn	18.5	1¼	GI	N	N	O	do.	+1.0	3,356	3.41
13bb	do.	do.	1946	Dn	12.6	1¼	GI	N	N	O	do.	+1.0	3,319	4.71
36aa	do.	do.	1946	Dn	16.8	1¼	GI	N	N	O	do.	+1.0	3,293	12.16
2-36-24ca	do.	do.	1946	Dn	22.5	1¼	GI	N	N	O	do.	+1.0	2,856	15.28
29ac	Alva Howard	C. Robinson	1943	--	37	18	GS	T	G	I,O	Hole in base.	+ .5	2,902	21.98
31bc	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	27.5	1¼	GI	N	N	O	Top of casing.	+1.0	2,917	22.62
Franklin County														
1-13- 1cc	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	15.7	1¼	I	N	N	O	Top of casing.	+1.0	1,752	6.15
2bc	do.	do.	1946	Dn	18.4	1¼	I	N	N	O	do.	+1.0	1,760	9.19
3ca	do.	do.	1946	Dn	13.7	1¼	I	N	N	O	do.	+1.0	1,760	8.08
4cb	J. Ziegler	J. Ziegler	1940	Du,Dr	10/47.5	24	GI	VC	T	I,O	do.	+1.0	1,770	12.11
7bb	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	12.3	1¼	I	N	N	O	do.	+1.0	1,776	5.45
1-14- 2cd	W. Sindt	Clarence Davis	1935	Du,Dr	10/44	24	W	T	T	I,O	Edge of steel beam.	+2.0	1,787	8.74
3ba	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	12.5	1¼	I	N	N	O	Top of casing.	+1.0	1,792	—
6bc	Ernst Blank	Ernst Blank	1935	Dr	40	24	GI	T	E	I,O	Edge of wall.	+1.0	1,815	7.25
7bb1	Univ. of Nebraska	Scherer and Murphy	1940	Dn	20	1	I	N	N	O	Top of casing.	+2.5	1,822	4.75
7bb2	Harry Blank	Harry Blank	1941	Du,Dr	29	24	W	T	T	I,O	do.	.0	1,820	4.55
11/ 26bc	John Monie	John Monie	—	Du	19.5	36	R	Cy	W	D,S	Base of pump.	+1.5	—	14.79
1-15- 5ca	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	13.6	1¼	I	N	N	O	Top of casing.	+1.0	1,835	4.29
8cb	A. Townsend	A. Townsend	—	Du,Dr	36	24	GI	VC	T	I.O	do.	+2.2	1,847	12.11
11/ 11ac	W. T. Hayes	W. T. Hayes	—	Du	18.5	36	B	Cy	W	S	Top of platform.	+ .7	1,820	16.58
1-16- 9bc	Walter Post	John Larrick	1936	Du,Dr	49	24	GI	N	N	A,O	Top of casing.	+1.0	1,875	13.38
10bd	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	13.7	1¼	I	N	N	O	do.	+1.0	1,860	2.86
14ab	C. Howell	Clarence Davis	1936	Du,Dr	10/80	24	GI	T	T	I,O	Hole in turbine.	.0	1,885	38.69
2-13-31ad	—	—	1927	Du,Dr	71	4	GI	N	N	A,O	Edge of pit.	+1.0	—	54.86
32dd	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	17.5	1¼	I	N	N	O	Top of casing.	+1.0	1,772	3.77
11/2-14-18da	Mrs. W. T. Williams	Davis (Deceased)	—	Dr	46	6	GI	Cy	W	O	At pump base.	+ .5	1,975	45.20
2-15-36bd	J. D. Wessels	—	—	Dr	32.2	6	GI	Cy	H	A,O	Top of casing.	+2.0	1,851	31.58
11/3-14-36dd	Univ. of Nebraska	Haworth and Scherer	1934	Dr	30.4	1¼	I	N	N	O	do.	+2.6	—	21.02
Furnas County														
3-21- 2cc	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	16.4	1¼	GI	N	N	O	Top of casing.	+1.0	2,066	8.94
12dc	do.	do.	1946	Dn	13.5	1¼	I	N	N	O	do.	+1.0	2,051	4.97
3-22- 2ba	do.	do.	1946	Dn	13.6	1¼	GI	N	N	O	do.	+1.0	2,110	7.06
3-25- 4bb	do.	Haworth and Schnittker	1946	Dr	21.8	8	GI	N	N	O	do.	+1.7	2,562	6.24
4-21- 9bd	Ralph Ballard	Hastings Well Co.	—	Dr	51	24	GI	T	T	I,O	Hole in base.	+1.0	—	16.40
32cc	Claud Rhynolds	Western Well Co.	1946	Dr	40	18	GI	N	N	O	Edge of casing.	+1.0	2,093	14.29
4-22-25cc	Norah Hayes	Western Land Roller	1941	Dr	35.8	18	GI	T	T	I,O	Top of casing.	.0	2,109	8.62
29ad	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	23	1¼	GI	N	N	O	do.	+1.0	2,136	16.62
32dd	Mrs. E. Coker	—	1930	Dr	40.2	24	GS	T	T	I,O	do.	+1.5	2,122	9.92
34ba	Clyde Payne	Kerst Bros.	1941	Dr	10/61	18	GI	T	G	I,O	Hole in base.	+ .5	2,121	13.63
4-23-20ab	Clyde Larson	Lane-Western	1940	Dr	10/80	18	GI	T	G	I,O	do.	+2.0	2,191	28.04
23bd	O. Moore	—	—	Dr	10/43	6	GI	Cy	H	S,O	Hole in side of casing.	+ .7	2,168	29.85
27dd	U. S. Geol. Survey	Waite, Sunyoke, and Bentall	1946	Dn	17.3	1¼	GI	N	N	O	Top of casing.	+1.0	2,156	10.29

Table 3.—Records of observation wells in the Republican and Frenchman River Valleys, Nebraska

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Furnas County—Cont.														
4-23-30cc	Breming Bros.	Breming Bros.	1939	Dr	10/93	24-29	GI	T	E	I,O	Top of casing.	+0.5	2,240	52.75
36aa	Harold Watson	—	—	--	10/63	18	I	T	E	I,O	Turbine opening.	+3.0	2,150	21.05
4-24-13cd	Cecil Thomas	C. Richards	1939	Dr	10/59	18-24	GI	T	T	I,O	Hole in base.	+ .6	2,201	18.28
15cc	U. S. Geol. Survey	Sunyoke, Waite, and Bentall	1946	Dn	24	1¼	GI	N	N	O	Top of casing.	+1.0	2,212	13.56
19cc	E. Purington	Leo Wilcox	1937	Dr	30	22	GI	T	T	I,O	Edge of casing.	+1.0	2,231	—
22dd	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	13.4	1¼	GI	N	N	O	Top of casing.	+1.0	2,198	6.02
29cd	D. Andrews	—	1940	Dr	10/80	18	GI	T	T	I,O	Opening in turbine.	+ .6	2,234	21.09
4-25-32cd	U. S. Geol. Survey	Waite, Sunyoke, and Bentall	1946	Dn	12.2	1¼	GI	N	N	O	Top of casing.	+1.0	2,261	5.20
34ad	John Sayer	Western Land Roller	1938	Dr	10/73.5	18	GI	T	T	I,O	Hole in base.	.0	2,251	15.22
Harlan County														
1-17-1da	U. S. Geol. Survey	Sunyoke and Schnittker	1946	Dn	13.7	1¼	I	N	N	O	Top of casing.	+1.0	1,880	6.06
12da	Edna Godeken	Les White	1938	Du,Dr	10/48	24	—	T	T	I,O	Hole in base of turbine.	.0	1,879	13.99
2-19-5cb	L. Short	—	1941	Dr	51	18	GI	T	G	I,O	Side of turbine.	+1.0	2,025	21.36
17da	Bernard Korte	—	1928	Du,Dr	10/42	72	B	VC	T	I,O	Well platform.	+1.0	1,998	20.30
28dd	Univ. of Nebraska	Scherer and Murphy	1940	Dn	22	1	I	N	N	O	Top of casing.	+1.2	1,975	9.19
34bc	Carl Fishbeck	Hastings Well Co.	1946	Dr	61	24	GI	T	T	I,O	Hole in base.	+1.0	1,980	21.49
3-20-7ab	Carl Struve	do.	1946	Dr	90	24	GI	T	G	I,O	do.	+1.0	2,079	31.00
16bb	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	17.4	1¼	I	N	N	O	Top of casing.	+1.0	2,045	7.53
18ca	Fish Imp. Co.	Hastings Well Co.	1946	Dr	57	18	GI	T	T	I,O	Hole in base.	+1.0	2,049	14.60
22dd	Charley Murdock	Ivan Runck	—	Dr	—	10	GI	Cy	W	S,O	Top of casing.	+3.0	2,042	27.75
25cc	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	23.8	1¼	GI	N	N	O	do.	+1.0	2,022	12.92
Hayes County														
5-33-30cb	Raymond Scott	Troutman	1944	Dr	10/90	22	GI	T	E	I,O	Side of turbine.	+ .6	—	19.76
31dc	Univ. of Nebraska	Haworth and Bennett	1936	Dn	23	1	GI	N	N	O	Top of casing.	+2.7	—	16.20
5-34-30ba	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	17	1¼	I	N	N	O	do.	+1.0	—	11.62
5-35-17da	do.	do.	1946	Dn	12.7	1¼	I	N	N	O	do.	+1.0	—	9.38
Hitchcock County														
2-33-2aa	M. Wertz	Kerst Bros.	1944	Dr	47	18	GS	T	E	I,O	Hole in base.	+1.0	2,663	10.91
6cb	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	16.5	1¼	GI	N	N	O	Top of casing.	+1.0	2,718	10.83
10ab	do.	do.	1946	Dn	16.5	1¼	GI	N	N	O	do.	+1.0	2,683	8.10
2-34-8da	Henry Pollman	Western Land Roller	1938	Dr	10/58	24	GS	T	T	I,O	Edge of base.	.0	2,772	19.24
11dc	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	18.5	1¼	GI	N	N	O	Top of casing.	+1.0	2,726	11.81
11/ 18aa	L. W. Melchert	Edwards & Sons	1944	Dr	48	18	—	T	E	I	—	—	—	—
2-35-13bb	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	22	1¼	GI	N	N	O	Top of casing.	+1.0	2,795	15.32
21bc	Rev. Otto Brownfield	A. Snyder	1934	Dr	46.6	18	GI	N	N	A,O	Hole in cover.	.0	2,828	20.15
24aa	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	12.1	1¼	GI	N	N	O	Top of casing.	+1.0	2,777	5.61
11/2-36-29ac	A. Howard	C. A. Robben	—	Dr	42	24	—	T	G	I	—	—	—	—
3-31-14bc	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	26.2	1¼	I	N	N	O	Top of casing.	+1.0	2,566	15.59
15cc	Joe Kautz	Joe Kautz	1923	Dr	15	4	—	Cy	H	D,O	do.	+2.0	2,562	9.09
17cd	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	17.9	1¼	GI	N	N	O	do.	+1.0	2,576	8.42
20da	do.	Sunyoke and Jones	1946	Dn	12.8	1¼	I	N	N	O	do.	+1.0	2,576	8.79
3-32-11bb	do.	do.	1946	Dn	18.5	1¼	I	N	N	O	do.	+1.0	—	14.29

Table 3.--Records of observation wells in the Republican and Frenchman River Valleys, Nebraska

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Hitchcock County--Cont.														
3-32-12cc	Mrs. Maude Morthole	Western Land Roller	1940	Dr	—	—	—	T	G	I,O	Hole in base.	0.0	2,610	21.64
26dd	Ernst Meintz	Kerst Bros.	1946	Dr	74	18	I	T	G	I,O	do.	+1.0	2,622	29.00
31aa	U. S. Geol. Survey	Schreurs and Jones	1946	Dn	12.5	1¼	GI	N	N	O	Top of casing.	+1.0	2,648	6.78
3-33-35dc	Lawrence			Dn	26.9	1¼	I	N	N	A,O	do.	+1.5	2,669	11.72
4-33- 8bb	Raymond Handel	Ronald Troutman	1942	Dr	93.6	18	GI	T	T	I	Hole in pump base.	+1.0	—	55.85
23ad	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	18.9	1¼	I	N	N	O	Top of casing.	+1.0	—	13.55
Nuckolls County														
1- 5-31cb	U. S. Geol. Survey	Keech and Sherwani	1947	Dn	23	1¼	I	N	N	O	Top of pipe.	+1.0	1,541	20.74
31cc	do.	Sunyoke and Schnittker	1946	Dn	12.4	1¼	I	N	N	O	do.	+1.0	1,516	3.11
1- 6-30dd	Marion Day		1920	Dr	48	6	T	N	N	A,O	Top of tile.	+1.0	1,573	34.60
31cc	U. S. Geol. Survey	Bollenbach and Schreurs	1947	Dn	13	1¼	I	N	N	O	Top of casing.	+ .5	1,547	9.15
33cb	do.	Waite, Sherwani and Hess	1947	Dn	11.5	1¼	GI	N	N	O	do.	+1.7	1,539	6.76
33cc	do.	do.	1947	Dn	18.7	1¼	I	N	N	O	do.	+1.0	1,542	12.49
35cb	do.	Keech and Sherwani	1947	Dn	21	1¼	I	N	N	O	do.	+2.0	1,544	16.33
35cc	do.	Sunyoke and Schnittker	1946	Dn	17.6	1¼	I	N	N	O	do.	+1.0	1,534	11.59
1- 7-19cb	do.	do.	1946	Dn	17.5	1¼	I	N	N	O	do.	+1.0	1,590	9.36
19dd	do.	do.	1947	Dn	13.4	1¼	I	N	N	O	do.	+1.0	1,578	8.78
27cb	do.	Waite and Schnittker	1947	Dn	27	1¼	I	N	N	O	do.	+1.0	1,585	21.47
31da	do.	do.	1947	Dn	22	1¼	I	N	N	O	do.	+1.5	1,582	11.90
32bb	do.	Bollenbach and Schreurs	1947	Dn	12.8	1¼	I	N	N	O	do.	+2.0	1,575	6.20
33ad	do.	Sherwani	1947	Dn	12	1¼	I	N	N	O	do.	+2.0	1,566	7.82
33dd	do.	Waite and Schnittker	1947	Dn	17.7	1¼	I	N	N	O	do.	+1.2	1,566	10.42
34bb	do.	Sunyoke and Schnittker	1946	Dn	12.5	1¼	I	N	N	O	do.	+1.0	1,567	4.84
35da	do.	do.	1946	Dn	15.4	1¼	I	N	N	O	do.	+1.0	1,554	9.06
36da	do.	Bollenbach and Schreurs	1947	Dn	17.2	1¼	I	N	N	O	do.	+1.5	1,549	10.30
1- 8- 7bb	do.	Keech and Sherwani	1947	Dn	21	1¼	I	N	N	O	do.	+2.0	1,611	8.28
7dd	do.	Sunyoke and Schnittker	1946	Dn	11.7	1¼	I	N	N	O	do.	+1.0	1,608	4.05
14cb	do.	Friend and Sherwani	1947	Dn	21.2	1¼	I	N	N	O	do.	+2.0	1,611	18.70
17aa	do.	Keech and Sherwani	1947	Dn	13	1¼	I	N	N	O	do.	+1.0	1,608	7.49
17da	do.	do.	1947	Dn	13	1¼	I	N	N	O	do.	+1.0	1,605	8.47
18cc	do.	Bollenbach and Schreurs	1947	Dn	20	1¼	I	N	N	O	do.	+1.0	1,621	13.23
21cb	do.	do.	1947	Dn	19	1¼	I	N	N	O	do.	+1.0	1,610	12.85
21dc	K. Teachworth	Sokal	1941	Du,Dr	10/56	18	GI	T	T	I,O	Hole in base.	+ .2	1,624	26.22
22ab	Luther Smith	do.	1941	Dr	20.5	12	GI	Cy	G	I,O	Edge of casing.	+1.0	1,598	4.71
22da	U. S. Geol. Survey	Waite and Friend	1947	Dn	17.1	1¼	I	N	N	O	Top of casing.	+1.0	1,595	11.10
22dd	do.	Bollenbach and Waite	1947	Dn	13	1¼	I	N	N	O	do.	+ .5	1,592	8.39
25aa	do.	Sherwani	1947	Dn	13	1¼	I	N	N	O	do.	+1.0	1,582	7.48
25ad	do.	Sherwani	1947	Dn	17.7	1¼	I	N	N	O	do.	+1.5	1,585	11.92
36aa	do.	Bollenbach and Schreurs	1947	Dn	18.5	1¼	I	N	N	O	do.	+1.0	1,587	12.80
Redwillow County														
2-29- 4aa	U. S. Geol. Survey	Sunyoke and Jones	1946	Dr	16.7	1¼	I	N	N	O	Top of casing.	+1.0	2,464	10.12
5ab	Roy Wilcox	Roy Wilcox	—	Du,Dr	52	96-24	C	VC	T	I	Edge of crossbar.	+1.0	2,482	17.65
2-30- 1aa	U. S. Geol. Survey	Sunyoke and Jones	1946	Dr	18.4	1½	I	N	N	O	Top of casing.	+1.0	2,486	9.78
12ad	Carl Schmidt	C. Robben	1945	Dr	75.3	22	GI	T	T	I,O	Opening in side of turbine.	+1.3	2,513	30.62
3-26- 5bb	H. Carr	Kerst Bros.	1943	Dr	10/97	18	GI	T	G	I,O	Hole in base.	.0	2,350	43.85

Table 3.—Records of observation wells in the Republican and Frenchman River Valleys, Nebraska—Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Redwillow County—Cont.													
3-26- 9cb	Charles Pucha	Kerst Bros.	1941	Dr	10/46	18	GI	T	E	I,O	Hole in base.	0.0	2,315	16.08
11bb	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	17.7	1¼	GI	N	N	O	Top of casing.	+1.0	2,295	9.22
3-27- 7dc	A. Helm	A. Helm	1936	Du	10/30	26	I	T	T	I,O	Edge of concrete.	.0	2,369	7.90
8ac	Fred Duckworth	—	—	Dr	22.5	4	GI	Cy	H	S,O	Top of casing.	+1.1	2,366	12.15
11aa	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	13.2	1¼	GI	N	N	O	do.	+1.0	2,236	6.79
11cd	John Tiller	John Tiller	1941	Dr	10/64	18	GI	T	E	I	Hole in base.	+ .1	2,341	16.62
17cb	U. S. Geol. Survey	Schnittker	1946	Dr	16.4	1¼	I	N	N	O	Top of casing.	+1.0	2,359	10.00
3-28-17da	do.	Sunyoke and Schnittker	1946	Dr	18.1	1¼	GI	N	N	O	do.	+1.0	2,411	10.95
20bb	Kenneth Tridle	C. Robben	1944	Dr	39	15	GI	T	E	I,O	Hole in base.	+1.0	2,418	10.39
21cd	Peter Vogue	Lee Guthrie	1944	Dr	10/45	18	GS	T	T	I,O	do.	+1.0	2,401	9.89
3-29-32db	Univ. of Nebraska	Scherer and Murphy	1940	Dn	20	1	I	N	N	O	Top of casing.	+1.2	2,473	6.26
35da	Leon Hickman	—	1925	—	10/40	24	GI	VC	G	I,O	Car frame.	+2.0	2,451	20.28
3-30-19bb	Mrs. Frank Cain	—	1939	Dr	—	24	GI	C	T	I,O	Top of casing.	-6.0	2,535	.90
26bc	Orville Brown	C. Robben	1943	Dr	10/58	18	GS	T	T	I,O	Hole in casing.	+1.0	2,500	9.13
29aa	U. S. Geol. Survey	Sunyoke and Jones	1946	Dn	12.3	1¼	I	N	N	O	Top of casing.	+1.0	2,516	4.35
34bb	J. Hauxwell	C. Robben	1944	Dr	53	18	GS	T	D	I,O	Hole in base.	+1.0	2,512	13.75
4-26-34db	J. Selover	Kerst Bros.	1945	Dr	76	24	GI	T	G	I,O	do.	+1.0	2,307	21.10
	Webster County													
1- 9- 9cb	U. S. Geol. Survey	Schnittker and Sherwani	1947	Dn	12.8	1¼	I	N	N	O	Top of casing.	+1.0	1,635	7.27
9cc	do.	Bollenbach and Schreurs	1947	Dn	13	1¼	I	N	N	O	do.	+1.0	1,637	7.75
11cb	do.	Sunyoke	1946	Dn	12.5	1¼	I	N	N	O	do.	+2.0	1,629	4.89
13ad	do.	Schnittker	1946	Dn	16.3	1¼	I	N	N	O	do.	+1.0	1,621	7.91
14bb	do.	Keech and Sherwani	1947	Dn	13	1¼	I	N	N	O	do.	+1.0	1,627	9.38
14bc	do.	Bollenbach and Schreurs	1947	Dn	17	1¼	I	N	N	O	do.	+ .5	1,629	12.79
16bc	G. Ohmstede	G. Ohmstede	1936	Du,Dr	10/34	36	W	VC	T	I,O	Side of steel beam.	+1.0	1,644	11.12
1-10- 1dc1	—	—	—	Dr	18	36	W	N	N	A,O	Top of curb.	+1.0	1,665	11.09
1dc2	—	—	—	Dr	26	36	—	—	—	A,O	Edge of casing.	+3.0	1,665	20.95
3ad	U. S. Geol. Survey	Sunyoke	1946	Dn	16.5	1¼	I	N	N	O	Top of casing.	+1.0	1,662	9.90
9ad	do.	Schnittker	1946	Dn	23.2	1¼	I	N	N	O	do.	+1.0	1,671	17.03
1-11- 1da	do.	Sunyoke	1946	Dn	16.4	1¼	I	N	N	O	do.	+1.0	1,682	7.75
5bc	do.	Schnittker	1946	Dn	15.2	1¼	I	N	N	O	do.	+1.0	1,710	4.92
11ab	do.	Sunyoke	1946	Dr	16.9	8	GI	N	N	O	do.	+1.1	1,690	7.60
16aa	do.	Schnittker	1946	Dn	32.5	1¼	I	N	N	O	do.	+1.0	1,710	20.59
1-12- 2bb	do.	Sunyoke	1946	Dn	12.5	1¼	I	N	N	O	do.	+1.0	1,726	4.82
4bb	do.	Schnittker	1946	Dn	15.8	1¼	I	N	N	O	do.	+1.0	1,741	5.14
8aa	do.	Sunyoke	1946	Dn	12.7	1¼	I	N	N	O	do.	+1.0	1,733	4.62
2- 9-24bd	Henry Pedersen	Henry Pedersen	1934	Dr	16.8	—	—	VC	T	I,O	Top of curb.	-4.6	—	—
2-10-36db	H. J. Somerhalder	H. J. Somerhalder	1932	Dr	35.4	60	W	C	G	I,O	do.	+ .5	—	27.29
11/2-11-2cd	James McParkland	John Wittwer	1909	Dr	80	8	I	Cy	W	O	Base of pump.	+1.0	1,881	74.80
2-12-34cd	Bernard McHenry	—	—	Dr	31	4	—	Cy	W	D,S,O	Top of casing.	.0	1,734	17.80
3-10-34cb	R. E. Adams	J. M. Banks	1931	Dr	39.5	6	I	Cy	H	A,O	do.	+ .8	—	—
	KANSAS													
	Jewell County													
1-6-5da	U. S. Geol. Survey	Schnittker and Keech	1947	Dn	13.1	1¼	I	N	N	O	Top of casing.	+1.0	1,538	9.90
5dd	do.	do.	1947	Dn	36	1¼	I	N	N	O	do.	+2.0	1,564	31.00

Table 3.--Records of observation wells in the Republican and Frenchman River Valleys, Nebraska—Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	Jewell County--Cont.													
C1-7-1bb	U. S. Geol. Survey	Schnittker and Keech	1947	Dn	16	1¼	I	N	N	O	Top of casing.	+1.0	1,552	10.93
2da	do.	do.	1947	Dn	13	1¼	I	N	N	O	do.	+1.0	1,551	7.90
	Republic County													
C1-5-7bb	U. S. Geol. Survey	Schnittker and Keech	1947	Dn	13.2	1¼	I	N	N	O	Top of casing.	+1.0	1,516	9.07
7cb	do.	do.	1947	Dn	25	1¼	I	N	N	O	do.	+1.0	1,530	21.35

CONFIGURATION OF THE WATER TABLE

Contour lines showing the configuration of the water table in the Republican River Valley are shown on plate 1 (in pocket). The altitude of the water table in the greater part of the area (with the exception of the valley east of Guide Rock) was determined by subtracting the depth to water level below land surface, as measured late in February and early in March 1947, from the altitude of the land surface at the well site and as shown on the topographic map of the area. The altitude of the water table east of Guide Rock was determined by subtracting the depth to water level below measuring point, as measured in November 1947, from the altitude of the measuring point as determined by a level party of the Bureau of Reclamation. The altitude of the water table at each well is shown beside the well location on plate 1. Altitudes of the water surface in the river and of the water surface in ponds also were used as control for the construction of the water-table contour map, an assumption being made that the surface-water altitudes are approximately equal to the water-table altitudes beneath the immediately adjacent land surface. In areas where no control was available, the course of the water-table contour lines was governed by the general course of the topographic contour lines, as the water table usually represents a subdued modification of the topographic surface.

In general, the direction of ground-water flow is toward the river, as indicated by the upstream bending of the contour lines. Some exceptions to this general rule are to be noted in areas where recent changes in the course of the river, caused by floods and the building

of natural levees, have resulted in the river flowing for short stretches at a level slightly higher than the valley floor on either side. These areas are indicated by the downstream bending of certain contour lines.

MUNICIPAL WATER SUPPLIES IN THE REPUBLICAN AND FRENCHMAN RIVER VALLEYS, NEBRASKA

As a part of the studies of ground water in the Republican and Frenchman River Valleys, information was collected concerning the municipal supplies of 20 cities and towns in the valleys.

Table 4 shows the pertinent details concerning these municipal wells and table 5 summarizes the water supplies, especially as to quantity.

The depths of the wells range from 35 to 129 feet and the diameters range from 10 to 240 inches. Individual yields range from 100 to 1,850 gallons per minute. Wells in some groupings are probably too closely spaced to insure full production without some mutual interference between wells while pumping. The three wells at Hardy illustrate this condition; the combined yield of the three wells while being pumped simultaneously is probably considerably less than the sum of the yield from individual wells if each is pumped when the others are idle. Adequate consideration of the spacing of wells will often result in a more economical installation because more water may be obtained from properly spaced wells when they are pumped simultaneously. The drawdown and thus the total lift is often considerably less if the wells are correctly spaced, and pumping costs are reduced accordingly.

Table 5 indicates that the total maximum water consumption in the 20 cities and towns totals about 6.1 million gallons per day and the total average consumption is about 2.4 million gallons per day.

Table 4.--Records of municipal wells in the Republican and Frenchman River Valleys, Nebraska

(Based principally on field data collected in 1947 by Ferd G. Schnittker. Arranged in order from west to east. For chemical analyses, see table 6).

City or town and Well No.	Date completed	Type of well a/	Depth of well (feet)	Diameter of well (inches)	Method of lift b/	Capacity of well (gpm)	Power c/	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Republican River Valley								
Haigler								
1-41-27cd1	1900	Dr	90	18	P	100	D	At pumphouse, east side of Main St. 4 wells connected to triplex pump.
1-41-27cd2	d/1946	Dr	90	10	T	190	E	Chemical analysis made.
Benkelman								
1-37-19aa1	--	Dr	37	10	C	250	E	3 wells connected in multiple.
1-37-19aa2	1932	Dr	42	18	T	300	E	West of power plant. Chemical analysis made.
1-37-19dd	1940	Dr	35	18	T	300	E	Southeast of intersection of Iowa and Rock Streets.
Trenton								
2-33-2ab1	e/1943	Dr	42	24	T	400	E	Located in pumphouse south of Moultrie Street.
2-33-2ab2	1946	Dr	34	24				Not equipped with pump, May 1947.

Note: See end of table for footnotes.

Table 4.--Records of municipal wells in the Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Culbertson								
3-31-17aa	--	Dr	100	18	T	150	E	Located near standpipe.
3-31-17ad	1932	Dr	62	18	T	250	E	Located east of City Hall. Chemical analysis made.
McCook								
2-29-5bc1	(d/)	Dr	82	24	T	900	E	
2-29-5bc2	(d/)	Dr	84	26	T	1,000	E	Chemical analysis made.
2-29-5bc3	d/1936	Dr	84	30	T	900	E	
2-29-5bc4	d/1944	Dr	81	30	T	1,850	E	
Indianola								
3-27-18bc1	f/1930	Dr	64	18	T	100	E	Old city well. Chemical analysis made.
3-27-18bc2	f/1947	Dr	62	18		250		Not equipped with pump, May 21, 1947.
Cambridge								
4-25-29cb	1928	Dr	24	24	T	150	E	Located in city park.
4-26-36ab	1935	Dr	50	22	T	350	E	Chemical analysis made.
4-26-36ab2	1935	Dr	50	22	T	300	E	West one of 2 wells in sec. 36.
Arapahoe								
4-23-23bc1	1928	Du,Dr	68	12	C	150	E	Dug well from 0 to 30 feet, drilled from 30 to 68 feet.
4-23-23bc2	1945	Dr	72	24	T	350	E	Chemical analysis made.
Oxford								
3-21-12aa1	e/1928	Dr	40	18	T	270	E	Main city supply well. Chemical analysis made.
3-21-12aa2	e/1933	Dr	39	18	T	200	E	One block east of main city well.
3-21-13dd		Dr		18	T	100	E	Standby installation.
Orleans								
2-19-21da1	1919	Du,Dr	48	18	C	100	E	4 wells, dug to 30 feet, drilled from 30 to 48 feet, interconnected to one pump.
2-19-21da2	1926	Du,Dr	45	24	T	100	E	Chemical analysis made.
2-19-21da3	g/ 1947	Dr	46	18	T	250	E	Not in use, May 1947.

Note: See end of table for footnotes.

Table 4.--Records of municipal wells in the Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Alma								
2-18-2bb1	(d/)	Dr	118	24	T	300	E	Northwest well of 3 wells.
2-18-2bb2	(d/)	Dr	129	24	T	300	E	Northeast well of 3 wells.
2-18-2bb3	(e/)	Dr	114	26	T	600	E	South well of 3 wells.
2-18-33ac	1947	Du,Dr	52	24	T	200	E	Chemical analysis made.
Naponee								
1-16-4cc	h/1929	Dr	40	--	T	250	E	Static water level, 14 feet below land surface; drawdown 8 to 9 feet. Chemical analysis made. Water chlorinated since 1939.
Bloomington								
2-15-32ab1	--	Du	85	24	T	100	E	Chemical analysis made.
2-15-32ab2	1917	Dr	90	18	P	150	E	Seldom used.
Franklin								
2-15-36da1	1932	Dr	59	24	T	450	E	
2-15-36da2	1941	Du	59	30	T	200	E	Chemical analysis made.
Riverton								
2-13-35cd	--	Du,B	28	24	P	200	E	Chemical analysis made.
Red Cloud								
1-11-1bb	e/1934	Dr	37	24	T	175	E	Located at 3d and Elm Streets.
2-11-35ad	--	Du,Dr	28	24	C	--	E	Used for power plant; can be used for city supply.
2-11-36cc1	1929	Dr	41	18	C	100	E	Located at 6th and Locust Streets.
2-11-36cc2	1929	Dr	45	18	T		E	Located at 6th and Elm Streets.
2-11-36cc3	e/1934	Dr	43	24	T	240	E	Located at 5th and Elm Streets. Chemical analysis made.
2-11-36cc4	e/1934	Dr	43	24	C	145	E	Located at 6th and Locust Streets.

Note: See end of table for footnotes.

Table 4.--Records of municipal wells in the Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Superior i/								
1-7-35dd1	--	Du	--	240	--	200	--	Located in well field near pumping plant.
1-7-35dd2	--	Dr	--	24	T	300	E	3 wells located in well field near pumping plant.
C1-7-2ab	--	Dr	--	24	T	800	E	4 wells located in well field south of Kansas State line. Gravel packed; drawdown, 2 feet. Chemical analysis made on composite sample.
Hardy								
1-5-31ca	--	Du,Dr	43-4[illegible]		P	200	E	3 wells (1-96 inch, 2 8 inch) located within a 20-foot triangle, connected to a triplex pump. Static water level, 12 feet below land surface; drawdown, 7 feet. Chemical analysis made on composite sample from 2 of these wells.
Wauneta								
5-36-11acl	(d/)	Dr	60	18	T	250	E	North one of 2 wells.
5-36-11ac2	(d/)	Dr	61	18	T	250	E	Chemical analysis made.
Palisade								
4-34-1abl	--	Dr	105	24	T	350	E	Chemical analysis made.
4-34-1ab2	1933	Dr	102	24	P	150	E	South one of 2 wells.

a/ B, bored; Dr, drilled; Du, dug.
b/ C, centrifugal; P, plunger-type (reciprocating); T, turbine.
c/ D, diesel; E, electric motor; G, gasoline.
d/ Driller, Layne-Western Well Co.
e/ Driller, Kelly Well Co.
f/ Driller, Lee Guthrie
g/ Driller, _____ Edwards
h/ Driller, J. L. Coles.
i/ Water is aerated; alum, lime, and chlorine added, settled and filtered.

Table 5.--Summary of municipal water supplies in the Republican and Frenchman River Valleys, Nebraska

(Arranged in order from west to east)

City or Town	No. of wells	Storage capacity (gallons)	Water main pressure (lb. per sq. in.)	Daily consumption (Thousands of gallons)	
				Maximum	Average
		Republican River Valley			
Haigler	5	40,000	60 to 70	40	25
Benkelman	5	50,000	50 to 60	--	150
Trenton	a/1	60,000	50 to 60	--	--
Culbertson	2	50,000	40 to 80	80	50
McCook	4	735,000	51 to 75	2,599	820
Indianola	a/b/1	44,000	50 to 60	50	30
Cambridge	3	1,000,000	50 to 60	500	235
Arapahoe	2	56,000	40 to 48	150	40
Oxford	c/2	100,000	72 to 75	200	100
Orleans	5	80,000	50 to 78	200	120
Alma	4	45,000	50 to 55	400	180
Naponee	1	--	26 to 40	--	d/15
Bloomington	c/1	30,000	40 to 60	60	30
Franklin	2	200,000	40	200	100
Riverton	1	20,000	30 to 70	30	15
Red Cloud	c/5	60,000	50 to 70	400	200
Superior	c/7	300,000	--	--	d/250
Hardy	3	23,000	50 to 70	d/90	
		Frenchman River Valley			
Wauneta	2	60,000	50 to 65	60	40
Palisade	2	280,000	48 to 55	40	30

a/ Another well available but pumping equipment not installed, May 1947.
b/ Bureau of Reclamation well and pump available as a stand-by.
c/ One additional well available for emergency use.
d/ Consumption in 1939.

CHEMICAL CHARACTER OF GROUND WATER IN THE REPUBLICAN AND FRENCHMAN RIVER VALLEYS, NEBRASKA

By Herbert A. Swenson

Introduction

In a careful appraisal of the ground-water resources of the Republican and Frenchman River Valleys in Nebraska, consideration must be given to the types of water present as established by chemical analysis. The degree of mineralization and the composition of water from selected irrigation, municipal, and observation wells in the valley should be known to determine the suitability of the ground water for the uses intended. Furthermore, information concerning the present chemical character of the ground water in both valleys will be a reference point for future quality of water studies in the valleys. Later studies will reveal any changes in mineral content of the ground water as a result of irrigation developments.

General

All ground water described in this report is from the alluvium of Pleistocene and Recent geological time. The beds of sand and gravel in these deposits generally furnish ample supplies of water of reasonably good quality for domestic, stock, municipal, and industrial uses, and locally for irrigation. Wells sampled in the Republican and Frenchman

River Valleys ranged in depth from 11 to 90 feet, and in concentrations of dissolved mineral matter from 315 to 1,850 parts per million. With the exception of the two wells sampled in the extreme western part of the valley, concentrations of dissolved solids did not exceed 828 parts per million. The unconsolidated character of the valley fill made exact correlation of water quality in different parts of the alluvium difficult, and no general trend in concentration or composition of ground water with increasing well depths was observed. Figure 4 gives concentrations in parts per million of dissolved solids and total hardness, and values of percent sodium for ground water from representative wells plotted as miles downstream from Haigler. A gradual decrease in mineralization and hardness of waters from west to east is indicated, but the results are not conclusive. Values for percent sodium remain fairly constant throughout the valley.

Analysis of samples

Discussion of ground-water quality in the Republican River Valley is based on the results of chemical analysis of 32 water samples from municipal, irrigation, and observation wells from Haigler in the west to Hardy in the east. Also considered in this section are analyses of water samples from two municipal wells at Wauneta and Palisade in the Frenchman River Valley. Partial analyses were made on some samples in which only bicarbonate, sulfate, chloride, nitrate, and total hardness were determined. Complete analyses were made on a majority of the

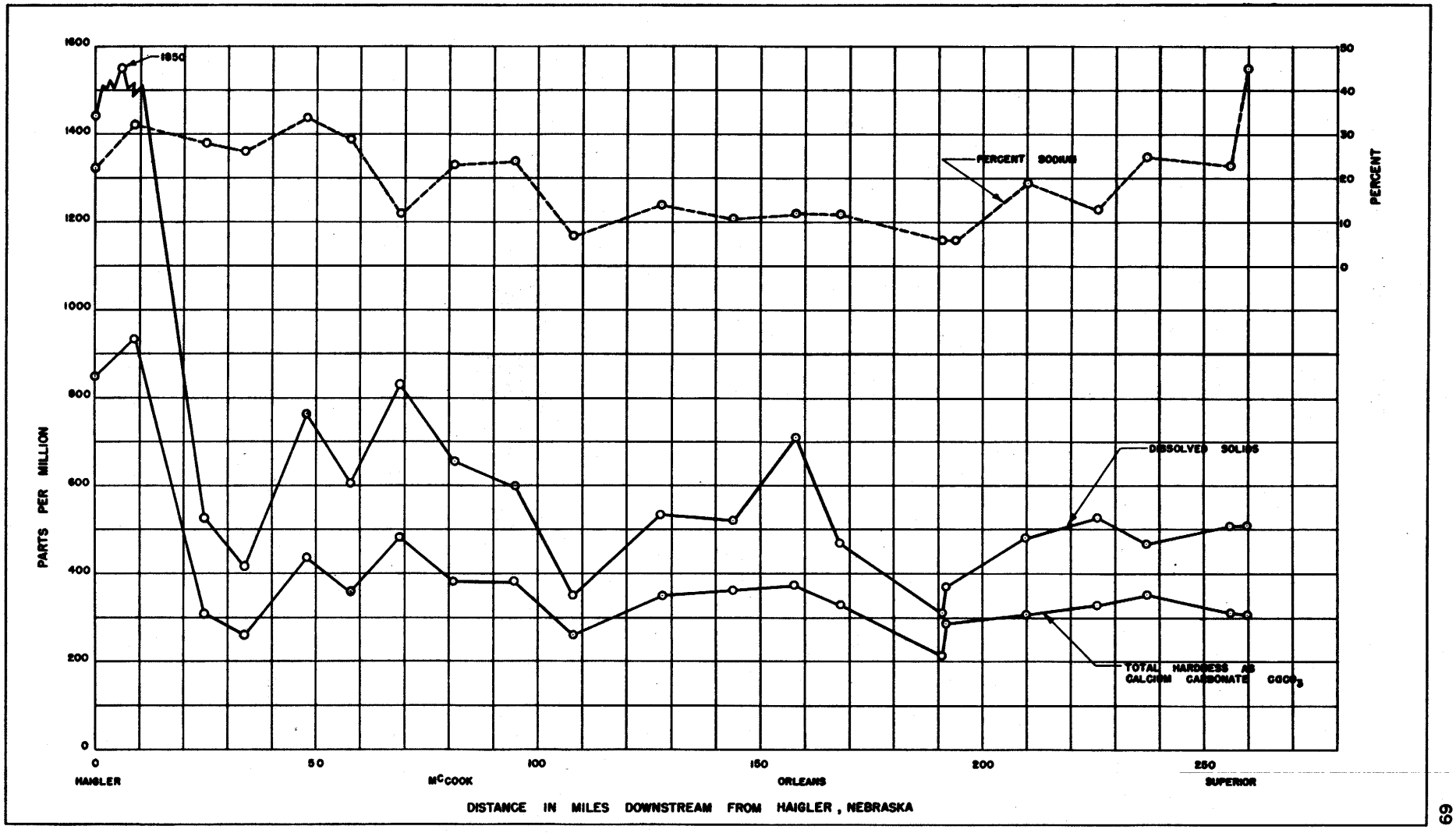


Figure 4.– Trends in mineral quality of ground waters in the Republican River valley, Nebraska

samples and determinations included pH, specific conductance, silica, iron, manganese, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, fluoride, nitrate, boron, dissolved solids, total hardness, noncarbonate hardness, and percent sodium. Table 6 gives the number of well waters sampled, classified according to use of the supply and type of analysis made.

Table 6.--Use of supply and number and types of analyses made for ground water sampled in the Republican and Frenchman River Valleys, Nebraska.

Use of supply	Number and type of analysis		
	Complete	Partial	Total
Municipal	18	5	23
Irrigation	4	4	8
Observation	3	0	3

The results of chemical analysis of the 34 waters sampled are given in table 7 where concentrations are expressed as parts per million. These analyses were made according to methods[3] in common use but give little or no indication of the sanitary condition or biochemical aspect of the water nor do they involve the determination of some of the rarer constituents of natural waters. For the cities of Bloomington, Franklin, and Red Cloud, analyses are given in table 7 for municipal supplies collected both in 1939 and 1947.

3 American Pub. Health Assoc. Standard methods for the examination of water and sewage, 9th Ed. 1946.

Table 7.—Mineral constituents, in parts per million, and related physical measurements of ground waters, Republican and Frenchman River Valleys, Nebraska

Analysis number	Owner and well number	Date of collection	Depth (feet)		Diameter (inches)	Discharge (gallons a minute)	Temperature (°F)	pH	Specific conductance Kx10⁵ at 25°C	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)	Manganese (Mn)	Dissolved solids	Hardness as $CaCO_3$		Percent sodium
			Well	To water surface																				Total	Noncarbonate	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
									REPUBLICAN RIVER VALLEY																	
373	City of Haigler 1-41-27cd2	4-30-47	90	11	10	190	55	7.9	183	53	0.02	221	74	108		339	708	52	0.8	0.8	—	—	1,440	856	578	22
374	Lee Clegg 1-40-26aa1	5- 1-47	80	15.5	16	—	54	8.0	229	40	.02	236	85	205		311	1,030	35	1.6	1.0	—	—	1,850	938	683	32
376	City of Benkelman 1-37-19aa2	5- 2-47	42	18	18	—	—	8.0	82.1	34	.02	79	27	56		409	63	16	2.0	2.0	—	—	525	308	0	28
378	Alvie Howard 2-36-29ac	5- 1-47	42	22	24	—	53	8.3	66.4	33	.02	68	22	43		285	99	8.7	1.4	.2	—	—	420	260	26	26
377	L. W. Melchert 2-34-18aa	5- 1-47	48	12	18	800	53	8.2	117	38	.02	105	40	103		447	214	39	1.4	4.0	—	—	765	439	72	34
375	City of Trenton 2-33-2ab1	5- 1-47	42	11	24	—	53	8.0	95.1	40	.02	97	29	68		397	145	21	.8	2.0	—	—	609	361	35	29
503	City of Culbertson 3-31-17ad	5-23-47	62	39	18	250	56	7.7	106	49	.00	135	36	33	30	368	168	55	.5	50	.11	0.0	828	485	183	12
506	City of McCook 2-29-5bc2	5-22-47	84	20	26	900	—	8.3	95.3	47	.20	107	28	46	29	428	131	30	.6	20	.25	.0	658	382	31	23

Table 7.--Mineral constituents, in parts per million, and related physical measurements of ground waters, Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
507	City of Indianola 3-27-18bc1	5-21-47	64	12	18	100	56	8.1	85.6	47	0.10	108	28	55		431	119	17	0.6	3.0	0.05	0.0	600	385	32	24
508	City of Cambridge 4-26-36ab1	5-22-47	52	15	22	350	55	8.4	49.9	54	.00	78	17	8.4		302	17	6.0	.5	10.	.03	.0	354	265	17	7
509	City of Arapahoe 4-23-23bc2	5-21-47	72	38	24	350	56	8.3	78.2	34	.00	101	26	29	23	396	77	28	.6	6.0	.08	.0	538	357	32	14
510	City of Oxford 3-21-12aa1	5-24-47	40	17	18	300	56	8.4	76.6	51	.00	105	24	21	18	388	56	32	.4	8.0	.09	.0	524	361	43	11
511	City of Orleans 2-19-21da1	5-24-47	45	34	24	100	55	8.3	95.8	40	.00	144	29	30		430	105	55	.2	6.0	.10	.1	711	379	26	12
512	City of Alma 2-18-33ac	5-25-47	52	11	24	150	56	8.4	66.6	53	.00	102	19	17		362	33	22	.2	10	.14	.0	477	333	36	12
A	City of Naponee 1-16-4cc	11-11-39	40	13-14	--	250	--	--	--	--	--	--	--	--	--	440	100	39	--	22	--	--	--	438	77	--
B	City of Bloomington 2-15-32ab1	11-11-39	85	78	--	1,000	--	--	--	--	--	--	--	--	--	268	16	8.0	--	2.5	--	--	--	210	0	--
513		5-15-47	85	52	24	100	55	8.0	44.4	27	.05	68	12	7.4	8.8	264	8.2	12	.2	5.0	.14	.0	315	219	3	6
C	W. T. Hayes 1-15-11ac	11-11-39	13.5	--	36	--	--	--	--	--	--	--	--	--		443	120	22	--	.5	--	--	--	426	63	--
D	W. T. Williams 2-14-18ad	11-11-39	46	--	6	--	--	--	--	--	--	--	--	--		122	7.0	7.0	--	2.0	--	--	--	99	0	--

Table 7.--Mineral constituents, in parts per million, and related physical measurements of ground waters, Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
	City of Franklin																									
E	2-15-36da2	11-11-39	55	39	--	350	--	--	--	--	--	--	--	--		298	28	16	--	5.0	--	--	--	246	2	--
514	16da2	5-16-47	59	16	30	200	56	8.1	53.5	22	0.00	90	15	8.1	6.4	318	21	17	0.2	6.5	.13	0.0	374	286	25	6
	John Monie																									
F	1-14-26bc	11-11-39	19.5	--	36	--	--	--	--	--	--	--	--	--		414	1,000	27	--	.5	--	--	--	990	650	--
	Uni. of Nebraska																									
G	3-14-36dd	12-12-36	30.4	--	1.25	--	--	--	--	30	.16	7.1	2.1	3.5	3.2	33	6.3	1.1	.2	5.4	--	--	88	26	0	20
	City of Riverton																									
515	2-13-35cd	5-15-47	28	18	96-24	150	55	8.2	66.6	24	.00	108	10	34	2.4	329	70	28	.1	6.0	--	.0	461	311	41	19
	City of Red Cloud																									
H	2-11-36cc	11-14-39	43	--	24	180	--	--	--	--	--	--	--	--		305	46	16	--	8.8	--	--	--	253	8	--
516	36cc3	5-16-47	43	24	18	200	56	7.9	67.2	21	.03	105	17	23	8.0	314	67	29	.1	30	--	.0	526	332	75	13
	James McParkland																									
J	2-11-2cd	11-14-39	80	--	8	--	--	--	--	--	--	--	--	--		179	25	6.0	--	5.1	--	--	--	153	5	--
	Henry Somerhalder																									
K	2-10-36db	12-12-36	35.4	25	40	300	--	--	--	--	--	42	7.4	14		164	14	8.0	.2	5.5	--	--	--	135	0	18
	U. S. Geol. Survey																									
3168	1-9-9cc	9- 9-47	13	7.75	1.25	--	60	7.5	71.5	35	.00	123	12	56		423	49	4.0	.6	.8	.16	--	469	356	9	25
	City of Superior																									
L	C1-7-2ab 1/	11-14-39	--	--	24	200	--	--	--	39	1.1	92	20	43		329	120	7.0	.2	1.1	--	--	510	312	42	23

1/ Located just south of the Kansas-Nebraska line in Kansas.

Table 7.--Mineral constituents, in parts per million, and related physical measurements of ground waters, Republican and Frenchman River Valleys, Nebraska--Continued

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
	U. S. Geol. Survey																									
3169	1-5-31cc	9-11-47	11	--	--	--	58	7.3	79.8	37	0.00	100	13		118	406	74	23	0.8	0.1	0.14	--	516	303	0	45
	City of Hardy																									
M	1-15-31ca	11-14-39	45	12	8	205	--	--	--	--	--	--			--	322	34	24	--	24	--	--	--	240	0	--
										FRENCHMAN RIVER VALLEY																
	City of Wauneta																									
504	5-36-11ac2	5-23-47	61	18	18	250	57	8.5	38.8	60	.00	52	14		13	226	19	5.0	.9	2.0	.04	.0	278	187	2	13
	City of Palisade																									
505	4-34-1ab1	6- 8-47	105	30	24	350	54	8.4	44.8	64	.6	56	15	20		250	26	5.0	.7	6.0	.09	.0	326	201	0	18

Well waters sampled for this report are grouped for purposes of discussion according to the use made of the supply. Municipal supplies are evaluated both with reference to drinking water standards recommended by the United States Public Health Service[4] and to hardness factor. Irrigation supplies and water from observation wells are considered as to suitability for plant growth with reference made to classification of irrigation waters proposed by Wilcox and Magistad[5].

Municipal supplies

In general the requirements for a public water supply are that it shall contain no organisms which cause disease; that it is sparkling clear and colorless; that it have a pleasant taste, free from odors, and preferably cool; that it is reasonably soft; that it is neither scale-forming nor corrosive; that it is free from objectionable gas, such as hydrogen sulfide, and objectionable minerals, such as iron and manganese; and that it is plentiful and low in cost. With respect to chemical characteristics, the water should not contain an excessive amount of soluble mineral substance nor excessive amounts of any chemicals employed in treatment.

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4 U. S. Public Health Service Drinking Water Standards, Public Health Reports: Vol. 61, No. 11, pp. 371 - 384, March 15, 1946.

5 Wilcox, L. V., and Magistad, O. C., Interpretation of analysis of irrigation waters and the relative tolerance of crop plants: U. S. Dept. Agr., Bur. of Plant Ind., Soils, and Agr. Eng. pp. 1-8, May 1943 (mimeographed).

According to the U. S. Public Health Service Drinking Water Standards, the following chemical substances which may be present in natural or treated waters should preferably not occur in excess of the following concentrations:

Constituent	Should not exceed (ppm)
Iron (Fe) & Manganese (Mn) together	0.3
Magnesium (Mg)	125
Sulfate (SO_4)	250
Fluoride (F)	1.5
Dissolved solids	500 (1,000 permitted)

Table 8 shows that all public water supplies studied meet the standards recommended for chemical characteristics by the Public Health Service with respect to magnesium and chloride and that all but two public supplies meet these standards with respect to iron and manganese. All supplies except that for Haigler conform to the requirements for sulfate. The fluoride value for all water supplies except that for Benkelman is within recommended limits. More than half of the city supplies contain dissolved mineral matter in concentrations above the suggested maximum of 500 parts per million, but only the Haigler supply exceeds 1000 parts per million dissolved solids, which is the permitted maximum for water supplies used by common carriers subject to the Public Health Service standards.

The public water supplies studied in this report are all hard.

Table 8.--Concentrations, in parts per million, of certain mineral constituents in public water supplies in the Republican and Frenchman River Valleys, Nebraska.

(All samples represent untreated water at the source and most were collected from a tap in the pump house)

Analysis No.	Municipal supply	Date sampled	Parts per million					
			Iron and Manganese	Magnesium	Sulfate	Chloride	Fluoride	Dissolved solids
			Republican River Valley					
373	Haigler	4/30/47	0.02	74	708	52	0.8	1440
376	Benkelman	5/ 2/47	.02	27	63	16	2.0	525
375	Trenton	5/ 1/47	.02	29	145	21	.8	609
503	Culbertson	5/23/47	.00	36	168	55	.5	828
506	McCook	5/22/47	.20	28	131	30	.6	658
507	Indianola	5/21/47	.10	28	119	17	.6	600
508	Cambridge	5/22/47	.00	17	17	6.0	.5	354
509	Arapahoe	5/21/47	.00	26	77	28	.6	538
510	Oxford	5/24/47	.00	24	56	32	.4	524
511	Orleans	5/24/47	.05	29	105	55	.2	711
512	Alma	5/25/47	.00	19	33	22	.2	477
A	Naponee	11/11/39	-	-	100	39	-	-
B	Bloomington	11/11/39	-	-	16	8.0	-	-
513	Bloomington	5/15/47	.05	12	8.2	12	.2	315
E	Franklin	11/11/39	-	-	28	16	-	-
514	Franklin	5/16/47	.00	15	21	17	.2	374
515	Riverton	5/15/47	.00	10	70	28	.1	481
H	Red Cloud	11/14/39	-	-	46	16	-	-
516	Red Cloud	5/16/47	.03	17	67	29	.1	526
L	Superior	11/14/39	1.1	20	120	7.0	.2	510
M	Hardy	11/14/39	-	-	34	24	-	-
			Frenchman River Valley					
504	Wauneta	5/23/47	.00	14	19	5.0	.9	278
505	Palisade	6/ 8/47	.60	15	26	5.0	.7	326

Values for total hardness as calcium carbonate ($CaCO_3$) range from 187 parts per million for Wauneta to 856 parts for Haigler, with an average of 350 parts for the 20 supplies analyzed. Excluding the high value of 856 for the Haigler supply, the average hardness is reduced to 323 parts per million.

Of the 20 public water supplies analyzed for this report, Superior is the only city that softens its water. An analysis of the delivered water in 1947 made by the State Department of Health laboratories showed 176 parts per million total hardness. In general, water that has less than 60 parts per million hardness is considered soft. The hardness of such water is scarcely noticed in ordinary household use. Water with hardness between 61 and 120 parts per million is usually rated as moderately hard, and people who are accustomed to quite soft water will notice the hardness of supplies in this range, especially in the upper part. Water with hardness from 121 to 180 parts per million is classified as hard and above 180 parts per million as very hard, and, in both these ranges, considerable savings in soap consumption can be effected by softening the water.

Irrigation and observation wells

Water from wells used for irrigation or observation purposes, is discussed with reference to specific conductance ($K \times 10^5$ @ 25° C), boron and chloride concentration, and percent sodium. Wilcox and Magistad[6] have classified waters for irrigation use as shown in table 9.

6 Wilcox, L. V., and Magistad, O. C., op. cit., p. 3.

Table 9.--Classification of Irrigation Waters

Determination	Class I (excellent to good)	Class II (good to injurious)	Class II (injurious to unsatisfactory)
Specific conductance ($K \times 10^5$ @ 25° C)	Less than 100	100-300	More than 300
Boron (parts per million)	Less than 0.5	0.5 - 2.0	More than 2.0
Percent sodium	Less than 60	60 - 75	More than 75
Chloride (equivalent per million)	Less than 5 (178 ppm)	5 - 10 (178-355 ppm)	More than 10 (355 ppm)

Waters of class I are considered suitable for most plants under most conditions; class II waters would probably be harmful to the more sensitive crops, while waters falling into class III would probably be harmful to most crops and unsatisfactory for all but the most tolerant.

Values are given in table 10 for specific conductance ($K \times 10^5$ at 25° C), boron, percent sodium and chloride for water samples collected from eight irrigation wells and three observation wells in the Republican River Valley.

Table 10.--Specific conductivity, boron, percent sodium and chloride values for irrigation and observation wells in the Republican River Valley, Nebraska

Analysis No.	Use of Well	Date sampled	Specific Conductance ($K \times 10^5$ at 25° C)	Boron (ppm)	Percent Sodium	Chloride (ppm)
374	Irrigation	5/ 1/47	229	-	32	35
378	Irrigation	5/ 1/47	66.4	-	26	8.7
377	Irrigation	5/ 1/47	117	-	34	39
C	Irrigation	11/11/39	-	-	-	22
D	Irrigation	11/11/39	-	-	-	7.0
F	Irrigation	11/11/39	-	-	-	27
G	Observation	12/12/36	-	-	20	1.1
J	Irrigation	11/14/39	-	-	-	6.0
K	Irrigation	12/12/36	-	-	18	8.0
3168	Observation	9/ 9/47	71.5	0.16	25	4.0
3169	Observation	9/11/47	79.8	.14	45	23

Although some of the information in table 10 is not available on water sampled from irrigation and observation wells, particularly for samples collected in 1936 and 1939, the data provide some basis for interpretation. All the irrigation and observation well water sampled meets class I requirements with respect to chloride concentrations. Those ground waters on which percent sodium and boron were reported also fall into this class with reference to these two constituents. Of the five waters on which specific conductance is reported, three may be grouped as class I, and two as class II. In general, the irrigation waters including ground water from observation

wells are suitable for crop production and should not have an adverse influence on the salinity of the soil.

For some years the Geological Survey has made graphic representation[7] of water analyses to show the relative concentrations of the different ions in a water as well as the chemical characteristics of different waters. In figure 5, concentrations of ground waters from selected municipal, irrigation, and observation wells, are given in terms of equivalents per million with the height of each diagram indicating the concentration. The total hardness in parts per million calcium carbonate is read to the top of the magnesium and is referred to the right ordinate. The figure above each diagram refers to the analysis number in tables 7, 8 and 10.

Figure 5 shows that all but three of the waters are of the calcium bicarbonate type. Samples Nos. 373 and 374 representing the public supply at Haigler and the L. Clegg irrigation well respectively have considerable sulfate, while No. 3169, an analysis of water from an observation well, has almost as much sodium as combined calcium and magnesium.

Summary of quality of water

All ground waters considered were from the alluvium with concentrations of dissolved solids varying independently of well depths.

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7 Collins, W. D., Graphic representation of water analyses: Ind. and Eng. Chem.; vol. 15, p. 394, 1923, Collins, W. D., Notes on practical water analyses: U. S. Geological Survey Water-Supply Paper 596 H, 1928.

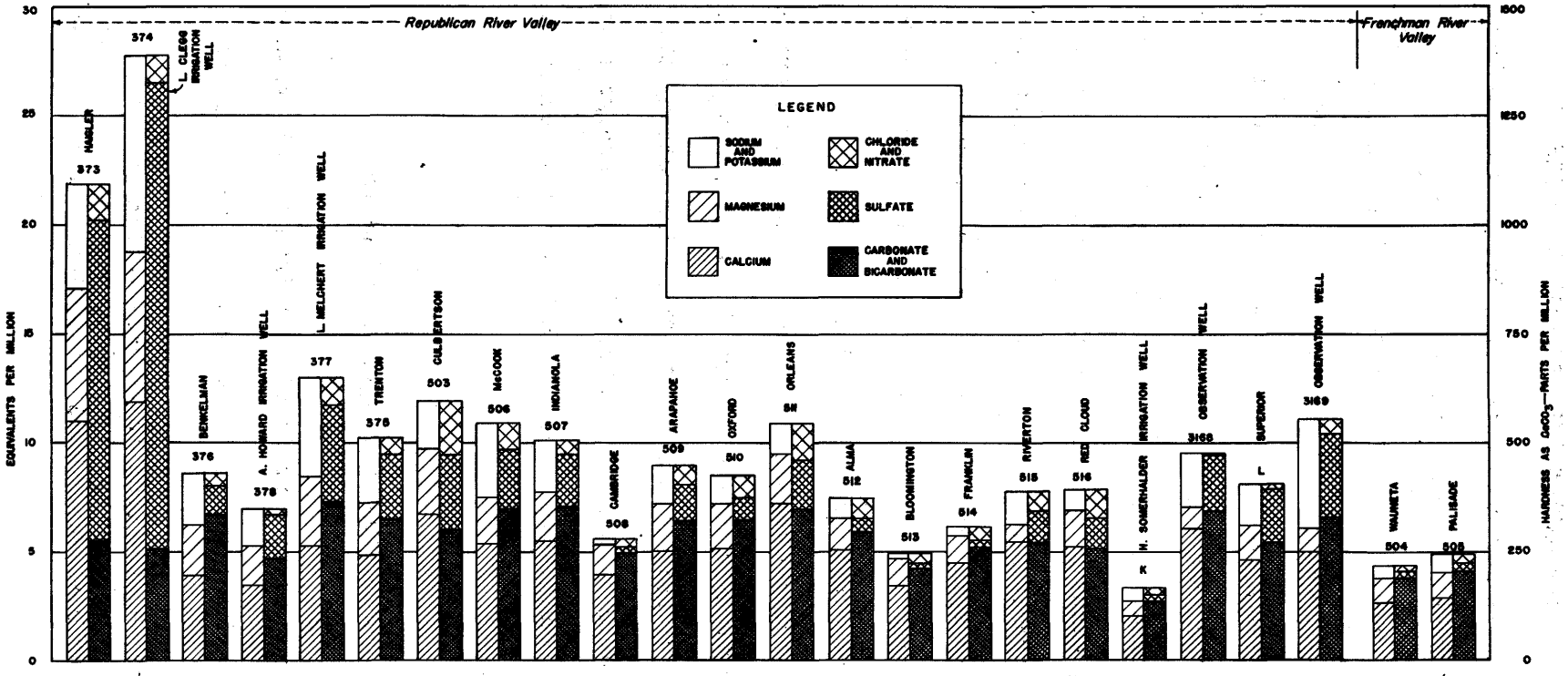

Figure 5.—Analyses of ground waters from the Republican and Frenchman River valleys, Nebraska (arranged in order from west to east)

Some decrease in mineralization of ground waters from west to east in the Republican River Valley was found, but values for percent sodium did not fluctuate appreciably. Results of chemical analysis have been interpreted with respect to the suitability of the water for the use intended.

All municipal supplies met chemical standards of the Public Health Service with respect to concentrations of magnesium, and chloride. All but two met the requirements for iron and manganese. One supply was high in sulfate and another supply high in fluoride. More than half of the public supplies contain dissolved solids in excess of 500 parts per million. All were hard waters and hardness values exceeded limits considered desirable.

Irrigation and observation well waters examined were of good quality for crop production and largely fell into class I waters.

Information on the chemical character of ground waters in the Republican River Valley will be helpful in the interpretation of any changes in mineral quality in these waters after irrigation development has begun. It is possible that additional well waters in the Frenchman River Valley should be sampled to define more completely the types of ground water present in that valley prior to extensive irrigation.