Ground-Water Resources of Mirage Flats, Nebraska

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1779-BB

Prepared as part of a program of the Department of Interior for development of the Missouri River basin

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By C. F. KEECH

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GROUND-WATER RESOURCES OF MIRAGE FLATS, NEBRASKA

By C. F. Keech

ABSTRACT

Mirage Flats is a nearly flat terrace adjacent to the left bank of the Niobrara River in western Sheridan County, Nebr. About 12,000 acres of terrace land is included in the Mirage Flats Irrigation District and is irrigated with water diverted from the Niobrara River at a point 8 miles downstream from the onstream Box Butte Reservoir. Because, in dry years, the amount of water stored in the reservoir is inadequate to meet the demand, farmers have installed wells which they pump from when water from the river is in short supply.

Studies by the U.S. Bureau of Reclamation indicate that about 6,000 acres outside the irrigation district are irrigable and could be served by extending the present system if adequate water supplies could be assured. Some of these lands are now (1963) being irrigated from privately owned wells.

This study was made to evaluate the ground-water supply and to document the present hydrologic conditions.

Infiltrating irrigation water has increased the amount of ground water in storage and raised the water table. To date withdrawal of ground water for irrigation has not appreciably changed the rising trend of the water table.

If properly managed, the existing water supply—surface water plus ground water—appears to be adequate for irrigation of all irrigable lands in the Mirage Flats area. Pumping ground water to supplement the supply of surface water, in dry years, would create storage space for recharge during normal or wet years, and would stop or reverse the trend of the presently rising water table and thus lessen the chance that some lands might become water logged.

Compared to most ground and surface water in Nebraska, the water in Mirage Flats is low in mineral content. No water quality problems should be expected from its use for irrigation purposes.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

In 1961 the Mirage Flats project, which comprises 12,000 acres of irrigated land in northwestern Nebraska, had been in operation 15 years. This irrigation project is small compared to others in the West but has been one of the most successful. The U.S. Bureau of Reclamation is investigating the feasibility of providing supplemental water to the existing project and of increasing the size of the project area to include adjacent lands most of which are northeast of the present irrigated area. These lands are referred to by the Bureau as the "Mirage Flats Unit," and consideration is being given to obtaining part of the irrigation supply for the unit from groundwater sources.

The Bureau of Reclamation requested that the U.S. Geological Survey determine the depth and configuration of the water table in Mirage Flats and adjacent lands, determine the quality of the ground water, and compile the available data pertaining to the aquifer. The investigation was begun in July 1961 as part of the program of the U.S. Department of the Interior for the development of the Missouri River basin.

LOCATION AND EXTENT OF THE AREA

Mirage Flats, a topographic feature, is relatively flat land on the irregularly shaped terrace which lies adjacent to and north of the flood plain of the Niobrara River in the west-central part of Sheridan County in northwest Nebraska. Hay Springs, the nearest town, is about 12 miles north of the area. The area studied in detail contains about 130 square miles and includes the Mirage Flats project lands plus adjacent lands, some of which are irrigated with ground water from privately owned wells. State Highway 87 traverses the area in a north-south direction, and the headquarters of the Mirage Flats Irrigation District is located on this highway about 2 miles north of the Niobrara River.

HISTORY OF MIRAGE FLATS

Homesteaders settled Mirage Flats in the early 1880's. For a few years they harvested good crops, but droughts in the late 1880's and in 1893–94 were so severe that crops were a total loss. The early settlers had migrated from the humid eastern states and knew so little about methods of dryland farming that they soon became discouraged and most of them emigrated from the homestead area. Those who did not leave formed an irrigation company and constructed a water-supply system consisting of a dam on the Niobrara River near Dunlap and a canal which extended nearly 20 miles and included two wooden flumes.

Some water was diverted to the land, but irrigation requirements greatly exceeded the available supply because no provision was made for storage of water near the use area and the supply canal leaked excessively. The system was abandoned in 1903 after several unsuccessful attempts were made to irrigate the crops. It received the coup-de-grâce when high winds collapsed one of the two wooden flumes on the supply canal and a prairie fire destroyed the other.

Largely to help alleviate the dire economic conditions resulting from crop failures during the drought and depression of the 1930's, the present Mirage Flats project was authorized under the Water Conservation and Utilization Act and was approved by the President of the United States on April 26, 1940. The project was developed jointly by the Bureau of Reclamation of the U.S. Department of the Interior and the Farm Security Administration of the U.S. Department of Agriculture. (On July 1, 1945, the Farm Security Administration became part of the Soil Conservation Service.)

The Bureau of Reclamation constructed the Box Butte Dam and Reservoir, the Dunlap Diversion Dam, and the canal and distribution system. (See fig. 1.) The Farm Security Administration purchased the 12,000 acres of land in 1940 and laid it out for irrigation. Later, the Soil Conservation Service developed the land for irrigation and parceled its 111 units to selected applicants, most of whom were veterans of World War II.

Construction of the Box Butte Dam began in January 1941 and continued to December 1942. Work on the project was discontinued during World War II, resumed in 1944, and completed in 1948. The Bureau of Reclamation administered the distribution of water to the project lands until January 1, 1951, at which time it was taken over by the Mirage Flats Irrigation District.

The Box Butte earth-filled dam across the Niobrara River is about 8 miles north of the city of Hemingford. The reservoir above the dam had an initial capacity of 31,060 acre-feet. The stored water is carried in the existing river channel for about 8 miles downstream to a diversion dam near Dunlap where the flow is diverted into the main canal that extends 18 miles to the project. The canal has a 16-foot bottom and a capacity of 220 second-feet. Water was first turned into the system September 1, 1946.

The amount of water diverted annually into the supply canal by the Dunlap diversion dam is about 17,040 acre-feet. The following amounts were diverted during the period 1955–60.

Year	*Acre-feet*	*Year*	*Acre-feet*
1955	15, 630	1958	16, 200
1956	16, 090	1959	19, 890
1957	15, 240	1960	19, 200

NATURE OF THE PROBLEM

Water stored in the Box Butte Reservoir on the Niobrara River in the Mirage Flats project area has not been continuously adequate to meet the irrigation demand, and the supply has been smallest in

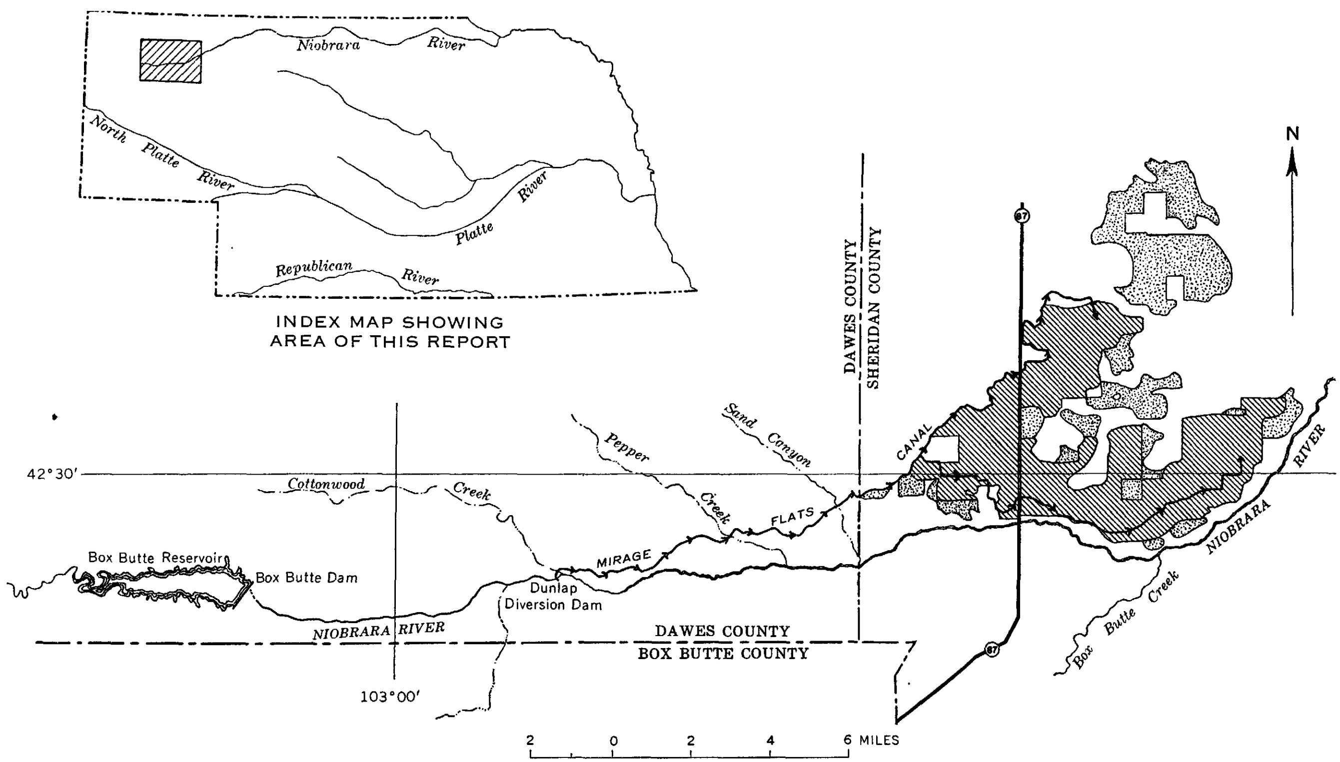

FIGURE 1.—Map showing the extent of the Mirage Flats Unit. Oblique-line pattern indicates area served by the irrigation system. Stipple pattern indicates areas that could be irrigated by extension of existing irrigation system.

dry years when needed most. Consequently, some farmers have augmented the supply from ground-water sources. The amount of irrigable land is considerably larger than the area now served by the Mirage Flats Irrigation District. Wells are being installed by farmers to irrigate these lands and the demand for ground water is increasing.

Studies by the U.S. Bureau of Reclamation indicate about 6,000 additional acres of land could be irrigated by extending the present irrigation system if additional water supplies could be developed. Possibly part of this additional supply could be developed from ground-water sources. It is imperative, therefore, to investigate the occurrence and chemical quality of ground water in the Mirage Flats vicinity in order to evaluate more accurately the available supply, and to document conditions prior to application of additional water to the land or to drilling additional irrigation wells.

Use of water for irrigation on the project lands already has caused some changes in the ground-water regimen; and with increased use of this water, additional changes can be anticipated. Recharge from the water that is spread on the land has caused the water table to rise in places and may have changed the chemical quality of the ground water slightly, although historic data regarding the quality are not available.

This study was made principally to describe the ground-water conditions in 1961. To determine the probable effect with time on ground-water resources of applying more water to the land or of withdrawing larger amounts of ground water would require a more comprehensive study.

PREVIOUS INVESTIGATIONS

No comprehensive study has been made previously of the ground-water resources of the area that includes Mirage Flats, although the geology and ground-water resources of the upper Niobrara River basin were described briefly by Bradley (1956). Bradley's report also contains a section on quality of the water and an annotated bibliography of other literature pertaining to the geology and water resources of the region.

METHODS OF INVESTIGATION

The principal fieldwork for this study was done during the summer of 1961, although a considerable amount of information concerning ground-water hydrology of the area has been obtained by the Geological Survey since 1950.

The hydrologic data obtained include an inventory of all the irrigation and most of the domestic and stock wells in the area and the collection of water samples for chemical analyses. A network of 18 observation wells was installed; 6 of these were drilled in 1961. Test holes were drilled at each well site and earth samples were obtained from each detected change in physical properties of the water-bearing materials formation. Drillers' logs were made for each test hole; these are given in table 3.

Records of water level fluctuations in all observation wells are published annually in Nebraska Water Survey Papers. (Keech, 1961; Keech and Hyland, 1962; and Emery and Malhoit, 1963.)

A well equipped with a recording gage was installed in September 1953, and since then a continuous record of the water-level fluctuations in the well has been obtained. Since 1950, observations have been made periodically in three privately owned wells.

The base map for plate 1 was prepared from U.S. Geological Survey topographic maps. Mean sea-level altitudes of measuring points on observation wells were established by spirit levels from Survey bench marks.

All wells in the area that discharge moderately large to large amounts of water were examined; pertinent data, obtained by direct measurement, observation, or interviewing the owner or operator of the well, were recorded. Data were also obtained on small wells where a depth-to-water measurement could be made. The information thus collected is included in table 4, and the location of the wells is shown in plate 1. Water samples were collected from 10 wells and were analyzed in the laboratory of the Geological Survey at Lincoln, Nebr. Since the installation of the network of observation wells, water-level measurements have been made monthly. It is proposed that monthly observations be continued for a period of 3 years and that semiannual observations be made after that time. The recording gage should be maintained to obtain a continuous record that will serve as an index to water-table fluctuations.

PERSONNEL AND ACKNOWLEDGMENTS

J. G. Cronin collected field data in May 1950 and periodically measured the depth to water in a few wells. He also investigated the depth to water in other wells in the area in an attempt to establish the effect of irrigation on the position of the water table. However, because the available information on water levels prior to irrigation in the area was not wholly reliable, Cronin could determine only that the water table had risen, not the amount of rise.

J. W. Nelson installed the network of observation wells established for this investigation. W. A. Buehrer and R. N. Strickland collected field data regarding other wells in the area and established altitudes of the measuring points on wells. J. B. Sheehan prepared the source material for the discussion of the chemical quality of the water.

The author wishes to express appreciation to the well owners who furnished data on wells, to the employees of the Soil Conservation Service who supplied information about the project and locations of irrigation wells, and to personnel of the Mirage Flats Irrigation District who assisted in obtaining data. Appreciation is also expressed to E. C. Reed, Director of the Conservation and Survey Division, University of Nebraska, for making available the State-owned test-hole drilling equipment for the installation of observation wells and to J. G. Lathrop of the Nebraska Water Resources Department for periodically measuring the depth to water in the observation wells.

WELL-NUMBERING SYSTEM

Wells are numbered in this report according to their location within the system of land subdivision of the U.S. Bureau of Land Management. The first numeral in the number indicates the township, the second the range, and the third the section. The lowercased letters that follow the section number indicate the position in the section. The 160-acre and 40-acre subdivisions of the section are letter "a," "b," "c," and "d" in a counterclockwise direction, beginning in the northeast corner. If more than one well is located within a 40-acre tract, consecutive numbers, beginning with 1, follow the lowercased letters. Figure 2 illustrates this well-numbering system.

GENERAL FEATURES OF THE AREA

The flood plain of the Niobrara River in the area of study is narrow, ranging in width from a few hundred feet to one-half mile. North of the flood plain, the land surface slopes upward to a terrace which averages 75 feet above the stream channel. This terrace ranges in width from 1 to nearly 5 miles and locally is called Mirage Flats (or simply the "Flats") because, from there, the Black Hills and the town of Hay Springs, which lie beyond the horizon, often can be seen as a mirage. North of the terrace the land slopes upward rather abruptly to a dissected tableland, the higher remnants of which are about 125 feet higher than the terrace. The Sand Hills region of Nebraska, consisting of a succession of rounded grass-covered hills and irregular ridges with intervening valleys and depressions, lies south and east of Mirage Flats.

The natural drainages into the Niobrara River from the northwest are higher than the water table and dry except during periods of rain when they carry surface runoff. Where the drainages cross the terrace they are shallow and barely discernible to an observer on the ground. These drainages are a source of ground-water recharge when they are flowing. Many artificial drains have been constructed on Mirage Flats to carry off irrigation wastewater, some of which seeps to the water table.

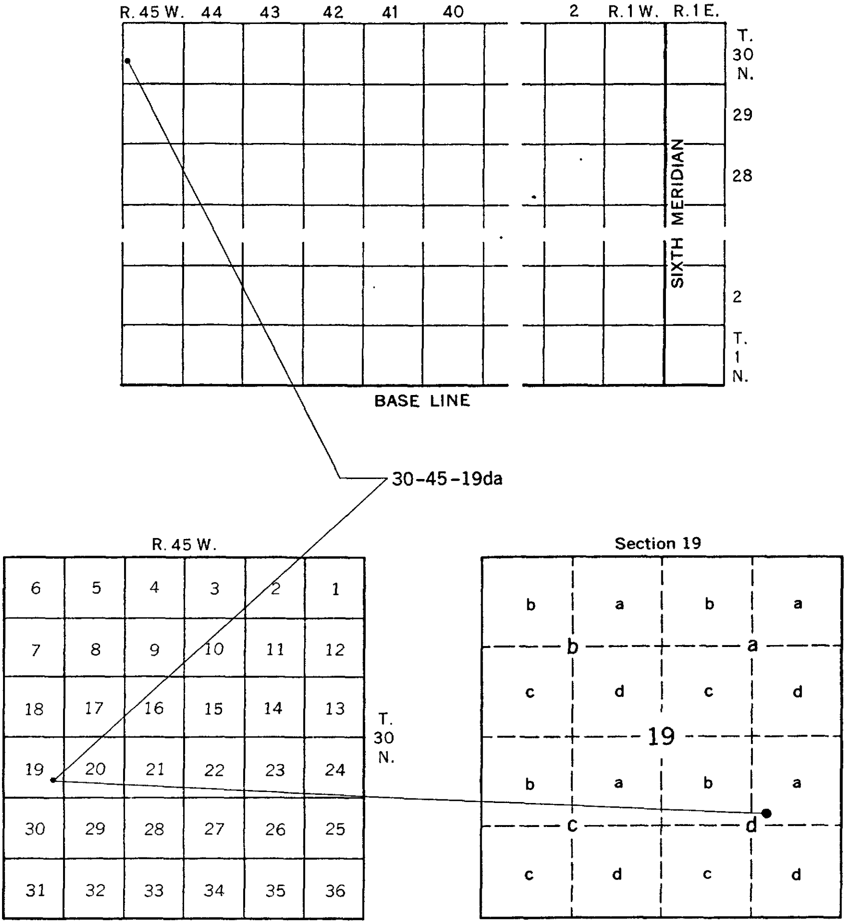

FIGURE 2.—Sketch showing well-numbering system.

Logs of 19 test wells (table 3) provide information on the composition and arrangement of the earth materials immediately underlying Mirage Flats. Typically, the silty surface soil is underlain by deposits of silt, fine sand, poorly consolidated fine-grained sandstone, siltstone, and calcareous sandstone.

The upper few feet of the materials underlying the terrace consist of Quaternary stream alluvium, principally silt and fine-grained sand interbedded with thin layers of coarser materials. This alluvium is underlain by strata of Tertiary age consisting of interbedded fine-grained sandstone, siltstone, silt, and clay. Some of the Tertiary strata are loosely cemented with calcium carbonate and some contain numerous calcareous concretions. No deep tests were drilled, but investigations made in neighboring Box Butte County (Cady and

Scherer, 1946) indicate that the rocks have similar physical characteristics to a depth of 500 to 600 feet. Deposits are saturated below the water table and constitute the principal aquifer from which wells in the area receive water.

CLIMATE

The climate at Mirage Flats is characterized by low humidity, hot summers, cold winters, wind, and large variations in precipitation from month to month and year to year. Sudden changes in weather, accompanied by great variations in temperature, are common. Thundershowers of local extent are common during the growing season Winter storms are normally widespread in extent. The normal annual precipitation is about 15.5 inches, most of which is received in spring and summer. Droughts of several years' duration are normal for the area. Climatic records of the U.S. Weather Bureau for Hay Springs show that January is the coldest month, with an average temperature of 22°F and a minimum of −40°F, and that July is the hottest month, with an average of 71.4°F and a maximum of 108°F. The growing season averages 132 days, with the last killing frost usually about May 15 and the first about September 24.

Without irrigation, crop production is uncertain. A measure of success can be expected, however, if drought-resistant crops are grown and soil moisture is conserved by summer fallow. Much of the soil is very sandy and will erode by wind if left without vegetative cover; for these reasons, most of the land in the vicinity of Mirage Flats is used for grazing and for growing small grain and hay.

GROUND WATER

REPLENISHMENT

The ground water that is slowly percolating southeastward through the aquifer beneath the Mirage Flats has its origin in three sources. Part enters the area by lateral percolation from lands to the northwest (see fig. 3), part reaches the zone of saturation by downward seepage of rain and snow water within the boundaries of the area, and part is added to the zone of saturation by seepage of the irrigation water that is distributed on the land from diverted river water and ground water from irrigation wells. When there is surface water runoff, water enters the area via the natural surface drainages and a small amount seeps to the zone of saturation.

THICKNESS OF THE ZONE OF SATURATION

The thickness of the principal zone of saturation beneath Mirage Flats is believed to be between 500 and 600 feet. The thickness is probably somewhat greater beneath the upland. The lower surface of this principal zone of saturation is considered to be the top of the Brule

Formation of Oligocene age. The formations lying below the top of the Brule are saturated but are generally so low in permeability that they can be considered below the lower limit of profitable drilling for water.

The geology of the deposits of Tertiary age is discussed in the report on geology and ground-water resources of Box Butte County by Cady and Scherer (1946).

CONFIGURATION OF THE WATER TABLE

The water table slopes southeastward toward the Niobrara River at an average of about 14 feet per mile. Ground water is discharged naturally to the river or by evapotranspiration on the flood plain along the stream, and it is discharged artificially from wells.

The depth to the water table ranges from less than 10 feet beneath the flood plain of the Niobrara River to more than 100 feet in the upland. The average depth to water beneath the Mirage Flats terrace is about 50 feet, although it ranges from about 20 feet beneath the lower parts to as much as 60 feet beneath the higher lands of the terrace.

The water table is the top of the zone of saturation; thus, the thickness of the principal aquifer is the vertical distance between the water table and the top of the Brule Formation. Figure 3 shows the generalized configuration of the water table beneath more than 1,000 square miles of the Niobrara River basin including the project area. The water-table contours are based on topographic maps and depths to water in wells as reported by farmers and drillers. Many of the data are from the files of the Conservation and Survey Division, University of Nebraska.

Because all points on a contour line have the same altitude, there is no difference in hydrostatic pressure along the line and no movement of water parallel to it. Water moves downslope at right angles to the contour lines because the maximum difference of pressure occurs at right angles to them. The ground water is moving into Mirage Flats from the northwest. The rate of movement is very slow, however, because the permeability and porosity of the aquifer are relatively small. Cady and Scherer (1946, p. 52) computed the rate of ground-water movement through Teritiary aquifers in Box Butte County to be only 90 feet a year.

Plate 1 shows, by contours at 10-foot intervals, the water table beneath Mirage Flats. Control for the contours was obtained by measuring the depth to water in wells from points determined by spirit levels. Most of the measurements of depth to water in the wells used as points of control were made in October 1961, although a few were made earlier during the summer.

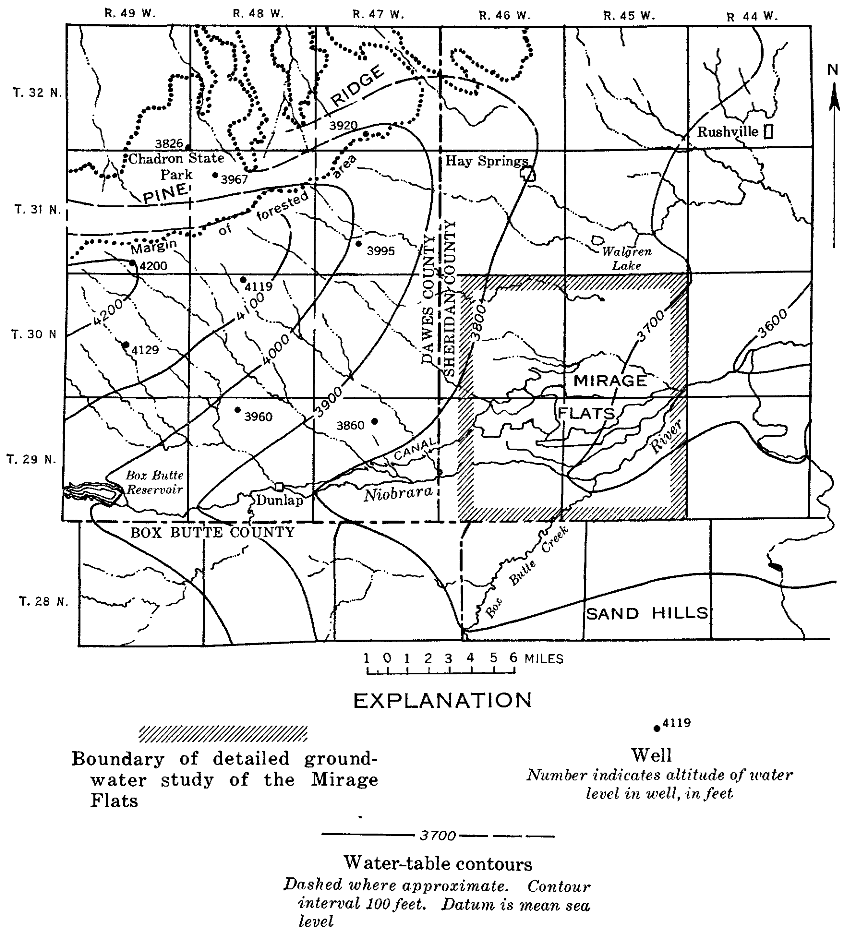

FIGURE 3.—Map of parts of Sheridan, Dawes, and Box Butte Counties, Nebr., showing the configuration of the water table in Mirage Flats and vicinity.

FLUCTUATIONS OF THE WATER TABLE

When land in the irrigation district was subdivided into farm units, wells were drilled to provide a water supply for domestic and livestock purposes for each unit. Most of these were installed in 1946, although a few were drilled in 1944 or earlier. Twenty-five wells were installed under supervison of the Soil Conservation Service in 1946, and depth to static water level was recorded by the driller of each well at the time of its completion.

Most of the wells were fitted with pumps and sealed over; consequently measurements of the depth to water cannot now be made. In 1951, depth-to-water measurements made in six of the wells indicated that the water table had risen an average of about 10 feet.

The accuracy of the drillers' measurements, however, could not be verified because the original measuring points were described as land surface, and land leveling practices after the wells were installed changed the altitude of the land surface at some of the well sites.

Depth-to-water measurements have been made periodically in three wells since May 1950, and a well equipped with a continuous recording gage was installed in October 1953 at the Mirage Flats headquarters. Records of water-level measurements in the wells are given in table 5.

The hydrograph of water-level fluctuations in recording-gage well 29–46–10aa1 (fig. 4) indicates that the water table at that point rose more than 3 feet from October 1953 to December 1962. The water level rose about 5 feet in well 29–46–4dc1 from May 1950 to October 1957 and about 7 feet in well 29–46–11dc from May 1950 to October 1959. The greatest rise in the latter two wells occurred prior to 1953. Unfortunately, well 29–46–4dc1 was sealed in October 1957 and 29–46–11dc was destroyed in 1959. It is reasonable to assume, however, that since the last observations the range of fluctuation of the water table at those points would resemble the graph of the recording gage (fig. 4).

The graph from the recording gage indicates that the average water level in the well has continued to rise even though some ground water has been withdrawn from the aquifer for irrigation. This rise indicates that recharge resulting from irrigation practices is greater than the amount being pumped.

UTILIZATION

WELLS FOR DOMESTIC AND STOCK SUPPLIES

All domestic and stock water supplies in Mirage Flats and vicinity are obtained from wells that generally are drilled to only a few feet below the water table. Most of the wells of this class are fitted with electrically powered pumps, but some have windmills. Most of the wells are 4 to 6 inches in diameter and cased with galvanized iron tubing, although some are 2-inch-diameter tubular wells. There is no place in the area where enough ground water to meet household and livestock requirements cannot be obtained.

IRRIGATION

The use of ground water for irrigation is comparatively new in Mirage Flats and vicinity. Until the late 1950's, ground water was used chiefly to supply domestic and stock needs and all irrigation water for the district was obtained from the Niobrara River.

Although a few successful wells had been installed earlier, principally in areas outside the irrigation district, the first significant use of ground water for irrigation occurred in 1955. The available supply

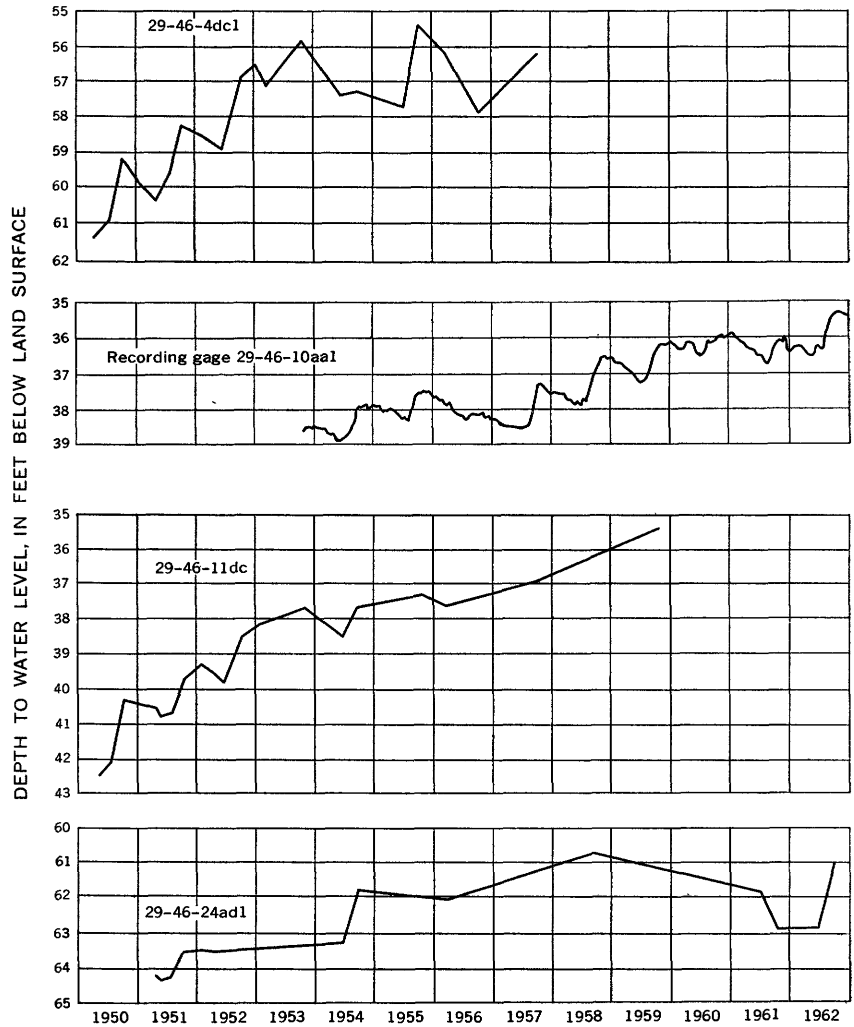

FIGURE 4.—Hydrographs of four wells in Mirage Flats, Sheridan County, Nebr.

from Box Butte Reservoir had become inadequate to meet irrigation demands during dry years, and groups of farmers in the district installed irrigation wells to augment the water supply. Most of these were drilled in 1956 and 1957. The success of the wells prompted farmers outside the district to install irrigation wells, and by the summer of 1961, 50 irrigation wells were in operation in Mirage Flats and vicinity. Technical description of the wells is given in table 4 at the end of this report.

The availability of ground water for irrigation has proved to be a valuable asset and its use has already added considerably to the economy of the areea. More comprehensive studies are needed to evaluate the amount of ground water available even though the evidence obtainet thus far indicates that additional amounts could be developed to make use of the artificial recharge resulting from irrigation practices on the land.

CHEMICAL QUALITY OF THE WATER

The chemical quality of the ground water in the Mirage Flats area results from a mixing of ground-water inflow from the northwest with recharge from local sources. Because the principal source of local recharge is irrigation water diverted from the Niobrara River and because the Niobrara River above (as well as below) the point of diversion is sustained in large part by ground-water inflow, it is not surprising that the ground water and surface water are chemically similar. Ground-water samples were obtained from 11 different wells, and surface-water samples were obtained from the Niobrara River at the bridge south of the headquarters of the Mirage Flats Irrigation District and also from several different places in the irrigation canal system. (See fig. 5.) The results of chemical analysis of these samples are given in tables 1 and 2.

The suitability of a water for irrigation depends on the effect of the water on soil productivity. The U.S. Salinity Laboratory Staff (1954) has stated that four major factors should be considered regarding the quality of irrigation water. These factors are the salinity hazard, the sodium hazard, the concentration of residual sodium carbonate, and the concentration of boron.

The ground water in the Mirage Flats area is of the medium-salinity low-sodium type, and the surface water is of the medium-salinity medium-sodium type. A medium-salinity water can be used for irrigation if a moderate amount of leaching occurs and if plants that have moderate salt tolerance are grown. A low-sodium water can be used on almost all soils with little danger of the development of harmful levels of exchangeable sodium. A medium-sodium water will present an appreciable sodium hazard in fine-textured soils that have high cation-exchange-capacity, especially under low-leaching conditions, unless gypsum is present in the soil; however, it may be used on coarse-textured or organic soils that have good permeability.

Both the ground water and the river water have low concentrations of residual sodium carbonate and, therefore, are safe for irrigation use in this respect. Because the boron concentrations are low, the water is excellent even for boron-sensitive crops.

For the constituents determined, with the exception of manganese, the water in the Mirage Flats area is suitable for domestic use accord-

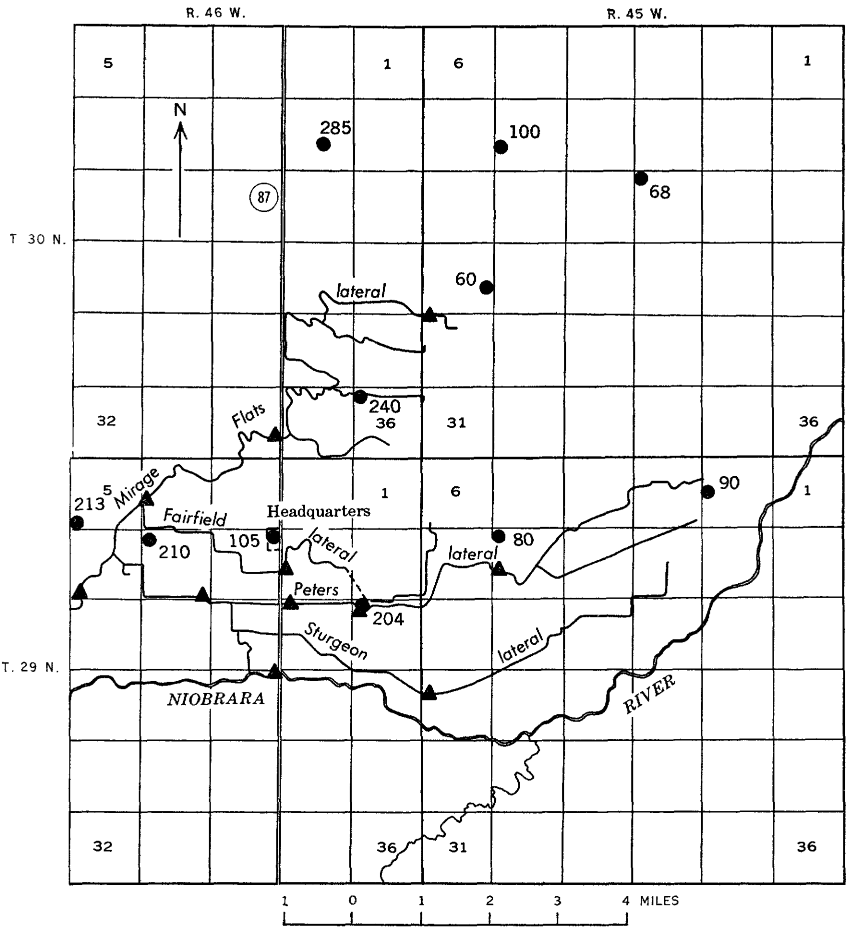

FIGURE 5.—Map showing chemical-quality sampling sites. ●100, Ground-water sampling site and depth of well, in feet. ▲, Surface-water sampling site.

ing to the standards of the U.S. Public Health Service (1961, p. 935–945). The analyses indicate that during June the ground water contained no manganese, but during November the water from most wells contained concentrations of manganese that exceeded the recommended maximum of 0.05 ppm.

Hard water is undesirable for domestic use because it causes high soap consumption and scale formation in boilers and pipes. High concentrations of silica also can result in scale formation in boilers and pipes. The ground water of Mirage Flats ranged from hard to very hard (131–278 ppm of hardness as $CaCO_3$) and contained high concentrations of silica (49–59 ppm). The river water also was hard (116–178 ppm of hardness as $CaCO_3$) and contained high silica concentrations (20–54 ppm, omitting one sample).

TABLE 1.—*Chemical analyses of*

[Results in parts per million except as

Well	Depth of well (feet)	Use	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Lead (Pb)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)
			1961								
29-45-2bc	90	D	June 19	55	56	0.01	0.00	------	43	7.4	11
			Nov. 13	53	56	.01	.09	0.00	44	6.3	11
8bb	80	D	Nov. 14	50	53	.04	.10	.00	56	8.9	12
29-46-5cc	213	I	June 19	54	55	.04	.00	------	41	7.7	11
			Nov. 14	53	57	.01	.11	.00	39	8.1	15
9bb2	210	I	June 20	54	57	.02	.00	------	47	8.9	17
			Nov. 13	53	55	.05	.07	.00	45	8.6	19
10aa2	105	D	June 19	54	49	.01	.00	------	86	10	16
			Nov 13	51	53	.02	.07	.00	82	12	16
13bb2	204	I	June 19	54	55	.02	.00	------	55	8.0	13
			Nov 14	52	55	.02	.10	.00	49	8.9	12
30-45-8cb2	100	D	June 19 [a]	54	59	.01	.00	.20	46	10	27
			Nov. 14	50	59	.02	.01	.00	48	9.7	26
15bb	68	D	June 19	52	55	.05	.00	------	86	15	41
			Nov. 14	49	55	.01	.06	.00	81	16	40
19da	60	D	June 19	55	54	.03	.00	------	62	7.9	14
			Nov. 13	52	55	.01	.03	.00	63	9.5	14
			1963								
30-46-11db	285	I	Jan. 11	--------	58	.07	--------	------	44	9.7	24
			1961								
36bb2	240	D	June 19	54	56	.02	.00	------	59	9.7	19
			Nov. 13	51	57	.00	.03	.00	47	8.4	12

[a] Copper (Cu), 0.02 ppm; zinc (Zn), 0.23 ppm.

CONCLUSIONS

The amount of available ground water is sufficient to support additional wells. The amount pumped in 1962 was about 3,000 acre-feet, which probably is less than the average annual amount of seepage to the zone of saturation of water diverted from the river. Water-level fluctuations in observation wells indicate that the present (1963) amount of withdrawal is not appreciably depleting the amount of ground water in storage.

Both the ground water and the water from the Niobrara River are suitable for irrigation and domestic uses.

The ground-water reservoir could be used more efficiently for storage, regulation of the total available water supply, reduction of nonbeneficial consumptive use, and more adequate distribution of the *ground water, Mirage Flats area*

indicated. Use: D, domestic; I, irrigation]

Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids (residue on evaporation at 180° C)	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium-adsorption-ratio	Specific conductance (micromhos per cm at 25° C)	pH
8.4	181	14	2.4	0.4	3.7	0.05	241	138	0	14	0.4	332	7.6
8.4	182	19	1.9	.4	3.0	.04	237	136	0	14	.4	330	7.6
10	212	22	10	.6	6.5	.05	289	176	2	12	.4	420	7.4
7.1	182	11	1.1	.5	1.9	.03	231	134	0	14	.4	320	7.6
7.3	189	18	.9	.5	1.7	.02	238	131	0	19	.6	330	7.8
8.1	196	24	6.5	.6	3.5	.04	277	154	0	18	.6	388	7.5
8.2	196	27	6.1	.6	3.0	.09	266	148	0	21	.7	386	7.8
10	250	43	19	.5	27	.08	416	256	51	12	.4	579	7.4
9.8	250	46	18	.4	26	.07	396	253	48	12	.4	558	8.2
8.5	206	24	6.6	.6	3.8	.05	298	170	1	14	.4	401	7.5
8.4	204	23	4.0	.5	3.2	.05	262	159	0	13	.4	378	7.6
8.8	210	31	6.8	.5	7.8	.06	316	156	0	26	.9	430	7.6
9.6	212	38	7.4	.5	9.7	.06	309	160	0	25	.9	438	8.1
13	353	58	14	.4	14	.11	481	278	0	23	1.1	706	7.4
12	347	62	12	.4	13	.10	461	269	0	23	1.1	686	8.0
8.8	211	22	6.8	.4	26	.07	317	187	14	13	.4	444	7.1
9.0	212	25	8.0	.4	34	.05	329	196	22	13	.4	468	7.6
10	220	19	3.5	.3	6.3	.07	302	150	0	24	--------	405	8.0
9.2	213	34	13	.5	13	.10	332	187	12	17	.6	467	7.8
8.2	193	22	2.8	.5	5.1	.07	260	152	0	14	.4	367	7.4

water. Ground water could be heavily used in dry years when river water is in short supply. The ground-water reservoir would be partly emptied and space would be available to store water in wet years when abundant irrigation supplies were available from the river. A considerable amount of ground water is used by phreatophytes growing in the shallow water-table areas adjacent to the river. Lowering of the water table by pumping would reduce the total amount of ground water being discharged naturally.

If the amount of development of ground water increases beyond the sustained yield of the aquifer, then several related effects may be anticipated. These include lowered static water levels in wells, greater drawdowns of water levels in pumped wells, and smaller yields. Greater lifts and smaller yields increase the cost of obtaining water supplies.

TABLE 2.—*Chemical analyses of*

[Results in parts per million

Date of collection	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)
Niobrara River south of										
1949										
July 22	-------	54	0.05	-------	44	5.3	44		220	10
1950										
July 4	18	42	.03	-------	46	6.8	34		228	0
Aug. 8	18	37	.33	-------	52	6.9	30		237	0
Aug. 26	390	20	.10	-------	43	2.1	10		158	0
Sept. 17	33	46	.04	-------	60	6.9	33		245	10
Nov. 12	30	41	.20	-------	52	6.2	29		229	0
1951										
Jan. 3	25	48	.10	-------	58	5.7	35		254	0
Apr. 4	26	45	.06	-------	55	7.4	30		246	0
July 7	5.5	37	-------	-------	-------	-------	-------	-------	224	0
1952										
Oct. 8	23	52	-------	-------	-------	-------	27	9.0	208	20
1953										
Aug. 18	34	-------	-------	-------	40	6.3	22	11	-------	-------
1960										
Oct. 6	22	52	.03	-------	11	30	27	9.8	237	0
1961										
Jan. 23	20	50	.01	0.00	44	11	23	7.1	230	0
June 1	16	49	.01	.00	48	8.8	26	10	237	0
June 19	87	53	.07	.00	45	7.4	29	11	230	0
Aug. 17	10	46	.10	-------	46	8.5	25	10	234	0
Mirage Flats										
June 20, 1961:										
NW¼SW¼ sec. 8, T. 29 N., R. 45 W	-------	-------	-------	-------	-------	-------	26	-------	240	0
SW¼NW¼ sec. 19, T. 29 N., R. 45 W	-------	-------	-------	-------	-------	-------	26	-------	241	0
NW¼SW¼ sec. 4, T. 29 N., R. 46 W	-------	-------	-------	-------	-------	-------	26	-------	238	0
SW¼SW¼ sec. 8, T. 29 N., R. 46 W	44	44	0.03	0.00	42	11	26	7.7	235	0
SE¼SE¼ sec. 9, T. 29 N., R. 46 W	-------	-------	-------	-------	-------	-------	26	-------	238	0
NW¼SW¼ sec. 11, T. 29 N., R. 46 W	-------	-------	-------	-------	-------	-------	26	-------	238	0
NW¼NW¼ sec. 13, T. 29 N., R. 46 W	-------	-------	-------	-------	-------	-------	26	-------	239	0
NW¼NW¼ sec. 14, T. 29 N., R. 46 W	-------	-------	-------	-------	-------	-------	26	-------	236	0
NW¼NW¼ sec. 30, T. 30 N., R. 45 W	-------	-------	-------	-------	-------	-------	26	-------	240	0
NE¼SE¼ sec. 34, T. 30 N., R. 46 W	-------	-------	-------	-------	-------	-------	26	-------	237	0

surface water, Mirage Flats area

except as indicated]

Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Residue on evaporation at 180° C	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$	Noncarbonate hardness as $CaCO_3$	Percent sodium	Sodium adsorption-ratio	Specific conductance (micromhos per cm at 25° C)	PH	Color
Mirage Flats headquarters													
22	4.5	0.6	0.8	------	293	0.40	132	0	42	------	412	8.4	------
21	4.0	.5	1.8	0.10	278	.38	143	0	34	------	385	7.8	------
21	3.0	.6	1.6	.17	280	.38	158	0	29	------	402	7.9	------
5.0	.5	.5	2.6	.12	190	.26	116	0	16	------	270	7.9	------
23	4.0	.6	1.5	.18	320	.44	178	0	29	------	438	8.4	------
23	3.5	.6	2.4	.20	284	.39	155	0	29	------	400	8.1	------
27	3.5	.6	2.4	.20	312	.42	168	0	31	------	440	7.0	------
20	4.5	.6	1.9	.06	302	.41	168	0	28	------	416	7.9	------
------	------	------	------	------	------	------	136	0	------	------	402	7.8	------
------	------	------	------	------	302	.41	160	0	25	0.9	408	8.6	------
------	------	------	------	------	230	.31	126	------	26	.9	342	7.5	------
19	3.0	.7	1.2	.07	281	.38	152	0	26	.9	414	7.7	4
19	2.6	.6	2.3	.04	274	.37	157	0	23	.8	405	7.9	3
19	3.1	.7	1.1	.09	289	.39	156	0	25	.9	418	8.1	7
22	4.4	.8	1.8	.07	292	.40	143	0	29	1.1	415	7.6	3
16	3.1	.6	.2	.05	275	.37	150	0	25	.9	403	7.7	6
Canal system													
------	------	------	1.6	------	------	------	160	0	26	0.9	412	8.0	------
------	------	------	3.8	------	------	------	157	0	27	.9	427	7.7	------
------	------	------	.7	------	------	------	153	0	27	.9	407	7.9	------
13	4.0	0.6	1.0	0.23	281	0.38	151	0	26	.9	406	7.9	4
------	------	------	.7	------	------	------	150	0	27	.9	404	7.7	------
------	------	------	.9	------	------	------	150	0	27	.9	408	7.9	------
------	------	------	1.3	------	------	------	150	0	27	.9	414	7.8	------
------	------	------	.3	------	------	------	149	0	28	.9	404	7.9	------
------	------	------	2.4	------	------	------	149	0	28	.9	423	7.9	------
------	------	------	.5	------	------	------	156	0	27	.9	405	8.0	------

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*

	Depth (feet)
29-45-7cc	
Soil, medium yellow-brown	0–1
Silt, slightly sandy, light yellow-gray	1–2
Sandstone, slightly silty, moderately consolidated; contains limy grains	2–13. 5
Sandstone; interbedded with silt and bentonite	13. 5–14
Sandstone, very fine to fine-grained, well-consolidated	14–25
Sandstone, very fine to fine-grained, well-consolidated, olive-gray; contains root casts and some dark-colored minerals	25–79
Silt, moderately sandy to slightly clayey, light yellow-gray	79–82. 5
Sandstone, very fine to fine-grained, well-consolidated, olive-gray; contains root casts and dark-colored minerals	82. 5–90
29-45-8dd1	
Soil	0–1
Silt, slightly clayey, medium yellow-gray; contains some sand and gravel	1–2. 5
Gravel, poorly sorted; contains rounded caliche cobbles	2. 5–5
Gravel, medium to coarse; contains a few caliche pebbles	5–6
Gravel, fine to coarse pebbles, poorly sorted	6–13
Sandstone, very fine to fine-grained, light olive-gray	13–20
Sandstone, very fine to fine-grained; interbedded with silt, light yellow-gray	20–57. 5
Sandstone, very fine to fine-grained, poorly consolidated, olive-gray; contains root casts and dark-colored minerals	57. 5–70
29-45-16aa	
Soil, black to dark-gray	0–1. 5
Silt, very light yellow-gray	1. 5–2. 5
Gravel, medium; contains pipy concretions	2. 5–3. 5
Gravel, medium to coarse	3. 5–5
Gravel, medium to very coarse	5–7
Gravel, very fine to fine; contains sandstone and limy nodules	7–10
Sandstone, fine; contains root casts and dark-colored minerals	10–15
Sandstone, fine to medium-grained, consolidated	15–30
Sandstone, very fine to fine-grained; contains some root casts	30–44
Sand, very fine, poorly consolidated; contains dark-colored minerals	44–60
Sandstone, fine-grained, consolidated; contains root casts and dark-colored minerals	60–65
Sandstone, fine-grained, poorly consolidated	65–67
Silt and sandstone interbedded	67–69
Sandstone, very fine to fine-grained, poorly consolidated; contains dark-colored minerals	69–72
29-45-18aa	
Soil, medium brown-gray	0–2. 5
Silt, moderately sandy, slightly clayey; contains some caliche cobbles	2. 5–3
Gravel, coarse, poorly sorted	3–7. 7
Silt, moderately sandy to slightly clayey, yellow-gray; contains gravel pebbles	7. 7–10

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

	Depth (feet)
29-45-18aa—Continued	
Sandstone, very fine to fine-grained, moderately consolidated, olive-gray; contains gravel pebbles and root casts	10–17.5
Silt, very sandy, slightly clayey, yellow-gray; contains some caliche pebbles	17.5–25
Sandstone, very fine to fine-grained, well-compacted; contains root casts and dark-colored minerals	25–46
Silt, moderately sandy, slightly clayey; contains dark-colored minerals	46–48
Sandstone, moderately consolidated; contains root casts	48–58
Silt, very sandy, light yellow-gray	58–60
Sandstone, very fine to fine-grained, moderately consolidated, olive-gray; contains root casts, dark-colored minerals, and some interbedded silt	60–70
Sand, very fine to fine, poorly consolidated	70–72
29-46-3ba	
Soil: Silt, moderately sandy, dark-brown	0–1
Silt, moderately sandy; contains calcareous grains	1–4
Caliche and silt, intermixed	4–5
Caliche, light yellow-gray	5–10
Sand, very fine to fine; contains some medium sand and calcareous grains	10–15
Silt, moderately clayey; contains fine sand grains and some iron	
Silt, moderately clayey; contains fine sand grains and some iron stain	15–25
Silt, moderately clayey to slightly sandy, medium yellow-brown	25–30
Sandstone, very fine to fine-grained, moderately consolidated; contains silt lenses and calcareous grains	30–40
Sand, very fine to fine; contains dark minerals	40–45
Sandstone, moderately consolidated; contains dark-colored minerals and root casts	45–72
29-46-8dd	
Soil: Silt; contains coarse sand grains	0–3.2
Silt, moderately clayey, slightly sandy	3.2–12
Gravel, coarse; contains well-rounded cobbles	12–20
Sand, very fine to fine; contains sandstone pebbles	20–25
Gravel, reworked sandstone; contains quartz and caliche pebbles	25–35
Sand and gravel, poorly sorted; contains caliche pebbles	35–75
Sand, very fine to fine; contains gravel-size grains	75–80
Sand, gravelly; sand is very fine to fine (70 percent sand)	80–85
Sandstone, very fine to fine-grained, well-consolidated, light olive-gray	85–90
29-46-9bb1	
Soil: Silt, dark-brown	0–1
Silt, moderately sandy; contains coarse sand grains	1–3
Silt; contains pebbles and calcareous grains	3–5
Gravel, silty; contains caliche pebbles	5–7
Silt, moderately clayey, slightly sandy	7–10

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

	Depth (feet)
29-46-9bb1—Continued	
Caliche, reworked	10–15
Silt, moderately clayey; contains siltstone and calcareous grains	15–21
Sandstone, very fine to fine, moderately consolidated, medium-brown; contains root casts and lenses of silt	21–26. 5
Silt, calcareous; contains root casts	26. 5–35
Sandstone, very fine to fine-grained, well-consolidated, medium-brown; contains root casts	35–44
Silt; contains sandstone	44–45
Sandstone, very fine to fine-grained, well-consolidated, medium-brown; contains root casts	45–46. 8
Caliche, consolidated, medium-brown; contains some silt	46. 8–55. 6
Sandstone, calcareous, indurated	55. 6–60
Sand, very fine to fine; contains siltstone, caliche, and dark-colored minerals	60–70
29-46-10aa1	
Soil: Silt, dark brownish-gray; contains a trace of fine to coarse sand	0–1. 5
Silt, slightly sandy, slightly darker in shade; contains a few calcareous fragments	1. 5–2. 5
Silt, moderately sandy; sand is fine to coarse	2. 5–3. 5
Sand, slightly silty; contains many calcareous fragments; sand is fine to coarse	3. 5–5
Sand, less silty; contains a trace of calcareous fragments	5–10
Sand, fine, to medium gravel; composed of sandstone fragments; below 40 ft, coarser grained and contains fragments of igneous and metamorphic rocks	10–45
Marl to sandstone (poor sample, much lag)	45–50
Sandstone, light greenish-gray; sand is fine to medium; from 60 to 85 ft, contains some calcareous cemented layers; from 85 to 95 ft, contains a trace of calcareous cemented layers; below 95 ft, contains some fine gravel	50–102
29-46-11cc	
Soil: Silt, dark-brown	0–1. 5
Silt, moderately clayey, slightly sandy, light yellow-gray	1. 5–5
Gravel, coarse to cobbles, poorly sorted; contains well-rounded caliche pebbles	5–10
Sandstone, very fine to fine-grained, moderately consolidated; contains root casts and dark-colored minerals	10–32. 5
Silt, very sandy, interbedded with sandstone, light yellow-gray; contains root casts and dark-colored minerals	32. 5–40
Sandstone, very fine to fine-grained, moderately consolidated, olive-gray; contains root casts and dark-colored minerals	40–45
Sandstone, well-consolidated, olive-gray; contains many root casts and silt lenses	45–60
Sand, very fine to fine with some medium sand; contains root casts and dark-colored minerals	60–72
29-46-13bb1	
Soil, dark-brown	0–2. 5
Silt, moderately sandy, light yellow-gray	2. 5–4. 8

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

	Depth (feet)
29-46-13bb1—Continued	
Gravel, coarse, poorly sorted; contains caliche cobbles	4. 8–9. 3
Silt, consolidated, light yellow-gray	9. 3–13. 7
Sandstone, very fine to fine-grained, consolidated; contains siltstone	13. 7–15
Sandstone, very fine to fine-grained, consolidated, olive-gray; contains root casts and dark-colored minerals	15–23. 8
Silt, very sandy, light yellow-gray; contains dark-colored minerals	23. 8–24. 5
Sandstone, consolidated, olive-gray; contains root casts and dark-colored minerals	24. 5–36. 2
Silt, moderately sandy, interbedded with siltstone	36. 2–40
Silt and sandstone, interbedded; contains root casts	40–45
Sandstone, poorly consolidated; contains root casts	45–52. 5
Silt, moderately sandy; contains siltstone and root casts	52. 5–57. 8
Sandstone, moderately consolidated; contains root casts and dark-colored minerals	57. 8–68
Silt and sandstone, interbedded, poorly consolidated, light olive-gray	68–70
Sandstone, well-consolidated; contains root casts and dark-colored minerals	70–72
29-46-16aa	
Soil, sandy, dark-brown	0–1. 5
Silt, moderately sandy, slightly clayey, light yellow-gray	1. 5–7
Gravel, coarse to cobbles, poorly sorted	7–8. 5
Sandstone, very fine to fine-grained, well-consolidated, olive-gray; contains root casts and dark-colored minerals	8. 5–30
Sandstone, consolidated; contains light yellow-gray silt	30–35
Sandstone, consolidated; contains root casts and dark-colored minerals	35–45
Silt and sandstone, interbedded	45–50
Sandstone; contains calcareous lenses, silt, and root casts	50–77
Sandstone, calcareous, indurated	77–84
Sandstone and limestone interbedded; contains root casts and dark-colored minerals	84–90
30-45-7dd	
Top soil, moderately sandy, very silty, medium-brown; sand is very fine	0–3
B zone soil, slightly sandy, very silty, medium yellow-brown; sand is very fine	3–10
Sand, very silty; sand is very fine	10–17
Silt, slightly clayey, moderately sandy; sand is very fine to fine with a trace of medium	17–20. 3
Sandstone, poorly consolidated; sand is very fine to medium with a trace of coarse	20. 3–25
Sand, very fine to medium	25–32. 8
Sandstone, slightly consolidated; below 35 ft, moderately consolidated; contains siliceous seed and root casts; sand is very fine to fine with a trace of medium	32. 8–40
Sandstone, slightly consolidated; below 48 ft, moderate consolidated; contains siliceous seed and root casts; sand is very fine to fine with a trace of fine gravel	40–51

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

30-45-7dd—Continued

	Depth (feet)
Silt, very sandy, light yellow-brown; sand is very fine to fine	51–55
Sand, very slightly consolidated, very fine to medium with a trace of coarse	55–60

30-45-14cc1

	Depth (feet)
Soil, very silty, very sandy, medium-brown; sand is very fine to medium	0–2
Soil, very silty, very sandy, medium-brown; sand is very fine to medium; contains calcareous nodules of fine to medium grain size	2–3. 5
Sand and gravel; sand is fine to very coarse; gravel is fine to medium	3. 5–10
Sandstone, slightly consolidated, moderately consolidated from 23.4 to 24 ft; contains siliceous root casts and rounded calcareous nodules of fine to medium grain size; sand is very fine to fine	10–30
Sandstone, very slightly consolidated; less coarse material from 55 to 60 ft; more coarse material from 65.5 to 70 ft; moderately consolidated from 70 to 84.5 ft; sand is very fine to fine	30–84. 5
Sand and gravel; sand is medium to very coarse; gravel is fine to medium	84. 5–90
Sand and gravel; contains caliche lens 94.5 to 98 ft; sand is medium to very coarse; gravel is fine to medium	90–100
Sandstone, moderately consolidated; sand is very fine to fine	100–110

30-45-15cc

	Depth (feet)
Soil, very silty, slightly sandy, dark-brown; sand is very fine	0–2. 5
Soil, very silty, slightly clayey, dark-brown	2. 5–4. 5
Soil slightly clayey, very silty, medium yellowish-brown	4. 5–5
Silt, very sandy, light yellowish-brown; sand is very fine	5–7. 7
Gravel; contains rounded calcareous nodules, quartz, and feldspar; gravel is fine to medium	7. 7–10
Gravel; contains some moderately cemented sandstone; sand is very fine to fine	10–20
Gravel; contains a trace of medium gravel	20–30
Sandstone, slightly consolidated; contains calcareous grains; sand is very fine to fine with a trace of medium	30–40
Sandstone, moderately consolidated; from 43.5 to 46.5 ft, well consolidated; sand is very fine to coarse	40–50
Sandstone, rounded, moderately consolidated; from 67.8 to 68.2 ft, well-consolidated; contains calcareous fragments and siliceous root casts; sand is fine to coarse	50–80
Sand, very fine to very coarse with some fine gravel; contains calcareous nodules of medium grain size; contains some greenish claystone and siliceous root casts	80–90
Sand, medium to very coarse; contains 10 percent fine gravel; contains well-rounded sandstone and calcareous nodules of medium to coarse grain size	90–100
Sand, medium to very coarse; contains 15 percent fine gravel and a trace of medium gravel	100–110

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

30-45-18dd

	Depth (feet)
Soil, silty, moderately sandy, medium-brown; contains very fine to fine sand	0-1. 8
Ogallala Formation—Valentine Beds of Johnson (1936)	
Interbedded caliche and clay, silty, sandy, light-gray; contains very fine to fine sand	1. 8-4
Sand, very fine to coarse; contains calcareous fragments and some well-rounded, well-cemented sandstone nodules	4-5
Interbedded sand and sandy caliche lenses; contains very fine to medium sand, calcareous nodules, and siliceous root casts	5-10
Sandstone, moderately consolidated; contains very fine to fine sand and siliceous root casts	10-15
Sandstone, slightly cemented; contains very fine to fine sand and siliceous root casts	15-20
Sandstone, slightly cemented; contains very fine to fine sand and siliceous root casts; contains claystone from 20 to 25 ft; contains claystone lens from 33 to 33.4 ft	20-45
Sandstone, slightly cemented; contains very fine to fine sand and siliceous root casts; contains interbedded moderately cemented sandstone lenses	45-50
Sandstone, slightly cemented; contains very fine to fine sand and siliceous root casts; contains well-rounded calcareous clay nodules	50-60

30-45-21bb

	Depth (feet)
Top soil, very silty, moderately sandy, medium-brown; sand is very fine	0-2
B zone soil, very silty, slightly clayey, slightly sandy, medium olive-green; sand is very fine	2-4
Sand, very silty, light yellow-brown; sand is very fine	4-8
Sandstone, slightly cemented; contains siliceous root casts; sand is very fine to fine	8-10
Sandstone; contains very fine to coarse sand with some fine gravel and calcareous nodules	10-30
Sandstone, slightly consolidated; contains calcareous fragments; sand is very fine to fine with a trace of fine gravel	30-40
Sandstone, slightly to moderately consolidated; contains calcareous fragments; sand is very fine to fine with a trace of fine gravel	40-50
Sandstone, slightly consolidated; contains calcareous fragments; sand is very fine to fine with a trace of fine gravel	50-55
Sandstone, very slightly consolidated; contains a moderately consolidated lens from 66.5 to 67 ft; contains calcareous fragments; sand is very fne to fine with a trace of fine gravel	55-70
Sandstone, very slightly consolidated; contains a moderately consolidated harder lens from 74.5 to 75 ft; contains calcareous fragments; sand is very fine to fine with a trace of fine gravel	70-75
Sandstone, moderately consolidated, slightly consolidated below 79.5 ft; contains calcareous fragments; sand is very fine to fine with a trace of fine gravel	75-80
Sandstone, very slightly consolidated; below 83.5 ft, well-consolidated; sand is very fine to coarse with a trace of fine gravel	80-85

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

	Depth (feet)
30-45-21bb—Continued	
Sandstone, well-consolidated; sand is very fine to coarse with a trace of fine gravel	85–90
Sandstone, moderately consolidated; sand is very fine to coarse	90–95
Sandstone, moderately consolidated; sand is very fine to coarse	95–105
Sandstone, moderately consolidated; sand is very fine to coarse with a trace of fine gravel	105–110
30-45-30aa1	
Sand, very silty, very fine to fine	0–3
Sand, moderately silty, very fine to fine	3–7. 8
Sandstone, very slightly cemented, slightly silty; contains very silty lens from 12.5 to 13.5 ft; moderately cemented below 15 ft	7. 8–20
Sand, very slightly consolidated, very fine to fine; contains snail fragments	20–40
30-46-23da	
Soil: Silt, very sandy, brown; contains roots	0–2. 5
Sand, fine to medium; contains dark-colored minerals	2. 5–7. 5
Silt, moderately sandy, slightly clayey, light yellow-gray	7. 5–10
Sand, fine to coarse; contains dark-colored minerals	10–24. 8
Sandstone, very fine to fine-grained, moderately consolidated, medium-brown; contains calcareous grains and dark-colored minerals	24. 8–27. 9
Sandstone, fine- to medium-grained, in part calcareous	27. 9–30
Sandstone; contains calcareous lenses	30–35
Sand, fine to medium; contains dark-colored minerals	35–37. 5
Sandstone, calcareous, consolidated, white	37. 5–38. 5
Sandstone, moderately consolidated, light medium-brown	38. 5–40
Sand, fine to medium; contains calcareous grains and dark-colored minerals	40–45
Sandstone, fine to medium-grained; contains a silt lens from 48.3 to 48.6	45–50
Sandstone and sand, poorly consolidated; contains feldspar and dark-colored minerals	50–55
Sandstone, moderately consolidated	55–60
Sandstone, fine to medium-grained, consolidated; contains dark-colored minerals and root casts	60–65. 7
Sandstone; contains calcareous lenses	65. 7–70
Sandstone, well-consolidated; contains dark-colored minerals	70–80
Sandstone, moderately consolidated; contains dark-colored minerals and some medium gravel	80–90
Sandstone, fine to medium-grained, well consolidated, olive-gray; contains dark-colored minerals and root casts	90–105
Sand, fine to medium; contains some gravel, dark-colored minerals, and root casts	105–110
Sandstone, fine to medium-grained, poorly consolidated; contains coarse gravel and feldspar	110–115
Sand, fine to medium with some coarse gravel, olive-gray; contains root casts	115–120
Sandstone, moderately consolidated, olive-gray; contains some coarse gravel	120–125

TABLE 3.—*Logs of test holes for observation wells in Mirage Flats, Sheridan County, Nebr.*—Continued

30-46-23da—Continued

	Depth (feet)
Gravel, medium to coarse; contains fine to medium sand	125–130
Sand, fine to medium; contains coarse gravel and root casts	130. 5–137
Sandstone, calcareous; contains silt, coarse gravel, root casts, and dark-colored minerals	137. 5–147

30-46-36bb1

Soil: Silt; contains calcareous grains and roots	0–2
Silt; contains calcareous grains	2–4
Silt, moderately sandy; contains calcareous grains	4–8
Caliche with silt lenses, light yellow-brown	8–13. 7
Silt; contains calcareous grains and siltstone	13. 7–20
Caliche intermixed with silt	20–24
Silt; contains abundant calcareous fragments	24–27
Sandstone, very fine grained, in part siltstone, medium-brown; contains calcareous areas and root casts	27–38. 5
Silt, very sandy with some sandstone, medium-brown	38. 5–45
Sandstone, silty, moderately consolidated; contains root casts	45–48
Silt; contains sandstone grains, calcium carbonate, and clay	48–72

TABLE 4.—*Records of wells in the Mirage Flats area, Nebraska*

Well number: See p. BB7 for description of well-numbering system.
Depth of well: Reported depths below land surface are given in feet; measured depths are given in feet and tenths.
Type of pump: Cy, cylinder; J, jet; N, none; T, turbine.
Type of power: D, diesel; E, electric; G, gasoline or tractor fuel; H, hand; N, none; P, propane; W, wind.
Type of casing: P, iron or steel pipe; Pl, plastic pipe.
Measuring point: Edp, end of discharge pipe; Hib, hole in base; Ls, land surface; Tc, top of casing; Tp, top of platform.
Altitude above mean sea level: Altitudes interpolated from topographic maps are given in feet; altitudes determined by altimeter are given in feet and tenths; altitudes determined by spirit levels are given in feet, tenths, and hundredths.
Depth to water: Reported depths are given in feet below land surface; measured depths are given in feet and hundredths.
Use of water: D, domestic; I, irrigation; N, none; O, observation well; S, stock.
Remarks: Ca, chemical analysis made of water; L, log of well given in table 3.

Well	Owner or user	Year drilled	Depth of well below land surface (feet)	Type of pump	Type of power	Diameter of casing (inches)	Type of casing	Measuring point			Static water level		Drawdown (feet)	Yield (gpm)	Use of water	Remarks
								Description	Distance above or below (−) land surface (feet)	Altitude above mean sea level (feet)	Depth to water below measuring point (feet)	Date of measurement				
29–45– 2bc	Vernon W. Jacobson	1951	90	J	E	6	P				50	7–24–61			D, S	Ca
3ad	Norman Stouffer	1955	78.0		E			Tc	−5.0	3,730	52.20	7–24–61			D, S	
3cb	H. W. Carroll	1949	90	J	E	6	P	Tc	−5.0	3,730	37.30	7–24–61			D, S	
5cd1	Don Murray	1953	86.6	Cy	W	6	P	Tc	.4		36.50	7–20–61			S	
5cd2	do	1957	200	T				Hib	0		39.17	10–18–61			I	
5da	do	1953	70.4	J	E		P	Hib	−5.0	3,751.5	34.99	7–20–61			D, S	
6bb	Wallace B. Mills		54.0	Cy	W	6		Hib			17.80	7–28–61			S	
7bb1	V. O. Feodersen		120	J	E	6	P				50	7–20–61			D	
7bb2	Whiting, Agler, and Feodersen		210	T	D	18	P	Edp	4.0		61.35	10–18–61			I	
7cc	U.S. Geol. Survey	1960	93.0	N	N	1¼	P	Tc	3.0	3,788.67	60.42	6–21–60			O	L
8bb	A. J. Peters	1926	80	Cy	E	5	P	Tc	−4.0		30.38	7–20–61			D,S	Ca
8db	W. R. Merrigan	1949	100	J	E	6					46	7–20–61			D,S	
8dd1	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	4.0	3,747.14	43.71	6–15–60			O	L
8dd2	W. R. Merrigan	1949	94.0	N	N	6		Tc	−5.0	3,742.70	37.42	7–20–61			D,S	
9ac	M. D. Bayless	1946	78.0	J	E	6	P	Tc	−5.5		38.60	7–23–61			D,S	
9ad	Dale M. Gering	1949	82.6	J	E			Tc	−6.0		40.30	7–23–61			D,S	
9bb1	H. H. Straetker	1961	255		E	18		Hib	1.0	3,756.8	51.09	8–29–61			I	
9bb2	do	1959	172			18		Tc	.0	3,756.7	51.21	10–18–61			I	
9cc	A. M. Letcher	1957	190		G	16	P	Hib	.0	3,740.83	43.33	10–17–61		900	I	
9dd	William Stanley	1949	85.0	J	E			Tc	.2	3,733.65	49.47	7–23–61			D,S	
10ba	L. T. Pieper	1961	228		G	18	P	Hib	1.5		48.43	7–28–61			I	
10bb	Norman Stouffer	1949	81.0	J	E			Tc	−5.0		42.32	7–24–61			D,S	
10cc	Everett Rinker	1961	183		E	16	P	Hib	.0		58.06	10–17–61			I	

10cd	do	1949	75	J	E	6		Tc	−7.0		45	6– –61			D,S	
10dd	Leo Weyers	1949	94	J	E			Tc	−6.0		61	7–23–61			D,S	
15aa	Charles Letcher	1956	100	Cy	W	5					60				D,S	
15ab1	Gerald Letcher	1960	100	J	E	5					60				D,S	
15ab2	do	1941	100	Cy	W	5		Tc	.5		63.89	7–24–61			D,S	
16aa	U.S. Geol. Survey	1960	71.3	N	N	1¼	P	Tc	3.0	3,735.65	50.48	6–21–60			O	L
16ad	Carl Jungck	1946		J	E	6	P	Tc	.5		58.14	7–22–61			D,S	
16ba1	A. M. Letcher	1946	75.7	J	E	6	P	Tc	−6.0	3,739.12	42.63	7–21–61			D,S	
16ba2	Charles Letcher	1956	190	T	G	16	P	Hib	.0		57.23	7–21–61			I	
16bc1	Keith Davis	1946	85.0	J	E	6		Hib	−5.0		51.53	7–22–61			D,S	
16bc2	do	1961	208		G	18	P	Hib	.0		56.65	10–17–61		500	I	
16dc	William E. Jungck			J	E	6		Tc	1.0		54.87	7–22–61			D,S	
17ba	Carl Thorson	1948	67	J	E			Hib	−6.5	3,747.23	31.04	7–21–61			D,S	
17bb	H. B. Richardson	1961	150		E	18	P	Hib	.0	3,750.96	36.98	10–17–61			I	
17bc	do	1946	66.0	J	E	6	P	Tc	−6.0		31.64	7–21–61			D	
17da	Wallace Mills	1961		J	E			Tc	.7		61.33	7–22–61			D,S	
18aa	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	2.7	3,753.41	36.68	6–21–60			O	L
18bc	Dan Ainslie	1947	100	J	E	6					32				D,S	
19aa	Joe Shaughnessy	1948	71.0	J	E			Tc	−6.0		58.57	7–23–61			D	
19ab1	Shaughnessy, Reitz	1956	230		D	18									I	
19ab2	H. Reitz	1948	110	J	E	6	P				58				D,S	
19ac	Joe Shaughnessy		100+	J	E	6	P	Tc	.6		69.30	7–23–61			D,S	
19bc	D. G. Ivarson	1946		Cy	H,E			Tc	.0		55.14	7–23–61			D	
19bd	Floyd Langford	1946	76.0	J	E	6	P	Tc	−6.5		50.36	7–23–61			D,S	
20bb1	Henry Unverzagt	1957			D										I	
20bb2	Ed W. Charles		85	Cy	H	6		Tc	.5		68.52	7–21–61			S	
20bb3	Ed W. Charles and L. Trupp	1954	200	T	C	18	P	Hib	.0		62.51	10–17–61			I	
29–46– 1bc	A. Lee Alcorn	1950	62.0	Cy	W	6		Tc	.3	3,700	36.08	7–29–61			S	
2aa	do	1956	185	T	E	18		Hib	1.0		36.21	10–18–61			I	
2bb	Oliver Harris		74.0	Cy	W			Tc	.6		41.60	7–29–61			S	
3ab	James Ehrman			Cy	W,H	3		Tc	.4	3,812.21	46.01	8– 2–61			N	
3ba	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	3.0	3,820.76	50.25	6–20–60			O	L
3cd	Walter Barnes	1954	102		G	16		Hib	.0		41.56	10–18–61			I	
3dc1	do		57.0	J	E			Tc	.0		39.22	8– 2–61			D,S	S
3dc2	Raymond Terrell		71.0	J	E			Tc	−7.5		36.20	8– 2–61			D,S	
4ba	do		65.0	Cy	W			Tc	.0	3,841.13	60.07	8– 2–61			N	
4ca	Alfred Deans	1961	125		G			Hib	.5	3,839.80	59.61	10–18–61			I	
4cc	do		100+	J	E	8		Tc	−9.0		48.85	8– 2–61			D,S	
4dc1	George Glenn	1946	111	J	E	6	P	Ls	.0		56.23	10–17–57			D,S,O	
4dc2	do	1961	184	T	E	18		Hib	.5		56.65	10–18–61		500	I	
4dd	Raymond Terrell		116.0		G			Tc			48.91	8– 2–61			I	
5ca	Edward Mortensen		210	T	E	18	P	Hib	1.5		77.72	10–18–61			I	
5cc	do	1959	213	T	E	18		Hib	1.0		78.67	10–18–61		1,000	I	Ca
8da	E. N. Christophersen	1920	72.0	Cy	W	5		Hib	.0	3,829.25	59.29	8– 3–61			D,S	
8dd	U.S. Geol. Survey	1960	93.0	N	N	1¼	P	Tc	3.0	3,827.94	57.84	6–20–60			O	L
9aa	A. A. Clapp	1948	80	J	E			Tc	−7.5		42.58	8– 2–61			D,S	
9ab	do	1961	178		G	18	P	Hib	.5		56.44	10–18–61			I	
9bb1	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	4.0	3,838.96	57.26	6–20–60			O	L
9bb2	Duane Sandberg	1961	210	T	E	18	P	Hib	2.0	3,834.33	55.94	10–18–61		900	I	Ca
9cb1	R. L. Alcorn	1956		T	G	18	P	Hib	1.0		56.29	10–18–61			I	
9cb2	do			J	E			Tc	1.2	3,829.01	58.70	8–18–61			D	
9db	M. S. Gibson	1956	204	T	D	18		Hib	1.0		52.84	10–18–61			I	
10aa1	U.S. Geol. Survey	1953	100	N	N	6	P	Tc	1.5	3,796	40.22	9–30–53			O	L

TABLE 4.—*Records of wells in the Mirage Flats area, Nebraska*—Continued

Well	Owner or user	Year drilled	Depth of well below land surface (feet)	Type of pump	Type of power	Diameter of casing (inches)	Type of casing	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Static water level: Depth to water below measuring point (feet)	Static water level: Date of measurement	Drawdown (feet)	Yield (gpm)	Use of water	Remarks
29-46-10aa2	Mirage Flats Irrigation Dist.	1946	105	J	E	7					42				D	Ca
10ad	Morris Bayless			Cy	H			Tc	.4		43.20	8-2-61			N	
10ba	A. A. Clapp			J	E	6		Tc	−5.5		39.00	8-2-61			D	
10bc	H. H. Smith	1956	200	T	D	18		Hib	.0		51.68	10-18-61			I	
10cb	do	1943	98	J	E	6		Tc	−6.0		41.84	8-3-61			D	
10cd	C. M. Andreasen	1919	100	Cy	W	6		Tc	1.0	3,821.54	64.04	8-7-61			D,S	
11cb	St. Peter's Ev. Luth. Church	1950	100+	J	E			Tc	−6.5		36.51	7-28-61			D	
11cc	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	2.5	3,787.12	37.22	6-17-60			O	L
11dc	Andrew Young	1946		Cy	H	6	P	Tc	.5		43.00	5-3-50			D,O	
12dc1	Mirage Flats School Dist. #30		100+	J	E			Tc	−6.0	3,787.65	49.44	7-28-61			D	
12dc2	John Haas		86.0	J	E			Tc	−7.0	3,788.07	47.71	7-28-61			D,S	
12dc3	U & I Sugar Beet Refinery		100+	Cy	H			Hib	.0	3,787.93	56.29	7-28-61			D	
12DD1	Floyd Stone	1961	180	T	G	18		Hib	.3	3,787.02	51.92	7-20-61			I	
12dd2	do	1949	110	J	E	18	P				60				D,S	
13bb1	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	3.0	3,778.57	40.36	6-21-60			O	L
13bb2	C. W. Gibson and E. J. Terrell	1955	204	T	E	18		Hib	.0	3,792.60	59.11	10-17-61			I	Ca
13cc	Nichols	1944	84.0	J	E			Tc	−6.0	3,900	42.15	7-26-61			D,S	
13cd1	R. E. Haush		91.0	J	E			Tc	1.0		50.35	7-26-61			D,S	
13cd2	C. W. Gibson and E. J. Terrell	1955	204	T	E	18					60				I	
14ba	Eldon Schomp		75.0	J	E			Tc	−5.5	3,779,22	29.03	7-28-61			D	
14bb	Leon Glenn	1961	130	T	E	8	P	Hib	.0	3,782.24	32.70	10-17-61			I	
14bc	Eldon Schomp	1955		T	D	18	P	Hib	.0		38.19	10-17-61			I	
14ca	J. F. Evans	1953	75.0	Cy	W	6	P	Tc	.5		42.11	7-26-61			S	
14cb	do		78.0	Cy	H			Tc	.3		40.16	7-28-61			S	
14dc	James Fowler		90	Cy	W						38				D,S	
15aa	Kenneth Peck	1948	51.0	Cy		6	P	Tc	−5.0	3,789.22	28.53	8-3-61			N	
16aa	U.S. Geol. Survey	1960	93.0	N	N	1¼	P	Tc	3.0	3,816.37	53.83	6-17-60			O	L
24ab	Adolph and Alex Hessler	1955	212	T	D	16		Hib	.0		57.28	7-26-61			I	
24ad1	Kenneth Pyle	1946	95.0	Cy	W	6	P	Tc	1.3		63.20	7-23-61			S,O	
24ad2	Adolph Hessler	1945	72.0	J	E	6	P	Tc	−5.0		56.48	7-26-61			D,S	
47- 9aa				T	E			Hib	1.5	3,902.2	42.68	7-18-62			I	
48- 4cd					W			Tc	.0	4,118.9	159.35	7-18-62			S	

30-44-19ac			139.0	Cy	W	6		Tc	1.6	3,778	119.72	8- 1-61			S	
19cb			125.0	Cy	W	8		Tc	1.5	3,774	110.30	7-12-61			S	
20dc			186.0	Cy	W	6		Tc	1.0	3,779	140.48	8- 1-61			S	
21			130.0	N	N			Tc	−1.5		121.40	8- 1-61			N	
45-4cd	May Prokop	1915	90	J	E	5		Tc	−7.0		12.16	8- 4-61			D,S	
5bb	Ira Aspden	1948	70	J	E	6		Tc	−6.0	3,770	27.90	8- 5-61			D,S	
6da				Cy	W			Tp	.0	3,770	29.24	8- 5-61			D,S	
7bb1	C. W. Lembrich	1926		Cy	E			Tp	1.0	3,767	16.75	8- 4-61			D,S	
7bb2	do	1942	30	Cy	E			Tp	.4	3,767	16.27	8- 4-61			D	
7cb	do	1937	71.0	N	N			Tp	.5		39.84	8- 4-61			N	
7dd	U.S. Geol. Survey	1961	61.9	N	N	1¼	P, Pl	Tc	4.0	3,767.13	29.05	7-26-61			O	L
8	W. A. Christians	1939	122	T	D	18									I	
8ac	Richard Huntington	1961	114	T	D						40				I	
8ad	do			Cy	W, H			Tc	.5		17.27	8- 4-61			D,S	
8bb			31.5	Cy	W	6		Tc	1.0		14.42	7- -61			S	
8cb1	W. A. Christians	1933	80	T	D	18	P	Ls	.0		22	-50	37	1,500	I	
8cb2	do	1939	100	Cy	H	6									D	Ca
8cb3	do	1942	80	T	D	18	P	Hib	.5		37.48	8- 4-61	37	1,500	I	
8da	do	1960	113	T	D	16									I	
8db	do	1938	60	Cy	W	18		Tp	.5	3,746	18.10	8- 4-61			S	
8dc	do		38.0	T	G			Hib	.5	3,750	19.59	7-17-61			I	
9ca1	Curtis McConnaha	1948	65	Cy	W						30				D,S	
9ca2	do	1940	20	Cy	W						15				S	
13db			134.0	Cy	W			Tc	2.0		121.51	7-31-61			S	
14cc1	U.S. Geol. Survey	1961	79.0	N	N	1¼	P	Tc	4.0	3,753.3	45.40	10-10-61			O	L
14cc2	Robert Schildhauer (Estate)		78.0	Cy	G	4		Tc	1.0	3,757	50.47	7-31-61			S	
15ab	B. H. Petersen		60	J	E			Tp	−6.0		22.98	7-19-61			D,S	
15bb	Paul Burrows	1923	68	Cy	W				45+						D	Ca
15bc	do			N	N	8		Ls	.0		53.21	7-12-61			O	
15cc	U.S. Geol. Survey	1961	111.0	N	N	1¼	P, Pl	Tc	5.1	3,767.3	49.80	7-26-61			O	L
16ac	Paul Burrows	1961	90.4	N	N	6		Tc	1.0		42.84	7-12-61			I	
16cd	do		79.8	N	N	8		Tc	.7	3,777	56.40	7-12-61			S	
17cd	Marjorie M. Burrows		70.4	Cy	W	6		Tc	.0	3,761.1	26.86	7-11-61			S	
17da	Milton Burrows		65.0	Cy	W	6	P	Hib	2.0	3,749	24.56	7-19-61			N	
17dd	do	1961	152	T	G	16		Tc	.5		47.60	7-11-61			I	
18bb	George Mattson			T	D			Hib	.0	3,785	33.24	10-18-61			I	
18dd	U.S. Geol. Survey	1961	61.9	N	N	1¼		Tc	4.0	3,760.5	22.91	7-26-61			O	L
19aa			65	Cy	W	6		Tc	.0	3,764.6	26.10	7-11-61			S	
19ca	Ben Whitney	1961	79	N	N	6		Tc	6.5		54.80	7-17-61			S	
19da	do	1960	60	Cy	E	6					40				D	Ca
19dc	do	1955	170.0	T	D	16		Hib	.0		41.46	7-17-61			I	
20aa	Milton Burrows				W	6		Tc	1.5	3,772.1	37.30	7-11-61			S	
20ab	do	1949	146	T	G	18		Tc	.0	3,762.4	32.88	7-12-61	30	1,000	I	
20dd	Lewis Dorhorst		15.0	Cy	W	6	P	Tc	.0		7.16	7-20-61			S	
21bb	U.S. Geol. Survey	1961	112.0	N	N	1¼	P	Tc	4.0	3,777.8	52.26	7-26-61			O	L
21bc	Marjorie M. Burrows	1949	87.8	Cy	W	6		Tc	1.5		27.24	7-11-61			I	
21cc	do		28.6	Cy	W	8		Tc	.0	3,725	4.04	7-12-61			S	
22aa	Robert Schildhauer (Estate)	1946	81	Cy	W	6					18				S	
22bc			92.6	N	N	6		Tc	.5	3,754.7	39.08	7-12-61				
23ab			120.0	Cy	W			Tc			101.67	7-31-61			S	
23bb	Robert Schildhauer (Estate)	1954	90+	Cy	G	6		Tc	.7		56.20	7-31-61			S	
24ba			89.3	Cy	W			Tc	.6		66.89	7-31-61			S	
24da			125.0	Cy	W			Tc	1.2		88.36	8- 1-61			S	

TABLE 4.—*Records of wells in the Mirage Flats area, Nebraska*—Continued

Well	Owner or user	Year drilled	Depth of well below land surface (feet)	Type of pump	Type of power	Diameter of casing (inches)	Type of casing	Measuring point: Description	Measuring point: Distance above or below (−) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Static water level: Depth to water below measuring point (feet)	Static water level: Date of measurement	Drawdown (feet)	Yield (gpm)	Use of water	Remarks
30-45-27ba	Charles R. Marcy		77.0	N	N	6		Tp	1.0	3,743.5	45.65	7-26-61			N	
27db1	do			Cy	W			Tc	1.0		3.80	7-26-61			N	
27db2	do	1954	56.0	J	E	6		Tc	−5.0	3,726.9	24.17	7-26-61			D	
28ad	Paul Schreurs	1940	22.0	Cy	W	6		Tc	1.0	3,715.1	7.26	7-26-61			S	
28cd	do	1921	67.2	J	E	5		Tc	−5.5		45.46	7-26-61			D,S	
29da	Lewis Dorhorst	1911	93.7	J	E			Tc	−5.5		36.06	7-20-61			D,S	
30aa1	U.S. Geol. Survey	1961	38.0	N	N	1¼	P, Pl	Tc	4.0	3,768.96	28.25	7-26-61			O	L
30aa2	Joe Schneider	1950	76.0	J	E	6		Tc	−5.0	3,761.3	19.80	7-17-61			D	
30aa3	do	1959	73.0	Cy	W	6		Tc	.5	3,760.1	16.73	7-17-61			S	
30ad	do	1957	165	T	P			Hib	.0	3,774.4	34.08	8-15-61			I	
31bb	W. A. Christians		56.0	Cy	W	6	P	Tc	.6	3,770.5	23.94	7-19-61			D	
32ab	City of Rushville			Cy	W			Tp	1.0		43.33	10-18-61			S	
33cd	Marcy Bros	1881		Cy	W			Tc	.0		5.25	9- 5-61			S	
34aa	do	1954	204	T	D	16		Hib	.0		69.03	10-18-61			I	
34ca1	G. E. Moser	1957		T	D			Hib	.0		55.75	10-18-61			I	
34ca2	do	1945	73.0	Cy	W			Tc	.5	3,738	54.69	7-25-61			S	
34dd	do			Cy	W			Hib	1.5		46.16	7-25-61			S	
35bb	Marcy Bros	1959	225	T	D	16		Hib	.0		62.72	10-18-61			I	
30-46-8cd	Louis Mendenhall		131.0	Cy	W	6		Tc	.0	3,931	114.83	7-15-61			S	
11db	do	1951	285			16		Ls	.0		31.29	1-11-53		600	I	Ca
15db	Dale Kutschara	1947	65	Cy	W	6				3,817	30				S	
19bc			133.0	Cy	W	6		Tc	1.0		127.44	7-15-61			S	
20ab	O. J. Horn	1949	158.0	Cy	W	6		Tc	.0	3,930	128.64	7-14-61			S	
20bb	Alfred Dean		159.0	Cy	W	6		Tc	1.5	3,950	135.30	7-14-61			S	
20cb	Ollie Leimbach		147.0	Cy	W	6		Tc	1.0	3,936	123.15	7-14-61			S	
21ca	O. J. Horn	1960	180.0	Cy	W	6		Tc		3,923	129.76	7-14-61			S	
23bc	Gene Walgren	1955	100	J	E	6				3,810	29				D	
23da	U.S. Geol. Survey	1960	151.8	N	N	1¼	P	Tc	3.0	3,858.9	95.19	6-22-60			O	L
24bb1	M. T. Heesacker	1946	120	Cy	W	8	P			3,867.1	105	7-11-61			S	
24bb2	do			N	N	6	P	Tc	.0	3,862.3	100.88	7-11-61			N	
25bb	Harold R. Ball	1950	94.0	Cy	W	6		Tc	.5	3,792.5	33.06	8-26-61			S	
25cc	Paul Rasmussen		94.0	Cy	W			Tc	.6	3,787.6	31.48	7-31-61			S	
26dc			100.0+	Cy	W			Tc	.0	3,800	40.34	7-21-61			S	

35aa	Lawrence Frimann	1959	224	T	G			Hib	1.5	3,799	40.68	10-18-61			I	
35bb	Roger H. Richardson		147	Cy	E					3,840	50				D, S	
35dd	Francis Kleve	1954	135	T	G	16		Hib	.0	3,775	18.86	10-18-61			I	
36ad	J. J. Johnson	1949	90	J	E	6		Tc	1.5	3,770	22.15	7-31-61			D, S	
36bb1	U.S. Geol. Survey	1960	75.0	N	N	1¼	P	Tc	2.5	3,783.9	25.79	6-21-60			O	L
36bb2	Gerald Frimann		240	J	E										D, S	Ca
36dc	Frank Kuskie	1950	90	J	E			Tc	−6.5	3,770	15.35	7-29-61			D, S	
36dd	do	1954	140	T	C	16		Hib	.4	3,760	23.95	7-29-61			I	
30-47-13ad			194.0	Cy	W			Tc	2.0		118.42	7-15-61			S	
48-4ab	Henry Stephenson	1962	356			14		Ls	.0	4,262.0	143.00	7-17-62			I	
49-21da	George Mazanec							Tc	.0	4,200.2	71.24	7-19-62			S	
31-47-28bb			52.0		E			Tc	2.4	4,008.4	13.42	7-17-62			S	
48-8bb					W	6		Ls	.0	4,163.7	196.33	7-17-62			S	
49-34bc					W	6		Tc	.0	4,337.7	137.95	7-18-62			S	
32-47-33ba					W	6		Tc	.0	4,119.8	199.60	7-17-62			S	
49-36dd	State of Nebraska		25	T				Hib	2.0	3,837.3	11	7-17-62			D	

TABLE 5.—*Periodic water-level measurements in selected wells in the Mirage Flats area, Nebraska*

[In feet below land-surface datum]

Date	Water level	Date	Water level	Date	Water level
		29-46-4dc1			
1950		*1952*		*1955*	
May 2	61.34	Jan. 29	58.45	July 12	57.77
July 19	60.93	Apr. 2	58.66	Oct. 18	55.45
Oct. 4	59.20	June 25	58.94		
Dec. 28	59.70	Oct. 6	56.87	*1956*	
1951		*1953*		Mar. 13	56.18
				Oct. 12	57.87
Apr. 20	60.28	Jan. 14	56.55		
May 12	60.28	Mar. 30	57.17	*1957*	
July 30	59.64	Oct. 30	55.94		
Oct. 3	58.23			Oct. 17	56.23
		1954			
		June 18	57.41		
		Sept. 18	57.32		
		29-46-10aa1			
1953		*1955*—Con.		*1958*	
Sept. 30	38.66	Nov. 30	37.51	Jan. 31	37.57
Oct. 31	38.54	Dec. 31	37.57	Feb. 28	37.59
Nov. 30	38.51			Mar. 31	37.69
Dec. 31	38.46	*1956*		Apr. 30	37.76
				May 31	37.77
1954		Jan. 31	37.76	June 30	37.70
		Feb. 29	37.85	July 20	37.69
Jan. 31	38.57	Mar. 31	37.80	Sept. 30	36.69
Feb. 28	38.55	Apr. 30	38.02	Oct. 31	36.53
Mar. 23	38.61	May 31	38.18	Nov. 30	36.60
Apr. 30	38.73	June 30	38.19	Dec. 31	36.56
May 29	38.95	July 31	38.19		
June 19	38.88	Aug. 31	38.10	*1959*	
July 31	38.62	Oct. 31	38.12		
Aug. 31	38.19	Nov. 30	38.20	Jan. 31	36.74
Sept. 30	37.96	Dec. 31	38.31	Feb. 25	36.73
Oct. 31	37.85			June 30	37.25
Nov. 30	38.02	*1957*		July 31	37.11
Dec. 31	37.88			Aug. 31	36.58
		Jan. 31	38.30	Sept. 30	36.33
1955		Feb. 28	38.43	Oct. 31	36.18
		Mar. 31	38.47	Nov. 30	36.18
Jan. 31	37.91	Apr. 10	38.53	Dec. 31	36.09
Feb. 28	38.03	June 30	38.45		
Mar. 31	37.99	July 31	38.42	*1960*	
Apr. 30	38.07	Aug. 31	38.00		
May 29	38.28	Sept. 30	37.25	Jan. 31	36.25
June 30	38.20	Oct. 31	37.37	Feb. 29	36.3
July 31	38.12	Nov. 30	37.52	Mar. 31	36.1
Aug. 31	37.67	Dec. 31	37.57	Apr. 30	36.15
Sept. 30	37.55			May 20	36.31
Oct. 31	37.45				

TABLE 5.—*Periodic water-level measurements in selected wells in the Mirage Flats area, Nebraska*—Continued

[In feet below land-surface datum]

Date	Water level	Date	Water level	Date	Water level
1960—Con.		*1961*—Con.		*1962*	
June 30	36.52	Feb. 28	36.06	Jan. 31	36.17
July 31	36.16	Mar. 31	36.15	Feb. 28	36.29
Aug. 31	36.17	Apr. 30	36.33	Mar. 31	36.39
Sept. 30	36.01	May 31	36.39	Apr. 30	36.49
Oct. 31	35.89	June 30	36.54	May 31	36.46
Nov. 30	35.95	July 31	36.68	June 30	36.25
Dec. 31	35.91	Aug. 31	36.60	July 31	36.27
1961		Sept. 30	36.16	Aug. 31	35.66
Jan. 31	35.95	Oct. 31	36.05	Sept. 30	35.35
		Nov. 30	36.00	Oct. 31	35.20
		Dec. 31	36.19	Nov. 30	35.25
				Dec. 31	35.27
29-46-11dc					
1950		*1952*—Con.		*1956*	
May 3	42.50	June 25	39.84	Mar. 13	37.62
July 19	42.12	Oct. 6	38.51	*1957*	
Oct. 4	40.29	*1953*		Oct. 18	36.93
Dec. 28	40.39	Jan 7	38.20	*1959*	
1951		Oct. 30	37.71	Oct. 8	35.43
Apr. 20	40.57	*1954*			
May 12	40.79	June 18	38.52		
July 30	40.66	Sept. 18	37.66		
Oct. 3	39.75	*1955*			
1952		Oct. 17	37.30		
Jan 29	39.25				
Apr. 2	39.54				
29-46-24adl					
1950		*1952*		*1958*	
May 2	64.32	Jan. 29	63.54	Sept 10	60.76
July 19	64.46	Apr. 2	63.57	*1961*	
Aug. 29	36.60	*1954*		July 23	61.90
Oct. 4	63.10	June 18	63.28	Oct. 10	62.98
Dec. 28	63.62	Sept. 18	61.81	*1962*	
1951		*1956*		June 5	62.90
Apr. 20	64.23	Mar. 13	62.06	Oct. 19	61.00
May 12	64.38				
July 30	64.23				
Oct. 3	63.59				

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UNITED STATES DEPARTMENT OF THE INTERIOR

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