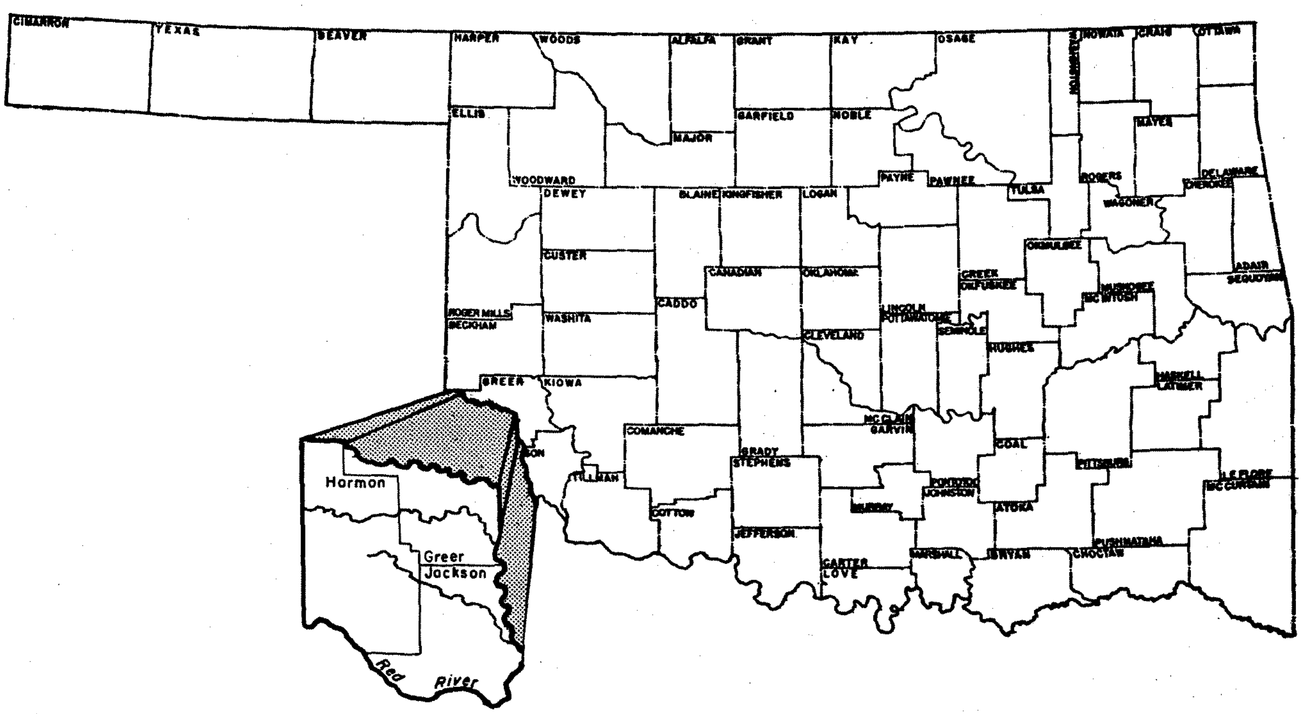
Ground Water Resources Harmon and parts of Greer and Jackson Counties, Oklahoma



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The report describes the geology of Harmon County and adjacent parts of Greer and Jackson Counties; it describes and interprets the geologic and hydrologic features that determine the source, movement, quantity and quality of ground water; and it assembles basic ground-water data that will be useful in planning and developing the ground-water resources of the area.

Oklahoma Water Resources Board

GROUND-WATER RESOURCES OF HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLAHOMA

By

C. E. Steele and J. E. Barclay

U.S. Geological Survey

Prepared by

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By C. E. Steele and J. E. Barclay

ABSTRACT

The area described in this report is in the southwest corner of Oklahoma and in the drainage basin of Red River. It includes Harmon County and adjacent parts of Greer and Jackson Counties--an area of about 1,170 square miles. The principal aquifer is in the Dog Creek Shale and the Blaine Formation of Permian age, but in parts of the area other formations of Permian age and the unconsolidated deposits of Quaternary age also are sources of ground water.

The Dog Creek Shale and Blaine Formation consist of interbedded shale, gypsum, anhydrite, dolomite, and limestone, which in places are characterized by solution channels and zones of secondary porosity. Test drilling shows that the thickness of the rocks capable or potentially capable of transmitting water in suitable quantities for irrigation averages about 80 feet. The yield of an individual well is largely dependent on the number, size, and interconnection of the water-filled solution channels which are best developed within the drainage basins of the major creeks. Virtually all the water used for irrigation in the area is obtained from wells tapping solution channels.

Water levels in the aquifer respond rapidly to the infiltration of precipitation, the principal source of recharge, and to the effects of pumping, the principal form of discharge. Water levels declined significantly during 1954 and 1956, owing to subnormal precipitation and heavy irrigation pumpage. They rose several feet during 1955 and 1957 when precipitation was above normal. During the 5-year period 1958-1962, when precipitation averaged near normal, water levels declined more than 3 feet. The decline was even greater during the drought year of 1963.

Yields of wells in the Dog Creek Shale and Blaine Formation range from less than 10 gpm (gallons per minute) to more than 2,000 gpm. Sufficient water for stock needs can be obtained at most places.

The usual methods of conducting aquifer tests were not used in this investigation. Because the physical and hydrologic properties of the principal aquifer differ so widely from those that were assumed in developing the formulas for determining coefficients of transmissibility and storage, the

conventional method of making aquifer tests was not considered applicable. However, by utilizing data on quantities of water pumped and measurements of water-level decline due to pumping in selected parts of the irrigation areas, reasonable estimates of the coefficients were calculated. The coefficient of transmissibility thus determined ranged from 1.2 x 10^5 to 4.6 x 10^5 gpd/ft (gallons per day per foot) and averaged 2.6 x 10^5 gpd/ft; the coefficient of storage ranged from 4 x 10^{-4} to 3 x 10^{-2} and averaged 1.6 to 10^{-2}. The coefficient of storage of the aquifer outside the irrigation areas was assumed to be about one-third of that inside the irrigation areas, or about 5 x 10^{-3}, and the average coefficient of storage for the parts of the aquifer affected by pumping for irrigation is assumed to be about 10^{-2}.

In most places the water from the Dog Creek Shale and the Blaine Formation is so highly mineralized that it is not suitable for drinking or cooking; however, the municipal supply of Duke and Eldorado is obtained from wells tapping these formations. Much of the water for rural domestic supplies is hauled from the larger towns whose municipal-supply wells tap terrace deposits either inside or outside the report area. Although the water is highly mineralized, it is generally used for livestock and in most of the area for irrigation.

Recharge to the Dog Creek Shale and Blaine Formation in the 400,000 acres affected by pumping for irrigation is about 7 percent of the rainfall, or about 56,000 acre-feet per year. The "safe perennial yield" of the main aquifer is tentatively estimated to be about 50,000 acre-feet per year, and the amoubt of water in storage is estimated to be about 340,000 acre-feet. Water in storage was about 12,500 acre-feet less in 1962 than 5 years earlier. If a third of the water in storage can be recovered by pumping, withdrawals at the estimated rate of the "safe perennial yield" could be continued for only 2 years if no recharge occurred. Because there has been continued development of the aquifer since 1955, it is concluded that the aquifer is overdeveloped and that a drought of 2 or 3 years' duration would result in the curtailment of pumping in the area.

INTRODUCTION

Prior to 1942 the bedrock in Greer, Harmon, and Jackson Counties was believed to be incapable of yielding more than enough water for domestic and stock needs. Then, in 1942, a successful irrigation well was drilled just west of the town of Duke, and by 1955, 327 irrigation wells were known to be in use within the area described by this report. Most of these wells obtain water from solution cavities in the gypsum, dolomite, or limestone beds of the Permian bedrock.

In 1949 the Oklahoma State Legislature, recognizing the value of the ground-water resources of the State, passed the Oklahoma Ground Water Law (title 82, sec. 1001-1019 incl., Oklahoma Statutes, 1951). The Oklahoma Planning and Resources Board was assigned responsibility for making hydrographic surveys to establish the facts necessary for the adjudication of water rights. The Board was authorized to cooperate with Federal agencies in making such surveys and to accept and use the results of the work of agencies of the Federal Government. In 1957 the Oklahoma State Legislature created the Oklahoma Water Resources Board and transferred to it the functions and responsibilities previously assigned to the Water Resources Division of the Oklahoma Planning and Resources Board.

Purpose and Scope of this Investigation

Owing to the rapidly increasing use of ground water for irrigation in the area described in this report, an appraisal of the ground-water supply was needed. An investigation to determine the occurrence, quantity, and quality of the water in the Permian bedrock was made, and the results of that investigation are presented in this report.

The investigation was begun in July 1953 by the U.S. Geological Survey in cooperation with the Oklahoma Planning and Resources Board. Project work was under the general administration of A. N. Sayre and P. E. Lamoreaux, former chiefs of the Ground Water Branch, U.S. Geological Survey, and O. M. Hackett, present chief. Cooperating agencies were the Division of Water Resources, Oklahoma Planning and Resources Board (Ira C. Husky, director); and the Oklahoma Water Resources Board (Francis J. Borelli, former director, and Frank Raab, director). Stuart L. Schoff, district geologist, U.S. Geological Survey, directly supervised the field work and A. R. Leonard the completion of the report.

Location and Extent of the Area

The area investigated covers about 1,170 square miles in the extreme southwestern part of Oklahoma (fig. 1). It is bounded on the north by the north line of T. 6 N., Rs. 26 and 27 W., and by Elm Fork of North Fork Red River; on the east by the east line of Tps. 4 and 5 N., R. 22 W., and Salt

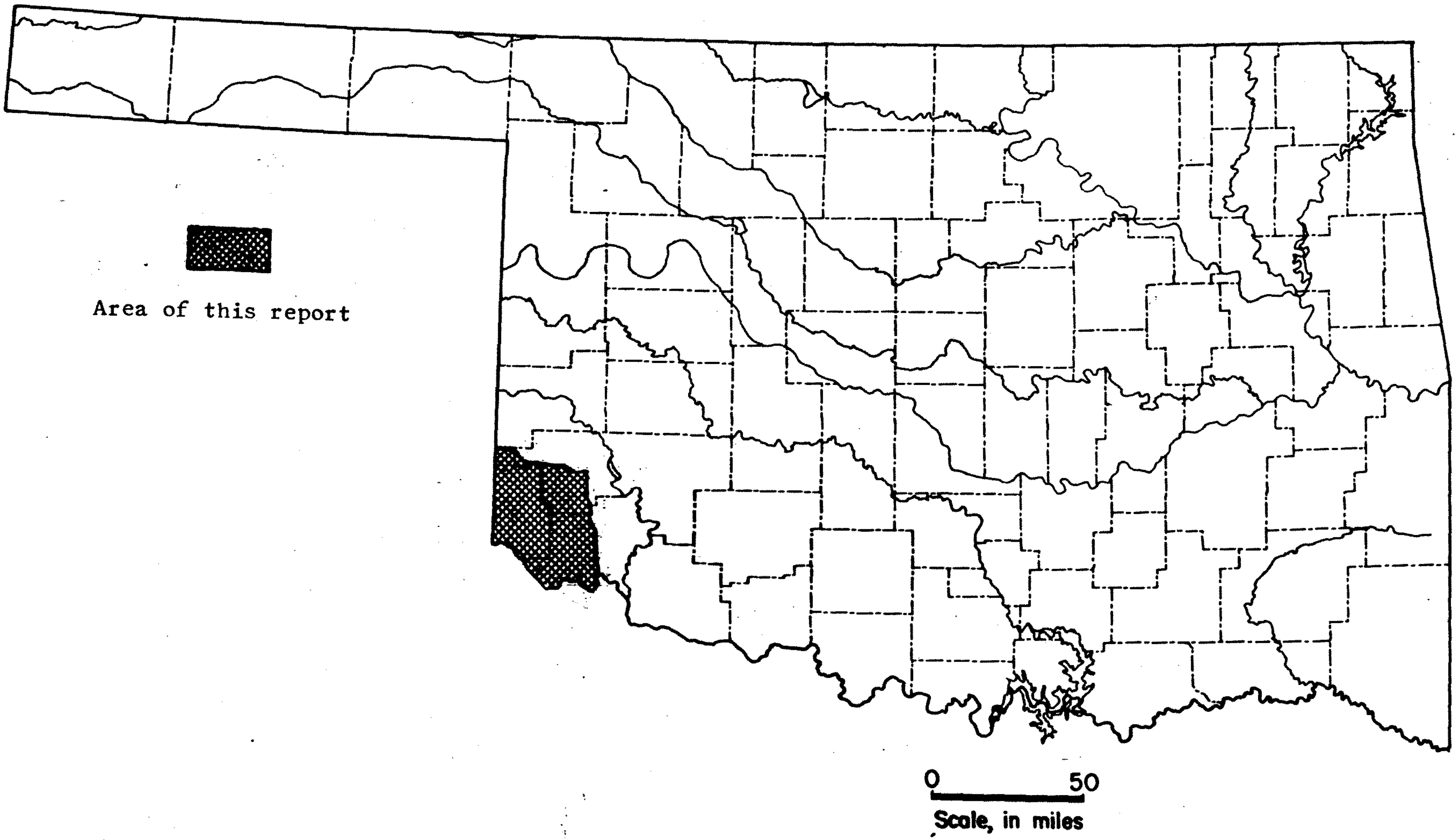

Figure 1.--Index map of Oklahoma showing area of this report.

Fork Red River; on the south by the Red River (the southern boundary of Oklahoma); and on the west by the State of Texas. The area includes all of Harmon County and adjacent parts of Greer and Jackson Counties.

Previous Work in the Area

Gould (1905) in his report on the geology and water resources of Oklahoma discussed the ground water and stratigraphy in the area of the present study. His report includes a geologic map, three measured sections of the Blaine Formation (then known as the Greer Formation), and detailed descriptions of the gypsum and limestone or dolomite beds. A table of well records includes data on 10 wells in the area and comments on the chemical quality of the water.

Reports by Clifton (1928, 1930) were concerned chiefly with the possibility of oil and gas production. He discussed briefly the drainage, topography, geologic history, and stratigraphy of the area. One of the reports also contains the logs of two wells in this area and a geologic map of Greer, Harmon, Jackson, and Tillman Counties.

Sears (1951) discussed the topography, drainage, and stratigraphy of Jackson County and most of Harmon and Greer Counties. His report includes three structure-contour maps and two figures showing subsurface correlation and structure, as determined by means of electric logs.

A report by Schoff (1948) contains brief discussions of the stratigraphy and hydrology of a small area near the town of Duke. Information on eight irrigation wells in Jackson and Greer Counties is given in a table, and the wells are discussed in more detail in the text. A chemical analysis of the water from one of the wells is included.

Methods of this Investigation

Local farmers and well drillers were interviewed and well logs were collected from them during the course of the field work. A systematic well inventory was begun in August 1953 and completed in January 1954 by personnel of the Oklahoma Planning and Resources Board and the U.S. Geological Survey. Special effort was made to obtain pertinent data on irrigation wells and other wells of large capacity. To obtain an estimate of the overall use of ground water in the area, a complete count of wells was made in two townships that were representative of the entire area--T. 5 N., R. 22 W., and T. 2 N., R. 24 W. Altogether, 776 wells and test holes were inventoried during the investigation; they are listed in appendix B.

Geologic mapping was begun in September 1953 and completed in early December 1953. Mapping was done with the aid of aerial photographs, and the contacts were drawn on township plats on a scale of one inch per mile. The base map was prepared from county highway maps, and the drainage was superimposed from aerial photographs. The Permian bedrock, terrace deposits, and alluvium were mapped as separate geologic units, but no attempt was made to subdivide the bedrock into all the recognized stratigraphic units. A distinctive gypsum bed, the Haystack Gypsum Member of the Blaine Formation, was selected as a key bed and its base was mapped to aid in illustrating the areal distribution of the Blaine and to help determine the regional structure of this formation and the overlying Dog Creek Shale. The stratigraphic sections given in appendix A also were measured in late 1953.

Several persons, especially irrigators and drillers, in the area of this investigation reported visible movement of water in wells. During the investigation there were several opportunities to both see and hear small streams of water flowing into wells. These observations suggested the possibility of rapid movement of ground water in areas where the larger solution cavities are concentrated. However, attempts to determine the rate of flow by use of a Pygmy current meter and by the use of fluorescein dye did not indicate rapid movement of ground water within the zone of saturation.

Bimonthly measurements of the water level in about 145 wells were begun in February 1954 and ended in June 1955; 44 of these wells were selected as observation wells in which measurements of water level were made every month. A field party of the Oklahoma Planning and Resources Board determined surface altitudes of test holes, wells, and selected points on the key bed by trigonometric leveling during the course of the investigation.

An inventory of pumpage for 1954 was begun in April 1954. All irrigators were interviewed in the spring and early summer of 1954, at the beginning of the irrigation season, and again in the fall of 1954 and early winter of 1955, after the irrigation season. During the pumpage inventory, records of several new irrigation wells were obtained; by the end of March 1955, a total of 327 irrigation wells had been inventoried.

Of the 127 test holes for which information was obtained, 8 were drilled as part of this investigation, 2 were drilled by the towns of Gould and Hollis, 115 were drilled by private landowners, and 2 were started by private owners, then deepened for this investigation.

Test-holes 2N-26W-3dbc1 and 4N-25W-31cdb1 were drilled by private owners in search of irrigation water and were deepened for this investigation to determine the depth to the bottom of the Blaine Formation, which is considered to be the lower limit of the strata from which large amounts of usable ground water can be obtained. Well 2N-26W-3dbc1 later was converted to an irrigation well. Test-holes 4N-24W-14bbb2, 4N-24W-17dad1, 4N-25W-23aaa1, 4N-25W-24cbc2, 4N-25W-24cbc3, 4N-25W-29aaa3, 4N-26W-14cdc2, and 4N-27W-13cdd2 were drilled to determine the depth to water not only in the terrace deposits and Whitehorse Group but also in the underlying Dog Creek Shale and Blaine Formation, but three of them were not suitable for that purpose. Each of the test holes first was drilled through the terrace deposits and Whitehorse Group and the and the depth to water measured. Then a casing was set to seal out the water in the upper rocks, the hole was deepened into the Dog Creek Shale or Blaine Formation, and if water was encountered, the depth to water in the lower strata was measured. The success of each test hole depended on the satisfactory setting and sealing of the casing to exclude water from the overlying rocks and on encountering water in the Dog Creek Shale or Blaine Formation.

A portable single-electrode logger was used to make an electric log of nine wells, but no beds could be correlated reliably from one to another of the wells.

Chemical analyses of 43 samples of ground water and 6 samples from springs were made in the U.S. Geological Survey laboratory at Oklahoma City. This laboratory is operated on a cooperative basis by the Geological Survey and the Oklahoma Water Resources Board. The analyses are given in table 7.

Well-Numbering System

The numbers used for wells and test holes in this report are based on the land-survey system of the Bureau of Land Management. In the location system the first digit of a well number indicates the township, the second the range, and the third the section in which the well is situated. The first lowercase letter denotes the quarter section (160-acre tract), the second the quarter-quarter section (40-acre tract), and the third the quarter-quarter-quarter section (10-acre tract). Within the tract wells are numbered serially, as indicated by the final digit of the number. Thus well 2N-23W-12bbd1 is the first well for which records were obtained in the SE$\frac{1}{4}$NW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 12, T. 2 N., R. 23 W. (fig. 2).

Some wells have been designated by only one or two lowercase letters. If only one lowercase letter is used, the well location is known only to the nearest quarter section. If two letters are used, the location is known to the quarter-quarter section.

Acknowledgments

The writers express appreciation to the many well owners who supplied information and permitted use of their wells for observation purposes. Walter Bell, Oscar Bryant, Ed Masters, Wilcy Moore, F. E. Motley, and Brian Putnam were especially helpful in allowing use of their wells for the experiments with fluorescein dye.

Most of the logs of wells and test holes collected for this report were made available through the cooperation of drillers, especially Jack Jenkins of Hollis and Ivan Owen of Duke.

The chemical analyses of water used in this report were made under the supervision of T. B. Dover, district chemist, and the streamflow measurements

under the supervision of S. K. Jackson, district engineer, both of the U.S. Geological Survey. The illustrations were drafted by Mrs. Grace Drennan, Oklahoma Water Resources Board. The periodic measurements of ground-water levels and much of the well inventory were by Dannie E. Spiser, Oklahoma Water Resources Board.

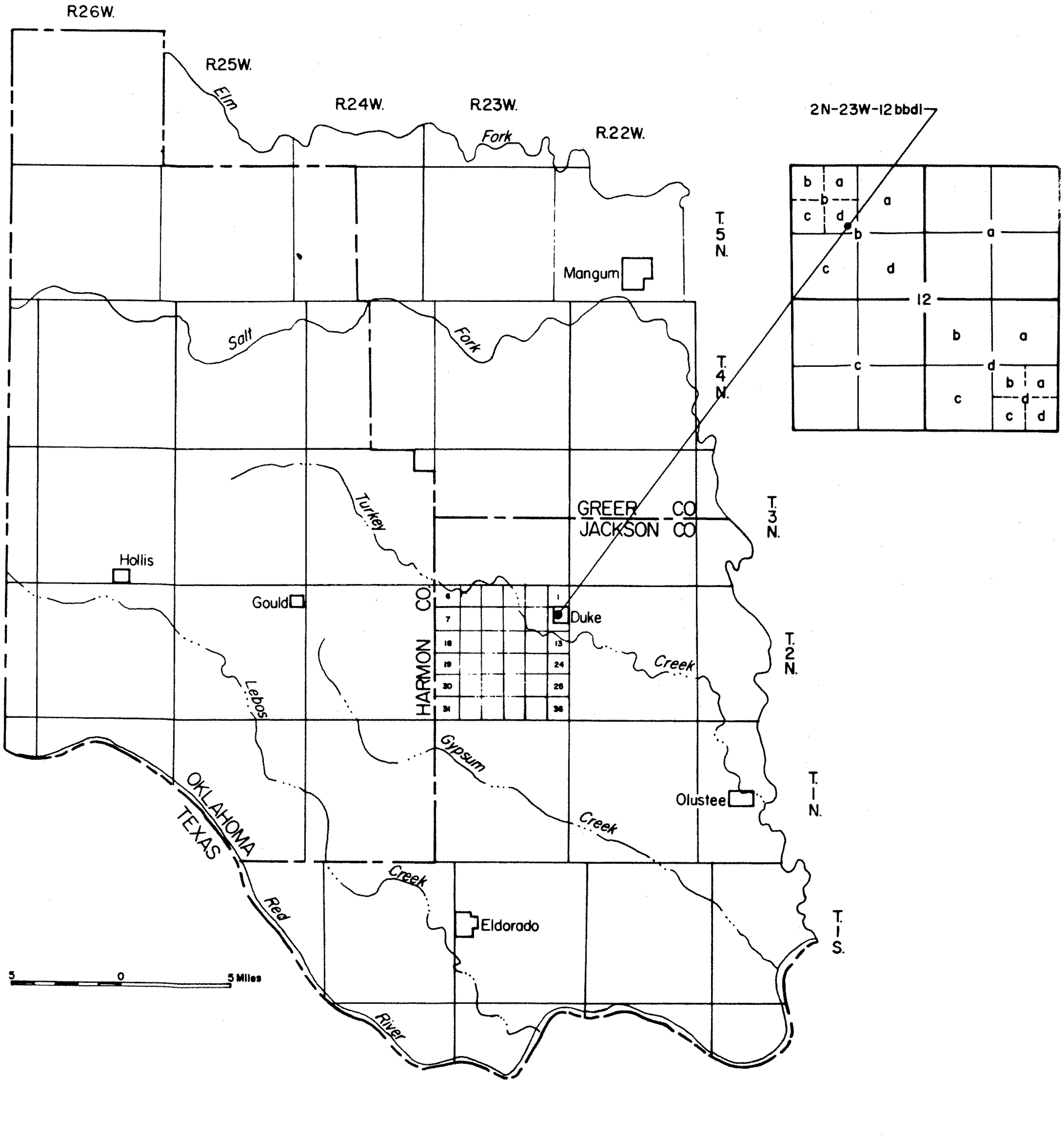

Figure 2 —Diagram showing well-numbering system used in this report.

GEOGRAPHY

Topography and Drainage

The maximum regional relief, as determined from altitudes established by a leveling party during the course of this investigation, is about 700 feet. The highest point recorded, in NE¼NE¼SE¼ sec. 16, T. 5 N., R. 26 W., has an altitude of 1,954.8 feet; the lowest point, along Gypsum Creek in the SE¼NW¼ sec. 12, T. 1 S., R. 22 W., has an altitude of 1,294.8 feet. The lowest point in the area, at the mouth of Salt Fork, has an altitude of about 1,230 feet. Although locally the relief is as much as 200 feet, it generally is much less.

The most widespread topographic form in the area is that which has been called "Gypsum Hills" by some authors (Gould, 1905; Clifton, 1928; and Sears, 1951). Gould applied the term to those areas having marked relief due to the "unequal erosion consequent upon the relatively hard ledges of gypsum which outcrop in this part of the territory and to the hard sandstone and dolomite which lie above the gypsum."

In Jackson and Harmon Counties "Gypsum Hills" topography is characterized by a series of benches supported by resistant beds. The edges of the benches slope sharply, and vegetation is sparse or absent on the slopes. Most of the escarpments are about 5 to 15 feet high and are spaced widely. Local relief is not great at most places, but along the escarpment that runs approximately north and south through R. 22 W., at points on the escarpment along the north side of the Red River, along Gypsum Creek, and along Salt Fork and Elm Fork, relief may be as much as 150 to 200 feet.

The escarpment in R. 22 W. roughly parallels the course of Salt Fork at a distance ranging from 1 to 10 miles from the stream. It becomes progressively closer to Salt Fork in an upstream direction until, along the eastward-trending part of the stream in Greer and Harmon Counties, it rises abruptly from the alluvium. In Greer County and eastern Harmon County, the resistant gypsum and limestone beds form sheer cliffs and steeply rolling hills that bound the valley on both sides.

In Rs. 25 and 26 W., the gypsum beds form sheer cliffs and steeply rolling hills along the south edge of Elm Fork valley. To the east the exposures of gypsum trend southward, away from the stream, and are partly obscured by terrace deposits.

In a few areas, such as along the drainage divide between Lebos Creek and Turkey Creek in Harmon County, drainage is not well developed and the land is flat to gently rolling. Parts of the areas mapped as terrace deposits, such as those in Rs. 21 and 22 W., along the west side of Salt Fork, and and those in the central part of T. 5 N., R. 23 W., are nearly flat. Sand dunes that range in height from about 5 to 30 feet form the dominant topography in the areas mapped as terrace deposits along the north side of the Red River, the south side of Elm Fork, and in T. 4 N., Rs. 24, 25, and 26 W.

Most of the surface is drained by nine streams, each of which has an integrated dendritic drainage pattern. These are the Red River and its tributaries: Lebos Creek, Gypsum Creek, Salt Fork, Turkey Creek, Elm Fork, Buck Creek, Fish Creek, and Mulberry Creek.

The Red River is an intermittent stream that is formed by the junction of Prairie Dog Town Fork Red River and Buck Creek about 2 miles east of the southwest corner of the State. It forms the south boundary of the area of this investigation and receives the drainage of all the area except that part along the north boundary, which is drained by Elm Fork of North Fork Red River.

Lebos Creek heads in the Texas Panhandle and flows southeastward across Harmon and Jackson Counties before joining the Red River in sec. 2, T. 2 S., R. 23 W. It is a perennial stream through the lower half of its course.

Gypsum Creek is an intermittent stream that originates in eastern Harmon County, flows southeastward through Jackson County, and joins the Red River in sec. 28, T. 1 S., R. 21 W.

Salt Fork is an intermittent stream. It heads in the Texas Panhandle and flows eastward across Harmon County and about 12 miles into Greer County before turning abruptly to flow southward through Greer and Jackson Counties. It joins the Red River in sec. 23, T. 1 S., R. 2

Turkey Creek is an intermittent stream that has its headwaters in the area of terrace deposits in T. 4 N., Rs. 24 and 25 W. It flows east-southeastward and joins Salt Fork in sec. 22, T. 1 N., R. 21 W.

The Elm Fork is a perennial stream with headwaters in the Texas Panhandle. It flows across the southwestern part of Beckham County, the northern part of Harmon County, eastward across Greer County, and empties into North Fork Red River at a point outside the report area.

Buck Creek is an intermittent stream that heads in the Texas Panhandle, flows across the extreme southwest corner of Oklahoma, and joins Prairie Dog Town Fork in sec. 7, T. 1 N., R. 26 W., to form the Red River. Only the lower 2 or 3 miles of the stream is in Oklahoma.

Fish Creek originates within the area of this investigation, in T. 5 N.. R. 25 W., and flows generally eastward for about 10 miles before emptying into Salt Fork in sec. 35, T. 5 N., R. 24 W. In the lower 2 miles of its course it has a perennial flow maintained by springs issuing from the Dog Creek Shale.

Mulberry Creek is only 5 miles long. It originates within the area of this investigation in T. 5 N., R. 23 W., and flows southward to join Salt Fork in sec. 16, T. 4 N., R. 23 W. It is a perennial stream in the lower part of its course, the flow being maintained by springs from terrace deposits.

Climate

The area has a dry subhumid climate (Thornthwaite, 1941, pl. 3). The normal annual temperature, as reported by the U.S. Weather Bureau (table 1) is 63.1°F at Hollis, and the average length of the growing season is 219 days. The mean annual precipitation is 22.05 inches at Eldorado, 22.69 inches at Hollis, and 22.99 inches at Mangum (tables 2 and 3).

Table 1.--Normal temperatures, in degrees Fahrenheit, at Hollis
(From records of the U.S. Weather Bureau)

Month	Temperature (°F)	Month	Temperature (°F)
January	40.2	July	85.5
February	44.4	August	84.9
March	51.7	September	76.3
April	62.4	October	64.9
May	71.3	November	50.4
June	81.3	December	42.4
Annual	63.1		

Table 2.--Summary of precipitation at Eldorado, Hollis, and Mangum
(From records of U.S. Weather Bureau)

Year	Precipitation, in inches			
	Eldorado	Hollis	Mangum	Average of three stations
1954	12.84	14.97	14.87	14.24
1955	31.80	25.18	30.29	29.10
1956	14.09	14.35	17.66	15.37
1957	36.05	32.10	30.95	33.03
1958	20.20	22.50	21.03	21.24
1959	24.82	28.43	26.61	26.62
1960	31.24	31.51	34.44	32.40
1961	22.42	16.79	24.39	21.21
1962	23.00	20.62	25.20	22.94
1963	14.54	14.70	14.25	14.50
10-year average	23.10	22.12	23.96	23.07
Long-term mean	22.05	22.69	22.99	22.58

Table 3.--Summary of monthly precipitation, in inches, at Eldorado, Hollis, and Mangum
(From records of U.S. Weather Bureau)

Month	Eldorado (1903-18) (1942-63) Maximum	Minimum	Mean[a]	Hollis (1922-63) Maximum	Minimum	Mean	Mangum (1892-1963) Maximum	Minimum	Mean
January	3.66	0.00		4.14	0.00	0.83	4.50	0.00	1.03
February	4.50	.00		2.38	.00	.90	4.61	.00	.95
March	5.60	.00		5.85	T	.96	6.25	.00	1.15
April	8.51	T		8.86	T	2.53	7.35	T	2.41
May	9.79	.01		12.70	.04	4.96	15.39	.91	4.74
June	8.82	T		9.65	.00	2.90	11.54	.00	2.69
July	7.70	T		8.14	.10	1.88	6.68	.00	1.61
August	10.44	.02		6.26	T	1.84	10.33	T	2.23
September	5.77	.00		8.61	.00	2.28	8.75	.00	2.24
October	11.51	.00		[illegible].06	T	1.91	15.75	.00	2.06
November	5.09	.00		2.97	.00	.76	6.03	.00	.90
December	5.03	.00		6.75	T	.94	5.00	.00	.98
Annual	36.58	11.57	22.05[a]	44.65	13.47	22.69	45.13	10.86	22.99

T Trace

[a] Average for 30 years of record

Agriculture

The economy of the report area is based on agriculture. The principal crops are cotton and wheat, but alfalfa and a variety of small grains and truck crops are becoming increasingly important as irrigation farming increases. Large parts of the area are used exclusively for grazing, and some of the cultivated land is used for grazing during the fall and winter months.

Industries

The Oklahoma Department of Commerce and Industry (1959, p. 22, 24) lists the following industrial or commercial enterprises in the area: at Hollis--a cottonseed processing plant, a machinery and equipment manufacturing company, a frozen-food plant, and a plant that manufactures handbags; at Mangum--a drainage- and irrigation-pipe manufacturer, a soft-drink bottling company, a dairy-products company, a gun shop, a feed mill, a brick and tile company, a printing and publishing company, an elevator, and a potato-chip company. Of these industries, one serves local markets, six serve State and regional markets, and two serve national markets.

There are cotton gins in both Hollis and Mangum and several in other parts of the area. In the extreme northwestern part of the area, sodium chloride salt is extracted by evaporation from waters issuing from springs in a canyon tributary to Elm Fork.

The Lone Star gasoline plant, which operated a few miles northwest of Hollis for several years, was closed in 1954.

Population

The area had a population of about 16,000, according to the 1960 census. Mangum, with a population of 3,950, is the largest city in the area. The 1960 populations of other cities and towns in the area were: Hollis, 3,006; Eldorado, 708; Olustee, 463; Duke, 333; and Gould, 241.

GENERAL GEOLOGY

The exposed rocks range in age from Permian to Quaternary. Throughout most of the area, the Permian rocks at the land surface consist of alternating layers of red and gray shale, gypsum, and limestone or dolomite, but in Tps. 5 and 6 N., R. 26 W., they consist predominantly of fine-grained red sandstone containing a few relatively thin, lenticular beds of gypsum. The Quaternary rocks consist of high-lying terrace deposits and alluvium, which underlies the bottom lands along the major streams.

The areal extent of the geologic formations are shown on the geologic map (pl. 1), and the character and water-bearing properties of each are described briefly in table 4.

Structural Summary

The structure of the bedrock in the area described in this report is related, in general, to the uplift of the Wichita Mountains to the northeast. According to Sears (1951, p. 52), the Permian rocks that are older than those exposed dip approximately 100 feet per mile southwestward. In order to determine the dip of the Dog Creek Shale and the Blaine Formation, the rocks from which most wells in this area obtain water, a key bed (the Haystack Gypsum Member of the Blaine Formation) was mapped, and the altitudes of several widely spaced points on this bed were determined by trigonometric leveling. (See section on the Blaine Formation.) The altitudes were determined for exposures in T. 1 N., R. 22 W.; T. 3 N., R. 22 W.; T. 4 N., R. 22 W.; T. 5 N., R. 23 W.; and T. 6 N., R. 26 W. On the basis of these altitudes, the regional dip of the Dog Creek Shale and Blaine Formation is about 14 feet per mile toward the south-southwest.

Small structural features are obscured by sinkhole development and the effects of local solution and collapse. The generally parallel valleys of streams, such as the Red River, and Lebos, Gypsum, and Turkey Creeks, suggest that structural features may have controlled the location of these valleys. The development of solution channels seems to be related to the surface drainge system (pl. 2) and both probably are related to structural features. However, the determination of the relations of these various features is beyond the scope of this investigation.

Permian System

The Permian rocks are the most productive source of ground water in the area. Although the towns of Duke and Eldorado obtain water from the Permian strata, the water from these rocks is rather highly mineralized and ordinarily is not used for human consumption. The Permian rocks include,

Table 4.--Generalized section of the exposed rocks in Harmon County and adjacent parts of Greer and Jackson Counties

System	Group	Formation	Thickness (feet)	Lithology and water-bearing properties
Quaternary		Alluvium	0 - 40±	Sand, gravel, silt, and clay underlying the lowlands along the major streams. Yields hard water to municipal and stock wells.
Quaternary		Terrace deposits	0 - 65±	Gravel, sand, silt, and clay underlying the terrace along the major streams and on the interstream divides. Yields hard water to domestic, stock, and municipal wells.
	UNCONFORMITY			
Permian	Whitehorse		155±	Very fine to fine-grained brick-red massive, friable sandstone. Some of the sandstone is well cemented with gypsum. Includes one or more anhydritic lenticular gypsum beds about 2 or 3 feet thick. Yields small to moederate amounts of water to domestic and stock wells.
Permian	UNCONFORMITY			
Permian	El Reno	Dog Creek Shale	100±	Reddish-brown and gray shale alternating with beds of limestone, dolomite, anhydrite, and gypsum which contain solution cavities that yield large amounts of hard water to irrigation, stock, and municipal wells.
Permian	El Reno	Blaine Formation	140	Reddish-brown and gray shale alternating with beds of gypsum, anhydrite, limestone, and dolomite. The gypsum, anhydrite, limestone, and dolomite beds contain solution cavities that yield large amounts of water to irrigation, stock, and municipal wells.
Permian	El Reno	Flowerpot Shale and Duncan Sandstone	120	Alternating layers of reddish-brown and gray shale and fine sandstone with interspersed layers of nodular gypsum that range in thickness from 1 to 6 inches. Yield small amounts of hard water to stock wells.
Permian	UNCONFORMITY			
Permian		Hennessey Shale		Alternating layers of reddish-brown and gray shale with some lenticular beds of siltstone and fine-grained sandstone. Not known to yield water to any wells in the area of this investigation.

from oldest to youngest, the Hennessey Shale, the Duncan Sandstone, the Flowerpot Shale, the Blaine Formation, the Dog Creek Shale, and the Whitehorse Group.

The principal aquifers, the Dog Creek Shale and the Blaine Formation, are composed, in parts, of beds of gypsum, limestone, and dolomite. Subsurface solution and removal by percolating waters has produced many cavities in these rocks, and these cavities yield most of the water to the many irrigation wells in the area.

Hennessey Shale

The oldest geologic formation that crops out in the area is the Hennessey Shale, which was named for exposures near Hennessey in Kingfisher County. It was described by Aurin, Officer, and Gould (1926) as a clay-shale formation underlain by the Garber Sandstone and overlain by the Duncan Sandstone. In this area, the Hennessey Shale is exposed in only a few places along the south side of Elm Fork. It is composed of alternating layers of reddish-brown and gray shale and contains some lenticular beds of siltstone and fine-grained sandstone.

The Hennessey Shale is not known to yield any water to wells in this area, but it does yield small amounts of hard water to domestic, stock, and municipal wells outside the report area.

El Reno Group

The El Reno Group consists of the strata between the top of the Hennessey Shale and the base of the Whitehorse Group. It comprises the following formations, in ascending order: the Duncan Sandstone, Flowerpot Shale, Blaine Formation, and Dog Creek Shale.

Duncan Sandstone and Flowerpot Shale

The Duncan Sandstone was named by Gould (1924, p. 326-329) for exposures near Duncan in Stephens County. In its type locality, it consists of two or three layers of ledge-forming sandstone separated by shale and ranges in thickness from 75 to 250 feet. According to Davis (1955, p. 51), the Duncan Sandstone correlates with the lower part of the Flowerpot Shale of northern Oklahoma and the San Angelo Sandstone of Texas.

The overlying Flowerpot Shale was named by Cragin (1896, p. 3, 24-27) for Flowerpot Mound in Barber County, Kansas. He described it as "chiefly highly gypsiferous varicolored clays, 150 feet thick....."

Character.--The Duncan Sandstone underlies the Flowerpot Shale, and the two formations comprise about 120 feet of strata between the Hennessey Shale, below, and the Blaine Formation, above. The Duncan Sandstone and the Flowerpot Shale were not differentiated on the Geologic map of Oklahoma (Miser, 1954) nor during this investigation. In the report area, they are exposed between the outcrop bands of the Blaine Formation and the Hennessey Shale, terrace deposits, or the alluvium along Salt Fork and Elm Fork (fig. 2). Scott and Ham (1957, p. 13) describe the Duncan Sandstone as a brown or buff, indurated crossbedded silty domomitic sandstone interbedded with buff to gray silty shale. They measured a thickness of 28 feet for the Duncan about 12 miles northeast of the area, and about $2\frac{1}{2}$ feet in sec. 23, T. 7 N., R. 23 W., about 8 miles north of Elm Fork. The Flowerpot Shale is composed of alternating layers of reddish-brown, gray and green shale interspersed with many beds of dolomite and nodular gypsum that range in thickness from 1 inch to 1 foot.

Water supply.--The Duncan Sandstone and Flowerpot Shale are not known to yield much water to wells in the area. In the eastern part of the area, a few stock wells, equipped with windmills, are drilled through the thin terrace deposits and into these formations. The water is reported to be high in sulfate and unpalatable.

Blaine Formation

Character, thickness, and correlation.--The Blaine Formation was named by Gould (1902, p. 47) for exposures in Blaine County. Gould described it as averaging 75 feet in thickness and consisting of red shale containing interbedded strata of gypsum and dolomite. According to Fay (1958) the chief distinguishing features in the type area are three massive gypsum members named, in ascending order, Medicine Lodge Gypsum, Nescatunga Gypsum, and Shimer Gypsum Members.

In the report area, the rocks that make up the Blaine Formation were first assigned by Gould (1902, p. 52-57) to his Greer division, which he described as "a thickness of from 150 to 300 feet of rocks consisting of red clays, shales, and sandstone with intercalated beds of gypsum and magnesian limestone or dolomite." The base of the division was not well defined, but the top member was given the name Delphi dolomite, which he later (1905) changed to Mangum dolomite. The five most prominent gypsum layers were named, in ascending order, the Chaney gypsum, Kiser gypsum, Haystack gypsum, Cedartop gypsum, and Collingsworth gypsum. Later, Gould (1924) provisionally correlated the gypsum members of the Blaine Formation at the type locality with the Haystack, Cedartop, and Collingsworth gypsums, respectively, of his Greer division in southwestern Oklahoma.

The Blaine Gypsum, as the name commonly is used in Texas (Sellards and others, 1933), includes, in addition to equivalents of the Blaine at the type locality, a part of the underlying Flowerpot Shale and part or all of the overlying Dog Creek Shale. However, in this report the Blaine includes the Chaney Gypsum Member, which is the lowest massive gypsum bed in the area, and, at its top, the Mangum Dolomite Member, which is well below the top of the formation as it is described in Texas. The total thickness of the formation, as thus defined, is about 140 feet. Thus, the Blaine Formation embraces the same stratigraphic units that constituted the Greer division of Gould. This usage coincides closely to the Blaine Gypsum as it is mapped on the Geologic map of Oklahoma.

The Oklahoma Geological Survey (Ham, 1958), on the basis of recent geologic work in the Carter area, has revised its classification of the Blaine Formation. As defined by Scott and Ham (1957) of that agency, the base of the Blaine is the base of the Haystack Gypsum Member and the top of the Blaine is the top of the gypsum member named Van Vacter by Scott and Ham. The Van Vacter Gypsum Member overlies the Mangum Dolomite Member but occurs only locally, and where it is absent the top of the Blaine is defined as the top of the Mangum. This definition excludes the Chaney and Kiser Gypsum Members, which, together with intervening shales, are considered by Scott and Ham to be a part of the underlying Flowerpot Shale.

The five gypsum beds and the Mangum Dolomite Member form a pronounced escarpment along the south and west sides of Salt Fork of Red River in Greer and Jackson Counties, although in Jackson County the escarpment is not as well defined as in Greer County. The escarpment is present also along the south side of Elm Fork in T. 5 N., R. 23 W., and in T. 6 N., Rs. 25 and 26 W.

The gypsum beds are mostly gray to white massive alabaster and contain many small clay-filled fissures. Solution channels as large as 1 foot in diameter can be seen in some surface exposures. In many places the beds consist largely of anhydrite and form well-defined ledges. They are not individually distinctive and cannot be identified reliably unless some underlying or overlying stratigraphic units also are exposed, so that identification can be substantiated by stratigraphic position. None of the gypsum beds is continuous laterally in surface exposures. Each either thins and disappears or is buried by rock debris from higher beds. For example, in the NW$\frac{1}{4}$ sec. 32, and the SW$\frac{1}{4}$ sec. 29, T. 5 N., R. 22 W., the the Cedartop Gypsum Member changes from a gypsum bed 3 or 4 feet thick to a 6-inch limestone bed within 100 feet.

The Haystack Gypsum Member persists laterally for much greater distances than do the other gypsum beds. Accordingly, it was selected as a key bed, and its base was mapped to help determine the structure of the Permian strata (pl. 1).

Between the gypsum members of the Blaine Formation are alternating layers of reddish-brown and gray to blue shale. The shale is calcareous in part and contains many thin beds of selenite or nodular alabaster that range in thickness from less than an inch to 6 inches. In some exposures shale contains many steeply dipping veins of selenite and satinspar gypsum which range in width from less than an inch to 4 inches.

The Mangum Dolomite Member, wherever exposed in the area, consists generally of slightly dolomitic limestone. It is gray, buff, or brown, and dense to finely crystalline. In most localities it is cavernous or honeycombed, but in other places it is massive and makes an excellent building stone. The unnamed limestone that lies about 10 feet above the Cedartop Gypsum Member (app. A) is very much like the Mangum and cannot reliably be differentiated from it unless a considerable part of the geologic section is exposed nearby. To further complicate the picture, several limestones in the overlying Dog Creek Shale are similar to the two limestones in the upper part of the Blaine Formation. Because their angle and direction of dip change sharply in short distances, the limestones are not considered satisfactory beds to map or for use in determining the structure of the underlying rocks.

Water supply.--Although most irrigation wells tapping the Blaine Formation in the eastern part of the area are pumped at rates ranging from 500 to 1,000 gpm (gallons per minute), a few have yields as high as 1,500 gpm. The wells obtain water from solution cavities in the gypsum, anhydrite, limestone, and dolomite beds of the Blaine. Because the occurrence of individual solution cavities cannot be predicted from surface evidence, it is not unusual for a successful irrigation well to be drilled within 100 feet of a place where another well drilled through the same sequence of beds failed to supply enough water for a stock well.

The water from the Blaine is very hard and has a very high calcium sulfate content. Although it constitutes the municipal-water supplies for the towns of Duke and Eldorado, it generally is unsuitable for human consumption.

Dog Creek Shale

Correlation and thickness.--The Dog Creek Shale was named by Cragin (1896, p. 39) for exposures along Dog Creek in Barber County, Kansas. According to Gould (1905, p. 53), Professor Cragin's original description of the Dog Creek Shale reads:

> "The Dog Creek*****consists of some 30 feet, or locally of a less or greater thickness, of dull-red argillaceous shales, with laminae in the basal part and one or two ledges of unevenly lithified dolomite in the upper. The color of these shales resembles that which prevails in most of the division below rather than of the terranes above the Dog Creek."

Cragin assigned the Dog Creek to a position below the Red Bluff Sandstones (later the Whitehorse Group) and above the Shimer Gypsum Member of the Cave Creek Formation (later the Blaine Formation). Gould (1902, p. 50) stated that in many parts of Oklahoma the thickness of the Dog Creek was much greater than that given by Cragin. He ascribed a thickness of 225 feet to the Dog Creek near Quinlan, in eastern Woodward County. He further stated that thicknesses of 150 and 175 feet were recorded at a number of places in Oklahoma, and that exposures were common along the top of the "Gypsum Hills" from Canadian County to the Kansas line, and beyond.

Locations where both the bottom and the top of the Dog Creek Shale are exposed within a distance of less than 5 or 6 miles of each other are known to occur in only the northwestern part of the area. The altitude of the base of the Dog Creek in the SE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 14, T. 6 N., R. 26 W., and of the top in the SW$\frac{1}{4}$NE$\frac{1}{4}$ sec. 23, T. 6 N., R. 26 W., were determined by trigonometric leveling. They show the Dog Creek to be about 55 feet thick in that locality, but the Dog Creek is believed to be thicker southward.

Character and subdivisions.--Because the full thickness of the Dog Creek Shale is not exposed anywhere in the area, the lithic character of the formation is known only from scattered exposures of less than the full thickness. A gypsum bed 15 feet thick immediately overlies the Mangum Dolomite Member and underlies a limestone bed 1 or 2 feet thick in the stratigraphic section that was measured in the NW$\frac{1}{4}$NW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 27, T. 6 N., R. 25 W. (app. A). This bed is the lower part of the Van Vacter Gypsum Member of the Blaine Formation of Scott and Ham (1957).

Several gypsum, anhydrite, limestone, and dolomite beds occur in the lower part of the Dog Creek Shale and perhaps throughout the formation. Where exposed, the limestone beds are buff to brown, dolomitic, dense to finely crystalline, and range in thickness from 1 foot to 5 feet. Like the Mangum Dolomite Member they are honeycombed and have a very high porosity. The dolomite beds are buff to light gray, dense, honeycombed, and thin-bedded, with about the same range of thickness as the limestones. The gypsum beds are gray to white, soft, and so badly slumped in most exposures that their thickness cannot be measured accurately. Solution channels 6 to 7 feet in diameter are exposed in the gypsum beds along Fish Creek in T. 5 N., R. 24 W., and some of these caverns have been traced several hundred feet. Anhydrite beds, exposed along the road cuts in most of southern Harmon County, are white, gray, or bluish gray, and range in thickness from 1 foot to 5 feet.

The base of the Haystack Gypsum Member of the Blaine Formation dips beneath the alluvium of Salt Fork in the NW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 9, T. 4 N., R. 23 W. Along the north side of Salt Fork the Mangum Dolomite Member disappears beneath the alluvium about a mile upstream from where the Haystack disappears. At this point the basal part of the Dog Creek Shale contains three other limestone beds 1 to 3 feet thick and lithologically similar to the Mangum. These limestone beds are separated from each other by 5 to 10 feet of reddish-brown and gray shale. In the next mile upstream the lower two of these three limestone beds disappear below the surface, and a gypsum bed 10 feet thick occupies the interval between the middle and upper limestone beds. In the next 4 miles upstream at least two more gypsum beds appear higher in the Dog Creek Shale. They differ widely in thickness in short distances along their outcrops; one grades latterly, within a distance of 100 feet, from a 10-foot gypsum bed to a 3-foot bed of sandy magnesian limestone. Above the upper bed of gypsum, which is about 30 feet thick, about 3 feet of thin-bedded light-gray dense dolomite is exposed.

In secs. 26, 27, 34, and 35, T. 5 N., R. 24 W., gypsum beds consisting of soft gray alabaster, more than 15 feet thick, are exposed along with several thin beds of limestone and dolomite. Because the gypsum beds slump badly, accurate measurements of their thickness and determinations of their stratigraphic position are possible in only a very few places.

Because of the lithologic similarity of the beds of the Dog Creek Shale to those in the Blaine Formation, the two formations could not be distinguished from each other.

Except in the area mapped on plate 1 as terrace deposits or alluvium, beds of gypsum, limestone, and dolomite from 1 foot to 5 feet thick are exposed throughout most of Harmon County south of Salt Fork. The exposures are designated Dog Creek Shale on the Geologic map of Oklahoma.

Water supply.--Many wells in Harmon County and western Jackson County are believed to obtain water from solution cavities in the gypsum, anhydrite, limestone, and dolomite beds of the Dog Creek Shale as well as from underlying rocks. Because the Dog Creek Shale and the Blaine Formation could not be distinguished in subsurface, it was not possible to determine which wells take water solely from the Dog Creek. The irrigation wells in Harmon County yield 500 to 2,000 gpm, or about as much as the wells in Jackson and Greer Counties which are believed to tap only the Blaine. For a well drilled into either the Dog Creek or the Blaine to yield enough water for irrigation, it must tap water-filled solution cavities. In Harmon County the water from these formations is very hard and has a very high calcium sulfate content (table 6). It is not known to be used for any regular consumption by humans. Locally in southeastern and northwestern Harmon County the water has a very high sodium chloride content.

Whitehorse Group

The youngest Permian rocks exposed in the area are those of the Whitehorse Group. As mapped on the Geologic map of Oklahoma, the Whitehorse Group includes those rocks above the El Reno Group and below the Cloud Chief Formation. The group unconformably overlies the El Reno Group and is divided into the Marlow Formation below and the Rush Springs Sandstone above. The two formations of the Whitehorse Group are not differentiated in this area on the Geologic map of Oklahoma nor were they mapped separately for this report.

The Whitehorse Group is exposed in the western half of T. 5 N., R. 25 W., the southern quarter of T. 6 N., R. 26 W., and almost all of T. 5 N., R. 26 W. It consists mostly of fine to very fine grained brick-red massive, friable sandstone. Some of the sandstone is well cemented with gypsum, and at some locations one or more anhydritic, lenticular gypsum beds, 2 to 3 feet thick, support poorly defined ledges. The topographic relief of the group indicates a maximum thickness of more than 100 feet.

Some domestic and stock wells derive small to moderate amounts of water from sandstone of the Whitehorse Group, but no wells tapping the Group are known to have large yields.

Quaternary System

The youngest rocks exposed in the report area are the terrace deposits and alluvium of the Quaternary System. The alluvium consists of stream-laid sediments in the bottom lands along the major streams; the terrace deposits, although of similar origin, occur at higher levels. Because this report is concerned primarily with water from the Permian bedrock, the water-bearing properties of the terrace deposits and alluvium were not studied in detail.

Terrace Deposits

The terrace deposits consist of interfingering lenses of clay, sandy clay, sand, and gravel. The largest areas of terrace deposits are along the north side of the Red River, the south side of Elm Fork, and the south and west sides of Salt Fork (pl. 1).

In the areas of terrace deposits along the north side of the Red River, the south side of Elm Fork, and in T. 4 N., Rs. 24, 25, and 26 W., the topography is dominated by sand dunes that range in height from about 5 to about 30 feet. It is in these areas that the terrace deposits are most inportant as an aquifer. The town of Gould gets its water supply from two wells that tap water from the terrace deposits in sec. 18, T. 4 N., R. 24 W., and the city of Hollis gets its water supply from four wells in sec. 20 and three springs in the terrace deposits in secs. 18 and 19, T. 4 N., R. 25 W. Many domestic and stock wells draw water from the terrace deposits, and yields of 100 to 300 gpm probably could be obtained.

The terrace deposits along the west side of the valley of Salt Fork, in Rs. 21 and 22 W., are composed almost entirely of brown and dark-gray clay. They are believed to be thin and may include colluvial material derived from the Permian bedrock to the west. The surface of the deposits is nearly flat with a very slight slope to the east or southeast. The town of Olustee obtains a small part of its municipal supply from a well tapping the terrace deposits in the NE$\frac{1}{4}$ sec. 20, T. 1 N., R. 21 W.

Alluvium

As mapped in this area, alluvium is the stream-laid sediment underlying the low-level terraces and the flood plain in the stream valleys and is separated from the higher terrace deposits on the basis of a well-defined topographic break. Because influent flow--that is, seepage from the stream into the alluvium--may occur naturally or be induced by pumping, the quality of the water in the alluvium may be affected by the quality of the water in the stream. The water in the major streams of this area is known to be highly mineralized.

Where the alluvium consists of significantly thick deposits of saturated sand and gravel it will yield moderate amounts of water to wells. The alluvium of Salt Fork in the report area yields water to a few stock wells, one irrigation well, and one of the Olustee municipal wells.

WATER RESOURCES

Surface Water

In the area of this investigation, only Elm Fork Red River, and the lower reaches of Fish, Lebos, and Mulberry Creeks may be classed as perennial streams. The discharge of these streams is maintained chiefly by effluent seepage of ground water from the Dog Creek Shale and the Blaine Formation. Other streams draining the area commonly cease flowing during the summer when evaporation, transpiration, and pumping are at a maximum.

A survey of water use made in 1953 indicated that only about 1,700 acre-feet of surface water was used for irrigation purposes. Most of the water was diverted from Gypsum, Lebos, and Turkey Creeks.

Through September 30, 1960, the records of discharge and stage of streams at gaging stations and at miscellaneous sites along the streams have been published in an annual series of U.S. Geological Survey Water-Supply Papers entitled "Surface Water Supply of the United States, pt. 7, Lower Mississippi River Basin.

Beginning with the 1961 water year, streamflow records and related data have been released by the Geological Survey in annual reports entitled "Surface-Water Records of Oklahoma."

Ground Water

The openings in permeable rocks that lie below the land surface generally are partly or completely filled with water called "subsurface water." (For definitions of many ground-water-hydrology terms see Meinzer, 1923.) Below a level known as the water table, all the openings are completely filled with water and the water-bearing rocks or deposits are called "aquifers." The permeable rocks that lie above the water table are said to be in the "zone of aeration." In most places this zone can be subdivided into three parts, in ascending order: the capillary fringe, the intermediate belt, and the belt of soil moisture. In some places, however, the capillary fringe and the belt of soil moisture may be in direct contact or the capillary fringe may extend to the land surface.

In one form or another, water occurs almost everywhere. Although the great bulk of the total water supply is stored in the seas and oceans, a constant circulation is taking place. Evaporation from the surfaces of the oceans, streams, and lakes is nearly continuous. Most of the moisture so evaporated condenses and returns as precipitation to the earth's surface, part of it returns to the ocean as surface runoff, and part of it infiltrates beneath the surface of the earth. Some of the water that infiltrates into the ground is held by capillary attraction near the surface and is later evaporated; some is used by vegetation and returned to the atmosphere by transpiration; and some joins the ground-water reservoir and slowly moves to places of discharge from wells and springs and into streams. This sequence of events is known as the hydrologic cycle and is represented graphically in figure 3.

Water-Table and Artesian Conditions

Ground water may occur under either artesian or water-table conditions. If an aquifer is overlain by a relatively impermeable stratum, the water in the aquifer may be confined and have an artesian pressure head.[1] Because of this pressure head, water stands at a level above the upper surface of the aquifer in any well that taps the aquifer. The surface to which the water from an artesian aquifer will rise under its full head when the confining layer is punctured is called the "piezometric surface" of that aquifer; it is an imaginary surface that coincides with the static level of the water in wells tapping the aquifer.

Water-table conditions exist where the upper surface of the water is not confined by an impermeable bed and it is free to fluctuate. This upper surface of the ground-water body is the water table. It is an irregular, sloping surface that in general approximates the slope of the land surface but has less relief. Where the rate of replenishment, or recharge, is greater locally than in the surrounding area, the water table may form a mound or ridge from which the water spreads outward.

"Perched" ground water is a body of ground water separated from another, underlying body of ground water by unsaturated strata. Perched water belongs to a different zone of saturation from that occupied by the underlying ground water and its water surface is a "perched water table," in

[1] Many explanations and definitions used for completeness of this report were freely copied from other published reports (Barclay and Burton, 1953; Meinzer, 1923: Reed, Mogg, Barclay, and Peden, 1952).

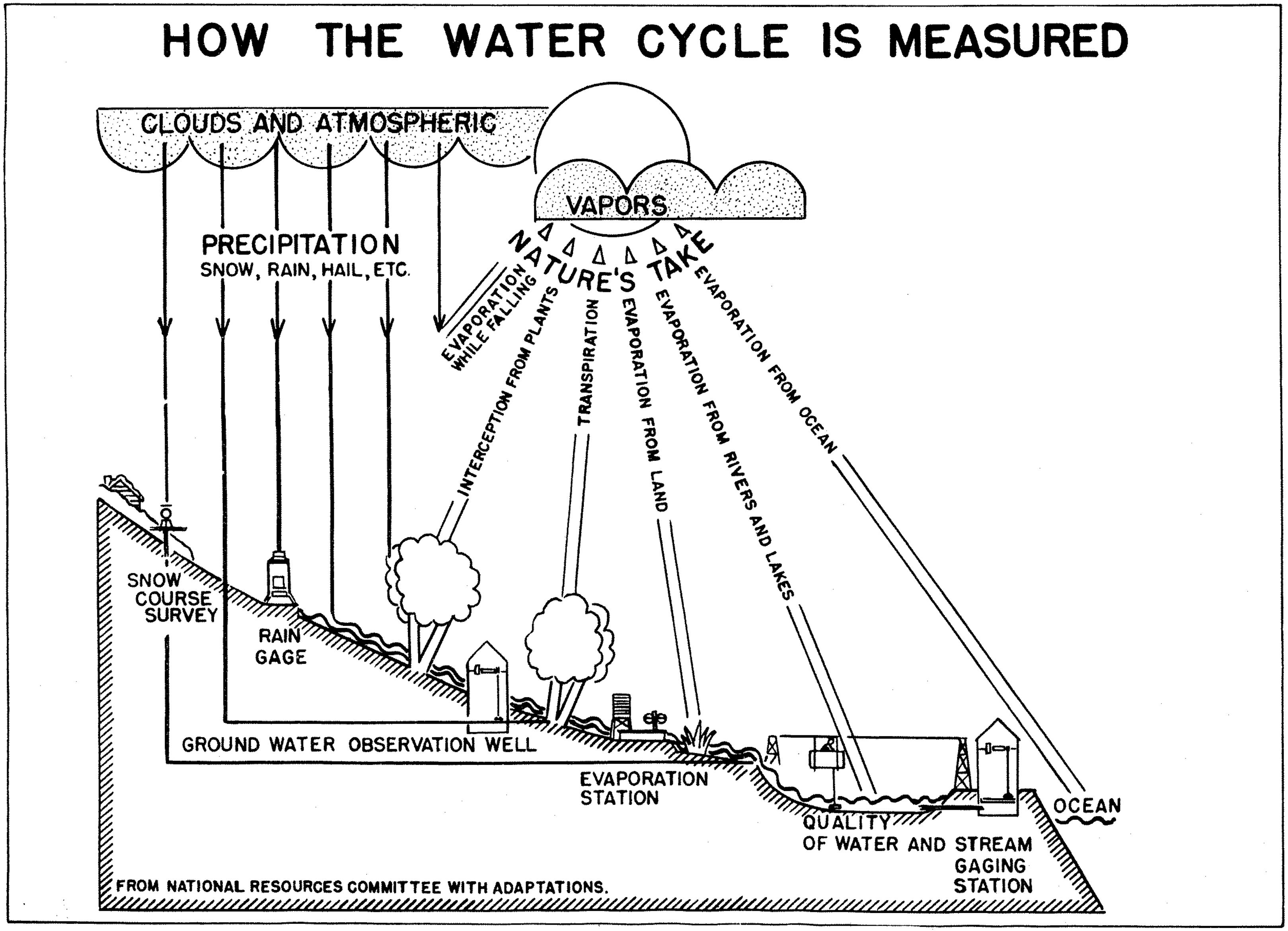

Figure 3.--Graphic representation of the hydrologic cycle

contrast to that of the lower zone of saturation, which is called the "main water table."

In the area much of the water is confined in solution channels in gypsum, limestone, and dolomite beds. All irrigation wells in the principal irrigation areas tap the Dog Creek Shale or Blaine Formation and derive all or part of their water from solution channels in these formations. Wells drilled into the Dog Creek Shale or Blaine Formation beneath alluvium or terrace deposits may derive part of their water from the surface deposits; therefore, the water tapped probably occurs under water-table conditions. Also, in areas of heavy pumping, artesian conditions may exist when water levels are high, and water-table conditions may exist after a period of sustained pumping. The terrace and alluvial deposits of the area, especially the terrace deposits on the south side of Salt Fork, may contain a body of perched ground water.

Movement

Ground water, like other liquids, moves from points of higher head to points of lower head; therefore, water loses head as it moves. The difference in altitude between any two points on the water table or piezometric surface is the difference in head at those two points. Although the quantity of water in an aquifer depends on the porosity, or percentage of openings, in the material composing the aquifer, the ease with which water moves within an aquifer is governed by the permeability of those materials. Permeability is a function not only of the size and arrangement of the particles in the aquifer but also of the size and interconnection of the pores or openings. A high porosity does not necessarily indicate a high permeability. For example, a fine-grained sediment, such as clay, may be highly porous but may have a low permeability because the openings are so small. Although saturated, a clay will not yield significant quantities of water to gravity drainage because nearly all the water is held to the surface of the clay particles by molecular attraction.

Irrigators and drillers have reported visible movement of water in wells in this area, and during the course of this investigation water has been seen and heard flowing into wells. Such observations suggested the possibility of a rapid ground-water movement in areas where large solution cavities are concentrated. Attempts were made to determine the rate of flow by the use of a Pygmy current meter and of fluorescein dye.

A conventional Pygmy current meter was adapted for use in the large-diameter wells by mounting it on a vertical shaft about 14 inches long, leaving the meter free to rotate on the shaft, and adding a short fin to direct the meter into any horizontal current. Light-weight steel discs about 10 inches in diameter were put on the shaft, one above the other below the meter, to prevent contact of the meter with the wall of the well. The earphone connections were conventional. Because of the protective discs and the construction of the instrument, the meter would be much more sensitive to horizontal than to vertical flow in a well; however, even a gentle raising or lowering of the meter in the well caused turbulence of the water which was recorded by the meter. Therefore, the instrument is believed to have been sensitive enough to record any abnormally rapid flow. No lateral movement of water could be detected in any of the six wells (1N-25W-1dbc1, 1N-25W-11baa1, 2N-22W-3bc1, 2N-22W-6cac1, 2N-23W-1cbd1, 3N-23W-21add1) in which the meter was used. One of the attempts to measure the rate of flow was made in a well (2N-23W-1cbd1) about 75 yards from an irrigation well that was being pumped. Even though pumping of the irrigation well had caused appreciable drawdown of the water level in the observation well, the flow was too slow to be detected by the current meter.

The use of fluorescein dye to trace ground-water movement was first described by Dole (1906). Attempts to use this method during this investigation were made on the Oscar Bryant farm in the SE$\frac{1}{4}$ sec. 21, T. 2 N., R. 25 W., and in the vicinity of the Wilcy Moore farm in the NW$\frac{1}{4}$ sec. 32, T. 3 N., R. 25 W. Oscar Bryant's irrigation well (2N-25W-21dac1) is one of six wells drilled very close together. Of the other five wells, one is welded shut and covered with soil. The remaining four wells (2N-25W-21dac3, -21dac4, -21dac5, and -21dac6) are about 100 feet to the northwest, north, northeast, and east, respectively, of the irrigation well. The dye was put in the northwest well because a preliminary water-level map showed a hydraulic gradient to the southeast. At about 1:00 p.m. on October 7, 1953, one-eighth pound of yellow fluorescein dye was dissolved in one quart of water and then the jar containing the solution was lowered and raised several times through the column of water in the well to insure a thorough mixing of the solution with the well water. Three samples of water were taken from each of the three observation wells that afternoon, and at about 4:35 p.m. the irrigation well was pumped for 1 minute and a sample of water was taken from it. None of the samples contained visible concentration of dye. The next morning the observation wells were checked again, and again no dye was noted. Then a series of eight samples of water was taken at various depths in the injection well to see if any change could be detected. The change of concentration at various depths between the time of injection and the next day is represented in figure 4 by the shaded area.

Because the driller of these wells reported that a small cavity was encountered at about 42 feet when drilling the injection well and because water could be heard flowing in a nearby well when the irrigation well had been pumped for several hours, the change in concentration of dye is believed to be due primarily to the pumping of the irrigation well during the experiment. When the last samples from the observation wells were collected, at about 11:30 a.m. on October 8, 1953, there still was no trace of the dye. The experiment was abandoned with the conviction that movement of ground water could not be detected by this method at this location.

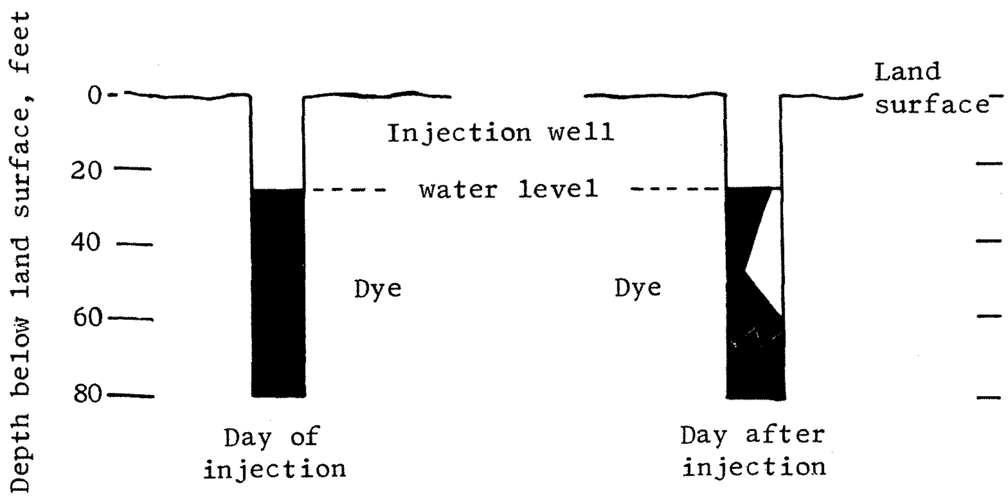

Figure 4.--Diagram showing in concentration of dye in irrigation well during test

Wilcy Moore's irrigation well (3N-25W-32bbb1) was chosen for use as the injection well in the other dye test for the following reasons: (1) according to Mr. Moore and the driller of the well, no cuttings could be recovered from a depth greater than 80 feet, a fact suggesting that the well was drilled into a solution channel; (2) eight other irrigation wells between half a mile and 2 miles southeast of Mr. Moore's well could be used as dye-detection points; and (3) according to Mr. Moore, the yield of his well was reduced when one of the nearby wells was being pumped, a fact indicating a direct hydraulic connection between the wells.

A pound of dye was dissolved in 10 gallons of water and the solution poured into the well. To be sure of thorough mixing in the well, the turbine pump was started several times and each time was shut off to cause backwashing when the water began to flow from the pump. Several samples of water were collected from the observation wells and the injection well between November 17 and 25, but none of the samples from the observation wells showed a trace of the dye and none of the samples from the injection well indicated a lessening of the dye concentration in that well. On December 14, 1953, nearly 4 weeks after the experiment was begun, the injection well was pumped for a few minutes; for only a moment the water was rather yellow, but the concentration of the dye had decreased noticeably. The experiment was terminated, the evidence indicating that natural ground-water movement is exceedingly slow through even the major solution channels at this location.

The failure to demonstrate rapid movement of ground water through wells led to the conclusion that such movement does not occur under natural conditions except, possibly, in the immediate vicinity of springs and in the small amount that is continuously percolating downward to the zone of saturation through small solution channels. Apparently the drilling of some wells has provided a conduit for movement of water from higher to lower solution channels and, if this is so, the sound of running water in the wells may be due to water trickling down either the inside or the outside of the casing, or both. The appearance of water movement probably is merely a surface phenonomen caused by water entering a well above the level of the water surface, more so on one side of the well than on the other. Generally, rapid lateral movement of water within the zone of saturation occurs only when large quantities of water are being withdrawn from wells.

Water-Level Fluctuations and Effects of Pumping

The water level in an aquifer rises or falls continuously in response to changes in the ratio of recharge to discharge. During wet seasons, water normally is added to storage at a faster rate than it is discharged and the water level rises. Conversely, during dry seasons, the rate of discharge exceeds the rate of recharge and water levels decline. It is the discharge of ground water that maintains the flow of streams when overland runoff is negligible. Discharge of water by evaporation, by transpiration, or by pumping from wells also lowers the water level. The position of the water level at any given time is the net effect of all previous recharge and discharge, and is a measure of the quantity of water then in storage. The position of the water level is determined by measuring the depth to water in wells, and changes in its position are detected by measuring the depth to water at intervals.

Some fluctuations of the water level in wells are not related to recharge and discharge, but may be caused by tides, earthquakes, or variations of atmospheric (barometric) pressure. Of these causes, it is believed that only the atmospheric pressure significantly affects the water levels in the report area.

Water-level measurements were made, at approximately bimonthly intervals, from February 1954 to June 1955 in about 145 wells tapping various aquifers in the area. (See table 5). An additional measurement was made in September 1954, when the water levels were believed to have reached their lowest stage of the year. Monthly measurements were continued in 44 wells in conjunction with the Oklahoma part of the Federal observation-well program and 34 were still being measured in 1963. Because many of the observation wells were pumped frequently by their owners, a measurement of the static water level could not be made on every visit to the well. The locations of the individual wells in which observations of the water level were made are shown on the map showing water-level contours (pl. 2) and the maps showing changes in water level (pls. 3-6).

The contour lines on the map (pl. 2) show the altitude of the water level for about February 1954. Measurements for this date were used because several months had elapsed since pumping for the 1953 irrigation season had ended and pumping for the 1954 irrigation season had not yet begun, and also because February is a period of very little plant growth and evapotranspiration loss would be low.

The hydrographs in figure 5 show average changes in water level, both inside and outside the irrigation areas, in 1954 and 1955. They show the rapid response of water levels to periods of heavy rainfall such as May 1954 and May and October 1955. They also show that although water levels decline somewhat in all areas during the late summer months, the decline is much greater in the areas where large quantities of water are withdrawn for irrigation.

Figure 6 is a hydrograph showing the average change in water level (based on a "zero" level in November 1950) in eight wells that have been measured for a relatively long period. Plate 7 consists of hydrographs for four wells, each in a different irrigation area. The four hydrographs are believed to be typical of the water-level fluctuations in the respective areas. Water levels in all four wells were relatively low near the end of 1956, about the end of a severe drought period. All rose sharply in 1957 during the intensive wet period that broke the drought. Water levels in all four wells declined during the period June-September each year when wells were pumped heavily for irrigation. An exception was 1960, an unusually wet year during which very little irrigation water was required and water levels rose during the normal irrigation season. Generally, water levels were not as low during the latter part of 1963 as they had been in other years. This suggests the drought of 1963 was not as severe, in its effect on ground-water supplies in this area, as the drought of the mid-fifties. One reason is that water levels were at a relatively high stage at the beginning of 1963.

The water-level-change maps, plates 3, 4, 5, and 6, illustrate the important changes in water level from season to season during the period when intensive field work was underway for this investigation. These illustrations show the water-level changes resulting from recharge, irrigation pumping and other forms of discharge, and the movement of ground water. The outlines of the irrigation areas, also shown on the maps, help demonstrate the relation of areas of pumping to the changes of water level during the various periods.

Plate 6, which is based on measurements in 126 wells, shows the change in water levels from June to September 1954. Levels declined throughout most of the area owing to the meager rainfall and heavy irrigation pumping. Declines were greatest in areas where pumping was most concentrated.

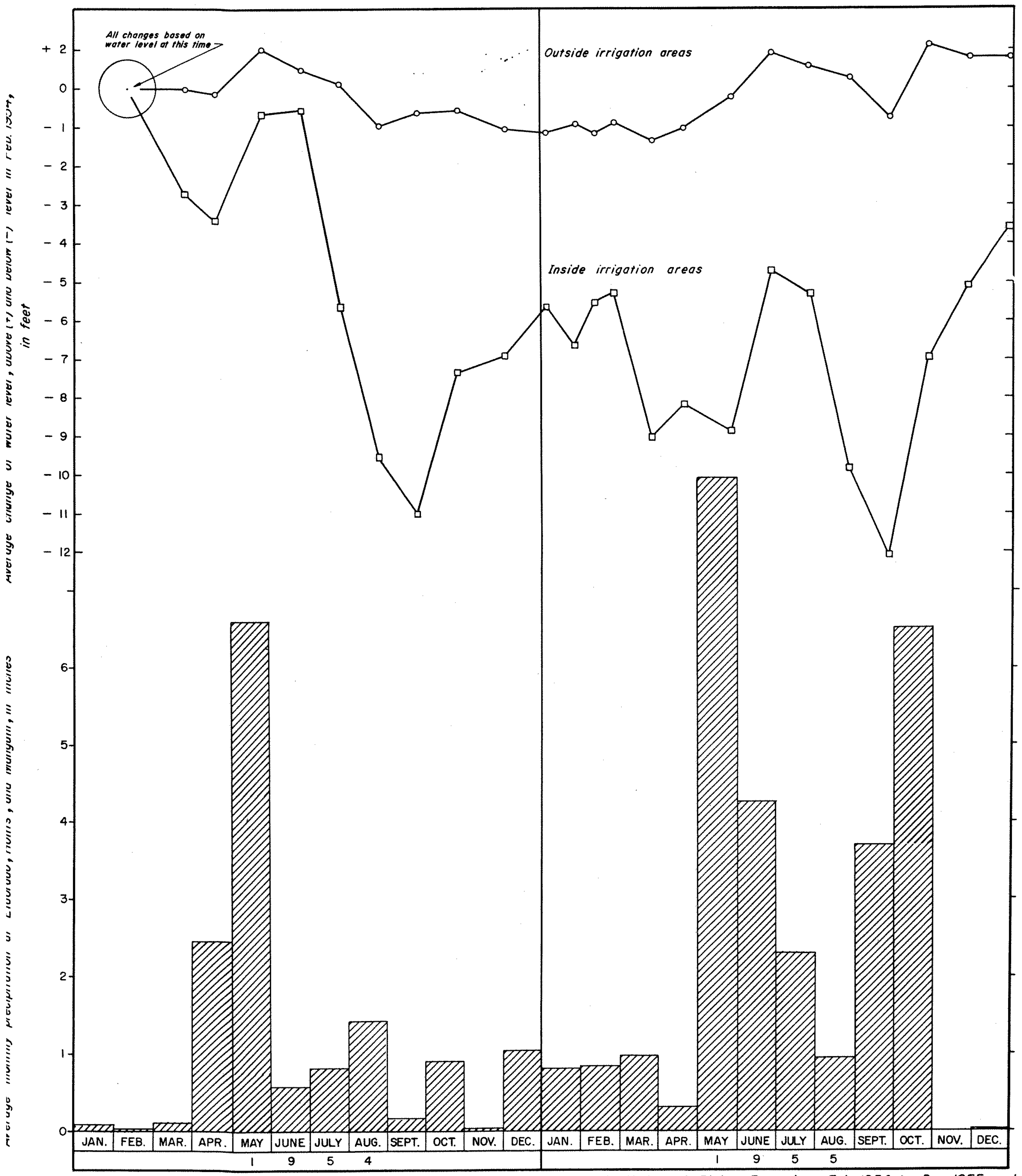

FIGURE 5-- Graphs showing average changes of water level in the Dog Creek Shale and Blaine Formation, Feb. 1954 to Dec. 1955, and average precipitation at Eldorado, Hollis, and Mangum.

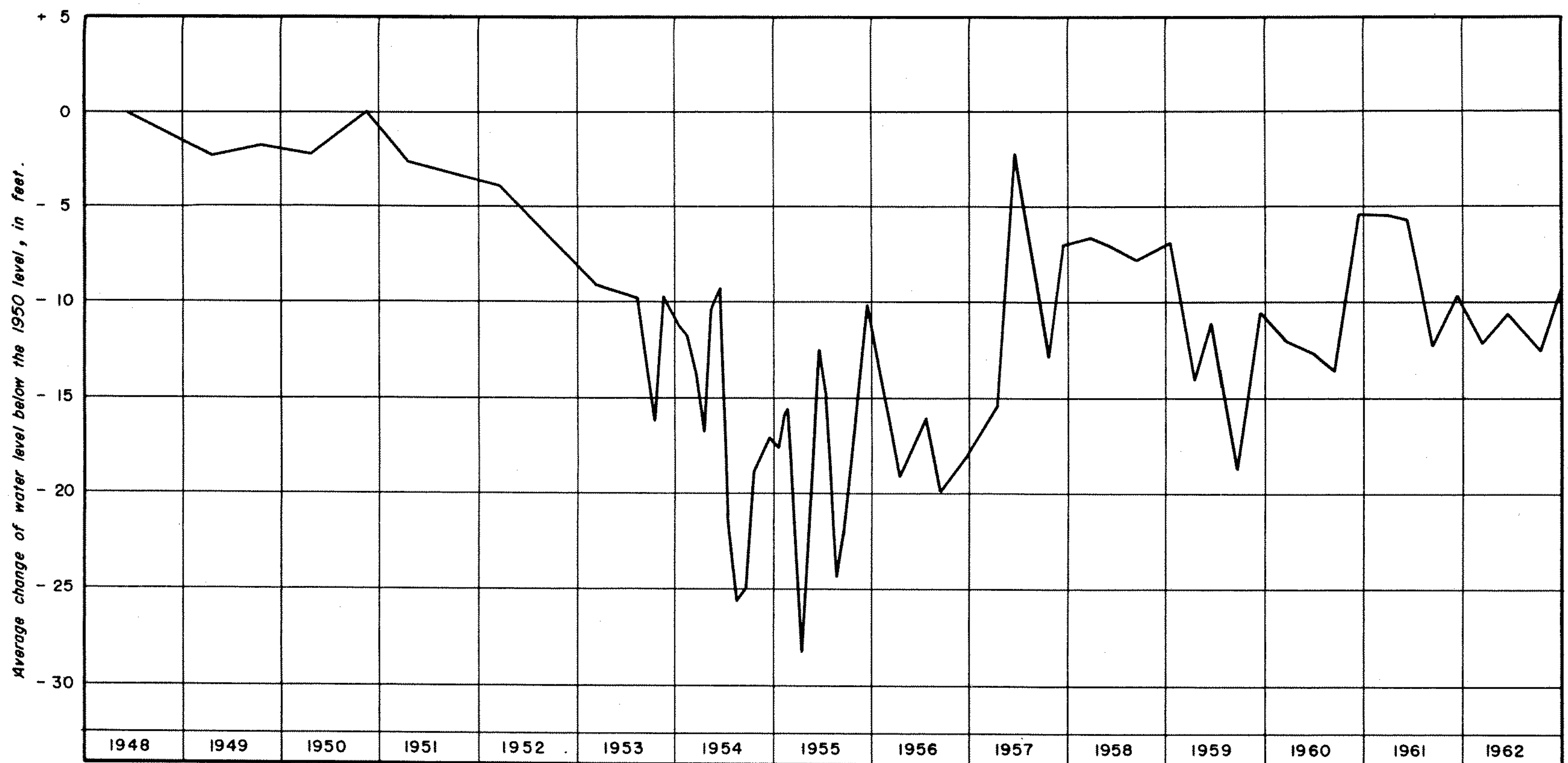

FIGURE 6--Hydrograph showing average change of water level in eight observation wells based on the November 1950 level.

Plate 3, based on measurements in 125 wells, shows the change in water levels from September 1954 to February 1955. A season of heavy pumping had just ended, but there was very little rainfall or pumping during this interval. The water level rose as much as 25 feet locally in some irrigation areas, but it declined in other places both inside and outside irrigation areas. The rate of recovery seemed to be slower southwest of Gould, along a tributary of Lebos Creek, than elsewhere. This seems to be a local condition, but if ground-water withdrawals are increased along this tributary, water levels may become so low during the irrigation season that they will not recover fully during the following nonirrigation season.

Plate 4 is based on the difference in water levels in 95 wells between April and June 1955. In April and early May considerable water was pumped for irrigation, but almost no water was pumped in late May and June because of heavy rains. The recharge from precipitation, together with the shifting of water to fill local cones of depression, caused a general rise in the water level. This demonstrates the rapid rate that a large volume of recharging water can penetrate the aquifer after a period of heavy precipitation. The rise of water level along the tributary of Lebos Creek, southwest of Gould, again lagged behind recovery in other parts of the area. There was a slight but persistent decline of water level in the terrace deposits south of Salt Fork and a rise in level in the northwestern part of the area. The decline in the terrace deposits may be caused by the time lag between infiltration and the resulting rise in water levels.

Plate 5, based on measurements in 135 wells, shows that the water level declined at least slightly throughout most of the area from June 1954 to June 1955. In the heavily pumped areas of T. 2 N., R. 25 W., and T. 3 N., R. 23 W., declines were rather large. This map shows a locally significant rise in water level just south of Hollis, which may identify a local but persistent source of recharge to the surrounding area. It may be caused by concentrated and well-developed sinkholes in the area and by a good catchment area of alluvial and terrace deposits. The time lag for recharge southwest of Gould is again noticeable.

The water-level data, from which water-level-change maps were developed, are given in table 5.

Discharge

Ground water is discharged continuously from an aquifer by seepage through springs and into streams, evaporation, transpiration by plants, flow into adjoining aquifers, and flow or pumping from wells.

Effluent seepage.--Water that flows out of the zone of saturation and into a stream whose surface is lower than the water level in the aquifer is termed effluent seepage, and a stream into which ground water discharges is called an effluent, or gaining, stream.

Table 5.--Depth to water in wells in Harmon County and adjacent parts of Greer and Jackson Counties

(feet below land-surface datum)

Well number	2nd week of Feb. 1954	3rd week of April 1954	4th week of June 1954	4th week of Aug. 1954	4th week of Sept. 1954	4th week of Oct. 1954	1st week of Jan. 1955	2nd week of Feb. 1955	3rd week of April 1955	4th week of June 1955
GREER COUNTY										
3N-22W-3bbb1	13.9	13.7	12.8	14.5	14.7	14.6	14.7	14.7	14.7	14.4
13baa1	12.5	14.3	10.4	10.8	10.9	11.4	11.7	14.4	12.1	11.0
16dac1	16.2	16.8	15.7	16.4	16.6	16.7	....	16.8	17.0	15.6
3N-23W-2bdd1	63.8	64.6	60.8	62.1	62.7	63.1	64.2	64.7	72.1	....
3dad1	39.8	39.6	36.7	39.8	39.0	41.5	42.0	52.2	....	42.3
3ddb1	....	41.1	36.3	40.0	42.0	43.2	43.9	56.8	47.6	41.3
4cba1	74.4	79.5	70.1	....	85.7	82.4	80.7	80.4	105.7	73.5
16daa1	40.8	48.1	....	65.5	....	54.0	48.4	45.6	66.5	38.4
17aa1	52.9	60.5	49.7	....	77.9	66.2	60.6	57.9	80.2	50.4
4N-22W-4aad1	6.5	7.9	7.3	9.3	9.6	10.2	9.4	9.3	8.9	7.5
15dcc1	7.3	7.1	5.5	....	8.0	8.3	8.6	8.7	9.7	5.1
17baa1	74.0	75.1	....	....	....	75.0	....	75.5	73.5	73.2
19dda1	74.8	75.0	75.1	73.9	73.7	73.9	73.9	73.9	74.0	72.5
27cbb1	6.2	5.6	4.8	5.9	6.4	6.5	6.6	6.8	7.5	4.0
32cbb1	47.8	47.7	46.1	46.6	46.8	46.8	47.1	47.1	47.1	46.3
4N-23W-3aaa1	....	54.5	56.4	....	....	....	....	....	....	53.9
20ddd1	37.6	38.6	35.4	39.6	40.0	39.3	39.0	39.0	42.2	39.0
20ccc1	+ 1.7	+ 0.9	+ 1.6	+ 0.3	0.0	+ 0.4	+ 0.1	+ 0.3	2.0	3.8
33dab1	....	48.3	42.1	....	61.3	48.9	47.0	46.7	57.6	50.1
4N-24W-12ddd1	27.0	27.0	27.2	29.7	30.1	30.4	29.6	30.4	36.9	29.8
14bbb1	31.9	32.2	32.3	32.4	32.5	32.5	32.6	32.6	32.5	32.8
26ddc1	69.9	72.0	69.4	72.0	73.3	71.7	74.0	74.3	79.1	77.8
5N-22W-7bbb1	15.4	16.5	13.6	15.8	17.9	18.1	17.6	16.7	19.3	11.4
11ddc1	33.8	33.8	33.6	34.1	34.1	34.1	34.1	34.0	....	....
16cdc1	9.7	9.5	8.9	9.4	9.9	10.8	13.6	13.1	14.5	9.9
19baa1	18.8	....	18.3	19.4	19.7	19.6	20.0	20.0	19.9	17.5
25bcc1	25.8	25.8	25.8	25.9	26.2	25.9	26.0	26.2	26.0	25.8
5N-23W-3cd1	52.8	58.4	50.4	....	....	....	....	....	....	....
6bbc1	31.6	32.1	32.7	32.9	33.1	33.2	33.5	33.8	34.2	34.2
20dcc1	60.2	60.6	60.8	61.0	61.1	61.4	61.7	61.6	62.1	....
22aaa1	94.9	....	92.9	100.1	....	96.8	99.7	99.0	....	94.7
5N-24W-2baa1	10.4	10.0	10.5	....	....	....	....	....	11.3	10.8
15ddd1	....	29.4	25.8	27.8	28.5	29.1	30.1	32.7	31.3	27.4
HARMON COUNTY										
N-24W-4bc1	85.9	86.8	77.8	83.0	87.0	89.1	89.8	90.5	92.1	86.7
15aad1	....	28.4	19.7	....	27.2	27.9	28.7	29.2	....	18.6
20ddd1	67.5	....	67.1	71.0	71.1	70.6	70.2	70.1	....	70.6
25dad1	30.1	30.3	29.2	31.2	31.8	32.2	32.3	32.3	32.7	31.4
30dbb1	11.2	12.1	11.6	17.8	17.3	15.4	13.7	13.4	17.4	12.2
34dcc1	15.1	15.4	15.6	....	16.8	16.6	16.2	15.7	16.4	14.7
1N-25W-4dba1	51.1	55.5	53.2	....	....	59.8	56.8	56.2	....	56.2
8caa1	102.6	113.7	103.6	107.1	108.7	108.5	107.6	106.7	109.2	106.9
11baa1	44.9	75.1	50.0	....	60.5	53.0	50.7	50.0	....	49.5
13dcc1	21.4	22.7	20.8	23.5	26.7	24.0	19.8	22.4	27.3	21.7
36cac1	20.6	21.5	21.2	....	....	25.2	24.0	23.4	27.2	21.7
1N-26W-5aab1	71.8	80.6	74.6	....	91.4	81.6	76.8	76.4	....	73.1
2N-24W-2bc1	52.5	....	....	....	....	....	54.1	54.0	....	....
13ccd1	64.6	64.7	64.2	65.9	65.0	65.0	65.2	65.3	....	64.1
17dcc1	33.9	33.7	34.2	34.1	34.2	33.3	33.7	33.4	34.2	33.7
22add1	14.9	17.0	14.9	....	15.2	15.1	....	....	....	15.4
30dcc1	53.6	....	60.7	....	92.2	81.3	79.7	77.1	....	81.5
2N-25W-2aaa1	57.1	....	59.9	....	....	....	....	68.5	....	....
5aaa1	49.2	55.1	51.1	....	74.3	61.3	....	....	....	....
6bcb1	30.6	32.2	30.8	....	....	....	....	35.2	....	36.2
7dab1	18.3	19.1	18.2	....	22.3	22.3	22.6	19.3	....	22.3
8daa1	....	....	....	....	59.0	44.8	40.4	38.5	....	40.1
14cbb1	21.2	24.8	....	....	43.8	37.8	31.7	30.4	....	31.9
17ccc1	24.4	27.9	28.9	....	....	34.3	31.8	32.2	....	30.8
21dac1	28.7	....	....	....	....	....	....	33.4	....	29.6
23abb1	21.4	24.8	22.7	....	37.5	35.5	30.4	28.9	....	30.3
25cdd1	37.6	....	40.8	....	54.6	54.1	52.9	52.1	....	50.4

Table 5.--Continued

(feet below land-surface datum)

Well number	2nd week of Feb. 1954	3rd week of April 1954	4th week of June 1954	4th week of Aug. 1954	4th week of Sept. 1954	4th week of Oct. 1954	1st week of Jan. 1955	2nd week of Feb. 1955	3rd week of April 1955	4th week of June 1955
				HARMON COUNTY--Continued						
2N-25W-26ac1	....	....	....	....	....	43.0	42.4	41.2	....	37.9
29bbb1	28.7	....	....	58.1	....	....	....	31.1	....	32.6
29ada1	30.3	33.7	....	....	....	....	....	34.9	....	....
30dbb1	46.5	58.8	45.0	....	70.6	....	47.8	46.4	....	50.5
31bbb1	43.1	....	45.7	....	....	....	....	51.7	....	....
34dab1	36.6	....	39.5	....	64.3	54.5	49.4	47.8	....	50.5
2N-26W-3ddb1	17.5	19.0	19.3	19.9	20.3	20.4	21.0	23.7	....	23.2
5bcc1	30.2	....	....	52.5	....	41.7	37.8	37.8	....	40.0
8dbc1	34.9	39.4	38.5	49.7	50.5	47.2	44.1	42.8	....	45.5
12cca1	47.6	48.6	57.6	66.1	....	51.6	51.7	51.5	52.4	49.0
15aad1	72.1	72.5	....	....	76.8	76.6	77.3	77.4	78.5	64.9
27bcd1	46.2	51.9	51.4	62.8	53.5	51.2	50.0	....	62.6	46.8
31cbc1	....	33.6	32.5	....	....	35.8	44.9	34.4	....	27.9
2N-27W-2ccb1	43.1	....	....	....	....	....	....	51.1	....	54.1
36dad1	33.2	34.0	32.8	55.0	40.2	36.2	36.1	33.7	43.6	30.2
3N-24W-3dda1	108.6	110.6	104.3	....	....	109.7	....	112.0	126.7	108.3
5dad1	....	80.8	74.3	....	83.0	80.6	83.0	82.8	....	77.8
9dcc1	62.4	63.6	57.7	62.7	64.3	64.5	65.4	65.4	....	61.6
29aaa2	65.3	65.7	61.3	64.3	66.0	66.2	67.3	67.2	....	63.3
3N-25W-1cdd1	133.6	135.8	131.4	134.5	....	135.8	....	....	....	134.1
2abb1	148.5	152.1	146.0	146.0	....	....	....	151.2	155.6	149.4
15bba1	20.6	20.9	20.3	20.3	20.9	20.9	20.6	20.7	21.0	20.2
30abb1	28.0	32.2	29.0	....	40.0	37.8	35.7	34.8	....	38.0
32bbb1	33.8	37.6	34.7	....	57.6	42.7	40.5	39.3	....	41.3
33aab1	87.0	94.7	85.0	....	....	....	....	....	....	....
3N-26W-12cdd1	56.2	....	56.6	74.2	68.1	66.6	....	64.1	....	67.5
22cdc1	68.8	68.4	....	....	....	....	....	....	....	....
29acb1	62.7	72.6	71.0	....	....	....	71.5	71.7	....	75.5
31dad1	45.2	55.2	51.1	....	....	57.0	52.6	51.5	66.0	55.2
35bab1	43.7	50.8	....	....	64.3	56.3	52.1	51.2	....	55.7
3N-27W-12cac1	30.4	30.9	30.9	30.3	30.1	29.9	30.2	30.4	30.9	31.4
25cbb1	70.1	....	75.6	....	89.0	82.9	77.8	76.6	....	81.1
4N-24W-17cdd1	....	25.3	25.3	26.0	26.2	26.8	28.2	27.5	27.6	27.7
18ada1	2.4	2.5	3.0	3.4	3.5	3.0	2.6	2.2	2.2	2.3
20daa1	32.1	28.2	....	....	....	....	....	....	....	....
31dda1	98.0	99.5	92.9	101.6	97.2	97.8	101.8	100.1	103.3	96.2
4N-25W-6aaa1	58.7	58.8	59.1	59.1	....	59.2	57.1	58.9	59.1	59.3
11da1	11.5	12.5	13.0	....	....	....	13.6	12.5	12.4	11.6
15bdd1	13.5	12.8	13.5	....	....	....	....	14.7	13.8	13.4
21ddd1	42.9	42.8	43.1	43.0	43.0	43.0	43.0	43.5	43.1	43.5
24cbc1	46.5	47.4	46.6	....	....	47.0	....	47.1	47.2	47.2
29aaa2	....	18.4	18.4	20.3	20.8	19.1	20.6	20.4	20.2	19.4
32ccd1	23.7	23.7	22.6	24.2	....	25.9	25.2	....	24.9	26.0
4N-26W-5ddc1	39.3	39.6	39.7	39.8	40.0	40.1	40.1	....	....	....
6cdb1	46.9	46.8	47.6	....	....	....	....	....	....	....
14cdc1	45.8	....	46.6	46.8	47.6	46.8	46.9	47.0	47.4	47.3
17bbb1	54.4	55.3	53.6	56.1	56.3	57.0	58.5	54.8	54.6	....
33ddd1	23.9	25.7	23.8	24.4	24.7	25.1	25.1	25.3	25.4	25.2
24ddd1	....	21.2	20.8	21.2	21.3	21.8	21.7	21.8	22.0	21.6
29ccc1	29.7	30.2	30.2	30.4	30.5	30.7	30.8	30.9	30.9	31.2
4N-27W-13cdd1	35.5	....	....	....	....	....	....	....	....	....
5N-24W-4ccd1	56.9	....	48.8	....	....	....	48.2	48.2	50.1	48.4
7dcd1	16.0	....	15.3	16.4	16.7	16.9	17.6	17.6	17.0	14.2
16ddd1	48.3	49.5	....	48.4	....	49.2	50.4	....	51.3	....
19ddd1	10.0	12.1	7.3	5.5	8.2	10.3	11.7	8.9	8.7	6.7
5N-25W-1caa1	31.4	34.7	21.3	34.7	30.0	32.0	34.6	35.7	37.1	22.8
16cdc1	24.8	25.4	25.0	26.2	25.8	25.5	25.5	25.6	25.7	25.7
19ddd1	22.3	22.6	22.0	22.1	22.4	22.7	23.0	23.0	22.3	23.0
23ccc1	18.1	17.2	17.2	17.6	....	....	17.3	17.3	....	17.4
27dcc1	22.7	22.8	....	....	....	....	....	....	....	....

Table 5.--Continued

(feet below land-surface datum)

Well number	2nd week of Feb. 1954	3rd week of April 1954	4th week of June 1954	4th week of Aug. 1954	4th week of Sept. 1954	4th week of Oct. 1954	1st week of Jan. 1955	2nd week of Feb. 1955	3rd week of April 1955	4th week of June 1955
					HARMON COUNTY--Continued					
5N-26W-7dca1	33.0	32.7	....	33.1	33.7	32.8	32.7	32.5	32.8	31.7
16daa1	45.9	46.1	46.2	46.2	48.0	46.3	....	....	....	....
23dbd1	55.4	57.0	....	56.2	....	56.1	....	....	....	....
27dbb1	62.5	....	....	....	....	60.9	61.2	....	....	61.7
29acb1	16.1	17.4	16.9	17.4	17.8	17.3	17.0	16.2	15.4	15.4
6N-26W-12cab1	14.3	16.0	11.4	....	....	....	16.4	16.7	16.0	10.9
13ddd1	56.0	56.3	54.0	55.4	57.8	56.5	56.7	56.9	57.4	....
17dcc1	44.4	47.7	36.5	....	....	....	49.3	50.8	51.7	35.7
34bcb1	28.7	28.9	....	61.2	29.3	29.3	29.7	29.0	....	29.6
					JACKSON COUNTY					
2S-23W-4aa1	10.6	10.2	9.8	20.6	....	....	22.5	....	20.7	....
8bca1	33.5	....	33.1	32.6	34.2	32.9	33.1	....	33.4	....
1S-22W-8ccc1	26.9	29.1	24.3	28.2	29.6	30.7	31.6	31.7	32.1	26.1
15abb1	4.7	4.1	3.7	....	6.4	6.4	6.5	5.3	....	....
30dda1	12.0	8.3	6.3	15.9	16.8	17.1	17.9	17.9	....	7.0
1S-23W-7dcc1	20.1	20.8	20.7	23.4	24.3	24.2	24.9	24.9	25.4	24.0
9dcd1	65.3	65.4	65.4	65.3	65.4	64.4	64.4	65.3	65.7	65.8
12cdd1	48.1	48.5	47.6	....	48.6	....	49.0	49.0	49.8	....
20ddc1	34.3	34.8	32.5	34.5	35.0	....	36.1	35.0	36.2	31.1
22ddc1	55.6	55.5	55.7	55.0	55.5	55.2	55.4	55.5	55.5	55.4
30daa1	20.7	21.6	20.0	21.9	22.6	23.0	23.5	23.6	23.9	21.4
33aaa1	38.7	38.7	37.6	37.8	38.2	....	....	....	....	....
1S-24W-2abb1	31.5	30.0	29.0	30.7	31.2	31.5	31.8	31.9	32.7	29.3
5bcd1	22.1	22.5	....	24.0	23.6	....	22.7	22.6	....	21.9
7adc1	23.3	23.6	....	....	....	....	....	....	....	....
10ccd1	54.9	55.1	54.5	55.1	55.4	55.6	55.9	56.1	57.0	55.8
20add1	59.5	60.4	59.6	....	65.7	61.8	62.1	62.1	64.2	60.8
21bcd1	63.6	64.7	63.7	....	70.9	66.0	66.4	66.3	....	65.2
1S-25W-13ccc1	75.6	76.6	76.0	78.7	79.2	77.0	76.5	76.2	79.7	76.4
1N-22W-11cbc1	8.9	9.1	7.6	....	17.8	....	18.0	....	10.2	9.1
18aab1	43.5	43.5	41.1	....	....	43.6	....	....	....	42.7
26aad1	12.7	13.4	11.7	12.3	12.7	12.9	13.4	13.6	....	12.9
32bcb1	14.7	....	....	13.9	14.4	....	17.0	18.1	....	14.3
1N-23W-10bbb1	28.2	29.0	23.3	26.8	27.9	28.3	31.5	29.7	....	24.6
11ddc1	37.6	38.3	35.2	36.7	37.3	37.8	38.3	38.6	39.2	37.0
19ddd1	23.3	....	21.9	....	26.7	....	....	....	27.6	24.7
22bcc1	50.9	50.5	50.2	50.8	51.1	51.2	54.3	51.3	....	....
24ccd1	22.3	23.2	18.3	24.9	25.9	26.7	27.0	26.7	26.5	19.4
31ddd1	43.7	44.6	43.1	44.9	....	46.2	47.9	47.3	48.2	44.8
34dcd1	25.9	26.9	25.4	27.6	28.3	....	....	....	....	....
2N-22W-4daa1	56.9	71.7	63.5	....	83.5	87.8	65.4	63.0	74.6	....
8dda1	35.2	37.4	35.2	41.4	41.6	39.9	40.4	39.7	43.0	40.7
22abb1	....	24.5	24.0	24.2	....	24.5	24.7	24.7	24.9	....
36bcc1	38.1	38.4	37.9	37.9	38.0	38.0	38.3	38.2	....	38.2
2N-23W-1cbd1	36.9	42.1	....	....	56.3	49.2	44.9	50.1	....	36.7
2bcb1	27.2	27.8	25.5	30.7	30.5	29.7	29.0	33.8	....	24.7
3cca1	31.5	32.0	29.3	....	....	35.5	34.0	33.2	....	31.6
10dbd1	18.9	19.8	17.5	....	23.4	21.7	20.8	20.4	....	17.3
12bbd1	....	37.9	34.0	63.2	52.4	45.1	41.0	39.4	46.6	33.4
12aa1	33.4	36.3	35.3	47.2	43.6	42.9	39.0	37.9	....	36.4
16aba1	30.6	31.7	30.5	37.4	35.7	....	32.9	30.7	....	26.5
21abb1	....	33.0	....	....	34.8	33.9	33.5	33.1	36.2	29.1
21aaa1	27.7	29.3	25.4	....	32.0	31.1	30.7	30.3	....	25.6
24bbb1	38.2	38.9	35.6	36.8	37.6	38.4	39.5	39.8	40.3	37.6
29abb1	44.5	....	42.9	....	49.9	47.5	46.6	46.7	....	....
32dad1	76.2	76.5	72.0	76.4	75.2	75.7	76.6	76.7	77.4	69.9
35dcc1	66.3	67.2	62.7	....	69.2	....	....	67.3	68.0	....
3N-22W-27ad1	7.8	9.1	6.1	9.1	10.3	10.6	10.2	10.5	....	5.5
32cbb1	43.0	47.1	44.3	48.9	48.4	48.6	48.8	47.9	50.3	48.6
3N-23W-19bbb1	81.8	83.4	79.6	83.6	84.3	84.2	84.5	84.4	87.0	82.7
26aad1	58.1	63.4	56.6	77.1	77.2	77.2	65.3	63.5	....	57.5

Table 5.--Continued

(feet below land-surface datum)

Well number	2nd week of Feb. 1954	3rd week of April 1954	4th week of June 1954	4th week of Aug. 1954	4th week of Sept. 1954	4th week of Oct. 1954	1st week of Jan. 1955	2nd week of Feb. 1955	3rd week of April 1955	4th week of June 1955
				JACKSON COUNTY--Continued						
3N-23W-27dad1	....	50.7	40.9	....	65.0	54.3	47.4	45.8	60.6	42.9
27aad1	46.1	50.9	44.0	....	68.1	59.9	54.3	50.6	....	47.4
27cdd1	30.8	....	20.3	....	....	42.3	36.2	34.6	....	29.8
30daa1	24.4	27.7	23.1	....	29.7	29.3	27.5	27.2	35.8	27.2
31bca1	25.9	26.3	24.0	29.7	....	26.6	26.7	26.4	....	25.4
32aab1	34.1	36.4	31.8	....	46.2	....	38.8	....	....	....
35bdb1	....	39.3	35.8	....	39.4	39.9	40.6	40.9	41.0	34.3
36aac1	44.5	45.4	48.6	46.0	47.3	46.6	47.5	47.7	48.8	45.1

The flow of Salt Fork increases as the stream crosses the outcrops of the Dog Creek Shale and Blaine Formation in the report area and then decreases rapidly as the stream progresses eastward across the outcrop of the Flowerpot Shale. Apparently the stream gains more water by seepage from the Dog Creek and Blaine than is lost along that part of its channel by evaporation and transpiration.

Springs.--Ground water discharges from springs at many places in the area. Of the 16 springs visited, the discharges range from mere trickles to an estimated 300 to 400 gpm. The largest spring flows from a large opening in gypsum rock in the NW$\frac{1}{4}$ sec. 16, T. 1 N., R. 23 W., and contributes to the flow of Gypsum Creek. Old settlers of the area report that at one time some of the springs had greater flows, especially the large spring mentioned above.

Concrete and stone reservoirs have been constructed to collect the water from some of the springs in sec. 25, T. 6 N., R. 24 W., and in sec. 31, T. 6 N., R. 23 W. Clark Stowe hauls water from his springs in sec. 25 to rural residents in the vicinity. Several small springs issue from the alluvium and terrace deposits northeast of Mangum; the water flows north into Elm Fork.

A few springs flow into Salt Fork along its eastward course through the area. Water issuing from the spring in the W$\frac{1}{2}$ sec. 7, T. 4 N., R. 26 W., flows northward into sec. 6, and supplies more than the 240 gpm that is pumped for irrigation in the SW$\frac{1}{4}$ sec. 6. In 1954 the Oklahoma Game and Fish Commission built a reservoir for recreation in the SE$\frac{1}{4}$ sec. 10, T. 4 N., R. 26 W. This lake, when full, covers about 50 acres and has a capacity of about 300 acre-feet. The spring-fed stream that supplies the reservoir had a measured flow of 360 gpm; according to the former owner of the springs, this was the smallest flow on record. Before 1948, springs in secs. 18, 19, and 20, T. 4 N., R. 25 W., were the only source of water used by Hollis, but now they furnish only a part of the supply. Several other small springs flow into the south side of Salt Fork in the vicinity of Mangum, and some of them furnish enough water for stock needs.

Evaporation.--Where the water table is near the land surface ground water may be discharged into the air by evaporation. In this area such losses probably are significantly large in only small areas of the terrace deposits and alluvium. Factors governing the rate of evaporation of ground water are temperature, wind velocity, humidity, type of soil, and depth to water. White (1932, p. 8) found by experiment that the depth to the water table is the principal controlling factor. He compared evaporation at different depths with evaporation from a free water surface, and expressed the evaporation at a given depth as a percentage of the evaporation from a free water surface. Evaporation was found to decrease progressively from 80 percent at a water-table depth to 5 inches to

2 percent at a water-table depth of 85 inches. As the depth to water in this area generally is greater than 85 inches, the amount of water evaporated from the water table probably is small. On the other hand, the loss by evaporation from the belt of soil moisture may be rather large; most of the water thus discharged does not come from the zone of saturation.

Transpiration.--Loss of water into the atmosphere by growing plants is called transpiration. Although the roots of most plants absorb water from only the belt of soil moisture, the roots of some water-loving plants, or phreatophytes, absorb water from the capillary fringe or from the zone of saturation itself. Salt cedar, willow, and other phreatophytes grow in some of the principal valleys of the report area. Locally, the loss of ground water by tranpiration may be large, but in most of the outcrop areas of the Dog Creek Shale and Blaine Formation the depth to water is so great that the discharge of ground water by plants is negligible.

Subsurface flow.--Where two aquifers are in contact, water may percolate from one into the other. In the part of the area where saturated terrace deposits overlie Permian bedrock, water moves downward from the terrace deposits into the bedrock wherever the hydrostatic head of the water in the bedrock is less than that of the water in the terrace deposits. Also, where alluvium abuts the Permian bedrock that forms the valley walls, water moves laterally out of the bedrock into the alluvium. With the exception of the Gypsum Creek irrigation area, the upper end of all the irrigation areas is in or near rather extensive terrace deposits. As shown by plate 2, these terrace deposits are so situated that some of the water percolating from them into the bedrock probably moves into the irrigation areas and replaces the water pumped for irrigation.

Pumpage.--Annual pumpage of ground water for irrigation has increased steadily since irrigation was begun in the 1940's. Information obtained in interviews with the irrigators indicates that about 49,000 acre-feet of water was pumped for irrigation in 1954. This amount is about 30 percent greater than the amount reported by the irrigators in replies to an official questionnaire of the Oklahoma Planning and Resources Board (Husky, 1956).

Municipal records show that pumpage totals about 926 acre-feet of water per year for the public supplies and it is estimated that pumpage for stock is about 110 acre-feet. The amount of water used for domestic purposes in rural areas is practically negligible, because of the generally poor quality of the water in most of the water in most of the area.

The total pumpage of ground water in the area of this investigation in 1954, therefore, was about 50,000 acre-feet.

Utilization

Most of the water used in this area is ground water. During this investigation, pertinent data were obtained for 654 wells and 127 test holes. Of the wells, 141 are unused, 14 are domestic wells, 152 are stock wells, 20 are public-supply wells, 326 are irrigation wells, and 1 is a recharge well. Wells used for both domestic and stock supplies are classified as stock wells. Data pertaining to the wells and test holes are tabulated in appendix B; the locations of wells and test holes are shown on plate 2.

Domestic supplies

Domestic wells are the privately owned wells that supply water for home use, such as cooking, washing, and sanitation. Because of the poor chemical quality of the water available in most of this area, there are not many domestic wells. Most of the water used for domestic purposes is hauled from the three towns in the area; also, some is hauled from privately owned springs in the vicinity of Reed. No attempt was made to determine the amount of ground water pumped from domestic wells because the amount is small in comparison with the amount used for other purposes.

Most domestic wells in the area are drilled, are cased with a small-diameter galvanized-iron casing, and generally are equipped with a cylinder pump. Relatively few automatic water systems are used. Some of the unused wells that were inventoried are abandoned domestic-supply wells. The abandoned wells reflect the decline in rural population that is evident from census records.

Stock supplies

A count was made of the number of stock wells in three townships during this study. A total of 27 were found in T. 2 N., R. 24 W.; 98 in T. 2 N., R. 26 W.; and 37 in T. 5 N., R. 26 W. Most of the stock wells are drilled, cased with 6-inch casing, and equipped with a cylinder pump and windmill. Because of its location with respect to land use, soil type, and general stock-water needs, T. 2 N., R. 24 W., is regarded as a typical and average township in the use of stock water; therefore, this township was selected for an inventory of the pumpage for stock use. About one million gallons of water was used in that township in 1953 (Roberts and Bunch, undated). The average annual pumpage for stock use was estimated by multiplying the amount used in the one township by the number of townships in the area. Annual use for stock in the project area is about 110 acre-feet. Much of the stock water of the area is obtained from privately owned ponds.

Public supplies

Public-water supplies of the cities of Mangum, Eldorado, and Hollis and the towns of Duke, Gould, and Olustee are obtained from wells. Several scattered wells in the area were dug for public supplies by the W.P.A. in the 1930's. Water for the city of Mangum, near the northeast corner of the area, formerly was obtained from terrace deposits just outside the city limits but in recent years has been obtained from terrace deposits about 17 miles farther north, outside the project area.

Duke.--In 1953 Duke had two wells tapping the Blaine Formation in sec. 12, T. 2 N., R. 23 W. The first well was drilled in 1946 and was tested at about 650 gpm. The second well was drilled in June 1952 as a standby and safety measure; however, both are used. Annual pumpage is estimated to be about 14,000,000 gallons, or about 43 acre-feet.

Eldorado.--In 1953 Eldorado had five wells that tapped water in the Dog Creek Shale or Blaine Formation. Two of these, in sec. 28, T. 1 S., R. 23 W., are dug wells and until the mid-1940's were the town's only source of water. Later three new wells, one dug and two drilled, were developed in the city in sec. 18, T. 1 S., R. 23 W., to supplement the inadequate supply of the first two wells. The city pumps about 70,000 gpd, or about 80 acre-feet per year. More recently the city has tested terrace deposits west and southwest of the city in search of a supply of suitable water, because the quality of water from the city wells is not suitable for most domestic needs.

Gould.--In 1953 Gould had two wells tapping the terrace deposits in sec. 18, T. 4 N., R. 24 W., about 10 miles north of town. The wells also supply a large part of the domestic needs of nearby rural residents who haul water from the town. The two wells cannot supply an adequate amount of water for the town in a season of peak use; therefore, hauling of water for domestic needs in the surrounding vicinity is sometimes limited. Gould's annual water use is estimated to be about 18 million gallons, or about 55 acre-feet.

Hollis.--Until 1948 the only sources of supply for the city of Hollis were the springs in secs. 18, 19, and 20, T. 4 N., R. 25 W., but this supply was supplemented by a well drilled in 1948 and by two additional wells drilled in 1951. The three wells tap terrace deposits in sec. 20, T. 4 N., R. 25 W., and have yields of 165, 225, and 265 gpm. In October 1955, another well was drilled near the first three wells to a depth of 200 feet into what could be an old stream channel now filled with terrace deposits. The well was tested in November 1955 at about 450 gpm.

Hollis pumps about 217 million gallons, or about 666 acre-feet per year, to supply its municipal needs and the domestic needs of nearby rural residents. In addition, in 1953, the Lone Star Gas Co. bought 14.5 million gallons of water for its gasoline plant about 2 miles northwest of town, making the total amount of water pumped by Hollis in 1953 about 230 million gallons, or 710 acre-feet. The gasoline plant was closed permanently in the early part of 1954.

Olustee.--In 1953 Olustee had one well in the NE$\frac{1}{4}$ sec. 20, T. 1 N., R. 21 W., tapping either the Flowerpot Shale or the Duncan Sandstone. The well yields about 13,000 gpd (gallons per day), which is only a small fraction of the daily need of the town. Most of the municipal supply was taken from Turkey Creek by facilities constructed in about 1924. In August 1954 a new well was drilled to tap the alluvium in the SE$\frac{1}{4}$SE$\frac{1}{4}$SE$\frac{1}{4}$

sec. 16, T. 1 N., R. 21 W.; it was tested at about 300 gpm. The town consumes 125,000 to 150,000 gpd at the peak summer rate but only about 25,000 gpd at the lowest winter rate. The annual use of water is estimated to average 27 million gallons, or about 83 acre-feet.

Irrigation supplies

In this area the seasonal distribution of rain may mean an excess early in the growing season followed by a deficiency. Therefore, irrigation frequently means the difference between economic success and failure, or between a bumper crop and a mediocre one.

A total of 326 irrigation wells have been inventoried. Except for the five irrigation wells that tap terrace deposits (four northeast of Mangum and one east of Olustee, outside the principal irrigation areas) all the irrigation wells tap either the Dog Creek Shale or Blaine Formation, or both, and all are grouped and roughly centered within the drainage basins of the major creeks in the area. An attempt was made to keep an up-to-date inventory of all irrigation wells in the principal irrigation areas while peronal interviews were being conducted to obtain records of 1954 pumpage. Because the process of interviewing the irrigators was not finished until early 1955, some wells that were drilled as late as 1955 were inventoried and are included in appendix B.

Most of the irrigation wells were drilled with percussion drilling machines, and are partly or entirely cased. Many were drilled to their full depth before any casing was installed, but some had to be cased while the hole was being drilled to prevent caving of the unconsolidated upper sediments. When surface casing was required, it generally was 20 inches in diameter and commonly was left in the well even after the finished casing, or "liner," had been set. Only a few wells have no casing.

The following paragraphs summarize facts about the principal irrigation areas and wells within the areas.

Buck Creek irrigation area.--The Buck Creek area is in the Buck Creek drainage basin in the southwest corner of the area. Consisting of only 6 square miles, it is the smallest of the five principal irrigation areas that are described in this report, but it is actually part of a large area lying mostly in Texas. However, the pumpage from the 11 wells--1,700 acre-feet--is much greater than from all the wells in the Gypsum Creek and Mulberry Creek irrigation areas combined. The water level in the area responds rapidly to discharge and recharge, and an irregular but definite decline from 1950 to 1956 is shown by records from three wells. Because most of the arable land in the Buck Creek area is already under irrigation, the annual rate of ground-water withdrawal is not likely to increase significantly in the future. However, if irrigation wells were to be drilled outside the boundaries of the irrigation area, the total withdrawal from the enlarged area would be correspondingly greater.

Gypsum Creek irrigation area.--The Gypsum Creek irrigation area is north of Eldorado and southwest of Duke in the drainage basin of Gypsum Creek, mostly in Jackson County. It is nearly oval and consists of about 30 square miles. The 30 square miles in this area makes it the third largest of the five principal irrigation areas, but the 100 acre-feet of water pumped from the two irrigation wells in use in the area in 1954 was the smallest amount pumped in any of the irrigation areas and was too small to cause any significant water-level fluctuations. Measurements made in 1954 show that the water level responds rapidly to recharge.

Lebos Creek irrigation area.--The Lebos Creek irrigation area is long and narrow, extending from northwest of Hollis to southeast of Eldorado The irrigation area extends a short distance into Texas, but is mostly within Oklahoma. It contains about 170 square miles and is the largest irrigation area described in this report. Since 1946, when the first irrigation well was drilled in the area, there has been continuous development. The development probably will continue, not so much as an expansion of the area but as an increasing concentration of wells within the area. Although lack of water probably will be the greatest controlling factor in the future expansion of the area, the quality of the water will be an additional controlling factor in some parts of the area. The maximum depth to which wells should be drilled is dependent on the depth to the bottom of the water-bearing strata in the Dog Creek Shale and Blaine Formation. The depth to which wells should be drilled will be limited also by the water of poor quality that is present, locally, in these formations and in the underlying formation--especially at depths greater than 400 feet below the land surface.

The yields of the 210 irrigation wells inventoried ranged from less than 100 gpm to a few thousand gallons per minute. The 30,000 acre-feet pumped in 1954 was almost twice the combined pumpage in the other four irrigation areas. Monthly water-level measurements made from February 1954 to June 1955 show that the water level responds very rapidly to discharge and recharge, and also that a difference in the rate of response occurs in certain parts of the area.

Mulberry Creek irrigation area.--The Mulberry Creek irrigation area is mostly in the Mulberry Creek drainage basin a few miles west of Mangum. In 1954 about 540 acre-feet of water was pumped for irrigation from eight irrigation wells in this 13 sq mi area. Available records do not indicate such a rapid response to discharge and recharge as is apparent in the other areas; however, the apparently slower response may result from inadequate water-level records.

Turkey Creek irrigation area.--The Turkey Creek irrigation area is in the drainage basin of Turkey Creek, near the center of the project area. It lies partly in Greer County, partly in Harmon County, and partly in Jackson County. This area now covers about 90 square miles and is the second largest of the five principal irrigation areas, with respect to both area and the amount of water pumped. Since 1942, when the first irrigation well was drilled, development and expansion of the area has been continuous; however, the limit of lateral expansion probably has been almost reached, and future development probably will consist of drilling additional wells within the area. As in the Lebos Creek irrigation area, water too highly mineralized for use has been tapped in several places. The quality of water will limit the size of the irrigation area and depth of wells. In 1954 the pumpage from 84 wells in the area totaled about 14,000 acre-feet. Water-level records for the period from February 1954 to June 1955 show that the water level responds very rapidly to discharge and recharge and that the fluctuations are greatest where the largest amounts of water are pumped. Water-level records for the period 1949-56 show an irregular but definite decline.

Yield of wells

The yield of a well that taps the Dog Creek Shale or Blaine Formation is governed by the size and (or) the number of water-filled solution cavities penetrated in drilling the well. Because the strata constituting these two formations not only differ in lithology from place to place but have been affected by solution activity in varying degree from place to place, the yields of wells differ appreciably.

Many of the existing wells yield more than 1,000 gpm and a few yield more than 2,000 gpm. One well in southern Greer County was pumped at a rate of about 2,550 gpm in May 1952 but for only a short period. Five other wells in the Lebos Creek irrigation area are reported to yield more than 2,000 gpm. Two of these five wells are reported to have yielded more than 2,000 gpm (the pumps' capacities) with less than 20 feet of drawdown and therefore are capable of yielding at a greater rate. Many of the wells yield between 500 and 1,000 gpm, but many others yield less than 10 gpm.

Most of the irrigation wells of low yield and others that failed to produce enough water for irrigation are near the edges of the principal irrigation areas. Therefore, yields are expected to be generally lower in the fringe areas than nearer the middle of the basins, where solution channels are better developed.

Transmissibility and Storage

The amount of water a well will yield depends on the hydraulic properties of the aquifer. The coefficient of transmissibility is defined as the rate of flow of water in gallons per day through a vertical strip of the aquifer 1 foot wide and extending the full saturated height, under a hydraulic gradient of 1 foot per foot at the prevailing temperature of the ground water. The coefficient of storage, S, of an aquifer is defined as the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that aquifer.

These properties of an aquifer generally are determined by aquifer tests. An aquifer test consists of pumping a well at a known rate for a given length of time and of measuring the depth to water in observation wells near the pumped well during the period of pumping and during the following period of water-level recovery. The test methods and the formulas for analyzing the data collected are based on several assumptions about the aquifer to be tested. As many of the necessary assumptions do not hold in the area described in this report, aquifer tests at individual well sites were not considered practicable.

Consideration was given to making a flow-net analysis, as has been done by others (notably Bennett and Meyer, 1952; and Taylor, 1948), to obtain values for the coefficients of transmissibility and storage of the major aquifer in the area. However, because so little is known about the detailed movement of flow induced by heavy pumping in the irrigation areas and because water-level fluctuations in one irrigation area seem not to be related to those in another, it was concluded that the porosity and permeability of the aquifer vary too widely from place to place for a flow-net analysis to be practicable.

Attempts were made to analyze the aquifer in the irrigation areas on a massive or regional basis. Plate 6 was used as a basic tool in determining the aquifer coefficients by this method. The pumpage from six selected areas was determined for a period of 87 days in the 1954 irrigation season. These areas are outlined on plate 6 by arcs of circles and the interconnecting segments of the irrigation-area outlines. The water pumped from the aquifer in each area was assumed to have been pumped at a continuous, uniform rate from a "single well" approximately at the center of pumping in that area, or at the intersection of the straight dashed lines in each of the circular areas. Lines were drawn to represent the change in water level due to pumping during the 87-day period between June and September 1954. "Observation wells" were assumed to be located at those points where the dashed lines intersect contours representing change in water level. Thus, the water-level drawdown in the observation wells at the end of the pumping period was the change in water level represented by the net-change line passing through the well.

The data thus obtained were analyzed by both the Theis nonequilibrium method and the Thiem method for determining the coefficients of transmissibility and storage of an aquifer (Wenzel, 1942), no corrections being made for interference of one area of pumping with another or for more than one of the apparent geologic semiboundaries. Because of the assumptions made, refinement of the calculations was not justified. The calculated coefficients of transmissibility ranged from 1.2×10^5 to 4.6×10^5 gpd/ft, and averaged 2.6×10^5. The coefficients of storage ranged from about 4×10^{-4} to about 3×10^{-2}, and averaged 1.6×10^{-2}. These values are believed to be reasonable for the coefficients of transmissibility and storage of the aquifer in the areas where solution channels are best developed, but they probably are several times too great for the aquifer throughout the irrigation areas and much too great for the aquifer as a whole. A reasonable value for the coefficient of storage for the part of the aquifer outside the irrigation areas is assumed to be one-third of that inside the irrigation areas, or about 5×10^{-3}, and the average coefficient of storage for the parts of the aquifer affected by pumping for irrigation is assumed to be half way between the two values, 1.0×10^{-2}.

The amount of available water in storage in the Dog Creek Shale and Blaine Formation was calculated by multiplying the areal extent by the estimated average thickness, and by the average storage coefficient of the aquifer. The extent of the infiltration area is about 400,000 acres. The thickness of the aquifer--that is, the average total thickness of anhydrite, dolomite, gypsum, limestone, and cavities in 69 test holes and wells that are judged to penetrate the aquifer fully--ranges from about 65 feet in the eastern part of the area to about 90 feet in the western part, and averages about 80 feet for the whole area. The total amount of water in storage is 400,000 x 80 x .01 = 320,000 acre-feet. Because the irrigation wells are concentrated where the aquifer is most productive, only a part, perhaps one-third or less, of the water in storage is available for pumping.

From July 1 to September 15, 1954, several wells declined in yield. However, the yield from some of these wells was increased by making a deeper pump setting or by deepening them and lowering the pump. The yields of other wells, generally those near the edges of the principal irrigation areas, declined but could not be increased successfully. Near the streams and in the central part of the irrigation areas, solution channels in the gypsum beds may be larger, extend to greater depth, and be more numerous than at the edges of the irrigation areas some distance from the streams. Thus, when the safe yield of an irrigation area is exceeded, the irrigation wells on the edges of the area probably will be the first ones affected by the reduction in storage and the resulting lower water levels. Unless water-level changes are observed closely, the failure of outlying wells may be one of the first serious warnings that the ground-water supply is being depleted.

Precipitation in 1957 was exceptionally high and averaged about 33 inches over the area--137 percent of normal. Water levels were low at the beginning of 1957 because of the extremely dry weather and heavy irrigation pumping during 1956. By the end of 1957, water levels over the area averaged about 12 feet higher than a year earlier, owing to the heavy precipitation and small irrigation pumpage during the year. On the basis of the storage coefficients calculated above, the total volume of water stored in the aquifer in the Dog Creek Shale and Blaine Formation increased by an estimated 48,000 acre-feet in 1957.

From December 1957 to January 1963 water levels throughout the area declined an average of 3.14 feet and the volume of water in the aquifer declined an estimated 13,000 acre-feet.

Annual Recharge

The replenishment of ground water in an aquifer is known as recharge, and under natural conditions an aquifer is recharged from one source or from a combination of several sources. The principal natural sources of recharge are influent streams, infiltrating precipitation, and subsurface inflow from other aquifers or areas. Recharge also may be induced by artificial means, such as recharge wells, canals, or water spreading.

When the investigation was begun, Salt Fork was considered a possible source of recharge to the Dog Creek Shale and the Blaine Formation. Discharge measurements showed that Salt Fork gains water along the first several miles of its course in the area. However, most of the gain may be due to springs issuing from the terrace deposits on the south side of the river and to inflow, on both sides of the river, from tributaries whose flow is sustained by springs issuing from the Permian rocks. Hence, it could not be determined whether the stream is influent or effluent with respect to the principal ground-water reservoir in the Dog Creek Shale and Blaine Formation along its course in the western part of the area.

Also, when the investigation was begun the water in the terrace deposits, and possibly also in the Whitehorse Group, was assumed to be perched and therefore not connected hydraulically to the zone of saturation in the Dog Creek Shale and Blaine Formation. It was believed possible that water from Salt Fork could move southward through the Dog Creek Shale and Blaine Formation to the irrigation areas, even though there is a ground-water divide in the terrace deposits between Salt Fork and those areas. To determine whether such southward movement was possible, several test holes were drilled south of Salt Fork between the State line and a line extending from Reed, so that the position of the piezometric surface in the Dog Creek Shale and Blaine Formation could be measured. It was found that eastward for 9 miles from the State line the piezometric surface is above the level of Salt Fork, that for a few miles farther east it is at about the same level, and that still farther east it is above the river level (pl. 2).

Apparently, therefore, the Salt Fork gains water in those stretches where the piezometric surface is above stream level and neither gains nor loses in the stretch where the river is gaining and, at least at low flow, practically no water is lost from the stream. Even if the stream were losing in that stretch during periods of high flow, any water leaking from the river channel would move southeastward (perpendicular to the water-level contours) and so could not possibly reach the Lebos Creek irrigation area, which is to the southwest. Furthermore, if only one or two of the several irrigation areas had a special source of recharge, it would be difficult to explain why the water-level responses to precipitation and pumping are so similar in all of them. Consideration of all the evidence leads to the conclusion that the Salt Fork is not a source of recharge to the Dog Creek Shale and Blaine Formation within the area.

Some recharge to the Dog Creek Shale and Blaine Formation probably results from percolation from the surficial terrace deposits and the Whitehorse Group in the northwestern part of the area and from the less extensive terrace deposits and alluvium elsewhere in the area. The surficial deposits are highly porous and permeable and they catch and hold a large percentage of the water that falls on their surfaces. Although leakage from the zone of saturation in these deposits probably is a source of recharge to the older rocks, the amount and extent of such recharge cannot be estimated from available data. It is not believed to be the major source of recharge to the ground-water reservoir in the irrigation areas.

Infiltrating precipitation probably is the major source of recharge to all the ground-water reservoirs in the area. The water level rises rapidly as a result of precipitation in the immediate vicinity (pl. 7), and it is believed that precipitation on the gypsum beds, where they crop out to the northwest of this area, is another important source of recharge to the principal aquifer. At least it is reasonable to assume that if the water in the Dog Creek and Blaine beneath the terrace deposits in the northwestern part of the area is not all derived from the overlying terrace deposits, then some of it must be from recharge in the outcrop area of the rocks.

After rains, water can be observed flowing into the many sinkholes. Some sinkholes receive all the runoff from several acres, whereas others receive runoff from much smaller areas. Organic matter pumped from wells is evidence that some water enters the aquifer without first being filtered through fine-grained materials. Other natural depressions, some of which may be sinks that have become plugged, contain shallow lakes in seasons of heavy precipitation. Although much of the lake water is evaporated, some probably infiltrates to the zone of saturation. Unless the water that enters the aquifer through sinks or by seepage from lakes is withdrawn from the aquifer by pumping from wells, it moves generally southeastward and discharges into Salt Fork and its tributaries. The percentage of the precipitation that infiltrates through sinkholes and from lakes obviously differs appreciably from place to place; therefore, no attempt was made to estimate the amount of recharge by this particular method.

Attempts have been made to recharge the ground-water reservoir artificially by introducing water into wells in at least two places in the area. One recharge well, about 3 miles west northwest of Duke, was drilled to drain an area of farmland; another recharge well is an abandoned irrigation well, about 4 miles west of Hollis, that also drains an area of farmland. The amount of water introduced by artificial recharge has been negligible, but with proper engineering design and operation, a system of recharge wells might be feasible.

The ground-water aquifers in this area are recharged principally by infiltrating precipitation and by subsurface flow. Annual pumpage for irrigation has increased rapidly since 1950. As a result of the pumping and also because precipitation was less than normal, the water level in the irrigation areas declined annually from 1950 to late 1955. The fall rains in 1955 were heavy enough to boost the total precipitation for the year to slightly above normal, and as a consequence the water levels in the irrigation areas were, on the average, about 2 feet higher in February 1956 than they were the previous February. It is concluded, therefore, that under normal conditions of rainfall and natural recharge, the 1955 rate of pumping did not exceed the average annual rate of recharge from precipitation.

In making the first of two estimates of the percentage of precipitation that recharges the Dog Creek Shale and Blaine Formation, the following assumptions were made: (1) Direct infiltration is the only significant source of recharge to the aquifer; (2) the percentage of precipitation infiltrating to the aquifer by each of the several routes consistently constitutes the same proportion of the total recharge; and (3) each time rain falls, the same percentage reaches the ground-water reservoir. Inasmuch as most of the rainfall occurs in the late spring and early fall, the evaporation rate would be about the same each time. Although the soil-moisture deficiency differs considerably from season to season, it is not considered to be a determining factor in the long run.

The extent of the irrigation areas, as shown on plate 6, is about 200,000 acres, and the catchment area that contributes recharge to the irrigation areas is estimated to be about twice that size--400,000 acres. The average precipitation at Eldorado, Hollis, and Mangum between February 1954 and February 1955 was about 1.24 feet (62 percent of normal), and from February 1955 to February 1956 was about 2.37 feet (118 percent of normal). From February 1954 to February 1955 the water level in the irrigation areas declined an average of about 5 feet and outside the irrigation areas it declined an average of about 1.5 feet. Total pumpage from the aquifer in 1954 is estimated to have been about 50,000 acre-feet and in 1955 to have been about 55,000 acre-feet. The loss of ground water to streams, evaporation, and transpiration is estimated to have been about 6,000 acre-feet per year. The storage coefficient of 0.016, determined from the regional aquifer tests, is assumed to be correct for the irrigation areas, and, as indicated previously, the coefficient for other areas is estimated to be about 0.005.

On the basis of these figures, the percentage of precipitation that became recharge in 1954 (R_{54-1}) and in 1955 (R_{55-1} was calculated according to the following formula:-

$$R = \frac{D_t \pm S_i \pm S_o}{P_t} 100$$

Where: R = percent of precipitation reaching the zone of saturation,
D_t = total discharge (natural discharge and pumpage), in acre-feet;
S_i = change in storage inside irrigation areas, in acre-feet;
S_o = change in storage outside irrigation areas, in acre-feet;
P_t = total volume of precipitation (falling on the catchment area), in acre-feet.

Then:

$$R_{54-1} = \frac{(50,000+6,000)-(5x0.016x200,000)-(1.5x0.005x200,000)}{1.24x400,000} 100 = 7.8\%,$$

and

$$R_{55-1} = \frac{(55,000+6,000)+(2x0.016x200,000)+(2x0.005x200,000)}{2.37x400,000} 100 = 7.3\%.$$

If the figures for pumpage in 1954 and 1955 are too large (and evidence suggests they may be at least 130 percent of actual pumpage), then the amount of recharge as determined above is too large and perhaps should be 5.5 percent to 6 percent.

The second estimate of the percentage of precipitation that becomes recharge was made in the following manner. It was calculated, from hydrographs and water-level records, that the water level would have risen an average of 3 feet during April and May 1954 and 5 feet during May and June 1955 if no water had been pumped from the aquifer. Twenty percent of the total rise was assumed to have been due to filling of cones of depression after pumps were stopped. The other 80 percent was assumed to come from the infiltration of precipitation from the heavy rains during those periods. The formula used for the second recharge estimate for 1954 (R_{54-2}) and 1955 (R_{55-2}) was:

$$R = \frac{F \times H \times S}{P} 100$$

Where: R = percent of precipitation reaching the zone of saturation
F = percent of water-level fluctuation resulting from infiltration of precipitation
H = change in water level, in feet
S = average coefficient of storage inside and outside the irrigation areas (1×10^{-2})
P = precipitation during period of water-level rise, in feet

Then:

$$R_{54-2} = \frac{0.80 \times 3 \times 0.01}{0.75} 100 = 3.2\%$$

and

$$R_{55-2} = \frac{0.80 \times 5 \times 0.01}{1.06} 100 = 3.8\%$$

The above formula, the average of the second recharge estimate (0.035), and the estimated discharge for the area can be used to calculate the water-level decline between February 1954 and February 1955. Based on this reasoning, the decline of water level should have been 9.7 feet:

$$s = \text{(decline due to discharge)} - \text{(rise due to recharge)}$$

$$= \frac{50{,}000 + 6{,}000}{400{,}000 \times 0.01} - \frac{1.24 \times 0.35}{0.01} = 14.0 - 4.3 = 9.7 \text{ ft.}$$

Inasmuch as the decline in water level in the irrigation areas was only about 5 feet, the second estimate of recharge evidently is too small. However, if the pumpage figure was 130 percent of actual pumpage (as suggested earlier), the computed decline based on actual pumpage would have been 6.3 feet. This is still substantially greater than observed declines; consequently the second recharge estimates are believed to be less reliable than the first estimates.

A rough check of the recharge estimates can be made by applying them to the 5-year period 1958 through 1962, when precipitation was approximately normal. During this period the total precipitation, averaged, for the three stations, was 124.4 inches, or 24.88 inches annually (103 percent of normal). Based on the 7 percent estimate derived above, annual recharge would have averaged 1.74 inches, or 58,000 acre-feet for the area.

Because precipitation was near normal, pumpage for irrigation is estimated to have been only about 1 acre-foot per acre irrigated, or about 35,000 acre-feet annually. Other pumpage has been estimated to be about 1,000 acre-feet per year and natural discharge to be about 6,000 acre-feet. Thus, the total discharge of ground water in the area is estimated to have averaged about 42,000 acre-feet annually during the 5-year period.

Water levels in observation wells in the area in January 1963 averaged about 3.14 feet lower than in December 1957. Using the storage figures previously developed, this change in water level means that in 1963 the ground-water reservoir contained about 12,500 acre-feet less water than 5 years earlier. The average decline in storage for the period was about 2,500 acre-feet annually.

A comparison of the recharge, discharge, and estimates of change in storage for the 5-year period indicates that the recharge estimate of 7 percent of total precipitation is too large, or the estimate of discharge from the reservoir for the period is too small, or both. If the recharge estimate were 6 percent, instead of 7 percent, then the annual recharge for the period would have averaged about 50,000 acre-feet.

Chemical Quality of the Water

Natural water contains variable amounts and kinds of dissolved constituents as a result of the solvent action of water on minerals and rocks. Within reasonable limits, the presence of minerals in water adds to the value of the water for irrigation use and human consumption. The minerals not only add certain plant nutrients to the soil, but improve the palatability of water for drinking. If no minerals were dissolved in water, it would have the flat taste of rainwater. Chemical analyses of 43 samples of ground water and 6 samples of spring water are listed in table 6, and the locations of the sampling points are shown in figure 7. Other data on the quality of water in streams in this area have been published (Walling, Schoff, and Dover, 1951; U.S. Geological Survey, 1952; Dover, 1953, 1954, 1956, 1958, 1959; Murphy, 1955; Pate, Murphy, and Orth, 1961; Cummings, 1963).

Because the wells chosen for sampling are scattered widely, the analyses are believed to represent nearly the full range in quality that may be expected. The 43 ground-water samples that were analyzed consist of 29 from wells in the Dog Creek Shale and Blaine Formation, 8 from wells in the Blaine Formation, 4 from wells in the terrace deposits, 1 from a well in the Whitehorse Group, and 1 from a well that tapped three or more formations of Permian age.

Suitability for Drinking

Standards for judging the suitability of water for drinking purposes have been established by the U.S. Public Health Service (1962). According to those standards, the maximum concentrations of certain constituents allowed in water that is provided for passenger use on carriers subject to Federal quarantine regulations are those given in the following table:

Constituent	Parts per million[1/]
Iron (Fe)	0.3
Fluoride (F)	1.6
Chloride (Cl)	250
Sulfate (SO_4)	250
Dissolved solids	500 (1,000 accepted)
Nitrate (NO_3)	45

1 A part per million (ppm) represents a unit weight of the substance dissolved in a million unit weights of water, such as a pound of calcium in a million pounds of water.

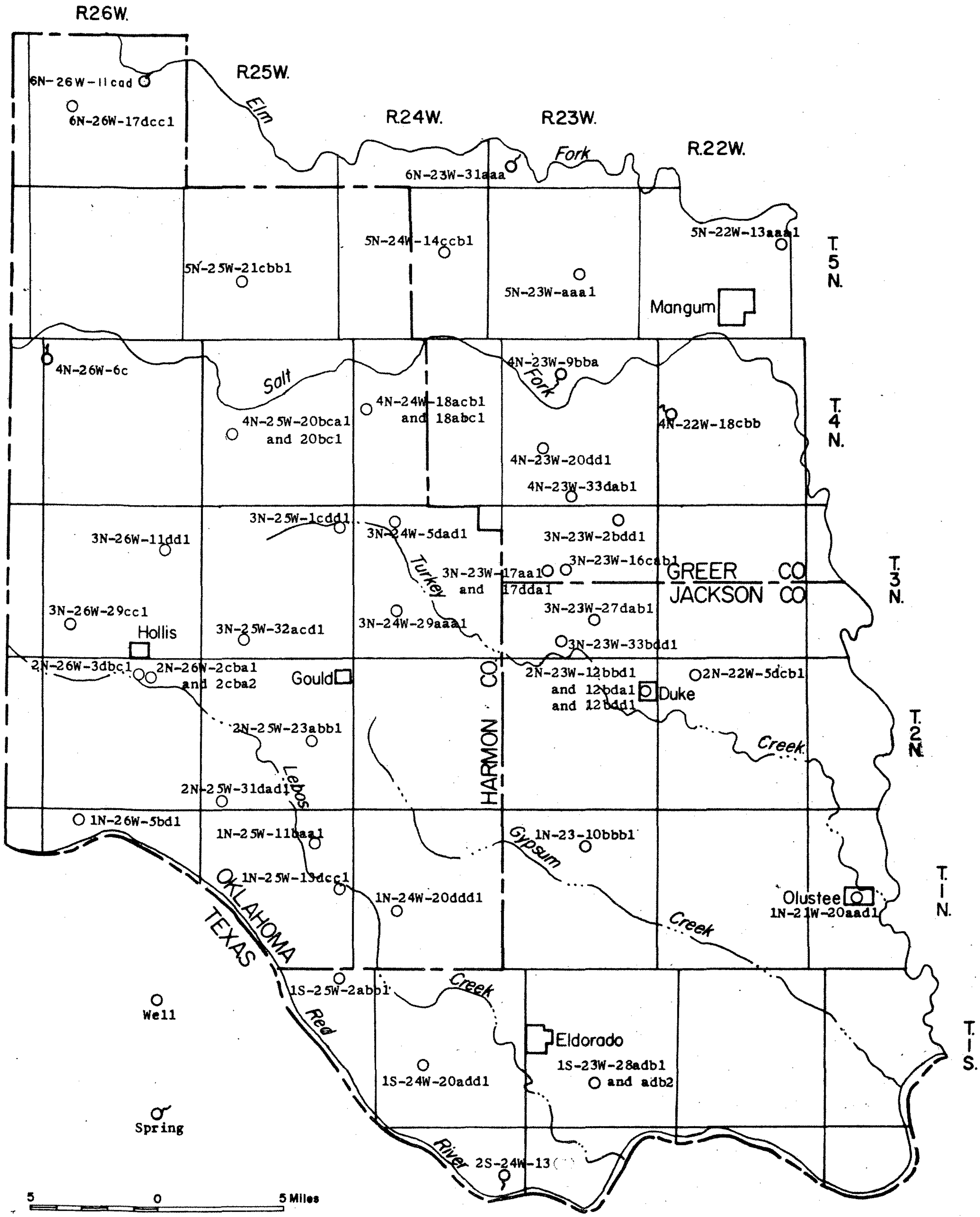

Figure 7.--Map showing where samples of water were collected for chemical analysis.

Table 6.--Chemical analyses of water from wells and springs in Harmon County, and adjacent parts of Greer and Jackson Counties, Oklahoma

Location: See text p. 7 for explanation of numbering system; well locations shown on pl. 2.

Geologic source: Qt, terrace deposits; Pw, Whitehorse Group; Pdc, Dog Creek Shale; Pb, Blaine Formation

Class of irrigation water: See text p. 56 for explanation.

(Analytical results in parts per million except as indicated)

Location	Depth of well (feet)	Geologic source	Date of collection	Temperature (°F)	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)	Dissolved solids: Residue on evaporation at 180 C	Dissolved solids: Calculated	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos at 25°C)	pH	Sodium adsorption ratio (SAR)	Class of irrigation water	Boron (B)
1S-23W-28adb1&2 1/	45, 45	Pdc, Pb	7-17-52	..	16	0.00	340	99	67	3.4	269	949	109	0.5	16	1,840	.....	1,260	1,040	..	2,180	7.1	0.8	C3-S1	.....
1S-24W-20add1	165	Pdc, Pb	9- 3-53	..	16	.00	716	146	913	9.1	225	2,050	1,440	.5	22	5,770	5,420	2,390	2,200	45	7,270	7.1	8.1	.....	0.83
1S-25W-2abb1	86	Pdc, Pb	9-25-53	65	13	.00	710	151	883	12	217	2,070	1,400	.7	15	5,640	5,360	2,390	2,210	44	7,160	7.2	7.8	.....	1.4
1N-21W-20add1	......	Qt	7-17-52	..	13	.05	87	12	20	8.3	106	188	27	.3	1.8	421	.....	266	180	..	632	7.2	.1	C2-S1	.....
1N-23W-10bbb1	92	Pdc,Pb	9-16-53	65	15	.00	608	79	38	4.3	178	1,630	50	.3	12	2,760	2,530	1,840	1,700	4	2,730	7.3	.4	C4-S1	.70
1N-24W-20ddd1	140	Pdc,Pb	9-18-53	65	15	.00	704	170	1,190	15	184	2,270	1,780	.7	3.2	6,580	6,240	2,460	2,300	51	8,580	7.2	10	.....	1.4
1N-25W-11baa1	180	Pdc,Pb	9-30-53	64	16	.00	596	114	97	5.2	188	1,730	115	.7	6.4	2,970	2,770	1,960	1,800	10	3,040	7.2	1.0	C4-S1	.58
1N-25W-13dcc1	120	Pdc,Pb	8-13-52	65	....	...	626	134	385		219	1,890	565	......	8.5	4,000	3,720	2,110	1,930	28	4,670	7.3	3.6	C4-S2	.....
1N-26W-5bd1	102	Pdc,Pb	8-12-52	65	....	...	608	130	122		199	1,810	185	......	12	3,260	2,960	2,050	1,890	11	3,350	7.2	1.2	C4-S1	.....
2N-22W-5dcb1	135	Pb	4- 7-50	65	....	...	624	159	181		201	1,840	370	......	3	3,650	3,280	2,210	2,050	15	3,830	....	1.7	C4-S1	.....
			8-14-52	65	....	...	620	141	163		186	1,810	312	......	6.6	3,510	3,140	2,130	1,970	14	3,700	7.2	1.5	C4-S1	.....
2N-23W-12bbd1	200	Pb	6-10-48	65	....	...	584	75	66		55	1,610	122	.4	18	2,740	2,500	1,770	1,720	8	2,780	....	.7	C4-S1	.....
			8-13-52	65	....	...	610	89	89		199	1,670	123	......	7.5	2,910	2,690	1,890	1,720	9	3,020	7.1	.9	C4-S1	.....
2N-23W-12bda1 1/ and 12bdd1	133, 83	Pb	7-17-52	..	16	.00	614	92	94	5.4	217	1,670	130	.5	9.2	2,920	.....	1,910	1,730	..	3,020	7.3	.9	C4-S1	.....
2N-25W-23abb1	130	Pdc,Pb	8-12-52	65	....	...	592	164	253		236	2,010	288	......	11	3,710	3,430	2,150	1,960	20	4,020	7.2	2.4	C4-S1	.....
2N-25W-31dad1	201	Pdc,Pb	10-15-53	65	13	.00	606	79	43	5.1	134	1,620	66	.5	5.8	2,680	2,510	1,840	1,730	5	2,680	7.2	.4	C4-S1	1.1
2N-26W-2cba1	102	Pdc,Pb	10- 2-53	65	16	.00	612	149	106	5.1	236	1,810	159	.7	26	3,220	3,000	2,140	1,950	10	3,320	7.0	1.0	C4-S1	.70
2N-26W-2cba2	189	Pdc,Pb	10- 2-53	65	16	.00	596	135	81	4.8	212	1,790	104	.7	17	3,050	2,850	2,040	1,870	8	3,080	7.2	.8	C4-S1	.70
2N-26W-3dbc1	450	Pdc,Pb	3- 5-55	..	....	...	2,250	2,330	49,300		76	2,160	85,000	......	6.2	144,000	141,000	15,200	15,000	88	140,000	7.3	174	.....	.....
3N-23W-2bdd1	90	Pb	5-16-52	..	....	...	600	102	82		251	1,690	81	......	21	2,920	2,700	1,920	1,710	9	2,990	7.2	.8	C4-S1	.....
3N-23W-16cab1	152	Pdc,Pb	8-14-52	64	....	...	600	141	149		277	1,840	172	......	20	3,280	3,060	2,080	1,850	13	3,460	7.1	1.4	C4-S1	.....
3N-23W-17aa1	189	Pdc,Pb	8-12-52	..	....	...	602	149	127		290	1,850	150	......	19	3,310	3,040	2,110	1,880	12	3,460	7.2	1.2	C4-S1	.....
3N-23W-17dda1	120	Pdc,Pb	8-12-52	..	....	...	598	184	566		165	2,250	710	......	.4	4,690	4,390	2,250	2,110	35	5,490	7.4	5.2	.....	.....
3N-23W-27dab1	118	Pdc,Pb	4- 6-50	65	....	...	600	113	94		263	1,720	109	......	7.7	3,110	2,770	1,960	1,750	9	3,090	....	.9	C4-S1	.....
3N-23W-33bdd1	75	Pdc,Pb	4- 7-50	65	....	...	634	137	222		257	1,840	350	......	10	3,690	3,320	2,150	1,940	18	3,940	....	2.1	C4-S1	.....
			8-14-52	65	....	...	614	142	299		251	1,910	398	......	14	3,730	3,500	2,120	1,910	23	4,160	7.2	3.2	C4-S1	.....
3N-24W-5dad1	155	Pdc,Pb	10- 5-53	65	16	.00	584	219	274	6.6	292	2,210	260	.7	14	3,960	3,730	2,360	2,120	20	4,190	7.2	2.6	C4-S2	2.2
3N-24W-29aaa1	169	Pdc,Pb	10-13-53	65	16	.00	761	413	3,220	70	135	3,440	4,810	.7	....	13,300	12,800	3,600	3,490	66	17,700	7.4	23	.....	13
3N-25W-1cdd1	...	Pdc,Pb	1- 5-54	65	13	.00	564	156	536	14	229	2,250	455	.5	.7	4,370	4,110	2,050	1,860	36	4,890	7.3	5.1	C4-S2	4.5
3N-25W-32acd1	156	Pdc,Pb	10- 9-53	65	15	.00	590	142	173	6.0	263	1,910	142	.7	21	3,330	3,130	2,060	1,840	15	3,460	7.1	1.6	C4-S1	1.9
3N-26W-11dd1	140	Pdc,Pb	10- 2-53	..	16	.00	590	179	159	6.2	257	2,000	155	......	15	3,450	3,250	2,210	2,000	13	3,580	6.9	1.5	C4-S1	1.3
3N-26W-29cc1	110	Pdc,Pb	10- 2-53	66	15	.00	596	156	152	6.9	228	1,910	180	.9	12	3,370	3,140	2,130	1,940	13	3,480	7.4	1.4	C4-S1	1.4
4N-23W-20dd1	.....	Pdc,Pb	12-10-48	..	....	...	620	146	84		270	1,910	79	......	10	3,340	2,980	2,150	1,930	8	3,030	....	.8	C4-S1	.....
4N-23W-33dab1	155	Pb	4- 5-50	..	....	...	606	128	52		260	1,760	66	......	17	3,060	2,760	2,040	1,830	5	2,970	....	.5	C4-S1	.....
			5-15-52	..	....	...	596	137	56		258	1,780	64	......	21	3,020	2,780	2,050	1,840	6	3,060	7.1	.5	C4-S1	.....
4N-24W-18abc1 1/ and 18acb1	.....	Pdc, Pb Qt	10-23-51	..	19	.00	84	21	51		357	60	16	.5	29	458	459	296	4	27	733	7.5	1.3	C2-S1	.....
4N-25W-20bca1 1/ and 20bc1	102,110	Qt	8-10-50	..	....	.00	72	17	39		284	54	14	......	32	410	.....	250	17	..	619	....	1.1	C2-S1	.....
5N-22W-13aaa1	35	Qt	12-23-53	63	9.4	.06	53	19	40	2.4	302	19	8	.5	17	315	318	210	0	29	409	7.9	1.2	C2-S1	.20
5N-23W-22aaa1	135	Pdc,Pb	4- 6-50	65	....	...	614	121	69		174	1,720	171	......	6.8	3,150	2,790	2,030	1,890	7	3,120	....	.7	C4-S1	.....
			8-14-52	65	....	...	594	125	102		175	1,750	172	......	12	3,090	2,840	2,000	1,850	10	3,320	7.1	1.0	C4-S1	.....
5N-24W-14ccb1	44	Pdc,Pb	12-22-52	..	13	.00	608	80	54	3.4	287	1,590	38	.5	19	2,730	.....	1,850	1,610	..	2,790	7.3	.5	C4-S1	.....
5N-25W-21cbb1	42	Pw	1-19-54	62	18	.00	588	101	94	3.3	179	1,740	38	1.3	75	2,900	2,750	1,880	1,740	10	2,940	7.4	.9	C4-S1	.57
6N-26W-17dcc1	116	Pdc,Pb	1-19-54	62	15	.00	600	101	29	3.8	230	1,690	8.8	.7	4.9	2,760	2,570	1,910	1,720	3	2,690	7.4	.3	C4-S1	.98
SPRINGS																									
2S-24W-13	......	......	3-10-50	..	....	...	88	36	152		363	116	186	......	20	814	.....	368	70	47	1,340	....	...	.....	.....
4N-22W-18cbb	.....	......	12-16-53	53	18	.00	453	54	36	3.3	225	1,130	29	.5	20	1,970	1,860	1,350	1,770	5	2,110	7.6	.4	C3-S1	.40
4N-23W-9bba	.....	......	2- 9-54	58	15	.00	464	58	40	3.2	228	1,140	24	.5	18	2,000	1,880	1,400	1,210	6	2,140	7.5	.5	C3-S1	.40
4N-26W-6c	.....	......	2- 9-54	65	16	.00	80	26	77	2.3	337	119	28	.5	24	557	539	306	30	35	841	7.7	1.9	C3-S1	.34
6N-23W-31aaa	.....	......	12-16-53	39	14	.00	62	32	46	2.7	400	28	7.2	.7	17	397	407	286	0	26	667	7.8	1.2	C2-S1	.23
6N-26W-11cad	.....	....	6-21-59	61	....	...	1,480	2,000	120,000		38	7,720	190,000	......	....	268,000	.....	11,900	11,900	96	210,000	6.4	34	.....	.....

1/ Composite sample from wells indicated

Most of the above standards are recommended on the basis of taste and the others are the upper limits regarded as wholly safe for human consumption.

Compounds of iron present in ground water usually precipitate as oxides when exposed to the air, and concentrations exceeding about 0.3 ppm will cause stains and discolorations on fabrics and porcelain fixtures. Of the 26 analyses that show iron content, none indicates an objectionable amount.

Fluoride in water, in small concentrations, helps to prevent dental cavities in children who drink the water during the years of formation of permanent teeth. Dean (1936) and others have shown that the teeth of children who habitually drink water containing more than about 1.5 ppm fluoride are likely to be mottled or stained. Fluoride determinations made in 25 of the analyses reported in table 6 show that the concentration ranged from 0.3 to 1.3 ppm. All were below the Public Health Service maximum of 1.6 ppm, and all were below the range that is likely to cause disfiguration of teeth.

Nitrate in water is considered to be the final oxidation product of nitrogenous material and generally has little effect on the suitability of water for ordinary uses. In high concentrations, nitrate has been known to cause methomoglobinemia (commonly referred to as "blue baby" disease, Waring, 1949, p. 147), if the water is drunk or used to prepare the infant's formula. The U.S. Public Health Service considers water containing less than 10 ppm of nitrate nitrogen (about 45 ppm when reported as nitrate) to be safe. Only one analysis, that of water from a well tapping the Whitehorse Group, had nitrate exceeding 45 ppm.

The limits listed for sulfate, chloride, and dissolved solids in water are based mainly on the taste of the water. A water having a chloride content exceeding about 250 ppm has a salty taste. Large amounts of calcium and magnesium impart a bitter taste to water and excessive amounts of magnesium sulfate (epsom salts) will cause temporary stomach disturbances. Water having a mineral content exceeding 500 ppm is unpleasant to the taste of someone who is accustomed to water of much lower mineral content.

The four samples of water from the terrace deposits meet all the standards set forth by the U.S. Public Health Service, but all samples from the Dog Creek Shale and the Blaine Formation and from the Whitehorse Group are too highly mineralized.

Suitability for Livestock

At the present time no definite standards have been set for the salinity of water consumed by farm animals. As animals apparently tolerate greater mineral concentrations than humans, water suitable for humans is assumed to be suitable for livestock. The Department of Agriculture and Government Chemical Laboratory of Western Australia[1/] lists thresholds of salinity tolerated by livestock in that area as shown in the following table:

Animals	Salinity (ppm)
Poultry	2,860
Pigs	4,290
Horses	6,435
Dairy cattle	7,150
Beef cattle	10,000
Adult dry sheep	12,900

Suitability for Irrigation

The total amount of dissolved minerals that can be tolerated in an irrigation water varies considerably with the type of soil being irrigated, the crop grown, the drainage of the land, and the amount of rainfall[2/]. In general, the higher the mineral content of an irrigation water the greater is the tendency for the minerals to accumulate in the soil. If a soil contains a high accumulation of salts, more water than is needed for crop growth must be applied in order to leach the accumulated salts from the soil. Of the various minerals generally present in natural water, the concentration of sodium and its relative ratio to calcium and magnesium, commonly referred to as the "sodium adsorption ratio (SAR)," is the most critical because of the tendency of sodium to impair the soil's permeability. This ratio is defined by the equation:

$$SAR = \frac{Na^{+1}}{\sqrt{\frac{Ca^{+2} + Mg^{+2}}{2}}}$$

Where the concentrations of Na^{+1}, Ca^{+2}, and Mg^{+2} are expressed in equivalents per million. To convert the concentrations of the sodium, calcium, and

[1]California Institute of Technology (1952, p. 154)

[2]Note: Most data in this section of the report were adapted from U.S. Salinity Laboratory Staff, 1954, Diagnosis and improvement of saline and alkali soils: U.S. Dept. of Agriculture, Agriculture Handb. 60.

magnesium ions from parts per million to equivalents per million they must be multiplied by 0.0435, 0.0499, and 0.9822, respectively. Values for the SAR of ground water analyzed from this area are given in table 6.

Figure 8 is a diagram for the classification of irrigation water based on the specific conductance and the sodium-adsorption ratio. The specific conductance of a water is a measure of the salinity hazard of the water, and the sodium-adsorption ratio is a measure of the sodium or alkali hazard of the water. If a point corresponding to the values for conductivity and SAR of a water is plotted, its position on figure 8 determines the quality classification of the water.

Low-salinity water (C1) can be used for irrigation of most crops on most soils with little likelihood that soil salinity will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.

Medium-salinity water (C2) can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance generally can be grown without special practices for salinity control.

High-salinity water (C3) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very high salinity water (C4) is not suitable for irrigation under ordinary conditions but may be used under special circumstances. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt-tolerant crops should be selected.

Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of the accumulation of harmful quantities of exchangeable sodium. However, sodium-sensitive crops such as stone-fruit trees and avocados may accumulate injurious concentrations of sodium.

Medium-sodium water (S2) will present an appreciable sodium hazard in fine-textured soils having high cation-exchange capacity, especially under low-leaching conditions, unless gypsum is present in the soil. This water may be used on coarse-textured or organic soils with good permeability.

High-sodium water (S3) may produce harmful quantities of exchangeable sodium in most soils and will require special soil management--good drainage, high leaching, and additions of organic matter. Gypsiferous soils may not develop harmful levels of exchangeable sodium from such waters. Chemical amendments may be required for replacement of exchangeable sodium, except that amendments may not be feasible with water of very high salinity.

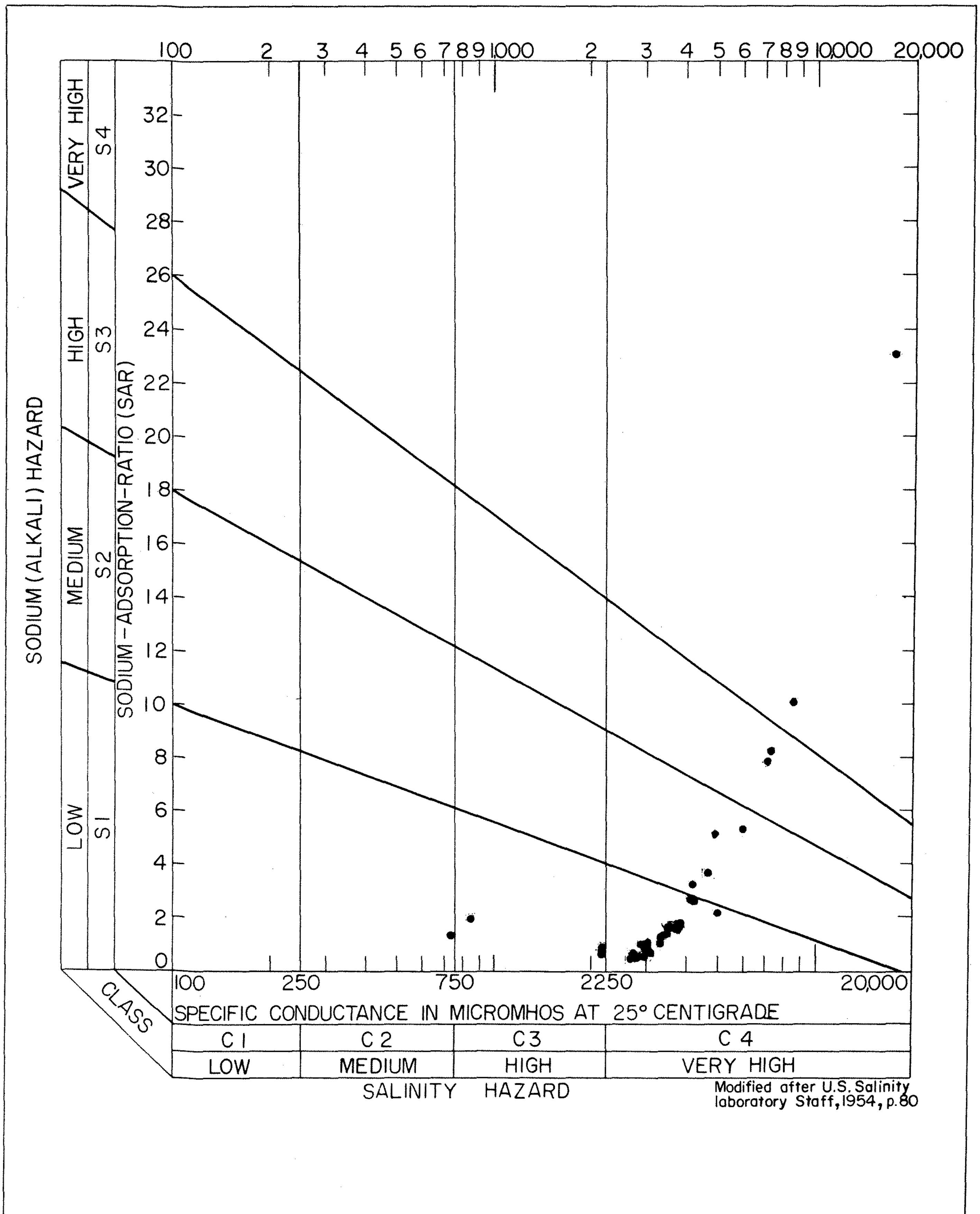

FIGURE 8-- Diagram showing the classification of water for irrigation.

Very high sodium water (S4) is generally unsatisfactory for irrigation purposes except at low and perhaps medium salinity, where the solution of calcium from the soil or use of gypsum or other amendments may make the use of this water feasible.

The quality classification based on salinity and alkali hazards is shown in table 6 for each of the analyses. The four analyses of water from terrace deposits indicate a medium salinity and a low-sodium hazard. However, most of the water available for irrigation in this area comes from the Dog Creek Shale and Blaine Formation and is highly mineralized. Samples of water from these formations indicate a water of very high salinity, but having a low-sodium hazard. Although classified as of unsatisfactory quality for irrigation on the basis of the salinity hazard, the water has been used continuously for irrigation of some lands for nearly 20 years without apparent ill effect. The good soil drainage and the low-sodium hazard of the water doubtlessly account for the successful use of the water. Continued use of the water for irrigation will provide some interesting data in regard to the high-salinity tolerance of crops, such as cotton, small grains, alfalfa, and truck crops, when the sodium hazard of the applied water is low.

In addition to the salinity and alkali hazards of an irrigation water, the boron content of the water is important. Boron in small quantities is essential to the normal growth of all plants, but in large quantities it is toxic. The permissible limits of boron for several classes of irrigation water, as proposed by Scofield (1936, p. 275-287), are less than 0.33 to 1.25 ppm for sensitive crops and 0.67 to 3.75 ppm for semitolerant and tolerant crops. Of the 20 determinations of boron in table 6, 18 were less than 3.75 ppm and of these 17 were less than 1.25 ppm. With two exceptions, the concentrations would indicate suitability of water for irrigation of crops in the semitolerant and tolerant class. Crops in the sensitive group, which would be damaged by the amount of boron in some of the water, include citrus and other fruit trees and a number of other deciduous trees, none of which are grown in the area studied. Of the crops commonly irrigated in the area, melons are sensitive, cotton and small grains are semitolerant, and alfalfa is tolerant to boron.

CONCLUSIONS

The aquifer developed in the Dog Creek Shale and Blaine Formation in Harmon County and adjacent parts of Greer and Jackson Counties ranks among the best solution-channel aquifers in the State. Yields of individual wells differ widely because they depend to a large extent on the number, size, and degree of interconnection of solution channels in the aquifer at the well site. Most of the irrigation wells are grouped along the major creeks where solution channels seem to be most numerous. Some wells do not yield enough water for livestock but others yield several thousand gallons per minute. Most of the irrigation wells yield between 500 and 1,000 gpm.

The average coefficients of transmissibility and storage of the aquifer underlying the irrigation areas were computed to be about 2.6×10^5 and 1.6×10^{-2}. The coefficient of storage outside the irrigation areas was estimated to be about 0.5×10^{-2}. From these values and the thickness and extent of the aquifer, the volume of water in storage was calculated to be about 336,000 acre-feet--nearly 6 times the volume discharged annually from the aquifer.

In 1954, the 50,000 acre-feet of water pumped from wells was about equal to the average annual recharge to the aquifer. However, because precipitation in 1954 was below normal, the amount of water pumped for irrigation probably was somewhat greater than normal. Because the precipitation was below normal, recharge also was less than normal and the water levels at the end of the year were lower than they had been at the beginning. Despite the decline in water levels, it is concluded that the ground-water resources were not yet fully developed in 1954 because the amount withdrawn would have been less than the recharge if precipitation had been more nearly normal.

Several new irrigation wells were put into use during 1955. However, because the precipitation that year was above normal, the withdrawal was less than it would have been if precipitation had been normal. Although the estimated 55,000 acre-feet that was withdrawn exceeded the average annual recharge the year-end water levels were higher than those at the beginning of the year because actual recharge exceeded the withdrawals.

Under average conditions, the wells now in use would be likely to withdraw more than the recharge and thus would cause a progressive lowering of water levels. It is concluded, therefore, that the ground-water resources have been slightly overdeveloped, as only by balancing the average annual rate of withdrawal and the recharge can the resource be maintained indefinitely. Although the amount of water available might be increased by artificially recharging the ground-water reservoir, techniques to accomplish this need further refinement. A large increase in the number of wells would doubtless result in an eventual reduction in the yield per well and the necessity to abandon some wells.

The annual recharge of the area is estimated to average about 50,000 acre-feet, or about the amount of water pumped for irrigation in 1954. Although the amount of water in storage is about 6 times the annual recharge, it should not be assumed that withdrawals at the 1954 rate could be continued for 6 years in the absence of recharge. In actual practice, probably only about a third of the water in storage actually could be withdrawn at that rate from the existing wells. Because the rate of recharge in the years of worst drought probably is about half the rate of recharge in a year of normal precipitation, it is estimated that annual withdrawals at the 1954 rate could be continued through an intensive drought period of 4 successive years. The number of irrigation wells in the area has increased greatly since 1954 and if all the wells now in use were to be pumped at such a rate that the average pumpage per well equaled that of 1954, the recharge rate would be exceeded significantly. Thus, the inescapable conclusion is that the ground-water resources of the area have been overdeveloped and that, for practical purposes, a drought of only 2 or 3 years' duration would seriously curtail irrigation in much of the area.

Water from the Dog Creek Shale and Blaine Formation is so highly mineralized that it is not generally usable for domestic or municipal supplies. However, it has been used throughout the area for irrigation, despite its high salinity, without apparent ill effects to the soil or crops. Because of the possible increase in mineralization that might result from return seepage of water applied for irrigation, it is desirable that the quality of water in the aquifer be monitored regularly. This is desirable also because of the salt water known to underlie the area at shallow depth. Some of the salt water may be drawn into the principal aquifer as a result of the intensive pumping for irrigation.

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APPENDIX A.--MEASURED STRATIGRAPHIC SECTION OF EXPOSED PERMIAN ROCKS IN GREER, HARMON, AND JACKSON COUNTIES, OKLA.

Section of Permian strata exposed in NW$\frac{1}{4}$NW$\frac{1}{4}$NW$\frac{1}{4}$ sec. 14 and in NE$\frac{1}{4}$NE$\frac{1}{4}$NE$\frac{1}{4}$ sec. 15, T. 4 N., R. 22 W., Greer County

	Thickness (feet)
Blaine Formation:	
Mangum Dolomite Member:	
Limestone, gray, crystalline, porous; ledge-forming	2+
Unnamed member:	
Shale, reddish-brown and gray in alternating layers	28
Collingsworth Gypsum Member:	
Gypsum (alabaster), gray, nodular to platy; ledge-forming	1
Shale, reddish-brown and gray in alternating layers; earthy to starchy fracture	1
Gypsum (alabaster), gray and white, argillaceous, soft; weathered to a gentle slope	9
Unnamed member:	
Limestone, gray, gypsiferous, porous	.3
Dolomite, light-gray, dense, massive, calcareous; ledge-forming	.5
Limestone, brownish-gray with thin reddish-brown layers; platy and porous; ledge-forming	1.5
Shale, gray, earthy to starchy fracture	2
Shale, reddish-brown with gray streaks; starchy fracture	8
Cedartop Gypsum Member:	
Gypsum (alabaster) and anhydrite, white and bluish-gray; many small solution cavities; ledge-forming	7
Unnamed member:	
Shale, gray, earthy to starchy fracture	2
Shale, reddish-brown, not well exposed	15
Haystack Gypsum Member:	
Gypsum (alabaster), white, nodular, argillaceous; ledge-forming	4
Gypsum (alabaster), white; clay, brown and gray; weathered to a gentle slope	6
Gypsum (alabaster) and anhydrite, white, clay-filled fissures; ledge-forming	5
Anhydrite, dark-gray, shows bedding planes	.4
Gypsum (alabaster) and anhydrite, gray and white, massive	1

Blaine Formation.--Continued

Unnamed member:

Shale, olive-drab to gray, fissile	.5
Shale, gray, calcareous and gypsiferous	.2
Shale, olive drab to gray, calcareous and gypsiferous	1.5
Gypsum (alabaster), and anhydrite, brownish-gray to white	.2
Shale, reddish-brown and gray in alternating layers, calcareous and gypsiferous	6.5
Gypsum (alabaster) and anhydrite, gray and white; ledge-forming	.7
Shale, reddish-brown and gray alternating layers, several thin beds of gypsum 1 to 2 inches thick	6.3
Gypsum (alabaster) and anhydrite, bluish-gray to white; ledge-forming	.5
Shale, reddish-brown and gray	2.7
Shale, reddish-brown, fissile to blocky, many veins of satinspar and selenite less than 2 inches thick	5.5
Shale, gray, platy to fissile, gypsiferous	5.1
Anhydrite, gray, and thin layers of shale; ledge-forming	.7
Shale, reddish-brown and gray in alternating layers, fissile to blocky, gypsiferous	6.6
Sandstone, gray, fine-grained, platy	.2
Shale, reddish-brown and gray in alternating layers; many veins of satinspar and selenite	7.5

Chaney Gypsum Member:

Gypsum (alabaster) and anhydrite, bluish-gray and white, clay-filled fissures	2

Flowerpot Shale:

Unnamed member:

Shale, reddish-brown and bluish-gray in alternating layers, fissile to blocky, calcareous	6.8
Shale, bluish-gray, and thin plates of selenite	1
Gypsum (satinspar), reddish-brown, platy; alternating with reddish-brown calcareous shale	1
Shale, reddish-brown and bluish-gray in alternating layers, in part calcareous; many beds of alabaster, mostly nodular and less than 6 inches thick, and a few thin veins of selenite	61
Total section measured	210.2

Section of Permian strata exposed in NE¼NE¼ sec. 8, T. 5 N., R. 23 W., Greer County

Blaine Formation:	
Unnamed member:	
Limestone, gray, massive to porous; lies on top of hill	1+
Shale, reddish-brown and gray in alternating layers	10
Cedartop Gypsum Member:	
Gypsum (alabaster), gray to white	12
Unnamed member:	
Shale, reddish-brown and gray in alternating layers	13
Haystack Gypsum Member:	
Gypsum (alabaster), gray to white, some anhydrite in lower 6 feet, upper 6 feet argillaceous	12
Unnamed member:	
Shale, reddish-brown and gray in alternating layers; thin gypsum (alabaster) beds	2.2
Shale, reddish-brown, gypsiferous	7.5
Shale, reddish-brown and gray; gypsum veins (selenite)	2
Siltstone, reddish-brown and gray	2
Shale, reddish-brown and gray in alternating layers; gypsum veins (selenite)	11
Chaney Gypsum Member:	
Gypsum (alabaster) and anhydrite, argillaceous	7.5
Flowerpot Shale:	
Unnamed member:	
Shale, reddish-brown and gray in alternating layers; thin beds and veins of gypsum	30+
Total section measured	110.2

Section of Permian strata exposed in NW¼NW¼SW¼ sec. 27, T. 6 N., R. 25 W., Greer County

Dog Creek Shale:	
Limestone, gray, dense to crystalline, porous; layers of light-gray dense dolomite about one-fourth inch thick	2+
Gypsum (alabaster), gray to white	15
Blaine Formation:	
Mangum Dolomite Member:	
Limestone, gray, crystalline, porous; layers of light-gray, dense dolomite about one-fourth inch thick	4
Unnamed member:	
Shale, reddish-brown and gray in alternating layers	17
Collingsworth Gypsum Member:	
Gypsum (alabaster) and anhydrite, tan to white	17

Blaine Formation.--Continued.

Unnamed member:	
Shale, reddish-brown and gray in alternating layers.....	15
Cedartop Gypsum Member:	
Gypsum (alabaster) and anhydrite, tan to white..........	16
Unnamed member:	
Dolomite, light-gray, dense............................	1
Shale, reddish-brown and gray in alternating layers.....	6
Haystack Gypsum Member:	
Gypsum (alabaster) and anhydrite, tan to white..........	7
Dolomite, light-gray, argillaceous, calcareous, dense...	1
Gypsum (alabaster) and anhydrite, tan to white..........	7
Total section measured	108.0

Section of Permian strata exposed in NE$\frac{1}{4}$NW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 12, T. 6 N., R. 26 W., Harmon County

Blaine Formation:

Mangum Dolomite Member:	
Limestone, gray, coarsely crystalline, massive to very porous..	2
Limestone, gray, dense, platy..........................	.5
Dolomite, light-gray, dense, platy.....................	.5
Unnamed member:	
Shale, reddish-brown and gray in alternating layers.....	13
Collingsworth Gypsum Member:	
Gypsum (alabaster) and anhydrite, white to light-gray...	16
Unnamed member:	
Limestone, gray to buff, finely crystalline, very porous..	2
Shale, reddish-brown and gray in alternating layers.....	9
Cedartop Gypsum Member:	
Gypsum (alabaster), gray, argillaceous.................	18
Unnamed member:	
Limestone, gray and brown, very porous.................	1
Shale, olive drab, calcareous..........................	3
Shale, reddish-brown and gray in alternating layers.....	6
Haystack Gypsum Member:	
Gypsum (alabaster), gray to white, argillaceous.........	12
Gypsum (alabaster) and anhydrite, white to light-gray...	6
Unnamed member:	
Shale, reddish-brown and gray in alternating layers; gypsum (selenite) in thin sheets....................	14
Kiser Gypsum Member:	
Gypsum (alabaster and selenite), gray, argillaceous.....	2
Shale, reddish-brown and gray in alternating layers.....	12.5
Chaney Gypsum Member:	
Gypsum (alabaster and selenite), greenish-gray to white, thin-bedded, argillaceous....................	2

Flowerpot Shale:

Unnamed member:

Shale, reddish-brown and gray in alternating layers.....	4
Gypsum (alabaster), gray to white......................	2
Shale, reddish-brown and gray in alternating layers; thin layers of selenite..............................	20+
Total section measured	145.5

Section of Permian strata exposed in NE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 30, T. 1 N., R. 22 W., Jackson County

Blaine Formation:

Mangum Dolomite Member:	
Limestone, gray, granular to crystalline, massive to thin bedded; some layers of light-gray dolomite about one-quarter inch thick. Solution cavities in upper 2 feet and along bedding planes; ledge-forming..	7
Unnamed shale member:	
Shale, reddish-brown and gray in alternating layers, mostly covered on slope..............................	38
Collingsworth Gypsum Member:	
Gypsum (alabaster); white where freshly exposed, gray where weathered; ledge-forming..................	12
Unnamed member:	
Clay, brown..	.5
Dolomite, light-gray, massive..........................	1.5
Shale, reddish-brown and gray in alternating layers, gypsiferous..	12
Cedartop Gypsum Member:	
Anhydrite, gray to white...............................	2
Gypsum (alabaster), gray, soft, argillaceous............	5
Unnamed member:	
Shale, reddish-brown and gray in alternating layers, gypsiferous..	18
Haystack Gypsum Member:	
Gypsum (alabaster), white to gray, argillaceous.........	10+
Total section measured	106

Appendix B.--Records of wells and test holes in Harmon County and adjacent parts of Greer and Jackson Counties, Okla.

Well number: For explanation see text p. 7; well locations shown on plate 2.

Geologic source: Qal, alluvium; Qt, terrace deposits; Pw, Whitehorse Group; Pdc, Dog Creek Shale; Pb, Blaine Formation; Pf, Flowerpot Shale.

Type of well: B, bored, Dd, drilled; Dg, dug.

Pump and power: C, cylinder; Cf, centrifugal, J, jet; N, none; R, rope and bucket; T, turbine; b, butane; E, electric; g, gasoline; h, hand; ng, natural gas; w, windmill.

Use: D, domestic; I, irrigation; N, none (includes unused or destroyed wells); P, public supply; R, recharge; S, stock.

Other data: C, chemical analysis shown in table 6; L, well log shown in appendix C.

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level: Depth below land surface (feet)	Water level: Date of measurement	Other data
GREER COUNTY												
3N-21W-6bb1	....	....	.....	Qt	13	Dg	N	N	.....	8.13	12-16-53	....
3N-22W-3bbb1	T. K. Underwood	....	1,508	Pf	23	Dg	J, e	S	.....	13.88	2- 9-54	....
9aad1	....	....	.....	Qt	19	Dg	C, w	N	.....	13.46	12-16-53	....
12ddd1	....	....	.....	Qt	19	Dg	N	N	.....	13.66	12-16-53	....
13baa1	L. T. Ray	....	1,438	Qt	17	Dg	C, w	S	.....	12.52	2- 9-54	....
16dac1	....	....	1,459	Pf	20	Dg	C, w	S	.....	16.23	2- 9-54	....
3N-23W-1aad1	....	1947	.....	Pb	15	Dg	C, w	S	.....	8.9	2-22-52	....
2bdd1	W. and E. Hurst	1952	1,568	Pb	90	Dd	T, b	I	.....	63.83	2-16-54	C
2ccd1	Dewey Thompson	1953	.....	Pb	145	Dd	N	N	.....	.....	....	L
2ccc1	do.	1954	1,527	Pb	...	Dd	N	N	.....	.....	....	....
2ccd2	do.	1954	.....	Pb	96	Dd	T, b	I	200	.....	....	....
3dad1	Claude Robertson	....	1,519	Pb	...	Dd	T, b	I	600	39.79	2-10-54	....
3ddb1	do.	1948	1,502	Pb	60	Dd	N	N	.....	25.82	4-15-49	L
3dad2	do.	1951	.....	Pb	80	Dd	N	N	.....	.....	....	L
3aaa1	do.	1954	.....	Pb	94	Dd	....	I	.....	35.14	5- 6-54	L
4cba1	Claude Boyett	1948	1,527	Pb	195	Dd	T, e	I	350	74.40	2-10-54	L
4ddb1	Cecil Norton	1954	.....	Pb	140	Dd	N	N	.....	.....	....	....
8daa1	W. W. Nelson	1953	.....	Pb, Pdc	150	Dd	C, w	S	.....	.....	....	L
9dba1	Bob Staton	1948	.....	Pb, Pdc	125	Dd	T, b	I	1,500	.....	....	L
10da1	Virgil Dennis	1951	.....	Pb	130	Dd	J, e	S	.....	.....	....	L
11cc1	E. W. Beck	1951	.....	Pb	135	Dd	T, b	I	500	.....	....	....
11acc1	J.W. Brawley	1953	.....	Pb	110	Dd	N	N	.....	.....	....	L
14bc1	R. V. Staton	1951	1,489	Pb	135	Dd	T, b	I	1,250	.....	....	L
16daa1	Ivan Owen	1949	.....	Pb, Pdc	105	Dd	T, b	I	600	40.82	2-10-54	....
16ccc1	do.	....	1,473	Pb, Pdc	...	Dd	N	N	.....	31.00	10-21-49	....
16cab1	do.	1948	1,459	Pb, Pdc	152	Dd	T, b	I	1,000	24.20	4-15-49	C, L
16dab1	do.	1949	.....	Pb, Pdc	153	Dd	N	N	.....	.....	....	L
16dba1	do.	....	.....	Pb, Pdc	173	Dd	T, b	I	1,000	.....	....	L
16abd1	Woods Templer	1952	.....	Pb, Pdc	109	Dd	T, b	I	1,200	.....	....	....
16dcb1	Ivan Owen	1952	....	Pb, Pdc	100	Dd	N	N	.....	.....	....	L
16dca1	do.	1952	.....	Pb, Pdc	110	Dd	C, w	S	.....	.....	....	L
17aa1	J. O. Moore	1951	1,470	Pb, Pdc	189	Dd	T, b	N	.....	52.86	2-10-54	C, L
17dda1	do.	1952	.....	Pb, Pdc	120	Dd	C, w	S	.....	.....	....	C, L
17aca1	do.	1954	.....	Pb, Pdc	127	Dd	....	I	325	.....	....	....
4N-22W-4aad1	....	....	1,504	Qt	13	Dg	N	N	.....	6.48	2- 9-54	....
5ad1	....	....	.....	Pf	19	Dd	C, w	S	.....	.....	....	....
11ccb1	....	....	.....	Pf	...	Dd	C, w	N	.....	29.86	12-15-53	....
13bac1	W. O. Deadman	....	.....	Pf	15	Dg	C, h	N	.....	6.32	12-16-53	....
14ddd1	....	....	.....	Pf	32	Dd	C, w	N	.....	21.46	12-16-53	....
15dcc1	....	....	1,563	Pf	...	Dd	C, w	S	.....	7.33	2-19-54	....
17baa1	....	....	1,739	Pb	81	Dd	C, w	S	.....	73.95	2-10-54	....
19dda1	E. C. Hill	1903	1,730	Pb	76	Dd	N	N	.....	74.84	2- 9-54	....
22cc1	Norman Meadow	1947	.....	......	...	Dd	C, w	S	.....	.....	....	....
23ada1	....	....	.....	Pf	...	Dd	C, w	S	.....	16.82	12-15-53	....
27cbb1	....	....	1,558	Pf	15	Dd	C, w	N	.....	6.17	2- 9-54	....
30bcc1	J. H. Olive	1933	.....	Pb	96	Dd	C, w	S	.....	82.34	11-24-53	....
32cbb1	L. E. Griffith	1953	1,650	Pb	67	Dd	C, w	S	.....	47.75	2- 9-54	....
35dcc1	....	....	.....	Pf	15	Dg	C, w	N	.....	8.19	1-12-54	....
36add1	....	....	.....	Qal	19	Dd	C, w	S	.....	11.01	12-15-53	....
4N-23W-3aaa1	Con Hammer	....	1,712	Pb	56	Dg	C, w	S	.....	.....	....	....
11ad1	....	....	.....	Pf	...	Dd	C, w	N	.....	66.40	1-27-54	....
15ccc1	V. Dennis	....	1,662	Pb, Pdc	...	Dd	C, w	S	.....	63.36	6-23-55	....
20dd1	W. H. Boyd	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	C
20ddd1	do.	....	1,602	Pb, Pdc	...	Dd	C, w	N	.....	37.58	2-10-54	....
20ccc1	....	....	1,578	Pb, Pdc	...	Dd	....	..	.....	+1,70	2-10-54	....
21aab1	J. C. Baity	....	1,627	Pb, Pdc	...	Dd	C, w	S	.....	59.57	6-16-55	....
24aad1	....	....	.....	Pb, Pdc	38	Dd	....	N	.....	32.63	2-21-52	....
27cdd1	Mrs. J. R. Dyer	.....	.....	Pb	69	Dd	....	N	.....	41.28	2-21-52	....
29ccc1	V. L. Meason	....	.....	Pdc	14	Dg	....	N	.....	11.35	2-21-52	....
30aba1	John Woodward	1937	.....	Pb, Pdc	235	Dd	J, e	S	.....	flowing	1-20-54	....
32dbb1	J. T. Hurst	....	.....	Pb, Pdc	210	Dd	N	N	.....	.....	....	L
33dab1	Earl Thomas	1948	1,550	Pb	155	Dd	T, b	I	670	31.17	4-16-49	C, L
35dcb1	W. B. Hurst	1961	.....	Pb	70	Dd	N	N	.....	47.70	5-16-52	L
36aab1	....	....	1,648	Pb	53	Dd	N	N	.....	49.56	2-21-52	....
4N-24W-1ccc1	W. E. Lanford	....	.....	Pb, Pdc	59	Dd	C, w	S	.....	.....	....	....
12ddd1	....	1935	1,676	Pb, Pdc	46	Dg	N	P	.....	27.03	2-10-54	....
14bbb1	....	1938	1,767	Qt	35	Dg	C, w	P	.....	31.93	2-10-54	....
14bbb2	U.S. Geol. Survey	1955	1,767	Pb, Pdc	234	Dd	N	N	.....	122.13	6- -55	L

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level		Other data
										Depth below land surface (feet)	Date of measurement	
GREER COUNTY												
4N-24W--Continued												
15ddd1	O. Parkley	1955	1,697	Qt	20	Dd	N	..	.....	14.22	2-21-52	....
15bcb1	C. R. Kerbo	1950	1,780	Pb, Pdc	263	Dd	N	S	.....	.....	....	L
26ddc1	....	....	1,618	Pb, Pdc	...	Dd	C, w	S	.....	69.85	2-10-54	....
5N-22W-6ccd1	Virgil R. Castle	1922	.....	Qt	25	Dg	R	S	.....	21.95	10-14-53	....
6ddc1	J. D. Gray	1913	.....	Qt	35	Dg	J, e	S	.....	26.14	10-15-53	....
6dcc1	do.	1923	.....	Qt	31	Dg	N	S	.....	22.09	10-16-53	....
7bbb1	O. O. Castle		1,617	Pf	18	Dg	R	S	.....	15.44	2- 9-54	....
8dcc1	Jim. Bishy	1934	.....	Pf	20	Dg	R	D	.....	18.66	10-14-53	....
8ddd1	Dennis Jones	....	.....	Qt	35	Dg	C, h	D	.....	35.34	10-13-53	....
9add1	....	....	.....	Qal	23	Dg	J,e, C,w	S	.....	21.00	10-14-53	....
9dcc1	Lee Caffey	1938	.....	Qt	45	Dg	C, w	N	.....	33.72	10-15-53	....
9ccc1	J. E. Bishop	1920	.....	Qt	50	Dg	J, e	S	.....	37.50	10-15-53	....
10dcc1	H. L. Dowdy	1923	.....	Qt	36	Dg	J, e	S	.....	23.73	10-14-53	....
10cdd1	John Price	1927	.....	Qt	30	Dg	J, e	S	.....	33.30	10-14-53	....
10ddd1	W. H. Griffis	1920	.....	Qt	37	Dg	J, e	D	.....	31.98	10-28-53	....
10add1	do.	1915	.....	Qal	18	Dg	C, w	S	.....	14.93	10-28-53	....
11dcc1	Layton Hanks	1920	.....	Qt	50	Dg	R	S	.....	32.48	10-13-53	....
11ddc1	do.	1951	1,574	Qt	50	Dd	N	N	.....	33.82	2- 9-54	....
11ddd1	....	....	.....	Qt	31	Dg	N	S	.....	26.49	10-13-53	....
5N-22W-11dca1	Layton Hanks	1954	.....	Qt	49	Dd	T, g	I	.....	33.82	4-20-55	....
12bd1	Earl Wetzel	....	.....	Qal	56	Dd	N	N	.....	18.82	11-25-53	....
13dbb1	City of Mangum	....	.....	Qt	...	Dd	N	N	.....	29.78	7-28-53	....
13acd1	do.	....	.....	Qt	...	Dd	N	N	.....	29.03	7-28-53	....
13adb1	do.	....	.....	Qt	...	Dd	N	N	.....	30.59	7-28-53	....
13ddd1	G. S. Hall	....	.....	Qt	20	Dg	J, e	D	.....	17.58	10-14-53	....
13aaa1	John Halford	....	.....	Qt	35	Dg	C, h	N	.....	27.83	10-14-53	....
14bbc1	George Johnson	....	.....	Qt	50	Dg	N	N	.....	dry	10-14-53	....
15abc1	C. A. Pierson	1911	.....	Qt	20	Dg	C, w	S	.....	.....	....	....
16dad1	John Vecke	1904	.....	Qt	22	Dg	C, w	S	.....	.....	....	....
16cdc1	Mrs. M. Stock	1901	1,659	Qt	18	Dg	C, w	S	.....	9.67	2-10-54	....
16b	Guy Waldroop	....	.....	Qt	...	Dg	C, h	D	.....	.....	....	....
17ddc1	H. M. Powell	1944	.....	Qt	35	Dd	J, e	S	.....	17.58	10-15-53	....
18aba1	W. H. Griffis	1942	.....	Pf	10	Dg	N	N	.....	5.17	10-28-53	....
19baa1	....	1942	.....	Pf	...	Dg	C, w	S	.....	18.80	2- 9-54	....
20aba1	B. B. Holey	....	.....	Qt	29	Dg	C, w	S	.....	27.90	10-15-53	....
20ddd1	E. E. Pierson	....	.....	Pf	108	Dd	C, w	S	.....	.....	....	....
23acd1	City of Mangum	....	.....	Qt	...	Dd	T	I	.....	.....	....	....
23dbb1	do.	....	.....	Qt	...	Dd	..	I	.....	26.90	7-28-53	....
23ca1	do.	....	.....	Qt	...	Dd	N	N	.....	24.80	7-28-53	....
23cdb1	do.	....	.....	Qt	...	Dd	N	N	.....	.....	....	....
23cbd1	....	....	.....	Qt	...	Dd	N	N	.....	.....	....	....
23bad1	City of Mangum	....	.....	Qt	...	Dd	N	N	.....	.....	....	....
23baa1	do.	....	.....	Qt	40	Dd	N	N	.....	25.42	7-28-53	....
5N-22W-23bdd1	do.	....	.....	Qt	...	Dd	C, w	S	.....	.....	....	....
23acb1	G. W. Johnson	1949	.....	Qt	58	Dd	T, b	I	550	28.00	7-28-53	....
24ccd1	M. L. Speed	1935	.....	Qt	48	Dg	J, e	D	.....	20.81	10-26-53	....
25bcc1	F. R. Baker	1940	1,642	Qt	28	Dg	J, e	S	.....	25.75	2- 9-54	....
26aab1	C. A. Loftie	1953	.....	Qt	58	Dd	J, e	S	.....	38.52	10-27-53	....
35add1	Mrs. Fred Parker	....	.....	Pf	33	Dd	R	S	.....	23.45	10-27-53	....
5N-23W-1ddd1	A. W. Stone	....	.....	Pf	29	Dg	R	S	.....	15.50	10-14-53	....
1aaa1	Rip Beck	....	.....	Qal	12	Dg	C, w	S	.....	10.87	10-14-53	....
2baa1	....	1936	.....	Qt	29	Dg	C, h	P	.....	21.60	11-17-53	....
3dda1	Ralph Clabaugh	....	.....	Qt	39	Dd	C, w	S	.....	20.85	11-18-53	....
3cd1	do.	....	1,712	Pf	57	Dg	C, w	S	.....	52.83	2- 9-54	....
3aad1	....	....	.....	Qt	28	Dg	N	S	.....	24.50	11-18-53	....
6bbc1	J. P. Stover	....	1,728	Qt	...	Dd	C, h	D, S	.....	31.57	2- 9-54	....
10aaa1	....	....	.....	Pb	37	Dg	N	S	.....	24.43	11-18-53	....
17ccc1	....	....	.....	Pb	...	Dg	C, w	S	...	15.59	10-26-53	....
17ddd1	Carl Bleick	....	.....	Pb, Pdc	85	Dd	C	S	.....	73.38	11-17-53	....
19aaa1	C. W. McDuff	1954	.....	Pb, Pdc	70	Dd	T	I	55	.....	....	....
20bab1	Robert Stock	1918	.....	Qt	17	Dg	N	S	.....	13.17	10-26-53	....
20dcc1	L. E. Pearson	....	1,731	Pb, Pdc	73	Dd	C, w	S	.....	60.15	2- 9-53	....
20aba1	Mrs. McKinley Pearson	1954	.....	Pb, Pdc	100	Dd	T, b	I	275	.....	....	....
21bdc1	Heatly	1952	1,728	Pb, Pdc	145	Dd	N	N	.....	61.80	8-27-53	L
22aaa1	Sidney Burcham	1948	1,754	Pb, Pdc	135	Dd	T, b	I	600	94.85	2-11-54	C
22bbb1	....	....	.....	Qt	33	Dg	C, w	S	.....	27.37	10-26-53	....
5N-23W-22daa1	Mrs. S. A. Turner	1937	.....	Pb, Pdc	110	Dd	C, w	S	.....	71.39	11-17-53	....
23ddd1	John Cooksey	1905	.....	Pb, Pdc	90	Dg	C, w	S	.....	.....	....	....
26abb1	H. D. Wells	1954	.....	Pb, Pdc	92	Dd	T, b	I	700	.....	....	....
27aca1	W. B. Mathews	1953	1,725	Pb, Pdc	109	Dd	T, b	I	650	64.82	7-29-53	....
27ccb1	J. B. Thompson	1942	.....	Pb, Pdc	76	Dd	J, e	S	.....	.....	....	....
27bda1	J.D. Gray	1953	1,717	Pb, Pdc	127	Dd	T, b	I	650	57.25	12-15-53	L
28baa1	D. R. Penn	1948	1,720	Pb, Pdc	153	Dd	T, b	I	300	.....	....	....
28baa2	do.	1930	.....	Pb, Pdc	65	Dg	C, e	S	.....	51.96	11-18-53	....
29dd1	....	....	.....	Qt	40	Dg	N	N	.....	22.67	11-15-50	....
33aaa1	J. B. Thompson	1953	.....	Pb, Pdc	85	Dd	T, e	I	650	51.75	11-17-53	....
5N-24W-2baa1	C. F. Slaton	....	1,696	Qt	15	Dg	N	N	.....	10.43	2- 9-54	....
12aaa1	Town of Reed	1934	.....	Qt	15	Dg	C	N	.....	11.23	11-17-53	....
14ccb1	....	....	.....	Pb, Pdc	44	Dg	C, w	S	.....	41.58	11-19-53	C
15ddd1	....	....	1,760	Pb, Pdc	...	Dd	C,w,h	S	.....	25.02	11-19-53	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level: Depth below land surface (feet)	Water level: Date of measurement	Other data
GREER COUNTY												
6N-23W-32ddd1	Bud Patton	....	.....	Qt	29	Dg	N	D	.....	22.15	11-17-53	....
6N-24W-27c	....	....	.....	Pf	33	Dd	N	N	.....	26.01	12-15-53	....
34cdd1	W. E. Pugh	1950	.....	Pf	34	Bd	R	S	.....	21.06	11-19-53	....
35cdd1	J. P. Taylor	1930	.....	Qt	14	Dg	N	D	.....	9.48	11-19-53	....
36ddc1	....	....	.....	Qt	32	Dg	N	S	.....	20.82	11-19-53	....
HARMON COUNTY												
1N-24W-2caa1	W. D. Payne	....	.....	Pb, Pdc	137	Dd	N	N	.....	24.40	1- 7-54	
2cad1	do.	1954	.....	Pb, Pdc	140	Dd	N	N	.....	.....	....	....
2cdb1	do.	1954	1,533	Pb, Pdc	247	Dd	N	I	200	81.94	2-25-53	L
4dd1	Oscar Bryant	....	1,542	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
4bc1	....	....	1,544	Pb, Pdc	...	Dd	C, w	S	.....	85.86	2-11-54	....
6bcd1	Carl Snider	1953	1,544	Pb, Pdc	204	Dd	N	N	.....	51.40	8-31-53	L
6cba1	do.	1953	1,540	Pb, Pdc	130	Dd	N	N	.....	.....	....	....
7cca1	Ovid Patrick	1953	.....	Pb, Pdc	170	Dd	N	N	.....	34.35	12-31-53	....
7cca2	do.	1954	.....	Pb, Pdc	207	Dd	T, b	I	270	35.50	4-16-54	L
8dba1	T. H. Hunter	1954	.....	Pb, Pdc	188	Dd	T, b	I	850	.....	....	L
8adb1	H. S. Beanland	1954	.....	Pb, Pdc	255	Dd	....	I	.....	.....	....	....
8bab1	Floyd Patrick	1955	.....	Pb, Pdc	250	Dd	N	N	.....	.....	....	....
9cbb1	Motley	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
15aad1	....	....	1,495	Pb, Pdc	...	Dd	C, w	S	.....	25.38	1- 6-54	....
17cbc1	H. S. Beanland	1949	.....	Pb, Pdc	138	Dd	T, b	I	850	.....	....	....
17aaa1	....	....	1,518	Pb, Pdc	...	Dd	C, w	S	.....	77.01	2-11-54	....
19bc1	R. L. Owens	1952	.....	Pb, Pdc	119	Dd	T, b	I	900	.....	....	....
19dac1	W. D. Ewing	1953	.....	Pb, Pdc	110	Dd	N	N	.....	18.16	8- 5-53	....
19ddb1	do.	1954	.....	Pb, Pdc	110	Dd	T, b	I	.....	.....	....	L
20ddd1	E. H. Mefford	1953	1,503	Pb, Pdc	140	Dd	T, b	I	670	67.46	2-10-54	C
20ca1	H. L. Richardson	1953	.....	Pb, Pdc	130	Dd	T, b	I	1,000	.....	....	....
21bbb1	....	....	.....	Pb, Pdc	...	Dd	C, w	N	.....	56.57	1- 7-54	....
25dad1	....	....	1,461	Pb, Pdc	...	Dd	N	N	.....	30.11	2-10-54	....
29bcc1	J. T. Cunningham	1953	.....	Pb, Pdc	140	Dd	T, e	I	420	24.37	8-25-53	....
30bb1	Troy Coke	1953	.....	Pb, Pdc	157	Dd	N	N	.....	.....	....	L
30daa1	Jack Gregory	1952	.....	Pb, Pdc	130	Dd	T, b	I	200	.....	....	....
30dbb1	do.	1953	1,581	Pb, Pdc	110	Dd	T, b	I	500	11.15	2-10-54	....
30cab1	Agatha Coke	1954	.....	Pb, Pdc	117	Dd	T, e	I	.....	.....	....	....
31b	J. R. Spradlin, Sr.	1955	.....	Pb, Pdc	85	Dd	....	I	.....	.....	....	....
32dbd1	do.	1955	.....	Pb, Pdc	...	Dd	....	I	.....	.....	....	....
34dcc1	Merritt & Washburn	1952	1,443	Pb, Pdc	94	Dd	T, b	I	655	15.09	2-11-54	....
35bcb1	....	....	.....	Qal	16	Dg	C, w	S	.....	10.43	1- 6-54	....
1N-25W-1aa1	W. H. Conner	1948	.....	Pb, Pdc	55	Dd	T, b	I	200	.....	....	....
1dbb1	George Bell	1954	1,530	Pb, Pdc	210	Dd	N	N	.....	31.47	2-16-54	....
1dbc1	do.	1954	.....	Pb, Pdc	180	Dd	T, b	I	640	.....	....	L
1cda1	Max McLaughlin	1954	.....	Pb, Pdc	169	Dd	T, b	I	810	.....	....	....
1cab1	Tom Crockett	1954	.....	Pb, Pdc	180	Dd	T, b	I	.....	.....	....	....
1ad1	W. H. Conner	1954	.....	Pb, Pdc	145	Dd	T, b	I	.....	.....	....	....
3dad1	J. B. Metcalf	....	.....	Pb, Pdc	145	Dd	N	N	.....	27.82	8- 7-53	....
3dad2	do.	1954	.....	Pb, Pdc	...	Dd	T, b	I	640	.....	....	....
3cbc1	Rhurmond Abernathy	1954	.....	Pb, Pdc	125	Dd	T, b	I	500	.....	....	....
4dba1	Joe L. Thomas	1951	1,545	Pb, Pdc	120	Dd	T, b	I	650	51.07	2-10-54	L
4dcb1	do.	1954	.....	Pb, Pdc	195	Dd	T, b	I	.....	.....	....	....
5bac1	A. B. Thornton	1954	.....	Pb, Pdc	213	Dd	T, e	I	.....	.....	....	....
6ada1	O. B. Magee	1953	.....	Pb, Pdc	210	Dd	T, e	I	140	104.46	9- 1-53	L
8caa1	Cummins	1953	1,581	Pb, Pdc	181	Dd	N	N	.....	102.59	2-10-54	....
9aaa1	Henry A. Purdue	1953	.....	Pb, Pdc	135	Dd	T, b	I	255	35.78	12-14-53	....
10add1	Henry McGlaughlin	....	1,516	Pb, Pdc	...	Dd	T, b	I	915	38.12	4-26-54	....
11baa1	Carl Snider	1953	.....	Pb, Pdc	180	Dd	T, b	I	600	44.93	2-10-54	C, L
11dcc1	Cleo Gallop	1953	.....	Pb, Pdc	83	Dd	N	N	.....	.....	....	L
11abc1	E. M. Byrd	1953	.....	Pb, Pdc	193	Dd	T, b	I	550	.....	....	....
11cbb1	Mrs. J. E. McClendon	1955	.....	Pb, Pdc	145	Dd	T, b	I	.....	.....	....	....
12bbb1	Roy O. Husband	....	.....	Pb, Pdc	170	Dd	T, b	I	625	.....	....	....
12bcc1	Cleo Gallop	1953	.....	Pb, Pdc	168	Dd	T, b	I	1,550	26.09	11-13-53	L
12cdb1	Fred Reeton	1954	.....	Pb, Pdc	127	Dd	T, b	I	1,000	.....	....	L
12ad1	J. M. Langston	1954	.....	Pb, Pdc	...	Dd	T, b	I	.....	.....	....	....
12da1	J. J. Thomason	1954	.....	Pb, Pdc	...	Dd	T, b	I	.....	.....	....	....
13dcc1	E. H. Mefford	1948	1,493	Pb, Pdc	120	Dd	T, b	I	800	21.35	2-10-54	C
13dda1	do.	1954	.....	Pb, Pdc	115	Dd	T, e	I	.....	.....	....	
13bab1	F. F. Brewer	1954	.....	Pb, Pdc	125	Dd	T, b	I	.....	.....	....	....
14bbb1	....	1954	.....	Qal	23	..	N	N	.....	18.65	10-20-53	....
22a	Magee	....	.....	Pb, Pdc	120	Dd	N	N	.....	.....	....	....
24acd1	L. S. Slaten	1948	.....	Pb, Pdc	120	Dd	T, b	I	425	.....	....	....
26cbb1	Sid Reid	1953	.....	Pb, Pdc	107	Dd	T, b	I	665	67.32	8-26-53	....
28aab1	J. M. Langston	1953	1,601	Pb, Pdc	390	Dd	N	N	.....	106.30	12-31-53	....
35ddb1	Fred Cope	1948	1,485	Pb, Pdc	72	Dd	T, e	I	820	16.72	9- 3-52	....
35dbb1	do.	1948	1,493	Pb, Pdc	95	Dd	T, e	I	1,100	.....	....	....
35cca1	Marshall Magee	1952	.....	Pb, Pdc	85	Dd	N	N	.....	.....	....	....
35caa1	do.	1952	.....	Pb, Pdc	105	Dd	T, e	I	785	32.14	8-26-53	L
36cac1	C. Y. Spradlin	1952	1,490	Pb, Pdc	54	Dd	T, b	I	300	20.55	2-10-54	....
1N-26W-5bd1	W. J. Hudson	1951	1,555	Pb, Pdc	102	Dd	T, b	I	1,350	.....	....	C
5aab1	Otho H. Morris	1953	1,603	Pb, Pdc	125	Dd	T, b	I	1,000	71.84	2-11-54	....
6bbb1	H. B. Bartlett	1946	.....	Pb, Pdc	35	Dd	N	N	.....	12.72	11-16-50	....
6bbb2	do.	1949	1,564	Pb, Pdc	54	Dd	T, b	I	725	14.25	11-16-50	....
6aa1	J. E. McClendon	1954	.....	Pb, Pdc	135	Dd	T, b	I	.....	.....	....	....
1N-27W-1aaa1	J. R. McClendon	....	1,565	Pb, Pdc	54	Dd	N	N	.....	14.80	11-16-50	....
1cda1	Warren Mitchell	....	.....	Pb, Pdc	91	Dd	T, g	I	300	.....	....	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level		Other data
										Depth below land surface (feet)	Date of measurement	
HARMON COUNTY												
1N-27W-1dac1	Charles R. Bartlett	....	1,592	Pb, Pdc	119	Dd	T, b	I	650	.....	....	....
1aaa2	J. R. McClendon	1953	1,564	Pb, Pdc	149	Dd	T, b	I	1,500	20.37	8-25-53	....
2N-24W-2bc1	....	....	1,504	Pb, Pdc	...	Dd	C, w	S	.....	52.48	2-11-54	....
5cd1	W. D. Payne	1953	1,580	Pb, Pdc	250	Dd	N	N	.....	.....	....	L
13ccd1	R. C. Bassel	....	1,484	Pb, Pdc	70	Dd	C, w	S	.....	64.55	2-11-54	....
17cd1	Cliff Jones	1953	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
17dcc1	do.	....	1,577	Pb, Pdc	146	Dd	C, w	N	.....	33.92	2-11-54	....
18cdc1	do.	1953	.....	Pb, Pdc	...	Dd	N	N	.....	10.00	10- 8-53	....
19ada1	Jim Looney	....	.....	Pb, Pdc	...	Dd	C, w	S	.....	.....	....	....
20acb1	Oscar Bryant	1944	.....	Pb, Pdc	195	Dd	C, w	N	.....	83.96	2-22-54	....
22add1	....	....	1,522	Pdc	17	Dg	C, w	N	.....	14.91	2-11-54	....
26acc1	Tapley Jordon	1950	.....	Pb, Pdc	140	Dd	N	N	.....	.....	....	L
27ada1	....	....	.....	Pb, Pdc	...	Dd	C, w	S	.....	47.92	1- 6-54	....
30dcc1	R. S. Moran	1953	1,571	Pb, Pdc	...	Dd	T, b	I	1,350	53.60	2-11-54	....
31b	Wilmoth McNeal	1954	.....	Pb, Pdc	...	Dd	....	N	.....	.....	....	....
35acc1	Tapley Jordon	1950	.....	Pb, Pdc	162	Dd	N	N	.....	.....	....	L
36bcb1	....	....	.....	Pb, Pdc	...	Dd	C, w	N	.....	72.31	1- 6-54	....
2N-25W-1bbb1	....	....	.....	Pdc	20	Dg	C, w	S	.....	16.39	2-10-54	....
2aaa1	J. D. Jones	1953	1,606	Pb, Pdc	215	Dd	T, b	I	500	57.07	2-11-54	L
4bcd1	Oscar Bryant	1953	.....	Pb, Pdc	210	Dd	N	N	.....	.....	....	....
4bdd1	do.	1953	.....	Pb, Pdc	160	Dd	N	N	.....	.....	....	....
4bcc1	do.	1953	.....	Pb, Pdc	133	Dd	T, e	I	1,600	44.16	4-21-53	....
4cbc1	Bryan Putnam	1953	.....	Pb, Pdc	...	Dd	T, b	I	900	50.13	8-20-53	....
5aaa1	D. S. Plummer	1952	1,609	Pb, Pdc	140	Dd	T, b	I	2,000	49.23	2-10-54	....
5ccb1	F. E. Motley	1953	.....	Pb, Pdc	120	Dd	N	N	.....	18.31	8-19-53	....
5aab1	Oscar Bryant	1953	.....	Pb, Pdc	80	Dd	N	N	.....	45.52	8-20-53	....
5aac1	do.	1953	.....	Pb, Pdc	145	Dd	T, e	I	1,500	43.20	8-31-53	L
5ca1	Mrs. J. P. Neal	1953	.....	Pb, Pdc	115	Dd	T	I	1,000	.....	....	L
5ccb2	do.	1953	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
6bcb1	Ola C. Hopkins	1952	1,611	Pb, Pdc	150	Dd	T, b	I	800	30.58	2-10-54	....
6cbb1	do.	1954	.....	Pdc	56	Dd	T, b	I	700	30.97	1-25-54	....
7dab1	L. D. Worrell	1953	1,591	Pb, Pdc	...	Dd	T, b	I	635	18.30	2-10-54	....
8aaa1	F. E. Motley	1953	.....	Pb, Pdc	148	Dd	N	N	.....	46.17	8-19-53	....
8daa1	Stellie Moore	1953	1,591	Pb, Pdc	120	Dd	T, e	I	510	37.49	8-21-53	....
8aaa2	F. E. Motley	1953	.....	Pb, Pdc	...	Dd	T, b	I	400	47.37	8-19-53	....
9bba1	Elmo Jones	1953	.....	Pb, Pdc	120	Dd	N	N	.....	51.68	11-18-53	....
10acb1	L. R. Morris	1954	.....	Pb, Pdc	199	Dd	....	I	.....	.....	....	....
11bac1	Loyd Duvall	1953	1,522	Pb, Pdc	175	Dd	T, b	I	330	36.54	8- 5-53	L
11dac1	Jennie Woodman	1954	.....	Pb, Pdc	130	Dd	T, b	I	450	58.00	4-27-54	....
12ad1	E. Q. Anderson	1953	.....	Pb, Pdc	265	Dd	N	N	.....	.....	....	....
12cca1	Sam Earls	1953	1,601	Pb, Pdc	266	Dd	N	N	.....	60.58	12-14-53	L
12ccc1	do.	....	.....	Pb, Pdc	...	Dd	T, b	I	.....	53.43	2-22-55	....
13bcc1	....	....	.....	Pb, Pdc	...	Dd	....	N	.....	26.65	8- 5-53	....
14dbb1	Gould Motor Co.	1953	.....	Pb, Pdc	95	Dd	N	N	.....	21.92	8- 4-53	....
14bab1	E. E. Woodman	1953	.....	Pb, Pdc	110	Dd	T, b	I	800	.....	....	....
14cbb1	Oscar Abernathy	1953	1,564	Pb, Pdc	115	Dd	T, b	I	900	21.19	2-10-54	....
14ccb1	Melvin Duvall	....	.....	Pb, Pdc	...	Dd	T, b	I	710	18.63	8- 4-53	....
14dba1	Gould Motor Co.	1953	1,576	Pb, Pdc	145	Dd	N	N	.....	33.88	1-26-54	L
14dbb2	do.	1954	.....	Pb, Pdc	...	Dd	T, b	I	800	22.57	1-26-54	....
15dab1	Aubrey Anthony	1953	.....	Pb, Pdc	105	Dd	T, b	I	700	25.36	8- 4-53	L
17ccc1	Don Groves	1952	1,577	Pb, Pdc	124	Dd	T, b	I	400	24.44	2-11-54	....
17bb1	Garland Motley	1953	.....	Pb, Pdc	145	Dd	....	I	900	.....	....	L
18cdd1	J. H. Motley	1953	.....	Pb, Pdc	137	Dd	T, b	I	2,000	.....	....	L
18cc1	do.	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
18ab1	G. F. Moore	1952	.....	Pb, Pdc	148	Dd	N	N	.....	.....	....	....
19aac1	W. H. Lewis	1952	.....	Pb, Pdc	140	Dd	T, b	I	1,000	.....	....	....
19da1	Vera Cunningham	1954	.....	Pb, Pdc	139	Dd	T, b	I	.....	.....	....	....
20dbb1	Travis Collier	1953	.....	Pb, Pdc	110	Dd	T, b	I	800	33.67	8-21-53	....
20ccc1	....	....	.....	Pb, Pdc	...	Dd	N	N	.....	2.00	10- 9-53	....
20bcd1	L. F. Trammel	1954	.....	Pb, Pdc	150	Dd	T, b	I	580	.....	....	....
21dac1	Oscar Bryant	1947	1,568	Pb, Pdc	112	Dd	T, e	I	650	28.73	2-10-54	....
21dac2	do.	1946	1,563	Pb, Pdc	112	Dd	N	N	.....	20.02	11-16-50	....
21dac3	do.	1952	.....	Pb, Pdc	81	Dd	N	N	.....	23.50	8-21-53	....
21dac4	do.	1952	.....	Pb, Pdc	100	Dd	N	N	.....	22.61	8-21-53	....
21dac5	do.	1952	.....	Pb, Pdc	60	Dd	N	N	.....	23.39	8-21-53	....
21dac6	do.	1952	.....	Pb, Pdc	94	Dd	N	N	.....	24.56	8-21-53	....
21aac1	Ray Walkup	....	1,588	Pb, Pdc	150	Dd	N	N	.....	43.67	1-25-54	....
21acc1	do.	1953	.....	Pb, Pdc	...	Dd	T, b	I	85	24.99	8-21-53	....
21ddc1	Oscar Bryant	1954	.....	Pb, Pdc	121	Dd	T, e	I	800	21.73	8-26-54	....
23abb1	H. L. Wilder	1952	1,556	Pb, Pdc	130	Dd	T, b	I	310	21.35	2-10-54	C, L
23dbd1	L. R. Morris	1952	.....	Pb, Pdc	105	Dd	T, b	I	785	.....	....	....
24cbb1	....	....	.....	Pb, Pdc	...	Dd	....	I	.....	.....	....	....
25da1	Earl Newberry	1952	.....	Pb, Pdc	97	Dd	T, b	I	550	.....	....	....
25cdd1	J. H. Motley	1953	1,545	Pb, Pdc	120	Dd	T, b	I	950	44.00	8- 4-53	....
25adc1	Joe Allison	1954	.....	Pb, Pdc	162	Dd	T, b	I	650	.....	....	....
26ac1	Jennie Woodman	1952	1,547	Pb, Pdc	120	Dd	T, b	I	640	26.44	8-12-54	L
26bc1	Cecil Cary	1955	.....	Pb, Pdc	165	Dd	T, b	I	.....	50.81	2-22-55	....
27bbb1	Ralph Moore	1947	1,552	Pb, Pdc	150	Dd	T, b	I	410	20.96	8-21-53	....
27ccc1	Marvin Williams	1952	.....	Pb, Pdc	100	Dd	T, b	I	585	27.16	4-16-53	....
27bb1	Ralph Moore	1954	.....	Pb, Pdc	...	Dd	T, b	I	.....	13.02	4-21-54	....
27dad1	James Q. Tucker	1954	.....	Pb, Pdc	...	Dd	T, b	I	.....	75.22	9- 9-54	....
28dbb1	G. D. Payne	1954	.....	Pb, Pdc	140	Dd	T, b	I	880	.....	....	....
28cab1	Robert Walkup	1954	.....	Pb, Pdc	115	Dd	T, b	I	300	.....	....	....
28ccd1	Travis Collier	1954	.....	Pb, Pdc	162	Dd	T, b	I	750	.....	....	....
28bcb1	Roy Ginn	1954	.....	Pb, Pdc	...	Dd	T, b	I	.....	33.10	2-23-55	....
29bbb1	Mrs. R. Y. Darnell	1952	1,578	Pb, Pdc	129	Dd	T, b	I	1,600	28.70	2-10-54	....
29ada1	Lee H. Lewis	1952	1,574	Pb, Pdc	130	Dd	T, b	I	525	30.28	2-11-54	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level: Depth below land surface (feet)	Water level: Date of measurement	Other data
HARMON COUNTY												
2N-25W-29dcc1	Guy B. Cummins	1952	.....	Pb, Pdc	138	Dd	T, b	I	520	65.35	8-19-53	....
29aac1	Bill Scivily	1953	.....	Pb, Pdc	110	Dd	T, b	I	865	28.22	8-19-53	....
29aa1	do.	1953	.....	Pb, Pdc	120	Dd	C, w	S	.....	28.01	8-19-53	....
29ccd1	Mrs. R. Y. Darnell	1955	.....	Pb, Pdc	135	Dd	T, b	I	.....	.....	....	....
29dbc1	Claude Richardson	1954	.....	Pb, Pdc	180	Dd	T, b	I	.....	.....	....	....
30abb1	Mrs. R. Y. Darnell	1953	.....	Pb, Pdc	166	Dd	T, b	I	620	.....	....	....
30dbb1	do.	1953	1,591	Pb, Pdc	155	Dd	T, b	I	950	46.54	2-11-54	....
31dac1	Claude Richardson	1953	.....	Pb, Pdc	175	Dd	N	N	.....	72.39	9-15-53	....
31dad1	do.	1953	.....	Pb, Pdc	201	Dd	N	N	.....	.....	....	C, L
31abb1	do.	1953	.....	Pb, Pdc	200	Dd	T, e	I	80	34.16	10-28-53	L
31bbb1	Mrs. J. M. Cary	1953	1,586	Pb, Pdc	155	Dd	T, b	N	725	43.12	2-11-54	L
31ada1	Claude Richardson	1953	.....	Pb, Pdc	170	Dd	N	N	.....	60.11	12-31-53	....
31db1	do.	1953	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
31aaa1	do.	1954	.....	Pb, Pdc	...	Dd	T, b	I	300	.....	....	....
31bbb2	Mrs. J. M. Cary	1954	.....	Pb, Pdc	...	Dd	T, b	I	.....	.....	....	....
32cac1	Travis Magee	1953	.....	Pb, Pdc	200	Dd	T, e	I	150	.....	....	L
32bca1	do.	1953	.....	Pb, Pdc	175	Dd	T, e	I	400	69.89	9-16-53	L
33dbd1	G. A. Williams	1954	.....	Pb, Pdc	165	Dd	T, b	I	510	42.15	4-14-54	....
34dab1	G. D. Payne	1952	1,546	Pb, Pdc	187	Dd	T, b	I	525	36.57	2-10-54	....
34bcb1	do.	1954	.....	Pb, Pdc	115	Dd	T, b	I	.....	.....	....	....
35cca1	Martin	....	1,544	Pb, Pdc	...	Dd	T, b	I	750	.....	....	....
35dcb1	John R. Hill	....	.....	Pb, Pdc	159	Dd	T, b	I	800	.....	....	....
35acb1	J. H. Motley	1953	.....	Pb, Pdc	...	Dd	....	I	400	.....	....	....
36dcb1	Martin A. Bullington	....	1,539	Pb, Pdc	...	Dd	N	N	.....	37.92	8- 7-53	....
36dac1	do.	1953	1,540	Pb, Pdc	230	Dd	T, b	I	300	39.70	8-25-53	L
36ba1	J. H. Motley	1953	.....	Pb, Pdc	...	Dd	T, b	I	155	35.92	1-26-54	....
36cd1	Martin A. Bullington	1954	.....	Pb, Pdc	184	Dd	T, b	I	.....	.....	....	....
2N-26W-1abb1	Charles McKinley	1952	.....	Pb, Pdc	144	Dd	T, b	I	820	.....	....	L
2cba1	J. H. Motley	1952	1,612	Pb, Pdc	102	Dd	T, b	I	1,000	17.42	4- 9-53	C
2cba2	do.	1953	1,612	Pb, Pdc	189	Dd	T, b	I	800	.....	....	C, L
2dc1	W. A. Horton	1953	.....	Pb, Pdc	120	Dd	T, b	I	1,500	.....	....	....
2baa1	Mark's Greenhouse	1951	.....	Pb, Pdc	70	Dd	T, e	I	.....	.....	....	....
3ac1	Raymond Keith	....	1,613	Pb, Pdc	109	Dd	T, g	I	450	12.47	11-16-50	....
3ddb1	J. M. Cunningham	1947	1,614	Pb, Pdc	200	Dd	N	N	.....	17.53	2-10-54	....
3da1	E. D. Kuykendall	1953	.....	Pb, Pdc	175	Dd	N	N	.....	.....	....	....
3dbc1	D. J. Shelby	1955	1,613	Pb, Pdc	450	Dd	T, b	I	.....	.....	....	C, L
3ddb2	J. M. Cunningham	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
4ccc1	Roy Sanford	1954	.....	Pb, Pdc	...	Dd	T, b	I	800	.....	....	....
5dbb1	do.	....	1,632	Pb, Pdc	...	Dd	T, ng	I	1,200	.....	....	....
5bcc1	Ward Bros	1948	1,640	Pb, Pdc	149	Dd	T, g	I	1,200	30.23	2-10-54	....
5bcd1	do.	1954	.....	Pb, Pdc	...	Dd	T, b	I	1,200	.....	....	....
6bbb1	Fred K. Riley	1953	.....	Pb, Pdc	150	Dd	T, b	I	400	.....	....	....
7acb1	R. W. Scott	1952	.....	Pb, Pdc	156	Dd	J, b	I	800	.....	....	....
8bcb1	J. J. Gee	1952	1,644	Pb, Pdc	174	Dd	T, b	I	495	38.72	8-25-53	....
8dbc1	Oscar H. Abernathy	....	1,644	Pb, Pdc	110	Dd	T, b	I	900	34.89	2-10-54	....
9cdb1	W. R. Horton	1953	.....	Pb, Pdc	124	Dd	T, b	I	900	48.49	8-25-53	....
10bbd1	S. A. Patterson	1954	.....	Pb, Pdc	110	Dd	T, b	I	900	.....	....	....
12cca1	Oscar H. Abernathy	....	1,630	Pb, Pdc	...	Dd	T, b	I	1,250	47.62	2-10-54	....
12ada1	do.	....	.....	Pb, Pdc	...	Dn	N	N	.....	24.20	9- 1-53	....
12ada2	do.	1953	.....	Pb, Pdc	120	Dd	T, b	I	330	24.03	12-31-52	....
15aab1	A. L. Prock	1953	1,672	Pb, Pdc	130	Dd	T, b	I	100	72.11	2-10-54	....
16add1	W. R. Horton	1954	.....	Pb, Pdc	...	Dd	T, b	I	450	.....	....	....
17da1	King	....	1,707	Pb, Pdc	285	Dd	N	I	200	98.11	8-25-53	....
17da2	do.	....	1,707	Pb, Pdc	...	Dd	....	N	.....	100.00	8-25-53	....
17b	C. W. Masters	1954	.....	Pb, Pdc	220	Dd	T, b	I	350	.....	....	....
21bcc1	Clarence Masters	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
25dbc1	D. T. Johnson	1954	.....	Pb, Pdc	202	Dd	T, b	I	150	.....	....	....
25bab1	Oscar Abernathy	1954	.....	Pb, Pdc	...	Dd	T, b	I	260	.....	....	....
27bcb1	Herschel Vaughn	1953	1,650	Pb, Pdc	150	Dd	T, b	I	350	46.20	2-10-54	....
27dbb1	Hendrick	....	.....	Pb, Pdc	...	Dd	N	N	.....	34.40	8-25-53	....
27d	do.	....	.....	Pb, Pdc	129	Dd	N	N	.....	.....	....	....
29cc1	Chock Earls	1952	.....	Pb, Pdc	186	Dd	....	N	.....	.....	....	L
31cbc1	T. C. Gilbert	....	.....	Pb, Pdc	...	Dd	T, g	I	900	31.51	11-16-50	....
31ddd1	J. R. McClendon	....	1,599	Pb, Pdc	...	Dd	T, b	I	890	.....	....	....
36abb1	Shellie Moore	1952	.....	Pb, Pdc	107	Dd	T, e	I	390	67.65	8-19-53	....
2N-27W-1abc1	C. R. & Mary Bennett	1952	1,658	Pb, Pdc	177	Dd	T, b	N	.....	.....	....	....
1bbb1	Mrs. Barbara Brown	....	1,659	Pb, Pdc	138	Dd	T, b	I	1,200	30.96	11-16-50	....
1ccb1	Ted & Clay Whorton	....	1,659	Pb, Pdc	150	Dd	T, b	I	1,100	43.13	2-10-54	....
1abd1	C. R. & Mary Bennett	1953	.....	Pb, Pdc	254	Dd	T, b	I	800	50.78	4-23-54	....
36dad1	A. A. Kite	1949	1,582	Pb, Pdc	220	Dd	T, b	I	1,000	33.24	2-10-54	L
36dab1	do.	1952	.....	Pb, Pdc	150	Dd	T, b	I	600	45.54	8-25-53	....
36bac1	Ollie Kite	1953	.....	Pb, Pdc	180	Dd	N	N	.....	62.40	8-25-53	L
36ab1	Winnie Klein	1953	.....	Pb, Pdc	200	Dd	C, w	S	.....	58.48	8-25-53	....
36ab2	do.	1953	.....	Pb, Pdc	155	Dd	N	N	.....	.....	....	....
3N-24W-3dda1	Joe Fox	1945	1,573	Pb, Pdc	190	Dd	C, w	S	.....	108.63	2- 9-54	....
5dad1	Cloyd Roberts	1953	1,545	Pb, Pdc	155	Dd	T, b	I	785	79.92	8-21-53	C
9dcc1	....	....	1,526	Pb, Pdc	...	Dd	C, w	N	.....	62.54	2- 9-54	....
11ccd1	....	....	.....	Pb, Pdc	...	Dg	C, w	N	.....	4.07	1- 5-54	....
13dab1	Howell Atwood	1951	1,543	Pb, Pdc	175	Dd	N	N	.....	66.00	1-19-54	....
13dab2	do.	1952	1,543	Pb, Pdc	315	Dd	N	N	.....	.....	....	L
14ccb1	....	1954	.....	Pb, Pdc	...	Dd	N	N	.....	79.30	9- 2-54	....
17abb1	....	....	.....	Pb, Pdc	...	Dd	C, w	N	.....	86.21	1- 5-54	....
20acd1	John R. Hill	....	1,539	Pb, Pdc	229	Dd	N	N	.....	77.25	10- 9-53	....
21ac1	J. C. Putnam	1952	.....	Pb, Pdc	...	Dd	T, b	I	775	46.37	8-21-53	....
21bc1	Wallace N. Bullington	1955	.....	Pb, Pdc	145	Dd	T, b	I	.....	.....	....	....
22bca1	Robert B. Bryant	1952	.....	Pb, Pdc	104	Dd	T, b	I	1,100	31.60	8-21-53	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level: Depth below land surface (feet)	Water level: Date of measurement	Other data
HARMON COUNTY												
3N-24W-23bcc1	Robert B. Bryant	1954	.....	Pb, Pdc	160	Dd	T	I	450	.....	....	....
24d	Frankie Johnson	1952	.....	Pb, Pdc	144	Dd	N	N	.....	.....	....	....
25bcb1	N. C. Thompson	1954	.....	Pb, Pdc	185	Dd	N	N	.....	49.82	4-28-54	L
29aaa1	Ballard Hill	1953	.....	Pb, Pdc	167	Dd	N	N	.....	66.01	9- 7-54	....
29aaa2	do.	1953	1,527	Pb, Pdc	169	Dd	T, b	I	.....	65.30	2-12-54	C, L
3N-25W-1cdd1	....	....	1,605	Pb, Pdc	...	Dd	C, w	S	.....	133.60	2- 8-54	C
2abb1	....	....	1,640	Pb, Pdc	...	Dd	C, w	S	.....	148.52	2- 8-54	....
4aa1	....	....	.....	Pb, Pdc	...	Dg	R	D	.....	12.08	12-30-53	....
15bba1	....	....	1,702	Pw	...	Dd	C, w	N	.....	20.61	2- 9-54	....
17caa1	Jimmie Edmundson	....	.....	Pb, Pdc	270	Dd	N	N	.....	.....	....	....
18baa1	....	....	.....	Pb, Pdc	...	Dd	N	N	.....	24.42	1- 5-54	...
29dba1	Oma Haskins	1954	.....	Pb, Pdc	200	Dd	T, b	I	550	62.20	11- 1-54	...
29adc1	J. F. Cunningham	1954	.....	Pb, Pdc	265	Dd	T, b	I	400	62.95	11- 1-54	....
30abb1	G. F. Moore	1953	1,620	Pb, Pdc	160	Dd	T, b	I	700	28.00	2- 9-54	L
31bdc1	F. E. Motley	1954	.....	Pb, Pdc	75	Dd	T, b	I	1,800	20.00	2-26-54	....
31ccd1	Garland Motley	1954	.....	Pb, Pdc	...	Dd	T, e	I	.....	.....	....	....
31daa1	Afton Baily	1954	.....	Pb, Pdc	140	Dd	T, b	I	.....	.....	....	....
32bbb1	Wilcy Moore	....	1,623	Pb, Pdc	160	Dd	T, b	I	1,060	33.77	2- 9-54	....
32dda1	Oscar Bryant	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
32ddb1	do.	1953	.....	Pb, Pdc	158	Dd	T, e	N	.....	52.88	8-20-53	....
32ad1	Walter P. Bell	1953	.....	Pb, Pdc	155	Dd	N	N	.....	.....	....	....
32acd1	do.	1953	.....	Pb, Pdc	156	Dd	T, b	I	1,200	47.89	8-31-53	C, L
32cad1	R. B. Tucker	1953	.....	Pb, Pdc	155	Dd	T, b	I	1,000	40.18	11- 4-53	L
32ddc1	Oscar Bryant	1954	.....	Pb, Pdc	...	Dd	T, e	I	1,100	.....	....	....
33aab1	do.	....	1,656	Pb, Pdc	...	Dd	N	N	.....	86.97	2-11-54	....
33dbb1	Wilcy Moore	....	.....	Pb, Pdc	200	Dd	N	N	.....	69.00	1-20-54	....
33dbc1	do.	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
33d	do.	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
35b	Stokesberry	....	.....	Pb, Pdc	340	Dd	N	N	.....	79.38	9- 1-53	....
3N-26W-2bbc1	....	....	.....	....	...	Dg	C, w	S	.....	13.17	12-30-53	....
5ada1	....	....	.....	Pw	...	Dg	C, w	N	.....	18.10	12-29-53	....
6aba1	....	....	.....	Qt	42	Dd	C, w	N	.....	19.40	12-29-53	....
9cb1	R. W. Wynn	1953	.....	Pb, Pdc	150	Dd	N	N	.....	21.54	8-26-53	....
9cb2	do.	1953	.....	Pb, Pdc	165	Dd	N	N	.....	21.18	8-26-53	....
11dd1	Robert Massey	1952	.....	Pb, Pdc	140	Dd	T, b	I	800	.....	....	C, L
11add1	J. M. Curry	1954	.....	Pb, Pdc	160	Dd	T, b	I	.....	.....	....	....
12cdd1	Chester Caswell	1953	1,655	Pb, Pdc	140	Dd	T, b	I	1,000	56.24	2-12-54	....
12cbc1	do.	1953	.....	....	...	Dd	N	N	.....	59.38	1- 5-54	....
13bbc1	....	....	.....	....	...	Dd	C, w	N	.....	35.14	1- 5-54	....
13c	R. B. Tucker	1954	.....	Pb, Pdc	190	Dd	T, b	I	.....	.....	....	....
13bba1	M. B. Briscoe	1954	.....	Pb, Pdc	160	Dd	T, b	I	.....	.....	....	....
14aa1	J. M. Coley	1952	.....	Pb, Pdc	232	Dd	T, b	I	1,200	.....	....	....
14ddb1	M. B. Briscoe	1954	.....	Pb, Pdc	140	Dd	T, b	I	.....	.....	....	....
18bbb1	....	....	.....	Pb, Pdc	16	Dg	C, w	N	.....	10.16	1- 5-54	....
20cad1	C. H. Alders	1954	.....	Pb, Pdc	135	Dd	T, b	I	200	95.36	4-16-54	....
21baa1	....	....	.....	Pb, Pdc	94	Dd	N	N	.....	79.39	12-30-53	....
22cdc1	Marcus McClanahan	1953	1,682	Pb, Pdc	165	Dd	N	N	.....	68.80	2- 9-54	L
22cca1	do.	1953	.....	Pb, Pdc	215	Dd	N	N	.....	75.80	11-27-55	L
22ccc1	do.	1953	.....	Pb, Pdc	165	Dd	N	N	.....	17.46	12-31-53	....
22bbb1	....	....	.....	Pb, Pdc	...	Dd	C, w	S	.....	60.05	12-30-53	....
22dd1	Raymond Keith	1954	.....	Pb, Pdc	140	Dd	T, b	I	.....	67.45	2-16-54	....
23cca1	Melvin Boyett	1952	.....	Pb, Pdc	137	Dd	T, b	I	1,000	.....	....	....
23aaa1	....	....	.....	Pb, Pdc	...	Dd	N	N	.....	34.86	1-26-54	....
24dad1	W. I. C. Castle	1953	.....	Pb, Pdc	136	Dd	T, b	I	900	.....	....	....
24ada1	A. B. Crump	....	.....	Pb, Pdc	...	Dd	T, b	I	75	67.68	1-25-54	....
25cd1	E. M. Crenshaw	....	1,628	Pb, Pdc	...	Dd	T	I	.....	.....	....	....
26ddd1	Frank Burns	1953	.....	Pb, Pdc	165	Dd	T, b	I	300	.....	....	....
26bdc1	Paul Metcalf	1953	.....	Pb, Pdc	185	Dd	N	N	.....	57.80	12-14-53	....
26bd1	do.	1953	.....	Pb, Pdc	143	Dd	N	N	.....	53.30	12-14-53	....
26bdd1	do.	1953	.....	Pb, Pdc	252	Dd	N	N	.....	56.97	12-24-53	L
26bdc2	do.	1953	.....	Pb, Pdc	251	Dd	N	N	.....	63.10	12-28-53	....
26baa1	do.	1954	.....	Pb, Pdc	170	Dd	N	N	.....	49.05	1- 7-54	....
26bab1	do.	1954	.....	Pb, Pdc	175	Dd	N	N	.....	.....	....	....
26bdd2	do.	1954	.....	Pb, Pdc	180	Dd	N	N	.....	51.00	1-20-54	....
27ccd1	J. B. Fowler	....	.....	Pb, Pdc	...	Dd	T, e	I	.....	54.13	2-16-55	....
28cbc1	Martin Tice	1954	.....	Pb, Pdc	125	Dd	T, b	I	.....	55.25	2-16-55	....
29cc1	A. C. Mayhugh	1952	.....	Pb, Pdc	110	Dd	T, ng	I	485	.....	....	C
29acb1	C. H. Alders	1952	1,660	Pb, Pdc	100	Dd	N	N	.....	62.73	2- 9-54	....
29acc1	do.	1952	.....	Pb, Pdc	100	Dd	T, b	I	130	.....	....	....
29bbb1	J. A. Carrick	1953	.....	Pb, Pdc	142	Dd	T, ng	I	900	.....	....	....
31cab1	Garrel A. Hay	1951	.....	Pb, Pdc	145	Dd	N	N	.....	.....	....	....
31cbd1	do.	1951	1,652	Pb, Pdc	119	Dd	T, b	I	800	43.38	1-26-54	....
31dbb1	Charles McKinley	1953	.....	Pb, Pdc	252	Dd	N	N	.....	.....	....	L
31dba1	do.	1953	.....	Pb, Pdc	170	Dd	N	N	.....	.....	....	....
31dbc1	do.	1953	.....	Pb, Pdc	155	Dd	N	N	.....	.....	....	....
31dad1	do.	1953	1,654	Pb, Pdc	231	Dd	T, ng	I	695	45.15	2- 9-54	....
31aa1	do.	1954	.....	Pb, Pdc	258	Dd	N	N	.....	73.00	2-22-54	....
32cbb1	J. M. Coley	1953	.....	Pb, Pdc	160	Dd	T, ng	I	1,635	.....	....	....
32bcb1	A. C. Mayhugh	1955	.....	Pb, Pdc	150	Dd	T, ng	I	.....	58.64	2-15-55	....
33bba1	W. R. Keith	1952	1,639	Pb, Pdc	115	Dd	T, b	I	750	.....	....	....
33dd1	H. M. Walker	1953	.....	Pb, Pdc	130	Dd	T, e	I	750	.....	....	....
33dda1	W. D. Carrick	1952	.....	Pb, Pdc	75	Dd	T, b	I	1,200	.....	....	....
33cba1	H. T. Branigan	1953	.....	Pb, Pdc	90	Dd	T, b	I	800	28.39	1-26-54	....
33aad1	William Sherd	1952	.....	Pb, Pdc	95	Dd	T, b	I	1,000	.....	....	....
33cab1	G. C. Hollis	1954	.....	Pb, Pdc	...	Dd	T, b	I	500	.....	....	....
34bbc1	Selma Clement	1954	1,651	Pb, Pdc	92	Dd	T, b	I	800	.....	....	....
34bab1	Arvle J. Orr	....	1,638	Pb, Pdc	163	Dd	T, b	N	.....	.....	....	....
34bcd1	G. W. McDonald	1952	1,636	Pb, Pdc	65	Dd	T, g	I	800	.....	....	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level		Other data
										Depth below land surface (feet)	Date of measurement	
HARMON COUNTY												
3N-26W-34ba1	Arvle J. Orr	....	.....	Pb, Pdc	170	Dd	N	N	.....	.....	....	....
34ccc1	Willie J. Cummins	1953	.....	Pb, Pdc	120	Dd	T, ng	I	500	.....	....	....
34bad1	Arvle J. Orr	1955	.....	Pb, Pdc	85	Dd	T, ng	I	.....	41.14	2-15-55	....
35aad1	Lona H. Christian	....	1,643	Pb, Pdc	180	Dd	T, b	I	855	.....	....	....
35cba1	Claude Essary	1952	.....	Pb, Pdc	55	Dd	T, g	I	125	.....	....	....
35bdc1	T. H. Cummins	1952	.....	Pb, Pdc	120	Dd	T, b	I	475	.....	....	....
35cac1	Marvin Swaim	1953	.....	Pb, Pdc	81	Dd	T, g	I	250	31.82	9- 1-53	....
35bab1	Charles Merida	1953	1,639	Pb, Pdc	125	Dd	T, b	I	900	43.79	2- 9-54	....
3N-27W-12cac1	....	....	1,769	Pb, Pdc	145	Dd	C, w	S	.....	30.40	2- 9-54	....
24aaa1	Mrs. Elsie Yancey	....	.....	Pb, Pdc	...	Dd	C, w	N	.....	45.99	1- 5-54	....
25cbb1	Mrs. Pearl Whiteside	1952	1,682	Pb, Pdc	102	Dd	T, b	I	950	70.08	2-10-54	....
36dd1	Maxine Brock	1953	.....	Pb, Pdc	226	Dd	T, b	I	750	.....	....	....
4N-24W-17cdd1	Wm. J. B. Moon	....	1,751	Pw	...	Dd	C, w	N	.....	25.50	12-30-53	....
17dad1	....	1956	1,784	Pb, Pdc	288	Dd	N	N	.....	162.5	6-28-56	L
18acb1	Town of Gould	....	.....	....	...	Dd	T, e	P	35	.....	....	C
18abc1	do.	....	.....	....	...	Dd	T, e	P	35	.....	....	C
18ac1	do.	1953	.....	Qt	46	Dd	N	N	.....	.....	....	....
18ada1	Public	1930's	1,744	Qt	17	Dg	N	P	.....	2.36	2- 8-54	....
19bba1	....	....	.....	....	...	Dd	J, e	S	.....	34.93	12-30-53	....
20daa1	C. R. Kerbo	1900's	1,715	Pw	...	Dd	C, w	S	.....	32.06	2- 8-54	....
31dda1	....	....	1,576	Pb, Pdc	...	Dd	C, w	N	.....	97.95	2- 8-54	....
4N-25W-6aaa1	Mrs. Vera Willhelm	....	1,827	Pw	...	Dd	C, w, h	S	.....	58.69	2- 9-54	....
11da1	....	....	1,668	Qt	...	Dg	C, w	S	.....	11.46	2-12-54	....
15bdd1	....	....	1,717	Qt	17	Dg	N	N	.....	13.50	2- 8-54	....
20bca1	City of Hollis	1948	.....	Qt	102	Dd	T, e	P	165	.....	....	C
20bc1	do.	1951	.....	Qt	110	Dd	T, e	P	265	.....	....	C
20bcc1	do.	1951	.....	Qt	105	Dd	T, e	P	225	.....	....	....
20bc1	do.	1955	.....	Qt	200	Dd	T, e	P	400	.....	....	....
21ddd1	....	....	1,836	Qt	...	Dd	C, w	N	.....	42.89	2-12-54	....
23aaa1	....	1956	1,797	Pb, Pdc	370	Dd	N	N	.....	226	6-21-56	L
24cbc1	Howard Robinson	....	1,806	Qt	...	Dd	C, w	S	.....	46.52	2- 8-54	....
24cbc2	....	1955	.....	Pb, Pdc	367	Dd	N	N	.....	.....	....	L
24cbc3	....	1955	.....	Qt	240	Dd	....	N	.....	.....	....	L
25aaa1	....	....	.....	Qt	...	Dg	C, w	S	.....	9.44	12-30-53	....
29aaa1	A. L. Carter	....	.....	Qt	19	Dd	C, w	S	.....	15.65	12-30-53	....
29aaa2	do.	....	1,798	Qt	...	Dg	R	S	.....	15.50	12-30-53	....
29aaa3	....	1955	1,798	Pb, Pdc	335	Dd	N	N	.....	147.5	11-28-55	L
31bbb1	....	....	.....	Qt	16	Dd	N	N	.....	8.83	12-29-53	....
31cdb1	J. E. Leathers	1955	1,754	Qt	474	Dd	N	N	.....	72.50	4-12-55	L
32ccd1	....	....	1,788	Pw	...	Dd	C, w	S	.....	23.74	2- 9-54	....
33cdc1	....	....	.....	....	...	Dd	C, w	S	.....	14.76	12-30-53	....
35ccc1	....	....	.....	Qt	...	Dg	N	N	.....	7.17	12-30-53	....
35ccc2	....	....	.....	Qt	...	Dd	C, w	S	.....	9.76	12-30-53	....
36dda1	....	....	.....	Qt	12	Dg	C, w	S	.....	6.48	12-30-53	....
4N-26W-3bc1	....	....	.....	Qal	...	Dg	N	N	.....	20.26	12-28-53	....
3aaa1	....	....	.....	Pb, Pdc	...	Dd	C, w	S	.....	20.80	1-27-54	....
4bcb1	....	....	.....	Pb, Pdc	...	Dg	C, w	N	.....	43.78	12-28-53	....
5ddc1	....	....	1,885	Qt	...	Dd	N	N	.....	39.32	2- 9-54	....
6cdb1	....	....	1,867	Pw	...	Dd	C, w	N	.....	46.89	2- 9-54	....
8bba1	....	....	.....	Pw	...	Dd	C, w	S	.....	50.20	12-28-53	....
11c	....	....	.....	Pw	28	Dd	C, w	S	.....	13.70	12-29-53	....
12ccb1	....	....	.....	Pw	...	Dg	J, e	S	.....	16.47	12-29-53	....
14cdc1	Monroe Webster	....	1,879	Qt	...	Dg	C, w	D	.....	45.82	2- 9-54	....
14cdc2	....	1955	.....	Pb, Pdc	318	Dd	N	N	.....	125.7	11- 3-55	L
15aa1	Public	....	.....	Qt	...	Dg	C, h	P	.....	6.14	12-28-53	....
17bbb1	....	....	1,925	Qt	...	Dd	C, w	N	.....	54.40	2- 9-54	....
17bcc1	....	....	.....	Qt	...	Dd	C, w	N	.....	52.46	12-29-53	....
19bbd1	....	....	.....	Qt	...	Dd	C, w	S	.....	.....	....	....
19ddd1	....	....	.....	Qt	...	Dd	C, w	N	.....	13.31	12-29-53	....
22dbd1	....	....	.....	Qt	43	Dd	C, w	S	.....	.....	....	....
22dbd2	....	....	.....	Qt	...	Dd	N	N	.....	25.93	12-29-53	....
22dca1	....	....	.....	Qt	...	Dd	N	N	.....	33.34	12-29-53	....
23ddd1	....	....	1,836	Qt	28	Dg	C, w	S	.....	23.90	2- 9-54	....
24ddd1	....	....	1,809	Qt	...	Dd	R	N	.....	20.61	12-29-53	....
29ccc1	....	....	1,882	Pw	37	Dd	N	N	.....	29.71	2- 9-54	....
29aaa1	....	....	.....	Pw	...	..	C, w	S	.....	30.84	12-29-53	....
34cc1	....	....	.....	Pw	10	Dg	C, w	N	.....	8.61	12-29-53	....
36cd1	....	....	.....	Qt	...	Dd	C, w	S	.....	4.50	12-29-53	....
4N-27W-12dd1	....	....	.....	Qt	...	Dd	C, w	S	.....	33.66	12-28-53	....
13cdd1	R. J. Holland	....	1,942	Qt	...	Dd	C, w	S	.....	35.51	2- 9-54	....
13cdd2	....	1955	.....	Pb, Pdc	415	Dd	N	N	.....	.....	....	....
25db1	....	....	....	Qt	...	Dd	C, w	S	.....	38.82	12-29-53	....
5N-24W-4ccd1	Mrs. Sam C. Hall	....	1,793	Pb	70	Dd	C, w	S	.....	56.88	2- 9-54	....
6aaa1	....	....	.....	Pb	57	Dd	C, w	S	.....	42.13	1-27-54	....
7dcd1	....	....	1,807	Pb, Pdc	35	Dd	C, w	S	.....	15.97	2- 9-54	....
16ddd1	State of Oklahoma	1946	1,792	Pb, Pdc	78	Dd	C, w, h	S	.....	48.32	2- 9-54	....
19ddd1	D. E. Morris	1950	1,771	Pb, Pdc	54	Dd	C, h	S	.....	10.03	2- 9-54	....
20add1	....	....	.....	Pb, Pdc	...	Dd	C, w	S	.....	.....	....	....
5N-25W-1caa1	Winfred Allen	1951	1,798	Pb, Pdc	85	Dd	C, w	S	.....	31.42	2- 9-54	....
16cdc1	....	....	1,867	Pw	29	Dg	N	N	.....	24.78	2- 9-54	....
17cdc1	B. Merritt	....	.....	Pw	...	Dd	C, w	S	.....	28.61	1- 8-54	....
17cdd1	....	....	.....	Pw	34	Dg	J, e	S	.....	28.28	1- 8-54	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level: Depth below land surface (feet)	Water level: Date of measurement	Other data
HARMON COUNTY												
5N-25W-17aad1	Jake Davidson	....	.....	Pw	43	Dg	C, w	S	.....	30.76	1-26-54	....
18cdc1	Carl Smith	1945	.....	Pw	112	Dd	C, w	D	.....	44.70	1- 8-54	....
18dcc1	....	....	.....	Pw	53	Dd	C, w	N	.....	30.64	1- 8-54	....
18ad1	B. B. Osborn	....	.....	Pw	32	Dg	J, e	D	.....	21.08	1-19-54	....
19ddd1	....	....	1,874	Pw	37	Dg	C, w	N	.....	22.32	2- 9-54	....
21cbb1	H. A. Williamson	....	.....	Pw	42	Dd	C, w	S	.....	29.93	1-19-54	C
23ccc1	....	....	1,787	Pb, Pdc	...	Dd	C, w	S	.....	18.12	2- 9-54	....
27dcc1	....	....	1,817	Pb, Pdc	52	Dd	C, w	N	.....	22.70	2- 9-54	....
28ccc1	....	....	.....	Pw	42	Dg	C, w	N	.....	37.16	1-26-54	....
5N-26W-7dca1	B. F. Hayes	....	1,927	Pw	70	Dd	C, w	S	.....	33.01	2- 8-54	....
16daa1	....	....	1,954	Pw	65	Dd	C, w	S	.....	45.94	2- 8-54	....
18aba1	D. L. Jones	....	.....	Pw	125	Dd	C, w	S	.....	43.16	1-15-54	....
23dbd1	Mars Heart	....	1,899	Pw	105	Dd	C, w	S	.....	55.44	2- 9-54	....
27dbb1	R. C. Fillpot	....	1,893	Pw	97	Dd	C, w	S	.....	62.45	2- 8-54	....
29acb1	F. S. Hughes	1952	1,818	Pw	22	Dd	C, e	S	.....	16.06	2- 8-54	....
6N-26W-12cab1	....	....	1,744	Pb	...	Dd	C, w	S	.....	14.27	2- 8-54	....
13ddd1	....	....	1,865	Pb, Pdc	...	Dd	C, w	S	.....	55.95	2- 8-54	....
17dcc1	Lynn Spurlin	1946	1,898	Pb, Pdc	116	Dd	C, w	S	.....	44.40	2- 8-54	C
33aab1	....	....	.....	Pw	34	Dg	C, w	S	.....	32.67	12-18-53	....
34bcb1	....	....	1,910	Pw	...	Dg	C, w	S	.....	28.65	2- 8-54	....
JACKSON COUNTY												
1S-21W-17baa1	....	....	.....	Qt	...	Dd	C, w	N	.....	14.54	1- 8-54	....
1S-22W-8ccc1	....	....	1,471	Pb	44	Dd	C, w	N	.....	26.91	2- 9-54	....
15abb1	....	....	1,345	Pf	...	Dd	C, w	S	.....	4.66	2- 9-54	....
19ccc1	....	1953	1,426	Pb	195	Dd	N	N	.....	.....	....	L
30dda1	....	....	1,380	Pb	...	Dg	C, w	S	.....	12.03	2- 9-54	....
36aab1	....	....	.....	Pb	...	Dg	C, w	N	.....	8.36	1- 8-54	....
1S-23W-7dcc1	City of Eldorado	....	1,445	Qal	32	Dd	N	N	.....	20.12	2- 9-54	....
9dcd1	Vera Wood	....	1,504	Pb, Pdc	...	Dd	C, w	S	.....	65.34	2- 9-54	....
12cdd1	D. H. Shumaker	....	1,484	Pb, Pdc	...	Dd	C, w	S	.....	48.07	2- 9-54	....
18bdd1	City of Eldorado	....	.....	Pb, Pdc	45	Dg	Cn, E	P	.....	.....	....	....
18acb1	do.	....	.....	Pb, Pdc	55	Dd	T, e	P	150	22.32	2-15-54	....
18dbc1	do.	....	.....	Pb, Pdc	50	Dd	J, e	P	100	.....	....	....
20ddc1	....	....	1,456	Pb, Pdc	40	Dd	C, w	S	.....	34.25	2- 9-54	....
22ddc1	....	....	1,479	Pb, Pdc	...	Dd	C, w	N		55.60	2- 9-54	
24ccb1	....	....	.....	Pb, Pdc	31	Dg	C, w	S	.....	.....	....	....
28adb1	City of Eldorado	....	.....	Pb, Pdc	45	Dg	Cn, e	P	.....	.....	....	C
28adb2	do.	....	.....	Pb, Pdc	45	Dg	T, e	P	.....	.....	....	C
30daa1	....	....	1,413	Qt	...	Dd	N	N	.....	20.70	2- 9-54	....
33aaa1	....	....	1,456	Pb, Pdc	...	Dd	C, w	N	.....	38.65	2- 9-54	....
1S-24W-1adb1	Billy Brewer	1954	.....	Pb, Pdc	...	Dd	T, e	I	.....	38.43	8-25-54	....
2abb1	....	....	1,452	Pb, Pdc	...	Dd	C, w	S	.....	31.50	2- 9-54	....
5bcd1	Lester R. Thompson	1953	1,462	Pb, Pdc	100	Dd	T, e	I	1,200	22.05	2- 9-54	L
6abb1	F. E. Motley	1953	.....	Pb, Pdc	103	Dd	T, b	I	2,000	.....	....	....
7dd1	T. L. Palmer	1952	.....	Pb, Pdc	98	Dd	N	N	.....	.....	....	....
7adc1	do.	1952	1,465	Pb, Pdc	72	Dd	T, b	I	1,800	23.27	2- 9-54	....
8d	Troy Coke	1952	.....	Pb, Pdc	134	Dd	N	N	.....	.....	....	L
8dab1	do.	1953	.....	Pb, Pdc	76	Dd	T, e	I	1,800	.....	....	....
10ccd1	....	....	1,477	Pb, Pdc	63	Dd	C, w	N	.....	54.87	2- 9-54	....
20add1	W. F. Spencer	....	1,495	Pb, Pdc	165	Dd	T, b	I	350	59.47	2- 9-54	C
21bcd1	Joe J. Cope	1952	1,499	Pb, Pdc	120	Dd	T, b	I	685	63.63	2- 9-54	....
21cdc1	....	....	.....	Pb, Pdc	...	Dd	C, w	S	.....	71.29	1- 8-54	....
36dcd1	S. D. Holder	1952	.....	Pb, Pdc	55	Dd	C, w	S	.....	.....		....
1S-25W-1bcd1	F. E. Motley	1953	.....	Pb, Pdc	97	Dd	T, b	I	2,000	20.58	8- 7-53	....
1bbb1	do.	1954	.....	Pb, Pdc	...	Dd	T, b	I	1,700	.....	....	
2abb1	Glen Hankins	1951	1,481	Pb, Pdc	86	Dd	T, e	I	1,000	.....	....	C
2baa1	W. H. Bernard	1952	.....	Pb, Pdc	80	Dd	T, e	I	1,100	14.93	9- 3-52	L
13ccc1	Wynfred Black	1953	1,527	Pb, Pdc	130	Dd	T, b	I	1,000	75.60	2- 9-54	....
13dc1	Ted Springs	1952	.....	Pb, Pdc	80	Dd	N	N	.....	.....	....	L
13dcc1	do.	1954	.....	Pb, Pdc	119	Dd	T, b	I	900	60.40	4-16-54	....
2S-21W-6ada1	....	....	.....	Pf	...	Dd	N	N	.....	16.03	1- 8-54	....
2S-23W-4aa1	....	....	1,420	Pb	...	Dd	C, w	S	.....	10.64	2- 9-54	....
8bca1	....	....	1,424	Pb	...	Dd	C, w	S	.....	33.45	2- 9-54	....
2S-24W-1ad1	City of Eldorado	1954	1,433	Pf	62	Dd	N	N	.....	.....	....	....
1ac1	do.	1954	.....	Pb, Pdc	100	Dd	N	N	.....	.....	....	L
1b1	W. C. Garren	1952	.....	Pb, Pdc	105	Dd	....	N	.....	.....	....	....
1b2	do.	1951	.....	Pb, Pdc	145	Dd	....	N	.....	.....	....	....
4acb1	Mrs. Ida V. Thorp	1952	.....	Pb, Pdc	124	Dd	....	N	.....	.....	....	....
12cc1	City of Eldorado	1954	1,479	Pb, Pdc	120	Dd	N	N	.....	.....	....	L
1N-21W-16ddd1	Town of Olustee	1954	.....	Qal	42	Dd	T, e	P	125	.....	....	....
20ba1	....	....	.....	Pf	...	Dd	C, w	S	.....	28.14	1-13-54	....
20aad1	Town of Olustee	....	.....	Qt	...	..	....	P	9	.....	....	C
21aaa1	L. A. Fessenden	1953	.....	Qt	62	Dd	T, b	I	400	.....	....	....
31cdd1	....	....	.....	Pf	...	Dd	C, w	N	.....	12.40	1-13-54	....
1N-22W-11cbc1	....	....	1,414	Qt	...	Dg	C, w	N	.....	8.91	2- 8-54	....
12daa1	....	....	.....	Qt	22	Dg	C, w	N	.....	17.09	1-13-54	....
18aab1	....	....	1,467	Pb, Pdc	...	Dd	C, w	S	.....	43.51	2- 8-54	....
26aad1	Mrs. Pearl Montgomery	1953	1,356	Pf	97	Dd	N	N	.....	12.71	2- 8-54	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level		Other data
										Depth below land surface (feet)	Date of measurement	
JACKSON COUNTY												
1N-22W--Cont'd												
27cac1	....	....	.....	Qt	...	Dg	C, w	N	.....	16.78	1-13-54	....
32bcb1	....	....	1,350	Qal	...	Dg	C, w	S	.....	14.73	2- 8-54	....
1N-23W-10bbb1	John G. Alexander	1951	1,430	Pb, Pdc	92	Dd	T, e	I	400	28.16	2- 8-54	C
11ddc1	....	1946	1,441	Pb, Pdc	...	Dd	C, w	S	.....	37.57	2- 8-54	....
19ddd1	....	....	1,449	Pb, Pdc	25	Dd	C, w	S	.....	23.34	2- 9-54	....
22bcc1	....	....	1,438	Pb	...	Dd	N	N	.....	50.94	2- 9-54	....
24ccd1	....	....	1,376	Pb	....	Dd	N	N	.....	22.32	2- 9-54	....
29bb1	Earl Hulett	1954	.....	Pb, Pdc	90	Dd	T, g	I	.....	.....	....	L
31ddd1	....	....	1,470	Pb, Pdc	53	Dd	C, w	N	.....	43.67	2- 9-54	....
32bbd1	Earl Hulett	1954	.....	Pb, Pdc	94	Dd	....	I	.....	49.4	2-17-55	....
34dcd1	....	....	1,453	Pb	....	Dd	C, w	S	.....	25.91	2- 9-54	....
2N-21W-17aa1	....	....	.....	Qt	16	Dg	N	N	.....	9.97	12-18-53	....
2N-22W-3bc1	Kizziar Brothers	1953	.....	Pb	117	Dd	T, b	I	135	63.55	2-17-54	....
4daa1	J. O. Nash	1953	1,425	Pb	110	Dd	T, b	I	700	56.86	2- 8-54	L
5dcb1	Frank Johnston	1948	1,428	Pb	135	Dd	T, g	I	775	38.50	6-10-48	C
5dab1	T. M. Walston	1953	.....	Pb	135	Dd	N	N	.....	.....	....	....
5dbb1	do.	1953	.....	Pb	135	Dd	....	I	800	.....	....	L
6ddd1	W. R. Renfro	1952	.....	Pb, Pdc	...	Dd	T, g	I	1,100	.....	.....	....
6cac1	Marshall Brothers	1954	.....	Pb	90	Dd		I	850	35.00	2-16-54	L
7aaa1	J. P. Machin	1952	.....	Pb	83	Dd	T, g	I	800	37.22	2- 1-52	....
8dcb1	Marvin Williams	1952	.....	Pb, Pdc	61	Dd	T, g	I	800	.....	....	L
8dda1	Mrs. Pearl Forgey	1953	1,417	Pb	75	Dd	T	I	700	35.17	2- 8-54	....
9bba1	D. M. Weyrick	1952	.....	Pb, Pdc	...	Dd	T, b	I	900	.....	....	....
9bab1	....	....	.....	Pb, Pdc	...	Dd	N	N	.....	.....	....	....
22abb1	O. E. Kaufman	1943	1,380	Qal	33	Dd	C, w	D	.....	23.95	12-10-53	....
36bcc1	....	....	1,386	Pf	...	Dd	C, w	S	.....	38.05	2- 8-54	....
36cbb1	....	1953	.....	Pf	96	Dd	N	N	.....	36.30	1-15-54	....
2N-23W-1ca1	L. B. Heidenreich	....	.....	Pb	70	Dd	N	N	.....	.....	....	....
1cbd1	J. W. Heidenreich	1952	1,424	Pb	85	Dd	N	N	.....	36.91	2- 9-54	....
1cbd2	do.	1953	.....	Pb	100	Dd	T, b	I	800	54.50	8- 5-53	....
1ca2	L. B. Heidenreich	1953	.....	Pb	...	Dd	T, b	I	500	.....	....	....
2bcb1	Loys Criswell	1951	1,425	Pb, Pdc	84	Dd	T, b	I	650	27.18	2- 9-54	....
2baa1	do.	1951	.....	Pb, Pdc	93	Dd	....	N	.....	.....	....	....
2bab1	do.	1951	.....	Pb, Pdc	96	Dd	....	N	.....	.....	....	L
2aaa1	K. Haddad	1953	.....	Pb, Pdc	90	Dd	T, e	I	500	55.90	7-29-53	....
3cca1	N. W. Warren	1952	1,439	Pb, Pdc	97	Dd	T, b	I	1,040	31.49	2- 9-54	L
4bdd1	C. Lee & J. R. Hill	....	1,445	Pb, Pdc	70	Dd	T, g	I	900	.....	....	....
4acd1	C. A. Bradford	1952	.....	Pb, Pdc	107	Dd	T, g	I	1,100	.....	....	L
4dcc1	Mervin Fast	1953	.....	Pb, Pdc	100	Dd	N	N	.....	.....	....	L
4bc1	C. Lee & J. R. Hill	....	.....	Pb, Pdc	75	Dd	N	R	.....	.....	....	....
8acc1	Carmack	1954	.....	Pb, Pdc	...	Dd	T, g	I	.....	.....	....	....
8db1	Truman Jones	1954	.....	Pb, Pdc	...	Dd	T, e	I	.....	44.30	2-22-55	....
8db2	do.	1954	.....	Pb, Pdc	...	Dd	T, e	I	.....	35.48	2-22-55	....
10dbd1	J. D. Ballard	1952	1,417	Pb	135	Dd	T, b	I	500	18.93	2- 9-54	L
10db1	do.	1951	.....	Pb	184	Dd	N	N	.....	24.16	3-20-52	....
10dc1	do.	1952	1,417	Pb	82	Dd	T, e	I	500	22.60	11-23-53	....
10abd1	Lee H. Warren	1952	1,430	Pb	90	Dd	T, b	I	900	31.30	5-16-52	L
10aad1	do.	1952	.....	Pb	70	Dd	N	N	.....	.....	....	....
11cd1	J. H. McMinn	....	.....	Pb	74	Dd	C, w	S	.....	.....	....	....
11dab1	do.	1954	.....	Pb	80	Dd	T, b	I	.....	.....	....	....
12bbd1	Ivan Owen	1942	1,421	Pb	200	Dd	T, b	I	580	29.12	6-10-48	C
12aab1	Herbert Onan	1948	1,417	Pb	90	Dd	T, e	I	810	33.38	2- 9-54	L
12bdd1	Town of Duke	1946	.....	Pb	83	Dd	T, e	P	.....	.....	....	C
12bda1	do.	1952	.....	Pb	133	Dd	....	P	.....	.....	....	C, L
15dc1	Parker Brawley	....	1,426	Pb	...	Dd	T, b	I	800	.....	....	....
15bca1	Chester Anderson	1953	...	Pb	140	Dd	N	N	.....	.....	....	....
15bba1	do.	1954	.....	Pb, Pdc	93	Dd	T, b	I	700	.....	....	....
16aba1	J. P. Dunnam	1951	1,429	Pb, Pdc	99	Dd	T, e	I	400	30.58	2- 9-54	L
16bac1	R. G. Moore	1951	1,435	Pb, Pdc	85	Dd	T, b	I	950	29.87	2- 5-52	....
16abc1	J. P. Dunnam	1954	.....	Pb, Pdc	104	Dd	T, e	I	500	.....	....	....
17a	Sercy	....	.....	Pb, Pdc	...	Dd	....	I	.....	.....	....	....
18cba1	Jesse Moore	1952	.....	Pb, Pdc	126	Dd	....	N	.....	.....	....	....
20bb1	Paul W. Davis	1951	1,439	Pb, Pdc	93	Dd	T, b	I	800	28.79	2- 5-52	....
20bbc1	do.	1951	.....	Pb, Pdc	76	Dd	N	N	.....	32.29	2- 5-52	....
21abb1	Johnnie Kenmore	1951	1,433	Pb, Pdc	84	Dd	T, g	I	190	25.98	2- 5-52	L
21adb1	do.	1951	1,447	Pb, Pdc	100	Dd	N	N	.....	36.69	3-20-52	....
21adb2	do.	1952	.....	Pb, Pdc	77	Dd	N	N	.....	.....	....	....
21aca1	do.	1952	.....	Pb, Pdc	80	Dd	N	N	.....	.....	....	....
21adb3	do.	1952	.....	Pb, Pdc	136	Dd	N	N	.....	.....	....	....
21aaa1	do.	1952	1,429	Pb, Pdc	89	Dd	T, b	I	180	27.72	2- 9-54	L
21cdc1	Leroy Kenmore	1952	.....	Pb, Pdc	135	Dd	T, g	I	800	43.79	7-30-53	....
21ba1	Boyd Davis	1954	.....	Pb, Pdc	85	Dd	T, g	I	.....	34.05	2-22-55	....
21bd1	do.	1954	.....	Pb, Pdc	90	Dd	T, e	I	.....	33.32	2-22-55	....
24bbb1	Moore	....	1,429	Pb, Pdc	52	Dd	N	N	.....	38.20	2- 9-54	....
26c	Glen Filbeck	....	.....	Pb, Pdc	110	Dd	N	N	.....	.....	....	L
26aab1	....	....	.....	Pb, Pdc	...	Dd	C, w	N	.....	43.57	1-14-54	....
29abb1	Arlis Motley	....	1,449	Pb, Pdc	...	Dd	T, b	I	600	44.54	2- 8-54	....
32dad1	....	....	1,482	Pb, Pdc	...	Dd	C, w	S	.....	76.18	2- 8-54	....
35dcc1	....	....	1,473	Pb, Pdc	...	Dd	C, w	S	.....	66.28	2- 9-54	....
3N-22W-26dcd1	....	....	.....	Qt	...	Dg	C, g	N	.....	8.91	1-19-54	....
27ad1	....	....	1,425	Qt	...	Dg	C, w	N	.....	7.80	2- 8-54	....
30cda1	W. F. Proctor	1950	.....	Pb	100	Dd	T, g	I	300	.....	....	....
31ddb1	Jim Bradford	1954	.....	Pb	...	Dd	T, e	I	450	.....	....	....

Well number	Owner or tenant	Date completed	Altitude of land surface (feet)	Geologic source	Depth of well (feet)	Type of well	Pump and power	Use	Yield (gpm)	Water level: Depth below land surface (feet)	Water level: Date of measurement	Other data
JACKSON COUNTY												
3N-22W--Cont'd												
32cbb1	Wilbur Leonard	1949	1,436	Pb	123	Dd	I, g	I	455	42.98	2- 8-54	....
32cbb2	do.	1954	.....	Pb	182	Dd	T, e	I	35	.....	....	....
36cdc1	....	....	.....	Qt	...	Dg	C, w	S	.....	9.57	1-14-54	....
3N-23W-19aaa1	Hugh Forman	1952	.....	Pb, Pdc	177	Dd	T, g	I	900	.....	....	L
19bbb1	do.	1952	1,530	Pb, Pdc	170	Dd	N	N	.....	81.84	2- 8-54	L
21abb1	Ivan Owen	1948	1,452	Pb, Pdc	43	Dd	N	N	.....	21.11	4-15-49	....
21add1	do.	1948	1,450	Pb, Pdc	100	Dd	....	I	1,000	23.92	4-15-49	....
21aab1	do.	1953	.....	Pb, Pdc	153	Dd	T, b	I	1,000	48.13	8-13-53	L
22bcb1	Joe Bond	1953	.....	Pb, Pdc	115	Dd	T, b	I	900	43.46	8-20-53	....
22add1	Cecil Lewis	1953	.....	Pb, Pdc	200	Dd	N	N	.....	.....	....	
22acd1	do.	1953	.....	Pb, Pdc	175	Dd	N	N	.....	.....	....	L
22acc1	do.	1953	.....	Pb, Pdc	200	Dd	N	N	.....	.....	....	....
23aaa1	Otis Bassel	1952	.....	Pb, Pdc	150	Dd	N	N	.....	69.80	8-13-52	L
23aac1	do.	1952	.....	Pb, Pdc	158	Dd	T, b	I	800	82.00	8-28-53	....
23cab1	Loys Criswell	1951	.....	Pb, Pdc	155	Dd	N	N	60	.....	....	....
23dbb1	Frankie Johnson	1951	.....	Pb, Pdc	195	Dd	N	N	15	.....	....	L
24bcb1	R. Ledbetter	1952	.....	Pb, Pdc	190	Dd	T, g	I	450	81.12	8-31-53	....
24bdc1	do.	....	.....	Pb, Pdc	140	Dd	N	N	.....	.....	....	....
25acc1	E. E. Brown	1951	.....	Pb, Pdc	121	Dd	T, b	I	.....	.....	....	....
25bcc1	Sam Maise	1952	.....	Pb, Pdc	90	Dd	C, g	S	.....	53.99	9-15-54	....
26cab1	Fred W. Tigert	1948	1,461	Pb, Pdc	130	Dd	T, g	I	1,000	46.53	4-15-49	....
26aad1	W. W. Cunningham	1952	1,467	Pb, Pdc	...	Dd	T, b	I	335	58.05	2- 8-54	....
27dab1	S. L. Spraggins	1948	1,442	Pb, Pdc	118	Dd	T, b	I	600	24.35	4-15-49	C
27dad1	do.	1948	1,449	Pb, Pdc	125	Dd	N	N	.....	57.10	8- 7-53	....
27aad1	Robert B. Bryant, Jr.	1947	1,458	Pb, Pdc	127	Dd	T, e	I	720	46.08	2- 8-54	....
27cdd1	Loys Criswell	1950	1,438	Pb, Pdc	...	Dd	T, b	I	550	30.80	2- 8-54	....
27bdb1	do.	1951	1,440	Pb, Pdc	100	Dd	T, b	I	1,200	21.51	2- 2-51	....
29ddd1	J. L. Ross	1951	1,450	Pb, Pdc	113	Dd	N	N	.....	.....	....	L
29cba1	Cecil Leonard	1951	.....	Pb, Pdc	154	Dd	N	N	.....	.....	....	L
29cbd1	do.	1951	.....	Pb, Pdc	100	Dd	N	N	.....	38.82	1-19-54	....
30aab1	Archie Leonard	1951	.....	Pb, Pdc	102	Dd	N	N	.....	.....	....	L
30aaa1	do.	1951	.....	Pb, Pdc	100	Dd	T, b	I	800	15.58	2- 5-52	....
30daa1	Cecil Leonard	1951	1,453	Pb, Pdc	90	Dd	T, b	I	500	24.42	2- 8-54	L
31cbb1	W. F. Blevins	1953	.....	Pb, Pdc	62	Dd	T, g	I	600	.....	....	L
31bca1	Bill Garman	1953	.....	Pb, Pdc	86	Dd	T, e	I	1,000	25.92	2- 8-54	....
32aab1	E. F. Walker	1949	1,447	Pb, Pdc	105	Dd	T, b	I	945	34.14	2- 8-54	....
33bdd1	Marshall Carroll	1947	1,446	Pb, Pdc	75	Dd	T, b	I	1,025	24.83	6-10-48	C
33abb1	S. L. Spraggins	1951	1,449	Pb, Pdc	120	Dd	N	N	.....	39.20	2- 2-52	....
33dba1	B. J. Spradlin	1951	.....	Pb, Pdc	82	Dd	T, e	N	.....	.....	....	....
33abb1	S. L. Spraggins	....	.....	Pb, Pdc	170	Dd	T, b	I	1,200	42.16	9-24-53	L
33dbb1	B. J. Spradlin	1953	.....	Pb, Pdc	73	Dd	T, e	I	1,250	.....	....	....
35bdb1	B. O. Yates	1948	1,441	Pb, Pdc	120	Dd	T, g	I	110	26.27	6-10-48	....
35bca1	do.	....	.....	Pb, Pdc	...	Dd	N	N	.....	32.58	8- 7-53	....
36bbd1	Robertson Brothers	1948	1,451	Pb, Pdc	120	Dd	T, g	I	100	42.30	4-15-49	....
36bc1	do.	1951	1,450	Pb, Pdc	150	Dd	T, b	I	700	39.72	2- 2-52	L
36cc1	W. M. Adams	1952	.....	Pb, Pdc	100	Dd	T, b	I	200	42.42	5-15-52	....
36aac1	Ralph Mitchell	1951	1,443	Pb, Pdc	149	Dd	T, b	I	200	44.52	2- 8-54	....

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

The logs on the following pages record the materials penetrated in the drilling of many wells and test holes. The logs described as sample logs were made by field analysis or by field and microscopic analysis of the drill cuttings by personnel of the U.S. Geological Survey or the Oklahoma Planning and Resources Board. The logs described as drillers' logs were made by field analysis of the drill cuttings by the well driller. The logs are arranged by county according to the well-numbering system used in this report (fig. 2, p. 7). The altitude refers to the ground level at the mouth of the well or test hole in feet above mean sea level.

Thickness in feet. Depth in feet below land surface.

GREER COUNTY

3N-23W-2ccd1. SE¼SW¼SW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	22	22
Gypsum	17	39
Shale, brown	7	46
Gypsum	8	54
Limestone (dry)	2	56
Shale, blue	4	60
Shale, brown	32	92
Gypsum	17	109
Shale, brown	14	123
Gypsum	6	129
Shale, blue	2	131
Shale, brown	14	145

3N-23W-3ddb1. NW¼SE¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay, black	10	10
Clay	9	19
Gypsum	5	24
Shale, blue	15	39
Shale, brown	9	48
Shale, red	3	51
Dolomite and limestone	5	56
Shale, red	4	60
(14-in. casing set at 6 ft.)		

3N-23W-3dad2. SE¼NE¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil	2	2
Gypsum	2	4
Shale, brown	11	15
Gypsum	21	36
Shale, brown and blue	8	44
Gypsum	3	47
Sand	3	50
Shale, brown and blue	30	80
(test hole, no casing)		

3N-23W-3aaa1. NE¼NE¼NE¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Soil	1	1
Limestone	2	3
Shale, blue	2	5
Shale, red	25	30
Gypsum	1	31
Shale, blue	1	32
Gypsum	11	43
Cavity, water-bearing	1	44
Gypsum	4	48
Shale, red	2	50
Gypsum	4	54
Limestone	2	56
Shale, blue	2	58
Shale, red	10	68
Gypsum	8	76
Shale, blue	2	78
Shale, red	16	94

3N-23W-4cba1. NE¼NW¼SW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,527.

Description	Thickness	Depth
Sand	8	8
Shale, red	18	26
Shale, blue	4	30
Shale, red	26	56
Shale, blue	23	79
Gypsum	10	89
Shale, brown	2	91
Limestone, shaly	4	95
Shale, blue	3	98
Gypsum	10	108
Shale, blue	5	113

3N-23W-4cba1.--Continued

Description	Thickness	Depth
Gypsum	13	126
Shale, brown	6	132
Gypsum	12	144
Shale, brown	14	158
Gypsum	2	160
Limestone, water-bearing, 100 gpm	10	170
Shale, red	5	175
Shale, brown	15	190
Shale, brown and blue	5	195
(14-in. casing set at 145 ft.)		

3N-23W-8daa1. NE¼NE¼SE¼. Drillers' log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	39	39
Gypsum	12	51
Shale, blue	3	54
Gypsum	11	65
Shale, blue	4	69
Gypsum	13	82
Shale, blue	3	85
Shale, red	5	90
Gypsum	19	109
Shale, brown	10	119
Gypsum	10	129
Shale and limestone, water-bearing, 2 gpm	2	131
Shale, blue	4	135
Shale, red	15	150

3N-23W-9dba1. NE¼NW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil	3	3
Shale, red	30	33
Gypsum, chalky; dolomite	13	46
Shale, blue	3	49
Dolomite	10	59
Shale, brown	6	65
Gypsum	9	74
Shale, brown	9	83
Gypsum	22	105
Shale, brown	3	108
Gypsum, hard, water-bearing	7	115
Dolomite, water-bearing	3	118
Limestone and clay	7	125

3N-23W-10da1. NE¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay, red and blue	30	30
Clay, blue	10	40
Clay, brown	9	49
Shale, blue; gypsum	11	60
Shale, blue	5	65
Gypsum	11	76
Shale, blue	4	80
Gypsum	15	95
Shale, blue	5	100
Shale, brown	10	110
Gypsum	13	123
Sand	2	125
Shale, brown	5	130
(reported yield, 10 gpm; 6-in. casing set at 72 ft.)		

3N-23W-11acc1. SW¼SW¼NE¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Soil	1	1
Shale, red	4	5
Shale, blue	3	8
Shale, red	10	18
Shale, blue	2	20
Gypsum	7	27
Shale, blue	3	30
Shale, red	20	50

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

GREER COUNTY.--Continued

3N-23W-11acc1.--Continued

Description	Thickness	Depth
Shale, blue	2	52
Shale, red	9	61
Shale, blue	3	64
Gypsum	9	73
Shale, blue	3	76
Shale, red	11	87
Gypsum	3	90
Shale, blue	2	92
Shale, red	18	110

3N-23W-14bc1. SW¼NW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,489.

Description	Thickness	Depth
Shale, red	20	20
Shale, red and blue	12	32
Shale, red	9	41
Limestone	1	42
Gypsum	7	49
Limestone	3	52
No sample	3	55
Gypsum	11	66
Shale, blue	1	67
Gypsum	1	68
Shale, blue	2	70
Gypsum	13	83
Shale, blue	1	84
Shale, brown	4	88
Gypsum	2	90
Shale, brown	1	91
Gypsum	17	108
Shale, blue	1	109
Shale, brown	7	116
Gypsum	4	120
Cavity	2	122
Limestone	8	130
Shale, red	5	135

(14-in. casing set at 10 ft.)

3N-23W-16cab1. NW¼NE¼SW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,459.

Description	Thickness	Depth
Soil	3	3
Shale, red, sandy	27	30
Shale, blue	4	34
Gypsum	12	46
Shale, red	18	64
Gypsum	12	76
Shale, brown	12	88
Gypsum	2	90
Sand	3	93
Limestone	12	105
Shale, brown	19	124
Shale, blue	2	126
Shale, red and blue	4	130
Gypsum	14	144
Shale, blue; limestone stringers	4	148
Shale, blue	1	149
Shale, brown	3	152

(Reported yield, 1,380 gpm; 16-in. casing set at 36 ft.)

3N-23W-16dab1. NW¼NE¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil	3	3
Clay, red, sandy	27	30
Shale, brown	5	35
Gypsum, water-bearing, 10 gpm	14	49
Shale, blue	3	52
Shale, brown	5	57
Gypsum	17	74
Shale, brown	9	83
Gypsum	12	95
Limestone, water-bearing	3	98
Shale, blue	3	101
Shale, red	13	114
Limestone, red	8	122
Shale, blue	8	130
Gypsum	13	143
Shale, blue	10	153

(Well abandoned and hole filled, April 1950.)

3N-23W-16dba1. NE¼NW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay, red; sand	25	25
Clay, brown; sand, 7-8 gpm	17	42
Gypsum	1	43
Shale, brown	3	46
Gypsum	5	51
Shale, brown	9	60
Gypsum	14	74
Shale, red	10	84
Gypsum, water-bearing	8	92
Sand and limestone	4	96
Shale, blue	3	99
Shale, red	21	120
Shale, blue	11	131
Gypsum	17	148
Shale, blue; limestone stringers	3	151
Shale, red and blue	12	163
Gypsum	7	170
Shale, blue	3	173

3N-23W-16dcb1. NW¼SW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay, brown	20	20
Shale, white	6	26
Gypsum	5	31
Shale, brown	3	34
Limestone, 15 gpm	3	37
Gypsum	10	47
Shale, blue and brown	8	55
Gypsum	20	75
Shale, blue and brown	8	83
Gypsum	12	95
Shale, blue	5	100

(Well abandoned, hole filled with earth.)

3N-23W-16dca1. NW¼SW¼SE¼. Driller's log supplied by Ronald Owen.

Description	Thickness	Depth
Clay	43	43
Limestone and gypsum	2	45
Shale, red	10	55
Gypsum	10	65
Shale and sand	2	67
Gypsum	8	75
Shale, red	5	80
Gypsum	20	100
Shale, red	10	110

(7-in. casing set at 43 ft.)

3N-23W-17aa1. NE¼NE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,470.

Description	Thickness	Depth
Soil	3	3
Shale, brown	55	58
Gypsum	9	67
Shale, blue	3	70
Shale, brown	4	74
Gypsum	12	86
Cavity	3	89
Gypsum	7	96
Shale, brown	4	100
Gypsum	13	113
Limestone; shale, blue	2	115
Shale, blue	5	120
Shale	5	125
Shale, brown and blue	20	145
Gypsum	20	165
Shale, blue	2	167
Shale, brown	11	178
Gypsum	8	186
Shale, blue (salty)	3	189

(Yield 940 gpm August 1952; 16-in. casing set at 67 ft.)

3N-23W-17dda1. NE¼SE¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red and blue	25	25
Gypsum; shale, blue	14	39
Shale, blue	3	42
Gypsum	12	54
Shale, brown and blue	4	58
Gypsum	13	71
Shale, brown	8	79
Gypsum	12	91

Thickness in feet. Depth in feet below land surface.

GREER COUNTY.--Continued

3N-23W-17dda1.--Continued

Description	Thickness	Depth
Shale, brown	9	100
Gypsum, 20 gpm	12	112
Shale, blue	8	120
(7-in. casing set at 102 ft.)		

4N-23W-32dbb1. NW¼NW¼SE¼. Driller's log supplied by Ronald Owen.

Description	Thickness	Depth
Clay	24	24
Gypsum	2	26
Shale, blue	15	41
Shale	17	58
Gypsum	7	65
Shale, blue; limestone	2	67
No sample	16	83
Shale, red	11	94
Shale, blue	4	98
Shale, red	7	105
Gypsum	12	117
Shale, blue	3	120
Gypsum	5	125
Shale, blue	5	130
Gypsum	10	140
Shale, blue	3	143
Shale, red; limestone	2	145
Gypsum	23	168
Shale, red	5	173
Gypsum	1	174
Shale, red; limestone	3	177
Gypsum	11	188
Sand and limestone	7	195
Shale, red	15	210
(Reported yield, 70 gpm.)		

4N-23W-33dab1. NW¼NE¼SE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,550.

Description	Thickness	Depth
Soil	2	2
Clay, red	38	40
Conglomerate	3	43
Clay, red	15	58
Gypsum	3	61
Limestone, blue	7	68
Shale, blue	2	70
Gypsum	13	83
Shale, blue	3	86
Gypsum	12	98
Shale, brown	10	108
Gypsum	11	119
Shale, blue	5	124
Gypsum	1	125
Shale, brown	4	129
Gypsum	6	135
Dolomite, water-bearing	4	139
Shale, red	16	155
(Reported yield, 800 gpm; 16-in. casing set at 54 ft.)		

4N-23W-35dcb1. NW¼SW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay	12	12
Gypsum	2	14
Shale, brown	25	39
Gypsum	3	42
Shale, brown	3	45
Gypsum	5	50
Sand, water-bearing	2	52
Shale, blue	8	60
Shale, brown	5	65
Shale, blue	5	70
(14-in. casing set at 70 ft.)		

4N-24W-14bbb2. NW¼NW¼NW¼. Sample log of test hole drilled by U.S. Geol. Survey. Altitude: land surface, 1,767.

Description	Thickness	Depth
Clay, brown, sandy	10	10
Clay, light-gray, sandy; sand stringers	8	18
Sand, brown, fine to medium	2	20
Clay, light-gray, sandy	5	25
Sand, medium to coarse	3	28
Gravel, coarse	2	30
Sand, fine	8	38
Clay, brown to white	2	40
Sand, coarse; clay, brown	3	43
Shale, reddish-brown and gray	10	53

4N-24W-14bbb2.--Continued

Description	Thickness	Depth
Gypsum, alabaster	2	55
Shale, reddish-brown and gray	9	64
Gypsum, alabaster and selenite	2	66
Shale, reddish-brown and gray; gypsum stringers	9	75
Gypsum, alabaster	8	83
Shale, bluish-gray; gypsum stringers	17	100
Shale, bluish-gray and brown	13	113
Gypsum	1	114
Shale, bluish-gray	1	115
Gypsum, alabaster	10	125
Shale, bluish-gray	5	130
Anhydrite	10	140
Shale, gray; gypsum stringers	2	142
Anhydrite	13	155
Shale, gray	4	159
Anhydrite	20	179
Shale, bluish-gray	4	183
Gypsum, alabaster; shale stringers, gray	15	198
Dolomite, gray, porous, water-bearing	2	200
Shale, blue and brown	10	210
Shale, brown	11	221
Anhydrite	2	223
Shale, brown	2	225
Anhydrite	9	234
(6-in. casing set at 59 ft.)		

4N-24W-15bcb1. NW¼SW¼NW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,780.

Description	Thickness	Depth
Sand	45	45
Shale, red	10	55
Shale, brown	33	88
Gypsum	7	95
Shale, brown	25	120
Shale, blue	8	128
Shale, brown	3	131
Gypsum	10	141
Shale, blue and brown	4	145
Gypsum	11	156
Shale, brown	2	158
Gypsum	11	169
Shale, brown	5	174
Gypsum	21	195
Shale, blue	2	197
Shale, brown	5	202
Gypsum	11	213
Sand	1	214
Shale, brown	21	235
Gypsum	22	257
Shale, blue	6	263
(Reported yield 15 gpm; 8-in. casing set at 56 ft; 7-in. casing set at 198 ft.)		

5N-23W-21bdc1. SW¼SE¼NW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,728.

Description	Thickness	Depth
Soil	10	10
Sand	50	60
Clay, red; sand	11	71
Sandstone, water-bearing	1	72
Clay, red	18	90
Clay, brown and blue	31	121
Gypsum	12	133
Clay, brown and blue	12	145

5N-23W-27bda1. NE¼SE¼NW¼. Driller's log supplied by Elmo Crenshaw. Altitude: land surface, 1,717.

Description	Thickness	Depth
Soil	10	10
Sand, white	70	80
Shale	18	98
Gypsum	4	102
Cavity, water-bearing	2	104
Gypsum	6	110
Shale	4	114
Gypsum	13	127
(16-in. casing set at 98 ft.)		

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY

1N-24W-2cdb1. NW¼SE¼SW¼. Driller's log supplied by Jack Jenkins. Altitude: land surface, 1,533.

Description	Thickness	Depth
No sample	4	4
Shale, blue	18	22
Shale, red	8	30
Shale, blue	4	34
Shale, red	11	45
Gypsum	6	51
Shale, red	26	77
Gypsum	7	84
Shale, blue	4	88
Shale, red	20	108
Gypsum	2	110
Shale, red	7	117
Shale, blue	5	122
Shale, red	4	126
Gypsum	12	138
Shale, blue	1	139
Gypsum	10	149
Salt	2	151
Shale, blue	5	156
Gypsum	9	165
Shale, blue	1	166
Gypsum	25	191
Shale, red	5	196
Gypsum	14	210
Limestone, blue, water-bearing	10	220
Shale, red	27	247

1N-24W-6bcd1. SE¼SW¼NW¼. Driller's log supplied by Jack Jenkins. Altitude: land surface, 1,544.

Description	Thickness	Depth
Soil	3	3
Shale, red	18	21
Shale, blue	11	32
Shale, red	4	36
Shale, blue	2	38
Gypsum	2	40
Shale, blue	2	42
Gypsum	2	44
Shale, red	6	50
Shale, blue	3	53
Gypsum	10	63
Shale, blue	2	65
Gypsum	6	71
Shale, red	5	76
Gypsum	5	81
Shale, red	2	83
Gypsum	29	112
Shale, red	16	128
Limestone	12	140
Shale, blue, water-bearing	2	142
Shale, red	10	152
Shale, red; gypsum, blue	16	168
Gypsum	6	174
Shale, blue and red	12	186
Shale, blue	5	191
Gypsum	12	203
Limestone; shale, blue	1	204
(Not enough water for irrigation)		

1N-24W-7cca2. NE¼SW¼SW¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
No sample	4	4
Limestone	5	9
Shale, red	17	26
Gypsum	2	28
Shale, red	23	51
Shale, blue	6	57
Gypsum	1	58
Shale, blue, water-bearing 58-60 ft	9	67
Shale, red	24	91
Gypsum	1	92
Shale, red	10	102
Shale, blue	8	110
Shale, red	4	114
Gypsum	2	116
Shale, blue	3	119
Shale, red	5	124
Gypsum	1	125
Shale, red and blue	8	133
Gypsum	5	138
Shale, blue; limestone, water-bearing	2	140
Gypsum	7	147

1N-24W-7cca2.--Continued

Description	Thickness	Depth
Limestone, water-bearing	5	150
Shale, red	5	155
Gypsum	1	156
Shale, red and blue	18	174
Gypsum	1	175
Shale, red	5	180
Limestone, water-bearing	3	183
Shale, red	3	186
Gypsum	4	190
Shale, blue	6	196
Gypsum	2	198
Shale, blue	1	199
Gypsum	6	205
Limestone, water-bearing	2	207

1N-24W-8dba1. NE¼NW¼SE¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Clay	18	18
Gypsum	7	25
Shale, red and blue	20	45
Gypsum	5	50
Shale, red and blue	46	96
Gypsum	9	105
Shale, blue	5	110
Gypsum	9	119
Shale, blue	2	121
Gypsum	2	123
Shale, blue	2	125
Gypsum	12	137
Shale, red	6	143
Gypsum	26	169
Shale, red	9	178
Gypsum	7	185
Limestone	3	188
(16-in. casing set at 99 ft.)		

1N-24W-19ddb1. NW¼SE¼SE¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Soil	4	4
Sand	18	22
Sand, fine, water-bearing	7	29
Shale, blue	7	36
Shale, red	9	45
Limestone, water-bearing	10	55
Shale, red	14	69
Shale, blue	6	75
Gypsum	25	100
Limestone	5	105
Shale, red	4	109
Gypsum	1	110
(16-in. casing set at 55 ft; 14-in. casing set at 80 ft.)		

1N-24W-30bb1. NW¼NW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red and blue	28	28
Gypsum, water-bearing	12	40
Shale, blue; sand	2	42
No sample	5	47
Gypsum	10	57
Shale, brown	3	60
Gypsum	3	63
Shale, brown	2	65
No sample	17	82
Gypsum	19	101
Shale, brown	10	111
Gypsum	11	122
Shale, blue; limestone	2	124
Shale, red	26	150
Gypsum	5	155
Shale, blue	2	157

1N-25W-1dbc1. NW¼NW¼SE¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
No sample	5	5
Shale, red	9	14
Shale, blue	1	15
Shale, red	9	24
Gypsum	7	31
Shale, blue	3	34
Shale, red	21	55

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

Description	Thick-ness	Depth
HARMON COUNTY.--Continued		
Shale, blue	1	56
Gypsum	3	59
Shale, red and blue	16	75
Gypsum	2	77
Shale, blue	2	79
Gypsum, water-bearing	8	87
Shale, blue	4	91
Gypsum	13	104
Shale, red	3	107
Gypsum	11	118
Shale, red	4	122
Gypsum	24	146
Limestone; shale, blue and red; main water-bearing zone	5	151
Gypsum	1	152
Shale, blue	3	155
Gypsum	11	166
Limestone; shale, red, water-bearing	7	173
Shale, red	7	180
1N-25W-4dba1. NE¼NW¼SE¼. Driller's log supplied by Ivan Owen.		
Clay	30	30
Shale, brown and blue	5	35
Shale, blue	8	43
Shale, brown	22	65
Gypsum	10	75
Shale, blue	10	85
Shale, brown	9	94
Shale, blue; limestone, water-bearing	14	108
Shale, brown	3	111
Gypsum	8	119
Shale, blue	1	120
(Reported yield, 650 gpm; 14-in. casing set at 70 ft.)		
1N-25W-6ada1. NE¼SE¼NE¼. Driller's log supplied by Paul Bible.		
No sample	28	28
Gypsum	15	43
Shale, blue	10	53
Gypsum	15	68
Shale, blue	5	73
Shale, red	2	75
Gypsum	15	90
Shale, blue	3	93
Shale, red	3	96
Gypsum	26	122
Limestone	16	138
Gypsum	18	156
Limestone, water-bearing	4	160
Shale, red	20	180
Limestone, water-bearing	2	182
Shale	2	184
Shale, red and blue	7	191
Gypsum	7	198
Limestone, sandy, water-bearing	2	200
Gypsum	3	203
Shale, calcareous	1	204
Shale, blue	3	207
Shale, red	1	208
No sample	2	210
(16-in. casing set at 209 ft. Perforated interval 129-209 ft.)		
1N-25W-11baa1. NE¼NE¼NW¼. Sample log of irrigation well. Altitude: land surface, 1,530.		
Sand, reddish-brown, medium to coarse	3	3
Sand, medium to very coarse, argillaceous; gravel, fine	8	11
Sand, coarse, argillaceous	6	17
Shale, reddish-brown and gray, argillaceous; limestone stringers	25	42
Shale, light-gray; limestone stringers	3	45
Shale, brown and gray, calcareous	5	50
Shale, reddish-brown and gray, calcareous; limestone stringers	15	65
Shale, gray, calcareous	10	75
Shale, reddish-brown and gray, calcareous	9	84
Limestone, gray; shale, reddish-brown	6	90
Shale, gray, calcareous	6	96
Shale, gray	3	99
Limestone, gray, porous, water-bearing	6	105
Gypsum, alabaster, white; shale stringers, reddish-brown	5	110

Description	Thick-ness	Depth
1N-25W-11baa1.--Continued		
Shale, reddish-brown and gray, calcareous; limestone stringers	5	115
Shale, reddish-brown and gray, calcareous; gypsum stringers, alabaster, white	5	120
Gypsum, alabaster, white	5	125
Dolomite, gray, porous, argillaceous	5	130
Shale, reddish-brown and gray, calcareous	5	135
Shale, reddish-brown and blue, calcareous; gypsum stringers, alabaster, white	6	141
Shale, reddish-brown and gray, calcareous; gypsum stringers, satinspar	9	150
Shale, blue and reddish-brown; gypsum stringers, alabaster	10	160
Shale, red and gray; gypsum stringers, selenite and satinspar	5	165
Limestone, gray, argillaceous	2	167
Dolomite, gray, porous; water-filled cavity 169.5-170 ft	3	170
No sample (most drill cuttings washed from bailer)	10	180
(16-in. casing set at 165 ft.)		
1N-25W-11dcc1. SW¼SW¼SE¼. Driller's log supplied by Jack Jenkins.		
Soil	4	4
Sand	11	15
Sand, very fine	15	30
Shale, blue	1	31
Shale, red	17	48
Sand and gravel, water-bearing	1	49
Shale, blue	11	60
Shale, red	3	63
Limestone, water-bearing	6	69
Shale, red	11	80
Shale, blue	1	81
Gypsum	2	83
(Problems with quicksand and other difficulties. Well abandoned and hole plugged. Lots of water.)		
1N-25W-12bcc1. SW¼SW¼NW¼. Driller's log supplied by Jack Jenkins.		
Soil	2	2
Shale, red	21	23
Shale, blue	7	30
Shale, red	9	39
Limestone, water-bearing	6	45
Shale, blue	3	48
Gypsum	12	60
Shale, blue	2	62
Gypsum	3	65
Shale, blue	1	66
Gypsum	14	80
Shale, red and blue	5	85
Gypsum	25	110
Shale, red	4	114
Gypsum	8	122
Limestone, water-bearing	1	123
Gypsum	6	129
Shale, blue	3	132
Limestone, blue	3	135
Shale, red	9	144
Gypsum	2	146
Shale, red and blue	9	155
Gypsum	2	157
Shale, blue	3	160
Gypsum	2	162
Shale, blue	3	165
Gypsum	3	168
1N-25W-12cdb1. NW¼SE¼SW¼. Driller's log supplied by Jack Jenkins.		
Shale, red, blue, and gray	46	46
Limestone, water-bearing	6	52
Shale, blue	2	54
Gypsum	11	65
Shale, red	2	67
Gypsum	16	83
Shale, red	5	88
Gypsum	7	95
Shale, red; some water	2	97
Gypsum	13	110
Shale, red	10	120
Gypsum	4	124
Cavity, water-bearing	3	127
(16-in. casing set at 54 ft. Perforated interval 46-54 ft.)		

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

1N-25W-35caa1. NE¼NE¼SW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	15	15
Cavity	11	26
Shale, brown	4	30
Cavity	6	36
Conglomerate	7	43
Shale, brown	3	46
Gypsum	24	70
Shale	9	79
Gypsum	10	89
Sand and limestone	5	94
Shale, blue and red	11	105
(16-in. casing set at 26 ft.)		

2N-24W-5cd1. SE¼SW¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Soil	4	4
Shale, red	16	20
Cavity, dry	1	21
Gypsum	2	23
Shale, red	12	35
Gypsum	2	37
Shale, red	25	62
Gypsum	7	69
Shale, red and blue	18	87
Gypsum	2	89
Shale, black	3	92
Gypsum	11	103
Shale, red and blue	9	112
Gypsum	1	113
Shale, red and blue	8	121
Gypsum	2	123
Shale, blue	2	125
Gypsum	2	127
Shale, blue	2	129
Gypsum	2	131
Shale, red	7	138
Gypsum	3	141
Shale, blue	2	143
Gypsum	8	151
Shale, blue	3	154
Gypsum	8	162
Shale, blue	2	164
Gypsum	15	179
Shale, blue	5	184
Gypsum	25	209
Shale, blue	2	211
Gypsum	1	212
Shale, blue	3	215
Gypsum	7	222
Limestone, water-bearing	5	227
Shale, blue	2	229
Shale, red	9	238
Gypsum	3	241
Shale, blue	2	243
Gypsum	3	246
Shale, red and blue	4	250
(Not enough water for domestic use.)		

2N-24W-26acc1. SW¼SW¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
No sample	15	15
Clay	15	30
Gypsum	2	32
Shale, brown and blue	20	52
Gypsum	9	61
Shale, blue	2	63
Shale, brown	3	66
Gypsum	9	75
Shale, blue	5	80
Gypsum	8	88
Shale, blue	3	91
Shale, brown	4	95
Gypsum	21	116
Shale, blue	4	120
Shale, brown	4	124
Gypsum	11	135
Sand, water-bearing	1	136
Shale, blue	4	140
(Large quantity of water but too salty for stock use; hole plugged.)		

2N-24W-35acc1. SW¼SW¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, blue and brown	25	25
Gypsum	5	30
Shale, brown and blue	30	60
Shale, blue	5	65
Shale, brown	13	78
Gypsum	9	87
Shale, blue and brown	5	92
Gypsum	8	100
Gypsum; shale, blue	5	105
Gypsum	10	115
Shale, blue	5	120
Gypsum	21	141
Shale, blue	2	143
Shale, brown	7	150
Gypsum	10	160
Sand, water bearing. Water level 105 ft below land surface	2	162
(7-in. casing set at 133 ft. Water too salty for stock use.)		

2N-25W-2aaa1. NE¼NE¼NE¼. Driller's log supplied by Ivan Owen. Altitude: Land surface, 1,606.

Description	Thickness	Depth
Shale, red	39	39
Gypsum	4	43
Shale, red	22	65
Shale, blue	3	68
Gypsum	10	78
Shale, blue	3	81
Shale, red	31	112
Shale, red and blue	11	123
Gypsum	7	130
Shale, red and blue	5	135
Gypsum	9	144
Shale, blue	5	149
Gypsum	10	159
Shale, blue	4	163
Shale, red	2	165
Gypsum	26	191
Shale, red	7	198
Gypsum	10	208
Shale; limestone, sandy, water-bearing. Water level 63 ft below land surface	3	211
Shale, red and blue	4	215
(12-in. casing set at 120 ft.)		

2N-25W-5aac1. SW¼NE¼NE¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Soil	5	5
Shale, red	25	30
Shale, blue	5	35
Cavity	2	37
Gypsum	3	40
Limestone, water-bearing	10	50
Shale, red	5	55
Gypsum	13	68
Shale, blue	2	70
Gypsum	5	75
Gypsum and limestone, water-bearing	10	85
Gypsum	5	90
Shale, red	10	100
Gypsum and limestone, water-bearing	5	105
Gypsum	18	123
Shale, blue	6	129
Gypsum, water-bearing	14	143
Cavity, water-bearing	2	145
(16-in. casing set at 70 ft.)		

2N-25W-5ca1. NE¼SW¼. Driller's log supplied by John Jenkins.

Description	Thickness	Depth
Soil and clay	10	10
Shale, red	40	50
Gypsum	2	52
Limestone, porous	13	65
Shale	5	70
Gypsum	2	72
Shale, red	6	78
Gypsum	10	88
Limestone, porous	2	90
Gypsum	16	106
Cavity	6	112
Gypsum	3	115
(16-in. casing set at 78 ft.)		

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

2N-25W-11bac1. SW¼NE¼NW¼. Driller's log supplied by Jack Jenkins. Altitude: land surface, 1,522.

Description	Thickness	Depth
Shale, red	17	17
Shale, blue	5	22
Gypsum	8	30
Shale, blue	5	35
Shale, red	21	56
Gypsum	6	62
Shale, blue	8	70
Gypsum	10	80
Limestone, water-bearing	3	83
Shale, blue	3	86
Gypsum	11	97
Shale, blue	2	99
Gypsum	3	102
Shale, blue	2	104
Gypsum	12	116
Shale, blue	6	122
Gypsum	27	149
Shale, red	6	155
Gypsum	10	165
Limestone	10	175

(14-in. casing set at 70 ft.)

2N-25W-12cca1. NE¼SW¼SW¼. Driller's log supplied by Jack Jenkins. Altitude: land surface, 1,601.

Description	Thickness	Depth
Shale, red	19	19
Cavity	1	20
Gypsum	6	26
Shale, red	5	31
Gypsum	2	33
Shale, red	8	41
Gypsum	5	46
Shale, blue	3	49
Gypsum	7	56
Shale, blue	1	57
Gypsum	3	60
Shale, red	9	69
Gypsum	2	71
Shale, red	6	77
Gypsum	2	79
Shale, red	9	88
Gypsum	2	90
Shale, blue	4	94
Gypsum	1	95
Shale, blue	2	97
Shale, red	2	99
Gypsum	4	103
Shale, red	1	104
Gypsum	4	108
Shale, red	6	114
Shale, blue	1	115
Gypsum	8	123
Shale, blue	2	125
Gypsum	14	139
Shale, blue	4	143
Gypsum	25	168
Shale, red and blue	2	170
Gypsum	14	184
Limestone, water-bearing	4	188
Shale, blue	2	190
Gypsum	2	192
Shale, blue	3	195
Shale, red	4	199
Shale, red; limestone	1	200
Shale, red; gypsum, thin layers	16	216
Gypsum	2	218
Shale, blue	3	221
Gypsum	13	234
Shale, blue	1	235
Gypsum	1	236
Shale, red and blue	9	245
Limestone, water-bearing	1	246
Shale, blue	4	250
Gypsum	10	260
Shale, blue	6	266

(Not enough water for irrigation.)

2N-25W-14dba1. NE¼NW¼SE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,576.

Description	Thickness	Depth
Shale, red	36	36
Shale, blue	5	41
Shale, red	5	46
Gypsum	9	55
Limestone, water-bearing	1	56
Shale	4	60
Gypsum	7	67
Shale, blue	4	71
Shale, red	4	75
Gypsum	7	82
Shale, blue	8	90
Gypsum	26	116
Shale, brown	17	133
Limestone	4	137
Shale, blue	3	140
Shale, red	5	145

(Not enough water for irrigation.)

2N-25W-15dab1. NW¼NE¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	21	21
Shale, red	7	28
Gypsum	6	34
Shale, brown	4	38
Gypsum	3	41
Shale, brown	5	46
Gypsum	9	55
Shale, brown (caves easily)	10	65
Gypsum	10	75
Shale, brown	4	79
Gypsum	13	92
Limestone (porous near top, hard at base)	5	97
Shale, red	8	105

2N-25W-17bb1. NW¼NW¼. Driller's log supplied by John Jenkins.

Description	Thickness	Depth
Soil	4	4
Clay	6	10
Clay, sandy	22	32
Rock, red, porous	2	34
Gravel and rock	18	52
Clay, red	11	63
Gypsum, porous	6	69
Shale	11	80
Shale, red	18	98
Gypsum	8	106
Gypsum, porous	14	120
Gypsum	23	143
Cavity	2	145

(16-in. casing set at 53 ft; 14-in. casing set at 98 ft.)

2N-25W-18cdd1. SE¼SE¼SW¼. Driller's log supplied by Chester Anderson.

Description	Thickness	Depth
Shale	24	24
Gypsum	12	36
Shale	6	42
Gypsum	11	53
Limestone, porous	2	55
Shale, red	35	90
Limestone, porous	2	92
Gypsum	17	109
Cavity	21	130
Limestone, porous	7	137

(16-in. casing set at 137 ft. Perforated interval 107-137 ft.)

2N-25W-23abb1 NW¼NW¼NE¼. Driller's log supplied by Ronald Owen. Altitude: land surface, 1,556.

Description	Thickness	Depth
No sample	5	5
Clay	7	12
Shale and limestone	38	50
Shale	16	66
Limestone	5	71
Gypsum	7	78
Shale, blue	3	81
Gypsum	23	104
Shale, red	6	110
Gypsum	16	126
Shale, blue	4	130

(12-in. casing set at 70 ft. Perforated interval 30-70 ft.)

Thickness in feet. Depth in feet below land surface.

Description	Thickness	Depth
HARMON COUNTY.--Continued		
2N-25W-26ac1. SW¼NE¼. Driller's log supplied by Ronald Owen. Altitude: land surface, 1,547.		
Clay	25	25
No sample, water at 36 ft	13	38
Gypsum	18	56
Limestone	1	57
Shale and limestone, 100 gpm at 58 ft	8	65
Gypsum	10	75
Limestone	7	82
Shale, red	18	100
Limestone and shale	3	103
Shale, blue	6	109
Gypsum	3	112
Shale	3	115
Gypsum	3	118
Shale, blue	2	120
(16-in. casing set at 37 ft.)		
2N-25W-31abb1. NW¼NW¼NE¼. Driller's log supplied by Lewis Bible.		
Clay, red	30	30
Clay, red; gravel, water-bearing	25	55
Gypsum, water-bearing	1	56
Shale, red	2	58
Gypsum	11	69
Limestone	5	74
Shale, red	15	89
Shale, red and blue	13	102
Limestone	24	126
Shale, blue	14	140
Gypsum	13	153
No sample	47	200
(16-in. casing set at 63 ft.)		
2N-25W-31bbb1. NW¼NW¼NW¼. Driller's log supplied by Jack Jenkins. Altitude: land surface, 1,586.		
Sand	10	10
Shale, red	55	65
Limestone, water-bearing	1	66
Shale, red and blue	31	97
Gypsum	15	112
Shale, blue; limestone	2	114
Shale, red	11	125
Limestone, water-bearing	6	131
Shale, blue	4	135
Limestone	3	138
Gypsum	15	153
Shale, blue	2	155
(16-in. casing set at 97 ft.)		
2N-25W-31dad1. SE¼NE¼SE¼. Driller's log supplied by Lewis Bible.		
Shale, red and blue	65	65
Gypsum	10	75
Shale, red	21	96
Gypsum	10	106
Shale, limestone stringers	4	110
Gypsum	12	122
Limestone	4	126
Gypsum	15	141
Limestone, water-bearing	3	144
Cavity, water-filled	6	150
Shale, red	21	171
Gypsum	4	175
Limestone	26	201
(16-in. casing set at 164 ft.)		
2N-25W-32bca1. NE¼SW¼NW¼. Driller's log supplied by Jack Jenkins.		
No sample	26	26
Gypsum	12	38
Shale, red	2	40
Gypsum	25	65
Shale, blue	3	68
Shale, red	34	102
Gypsum	16	118
Shale, red	19	137
Gypsum	8	145
Shale, red	5	150
Gypsum	23	173
Shale, blue	2	175
(16-in. casing set at 152 ft. Perforated interval 97-152 ft.)		
2N-25W-32cac1. SW¼NE¼SW¼. Driller's log supplied by Jack Jenkins.		
Soil and clay	10	10
Gypsum	12	22
Shale, red	8	30
Gypsum	2	32
Shale, red	10	42
Gypsum	11	53
Shale, blue	9	62
Shale, red	5	68
Gypsum	9	77
Shale, blue	4	81
Gypsum	8	89
Limestone, blue	2	91
Limestone, red, water-bearing	5	96
Gypsum	10	106
Shale, red	4	110
Gypsum	6	116
Limestone, water-bearing	1	117
Gypsum	9	126
Shale, blue	5	131
Gypsum	2	133
Shale, red	5	138
Shale, gray	6	144
Shale, red; limestone stringers	24	168
Limestone	2	170
Shale, red	30	200
2N-25W-36dac1. SW¼NE¼SE¼. Driller's log supplied by Jack Jenkins. Altitude: Land surface, 1,540.		
Soil	3	3
Shale, blue	4	7
Shale, red	11	18
Limestone	4	22
Shale, blue	5	27
Shale, red	7	34
Limestone; shale, blue	5	39
Gypsum	5	44
Shale, blue	2	46
Gypsum	27	73
Shale, red	6	79
Gypsum	1	80
Limestone, water-bearing	3	83
Shale, red	8	91
Limestone, water-bearing	5	96
Shale, red	12	108
Limestone	2	110
Shale, blue	2	112
Shale, red	3	115
Gypsum	1	116
Shale, blue	2	118
Gypsum	3	121
Shale, blue	2	123
Limestone; shale, blue	5	128
Gypsum, water-bearing	1	129
Shale, blue	2	131
Gypsum	15	146
Shale, blue; limestone	4	150
No sample	80	230
(In May 1954 well deepened to a depth of 230 ft without tapping water-bearing strata.)		
2N-26W-1abb1. NW¼NW¼NE¼. Driller's log supplied by Ivan Owen.		
Clay, red	53	53
Sand, water-bearing	4	57
Wash	8	65
Gypsum	5	70
Shale	8	78
Gypsum	10	88
Shale, white	2	90
No sample	5	95
Gypsum and sand	10	105
Shale, blue	3	108
Gypsum, blue	1	109
Shale, blue	2	111
Gypsum	12	123
Shale, blue	6	129
Sand, red	1	130
Shale and sand, red	4	134
Gypsum	10	144
(16-in. casing set at 85 ft. Perforated interval 58-85 ft.)		

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

2N-26W-2cba2. NE$\frac{1}{4}$NW$\frac{1}{4}$SW$\frac{1}{4}$. Driller's log supplied by Chester Anderson. Altitude: land surface, 1,612.

Description	Thickness	Depth
No sample	8	8
Sand and gravel	15	23
Clay	14	37
Gravel	5	42
Sand	28	70
Clay	16	86
Gypsum	11	97
Limestone	2	99
Shale, red	19	118
Limestone	1	119
Sand, water-bearing	3	122
Rock	2	124
Shale	5	129
Rock	2	131
Shale	2	133
Gypsum	23	156
Limestone	1	157
Shale	9	166
Rock	18	184
Shale	5	189

(18-in. casing set at 49 ft; 16-in. casing set at 87 ft.)

2N-26W-3dbc1. SW$\frac{1}{4}$NW$\frac{1}{4}$SE$\frac{1}{4}$. Driller's log to 300 feet, supplied by John Jenkings. Sample log below 300 feet. Altitude: land surface, 1,613.

Description	Thickness	Depth
No sample	17	17
Sand	10	27
Clay	13	40
Limestone, porous	8	48
Shale	17	65
Shale, red	21	86
Limestone	5	91
Shale, red	16	107
Gypsum	1	108
Shale, red	2	110
Gypsum	17	127
Sand	3	130
Gypsum	10	140
Limestone, porous	3	143
Shale, blue	12	155
Gypsum	17	172
Shale, blue	12	184
Gypsum	18	202
Shale, blue	6	208
Gypsum	4	212
Shale, red	2	214
Shale, blue	4	218
Shale, blue; limestone stringers	5	223
Gypsum	1	224
Limestone	2	226
Shale, blue	10	236
Limestone	4	240
Shale, red	5	245
Gypsum	5	250
Shale, blue; gypsum stringers, alabaster	24	274
Shale, red	9	283
Shale, blue; limestone stringers	6	289
Shale, red and blue	7	296
Shale, red	4	300
Shale, brown and gray, earthy; gypsum, selenite and alabaster	5	305
Shale, bluish-gray, earthy; gypsum, selenite and alabaster	5	310
Shale, bluish-gray; gypsum, selenite and alabaster	10	320
Shale, bluish-gray and reddish-brown; gypsum stringers, alabaster	10	330
Shale, gray, earthy; anhydrite, gray to white	10	340
Shale, reddish-brown to gray; gypsum alabaster and selenite (pink)	15	355
Shale, bluish-gray; gypsum, selenite	5	360
Shale, brown and gray, earthy, gypsiferous	5	365
Shale, brown and gray, earthy; siltstone, brown, calcareous	15	380
Shale, gray and brown; gypsum stringers, alabaster and selenite	15	395
Shale, brown and gray, earthy to plastic	10	405
Shale, reddish-brown and gray; anhydrite	5	410
Shale, reddish-brown and gray; gypsum, alabaster; dolomite stringers, gray	5	415
Shale, brown and gray, conchoidal, gypsiferous	30	445

(Salty water in cavity at 443 ft. Test hole plugged back to 300 ft and completed by owner as an irrigation well.)

2N-26W-29cc1. SW$\frac{1}{4}$SW$\frac{1}{4}$. Drillers's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale; gypsum stringers	40	40
Gypsum	10	50
Shale, blue	4	54
Shale, brown	2	56
Gypsum	7	63
Cavity	4	67
Shale, brown	11	78
Gypsum	7	85
Cavity	5	90
Shale, brown	3	93
Gypsum	11	104
Shale, blue	2	106
Gypsum	13	119
Limestone	1	120
Shale, blue	10	130
Shale, red	24	154
Gypsum; limestone, blue; shale	11	165
Shale	5	170
Shale, brown and blue	13	183
Gypsum	3	186

2N-27W-36bac1. SW$\frac{1}{4}$NE$\frac{1}{4}$NW$\frac{1}{4}$. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay, brown	19	19
Gypsum	6	25
Shale, brown	25	50
Gypsum	5	55
Shale, red	4	59
Gypsum	4	63
Limestone, porous	7	70
Shale, blue	3	73
Shale, red	24	97
Gypsum	8	105
Shale, brown	17	122
Shale, blue and red	20	142
Gypsum	2	144
Shale, blue	3	147
Gypsum	8	155
Shale, blue	5	160
Shale, red and blue	13	173
Gypsum	1	174
Shale, blue	2	176
Shale, red and blue	4	180

(Reported yield 80 gpm. Not completed as an irrigation well.)

2N-27W-36dad1. SE$\frac{1}{4}$NE$\frac{1}{4}$SE$\frac{1}{4}$. Sample log. Altitude: land surface, 1,582.

Description	Thickness	Depth
Soil and clay, gypsiferous, calcareous	10	10
Clay, brown, sandy, calcareous	5	15
Clay, brown, gypsiferous	15	30
Shale, blue, calcareous	10	40
Gypsum, alabaster, calcareous	10	50
Shale, gray, calcareous; gypsum stringers, alabaster	5	55
Gypsum, alabaster, calcareous	5	60
Shale, brown, calcareous	5	65
Shale, brown, gypsiferous	5	70
Gypsum, alabaster, calcareous	5	75
Shale, blue, calcareous	10	85
Gypsum, alabaster	10	95
Gypsum, alabaster, calcareous, porous	7	102
Shale, red, gypsiferous	3	105
Shale, brown, calcareous; gypsum stringers, alabaster	5	110
Shale, gray, calcareous; gypsum stringers, alabaster	5	115
Gypsum, alabaster	5	120
Shale, gray, calcareous, gypsiferous	10	130
Gypsum, alabaster	5	135
Shale, blue, calcareous, gypsiferous	10	145
Gypsum, alabaster	10	155
Shale, blue and red, calcareous, gypsiferous	5	160
Gypsum, alabaster	17	177
Shale, red and blue, calcareous	3	180
Shale, red and blue; gypsum stringers, alabaster	5	185
Shale, red and blue, calcareous; gypsum stringers, alabaster	5	190
Gypsum, alabaster	5	195
Shale, gray, calcareous, gypsiferous	5	200
Shale, reddish-brown; gypsum stringers, alabaster	10	210
Shale, reddish-brown, calcareous; gypsum stringers, alabaster	10	220

(Yield, 1,400 gpm; 45 ft drawdown after 14 hr test.)

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

3N-24W-13dab2. NW¼NE¼SE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,543.

Description	Thickness	Depth
Shale, brown	32	32
Gypsum	9	41
Shale, brown	14	55
Shale, brown and blue	34	89
Gypsum	9	98
Shale, blue	5	103
Gypsum	9	112
Shale, blue	2	114
Shale, brown	3	117
Gypsum	14	131
Shale, blue and brown	4	135
Gypsum	23	158
Shale, brown	7	165
Gypsum	10	175
Cavity, water-bearing	1	176
Shale, blue	8	184
Shale, red and blue	27	211
Gypsum	17	228
Shale, blue	7	235
Shale, brown	4	239
Gypsum	8	247
Shale, blue	2	249
Shale, brown	16	265
Gypsum	4	269
Shale, brown	3	272
Gypsum	7	279
Shale, brown and blue (about 3 gpm at 290 ft)	36	315

(Test hole plugged.)

3N-24W-25bcb1. NW¼SW¼NW¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Shale, red and blue	46	46
Gypsum	10	56
Shale, blue	2	58
Gypsum	12	70
Shale, blue (some water)	2	72
Gypsum	12	84
Shale, blue	6	90
Gypsum	22	112
Shale, blue and red	8	120
Gypsum, water-bearing	10	130
Shale, red and blue	36	166
Gypsum	17	183
Shale, blue	2	185

(10-inch casing set at 47 ft.)

3N-24W-30aaa2. NE¼NE¼NE¼. Driller's log supplied by Jack Jenkins. Altitude: land surface, 1,527.

Description	Thickness	Depth
Soil	3	3
Shale, red	12	15
Shale, blue	5	20
Gypsum	2	22
Shale, red	16	38
Gypsum	1	39
Shale, red	3	42
Gypsum	1	43
Shale, red	3	46
Shale, blue	9	55
Gypsum	2	57
Shale, blue	4	61
Shale, red	3	64
Gypsum	13	77
Shale, blue	5	82
Gypsum	12	94
Shale, red	16	110
Shale, blue	5	115
Shale, red	4	119
Gypsum	4	123
Shale, blue (some water)	1	124
Gypsum	21	145
Shale, blue	2	147
Gypsum	1	148
Shale, red	2	150
Gypsum	5	155
Shale, red; limestone, water-bearing	5	160
Gypsum, water-bearing	4	164
Shale, blue	1	165
Shale, red	4	169

(16-in. casing set at 64 ft.)

3N-25W-30abb1. NW¼NW¼NE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,620.

Description	Thickness	Depth
Shale	60	60
Shale and sand	20	80
Limestone	13	93
Gypsum	9	102
Shale, blue and brown; gypsum	6	108
Gypsum	14	122
Shale, blue and brown	5	127
Gypsum	23	150
Sand	1	151
Gypsum	6	157
Shale, blue; limestone	2	159
Gypsum	1	160

(16-in. casing set at 80 ft; 14-in. casing set at 130 ft. Perforated interval 100-130 ft.)

3N-25W-32acd1. SE¼SW¼NE¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
No sample	18	18
Shale, gray	17	35
Shale, red and blue	28	63
Gypsum	9	72
Shale, red and blue	4	76
Limestone	4	80
Gypsum	6	86
Shale, gray	6	92
Gypsum	13	105
Shale, blue	4	109
Gypsum	6	115
Limestone, water-bearing	1	116
Gypsum	25	141
No sample, yields water	2	143
Shale, red; limestone, water-bearing	13	156

(16-in. casing set at 83 ft.)

3N-25W-32cad1. SE¼NE¼SW¼. Sample log.

Description	Thickness	Depth
Sand	12	12
Shale, red	18	30
Shale, blue	6	36
Dolomite, light-gray, porous	5	41
Shale, blue	4	45
Gypsum, alabaster, white, water-bearing (lots of water)	14	59
Shale, blue	1	60
Gypsum, alabaster, white (most drill cuttings lost)	5	65
Dolomite, gray, argillaceous, conchoidal fracture	2	67
Gypsum alabaster and selenite, tan	9	76
Shale, gray, calcareous	5	81
Gypsum, alabaster, white	4	85
Gypsum, alabaster and selenite white and tan	5	90
Shale, blue	2	92
Gypsum, alabaster	1	93
Cavity, filled with water	1	94
Gypsum, alabaster, white to gray	16	110
Shale, brown and blue, gypsiferous	6	116
Gypsum, alabaster and selenite, white	14	130
Shale, gray, calcareous	4	134
Shale, reddish-brown and gray, earthy	9	143
Gypsum, alabaster	2	145
Shale, reddish-brown and gray	2	147
Gypsum, selenite, argillaceous	8	155
Shale, blue		...

(16-in. casing set at 65 ft. Perforated interval 50-65 ft.)

3N-26W-11dd1. SE¼SE¼. Driller's log supplied by Ray West and John Jenkins.

Description	Thickness	Depth
Soil and clay	15	15
Shale, red; sand	36	51
Gypsum, white	5	56
Shale, red	29	85
Limestone	7	92
Shale, red; rock	17	109
Gypsum, white	3	112
Limestone, porous, water-bearing	3	115
Gypsum, blue	7	122
Shale, blue and gray	6	128
Gypsum	8	136
Sand, water-bearing	2	138
Gypsum	2	140

(Reported yield, 1,000 gpm; 16-in. casing set at 85 ft.)

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

3N-26W-22cdc1. SW¼SE¼SW¼. Sample log. Altitude: land surface, 1,682.

Description	Thickness	Depth
Shale, red	46	46
Gypsum, alabaster	6	52
Shale, reddish-brown and gray, calcareous; gypsum stringers, selenite	3	55
Shale, reddish-brown and blue, calcareous; gypsum stringers, selenite	17	72
Anhydrite, gray to white	3	75
Shale, gray, calcareous; gypsum stringers, alabaster and selenite	6	81
Shale, bluish-gray, slightly calcareous	4	85
Shale, reddish-brown and gray, slightly calcareous; gypsum stringers, selenite	5	90
Shale, reddish-brown and blue; gypsum stringers, satinspar	8	98
Dolomite, gray, dense	6	104
Shale, gray	3	107
Limestone, gray, argillaceous	5	112
Shale, bluish gray	4	116
Shale, brown and gray; gypsum stringers, selenite	4	120
Gypsum, alabaster, white to gray	5	125
Dolomite, gray, dense, conchoidal fracture, argillaceous, calcareous	5	130
Shale, gray, calcareous	5	135
Anhydrite, gray to white; gypsum, alabaster, gray to white	5	140
Anhydrite, gray to white; gypsum, alabaster, gray to white; shale, gray	6	146
Anhydrite, gray to white; gypsum, alabaster, calcareous	14	160
Shale, blue	5	165
(Not enough water for irrigation.)		

3N-26W-22cca1. NE¼SW¼SW¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Shale, red	54	54
Gypsum	4	58
Shale, blue	5	63
Shale, red and blue	10	73
Shale, blue	5	78
Gypsum	12	90
Shale, blue	5	95
Shale, red	11	106
Gypsum	15	121
Shale, red and blue	6	127
Gypsum	7	134
Shale, dolomitic	4	138
Shale, blue	2	140
Gypsum	9	149
Shale, white and gray	5	154
Salt	1	155
Gypsum	15	170
Shale, blue	1	171
Shale, brown and blue	4	175
Gypsum	21	196
Shale, blue	1	197
Shale, brown	3	200
Gypsum	15	215
(Not enough water for irrigation.)		

3N-26W-26bdd1. SE¼SE¼NW¼. Driller's log supplied by Jack Jenkins.

Description	Thickness	Depth
Sand; shale, red	33	33
Gypsum	3	36
Shale, red	22	58
Gypsum	15	73
Shale, blue	7	80
Shale, red and blue, water-bearing	16	96
Gypsum	6	102
Shale, blue and red	9	111
Gypsum	13	124
Shale, blue	3	127
Gypsum	6	133
Shale, blue	7	140
Gypsum	3	143
Shale, blue	4	147
Gypsum	27	174
Shale, red; limestone, water-bearing	4	178
Gypsum	16	194
Shale, blue	8	202
Shale, red; limestone	26	228
Gypsum	2	230

3N-26W-26bdd1.--Continued

Description	Thickness	Depth
Shale, brown	2	232
Gypsum	20	252
(Not enough water for irrigation. Test hole plugged.)		

3N-26W-31dbb1. NW¼NW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red	15	15
Limestone or gypsum	3	18
Shale, white	6	24
Shale, brown	15	39
Gypsum	11	50
Shale, blue and brown	10	60
Shale, brown	5	65
Gypsum	4	69
Shale, blue	9	78
Gypsum	9	87
Shale, blue	4	91
Gypsum	3	94
Shale, blue (water seep at 96 ft)	2	96
Gypsum	10	106
Shale, blue and brown	7	113
Gypsum	7	120
Shale, brown	2	122
Gypsum	17	139
Shale, blue and brown	8	147
Gypsum	11	158
Limestone; shale, blue	6	164
Shale, blue	2	166
Shale, brown	21	187
Gypsum	2	189
Shale, brown	3	192
Gypsum	18	210
Limestone, yellow	1	211
Shale, blue and brown	11	222
Shale, brown	3	225
Shale, blue; limestone	5	230
Shale, brown	6	236
Gypsum	6	242
Shale, blue	1	243
Shale, brown	4	247
Gypsum	5	252
(Not enough water for irrigation.)		

4N-24W-17dad1. SE¼NE¼SE¼. Sample log of test hole drilled by the U.S. Geol. Survey in June 1956. Altitudes: land surface, 1,784; water level in terrace deposits and Whitehorse Group, 1,754; water level in Dog Creek Shale and Blaine Formation, 1,622.

Description	Thickness	Depth
Terrace deposits:		
Sand, brown, very fine to fine	8	8
Sand, red, very fine to fine; clayey; caliche	4	12
Sand, brown, very fine to fine	13	25
Sand, brown, very fine to medium	5	30
Sand, medium to very coarse; gravel; clay stringers; water-bearing	8	38
Whitehorse Group:		
Sand, red; stringers of blue sand	19	57
Dog Creek Shale and Blaine Formation:		
Shale, red, blue mottling	8	65
Shale, red; gypsum stringers	3	68
Shale, red, blue mottling	7	75
Shale, red and blue; gypsum stringers	5	80
Shale, red	15	95
Shale, red; gypsum stringers	5	100
Shale, red and blue	20	120
Shale, red and blue; gypsum stringers	39	159
Gypsum	6	165
Shale, red and blue	35	200
Gypsum; dolomite stringers	10	210
Shale, blue; gypsum stringers	4	214
Gypsum	13	227
Shale, red and blue	2	229
Gypsum; dolomite stringers	8	237
Shale, red and blue	5	242
Gypsum	6	248
Shale, blue	1	249
Gypsum	13	262
Shale, red and blue	6	268
Gypsum	6	274
Gypsum, porous; dolomite stringers; water-bearing	6	280
Dolomitic limestone; water-bearing	4	284
Shale, red and blue	4	288

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

4N-25W-23aaa1. NE¼NE¼NE¼. Sample log of test hole drilled by U.S. Geol. Survey in June 1956. Altitudes: land surface, 1,797; water level in terrace deposits and Whitehorse Group, 1,767; water level in Dog Creek Shale and Blaine Formation, 1,571.

Description	Thickness	Depth
Terrace deposits:		
Soil	3	3
Sand, brown, very fine, clayey	4	7
Sand, brown, very fine to fine	3	10
Sand, brown, fine	1	11
Sand, brown, fine to medium	1	12
Sand, very fine to fine, clay stringers	2	14
Sand, very fine to fine; stringers of clay and claiche	2	16
Sand, very fine to fine; caliche stringers	2	18
Sand, fine to medium	2	20
Sand, fine to medium; stringers of clay and caliche	5	25
Sand, very fine; stringers of clay and caliche	1	26
Sand, fine	1	27
Sand, fine to medium; clay stringers	3	30
Sand, coarse to very coarse; gravel; water-bearing	15	45
Whitehorse Group:		
Sandstone, red; shale stringers	8	53
Shale, red, blue mottling, sandy	32	85
Sandstone red	9	94
Dog Creek Shale and Blaine Formation:		
Shale, red, blue mottling	21	115
Shale, red; stringers of blue shale; gypsum stringers	32	147
Shale, red and blue	6	153
Shale, red and blue; gypsum stringers	4	157
Shale, red and blue	15	172
Shale, red and blue; gypsum stringers	7	179
Shale, red and blue	15	194
Shale, red; blue shale stringers; gypsum stringers	9	203
Shale, red	5	208
Shale, red; blue shale stringers; gypsum stringers	11	219
Shale, red and blue	23	242
Gypsum	12	254
Shale, red and blue	15	269
Shale, red and blue; gypsum stringers	7	276
Shale, red and blue	9	285
Gypsum, dolomite stringers	9	294
Shale, blue	3	297
Gypsum	10	307
Shale, blue	1	308
Gypsum	10	318
Shale, red and blue	7	325
Gypsum; dolomite stringers	4	329
Shale, blue	1	330
Gypsum; dolomite stringers	13	343
Shale, red	4	347
Gypsum	1	348
Shale, red	1	349
Gypsum, small amount of water	13	362
Dolomitic limestone, porous; stringers of blue shale; water	5	367
Shale, red and blue	3	370

4N-25W-24cbc2. SW¼NW¼SW¼. Sample log of test hole drilled by U.S. Geol. Survey in December 1955.

Description	Thickness	Depth
Terrace deposits:		
Sand, red, fine	10	10
Sand, white, medium	10	20
Sand, white, medium; caliche stringers	9	29
Sand, coarse	3	32
Sand, coarse; gravel	8	40
Whitehorse Group:		
Sandstone, red; shale stringers, red and blue; shale, sandy	80	120
Dog Creek Shale and Blaine Formation:		
Shale, red and blue	10	130
Shale, red	18	148
Gypsum	3	151
Shale, red and blue	19	170
Shale, red and blue; gypsum stringers	31	201
Gypsum	3	204
Shale, red	18	222
Gypsum	2	224
Shale, red and blue; gypsum stringers	15	239

4N-25W-24cbc2.--Continued

Description	Thickness	Depth
Dog Creek Shale and Blaine Formation.		
Gypsum	10	249
Shale, blue	2	251
Shale, red; gypsum stringers	9	260
Shale, red and blue; gypsum stringers	10	270
Shale, red and blue	8	278
Gypsum; shale stringers, blue	2	280
Shale, blue	2	282
Gypsum	6	288
Dolomite	4	292
Shale, blue	3	295
Gypsum	11	306
Shale, blue	1	307
Gypsum	1	308
Shale, brown	1	309
Gypsum	7	316
Gypsum, limestone stringers	2	318
Shale, blue	6	324
Gypsum	16	340
Shale, blue	3	343
Gypsum	14	357
Dolomite, porous; limestone stringers; shale stringers, blue	4	361
Shale, red and blue	6	367

4N-25W-24cbc3. SW¼NW¼SW¼. Sample log of test hole drilled by U.S. Geol. Survey in June, 1955.

Description	Thickness	Depth
Terrace deposits:		
Sand, brown, fine to coarse; clay stringers	10	10
Sand, brown, fine to medium	9	19
Clay, brown; caliche	1	20
Sand, brown, medium to coarse	5	25
Sand, brown, medium to coarse; clay stringers	5	30
Clay, brown, sandy	5	35
Sand, coarse; clay, brown; caliche	8	43
Gravel, fine; sand, very coarse	7	50
Sand, medium to coarse, water-bearing	5	55
Gravel, medium to coarse, clay streaks; water-bearing	6	61
Red beds (bedrock):		
Shale, reddish-brown and gray	59	120
Shale, reddish-brown and gray; gypsum stringers, alabaster	10	130
Shale, reddish-brown and gray, sandy	10	140
Shale, reddish-brown and gray	30	170
Shale, reddish-brown and gray; gypsum stringers, alabaster	10	180
Shale, reddish-brown and gray	20	200
Shale, reddish-brown and gray; gypsum stringers, alabaster	28	228
Gypsum, alabaster	4	232
Shale, reddish-brown and blue	8	240

4N-25W-29aaa3. NE¼NE¼NE¼. Sample log of test hole drilled by U.S. Geol. Survey in November 1955. Altitudes: land surface, 1,798; water level in terrace deposits and Whitehorse Group, 1,778; water level in Dog Creek Shale and Blaine Formation, 1,652

Description	Thickness	Depth
Terrace deposits:		
Sand, fine to medium	3	3
Sand, medium to coarse	1	4
Sand, fine to very fine	16	20
Sand, medium to coarse	3	23
Whitehorse Group:		
Sandstone, red; shale stringers; gravel stringers	21	44
Sandstone, red; shale stringers	26	70
Shale, red and blue, sandy	15	85
Shale, red and blue; gypsum stringers	5	90
Shale, red and blue; sandstone stringers, red and blue; gypsum stringers	22	112
Shale, red and blue	3	115
Shale, red	3	118
Shale, blue	2	120
Shale, brown and blue; gypsum stringers	12	132
Sandstone, red; gypsum stringers; shale stringers	46	178
Dog Creek Shale and Blaine Formation:		
Gypsum	1	179
Shale, blue and brown; gypsum stringers	15	194
Gypsum	5	199
Shale, gray; gypsum stringers	12	211
Shale, red	8	219
Shale, red and blue; gypsum stringers	6	225
Gypsum	4	229

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

HARMON COUNTY.--Continued

4N-25W-29aaa1.--Continued

Dog Creek Shale and Blaine Formation.--Continued

Description	Thickness	Depth
Shale, blue and brown; gypsum stringers; dolomite stringers	10	239
Dolomite; gypsum stringers	10	249
Shale, blue; gypsum stringers	3	252
Gypsum	10	262
Shale, red and blue; dolomite stringers; gypsum stringers	2	264
Gypsum	2	266
Shale, red and blue; gypsum stringers	1	267
Gypsum	5	272
Shale, gray; gypsum stringers	4	276
Shale, blue and brown	3	279
Gypsum	5	284
Limestone, soft, porour	1	285
Gypsum	13	298
Limestone, porous	1	299
Shale, red and blue; gypsum stringers	7	306
Gypsum; limestone stringers	11	317
Dolomite, porous	3	320
Limestone	4	324
Shale, blue	2	326
Shale, red	9	335

4N-25W-31cdb1. NW$\frac{1}{4}$SE$\frac{1}{4}$SW$\frac{1}{4}$. Driller's log to 295 feet, supplied by Jack Jenkins. Sample log below 295 feet. Altitude: land surface, 1,754.

Description	Thickness	Depth
Soil	3	3
Sand	14	17
Shale, red	73	90
Shale, blue	4	94
Gypsum	5	99
Shale, red	14	113
Shale, blue and red	7	120
Gypsum	13	133
Shale, blue	5	138
Shale, red	14	152
Gypsum	5	157
Shale, blue	5	162
Gypsum	15	177
Shale, red and blue	4	181
Gypsum	16	197
Shale, blue	1	198
Gypsum	10	208
Limestone; shale, blue	4	212
Shale, blue	4	216
Gypsum	31	247
Shale, blue	2	249
Gypsum	16	265
Shale, blue	7	272
Shale, red	11	283
Shale, blue	7	290
Shale, red	4	294
Gypsum	4	298
Shale, blue	1	299
Gypsum; shale stringer, blue	5	304
Shale, blue	1	305
Gypsum; shale stringer, blue	4	309
Shale, blue; gypsum stringers	2	311
Gypsum; shale stringers, red and blue	4	315
Shale, brown and blue	8	323
Gypsum	15	338
Limestone	2	340
Shale, blue and brown	16	356
Gypsum	3	359
Shale, blue	5	364
Gypsum	1	365
Shale, blue; gypsum stringer	3	368
Dolomite	3	371
Shale, blue	1	372
Gypsum	6	378
Shale, blue and brown	36	414
Gypsum	1	415
Shale, blue	2	417
Shale, blue; gypsum	4	421
Shale, blue	5	426
Gypsum	1	427
Shale, brown and blue	39	466
Shale, brown; salt stringers	1	467
Salt	1	468
Shale, brown and blue; salt stringers	1	469
Shale, brown and blue	5	474

4N-26W-14cdc2. SW$\frac{1}{4}$SE$\frac{1}{4}$SW$\frac{1}{4}$. Sample log of test hole drilled by U.S. Geol. Survey in November 1955. Altitudes: land surface, 1,878; water level in terrace deposits and Whitehorse Group, 1,831; water level in Dog Creek Shale and Blaine Formation, 1,753.

Description	Thickness	Depth
Terrace deposits:		
Sand, red, fine to medium	5	5
Sand, brown, fine to very fine	10	15
Sand, brown, fine to medium	25	40
Sand, white, medium to coarse	4	44
Caliche	1	45
Sand, coarse, very coarse and gravel	7	52
Whitehorse Group:		
Sandstone; shale stringers, red and blue	59	111
Dog Creek Shale and Blaine Formation:		
Shale, red and blue; gypsum stringers	65	176
Shale, red and blue; dolomite stringers	6	175
Shale, brown and blue; dolomite stringers; gypsum stringers	41	216
Gypsum	5	221
Shale, brown and blue; gypsum stringers	20	241
Gypsum	5	246
Shale, gray	10	256
Shale, brown and blue	8	264
Gypsum	2	266
Shale, brown and blue; gypsum stringers	13	279
Gypsum	3	282
Dolomite	6	288
Shale, red and blue	4	292
Gypsum	14	306
Shale, red and blue	4	310
Gypsum	5	315
Cavity	3	318

JACKSON COUNTY

1S-22W-19ccc1. SW$\frac{1}{4}$SW$\frac{1}{4}$SW$\frac{1}{4}$. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,426.

Description	Thickness	Depth
Shale, red, water seep at 4 ft	22	22
Shale, brown	20	42
Gypsum	13	55
Shale, blue	3	58
Shale, red	10	68
Shale, blue; limestone	2	70
Gypsum	3	73
Shale, brown	22	95
Gypsum	10	105
Shale, blue	3	108
Shale, red	11	119
Shale, brown	30	149
Gypsum	4	153
Shale, brown	37	190
Shale, red	5	195
(No water; test hole plugged.)		

1S-24W-5bcd1. SE$\frac{1}{4}$SW$\frac{1}{4}$NW$\frac{1}{4}$. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,462.

Description	Thickness	Depth
Clay	8	8
Sand	19	27
Shale, blue (water seep at 30 ft)	3	30
Shale, red	10	40
Limestone	4	44
Shale, red and blue	11	55
Limestone	5	60
Shale, red	3	63
Gypsum	1	64
Shale, red; gypsum	16	80
Sand	5	85
Limestone	6	91
Shale, red	9	100
(16-in. casing set at 94 ft. Perforated interval 44-94 ft.)		

1S-24W-8d. S$\frac{1}{2}$SE$\frac{1}{4}$. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay	12	12
Sand, red	20	32
Shale, blue	3	35
Shale, red	9	44
Limestone, water-bearing (25-30 gpm)	1	45
Shale, red	13	58
Limestone	1	59
Shale, brown and blue	33	92
Gypsum	1	93
Shale, brown	12	105
Gypsum	14	119
Shale, red	15	134
(Not enough water for irrigation.)		

APPENDIX C.--LOGS OF WELLS AND TEST HOLES IN HARMON COUNTY AND ADJACENT PARTS OF GREER AND JACKSON COUNTIES, OKLA.

Thickness in feet. Depth in feet below land surface.

JACKSON COUNTY.--Continued

1S-25W-2baa1. NE¼NE¼NW¼. Driller's log supplied by Chester Anderson.

Description	Thickness	Depth
Soil	8	8
Gypsum (water seep at 10 ft)	2	10
No sample	5	15
Gypsum	12	27
Shale, blue	6	33
Shale, with thin limestone beds	7	40
Gypsum	27	67
Shale, with thin limestone beds	5	72
Gypsum	1	73
Cavity	7	80

(Reported yield, 1,100 gpm; 16-in. casing set at 40 ft.)

1S-25W-13dc1. SW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red and blue	25	25
Shale, red and blue	35	60
Limestone, water-bearing	6	66
Gypsum	6	72
Cavity	5	77
Shale, red	3	80

(16-in. casing set at 70 ft.)

2S-24W-1ac1. SW¼NE¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Clay, red, sandy	10	10
Shale, red	32	42
Shale, blue; water-bearing	3	45
Shale, red	25	70
Shale, red, very hard	16	86
Limestone, salt water	4	90
Shale, blue	7	97
Shale, red	3	100

(Reported yield, 500 gpm. Water too salty for intended use.)

2S-24W-12cc1. SW¼SW¼. Driller's log supplied by Clarence Trussler. Altitude: land surface, 1,479.

Description	Thickness	Depth
Clay, red-sandy	30	30
Shale, blue	31	61
Shale, red	8	69
Limestone, water-bearing	9	78
Shale, red	12	90
Shale, blue	2	92
Shale, red	7	99
Shale, blue	1	100
Shale, red	18	118
Sand, salt water	2	120

(10-in. casing set at 90 ft. Interval between 90 and 120 ft plugged with earth.)

1N-23W-29bb1. NW¼NW¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Soil	1	1
Clay and shale	5	6
Gypsum	10	16
Shale, blue	1	17
Gypsum	7	24
Shale, blue	1	25
Gypsum	14	39
Shale, red	9	48
Cavity, water-bearing	2	50
Gypsum, water-bearing	15	65
Limestone, water-bearing	4	69
Gypsum	2	71
Cavity, water-bearing	2	73
Gypsum	2	75
Limestone	6	81
Shale, red	5	86
Limestone, water-bearing	2	88
Shale, red	2	90

(14-in. casing set at 90 ft.)

2N-22W-4daa1. NE¼NE¼SE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,425.

Description	Thickness	Depth
Shale, brown	32	32
Shale, red and blue	20	52
Shale, brown	35	87
Gypsum	12	99
Limestone, water-bearing	5	104
Shale, blue	2	106
Shale, red	4	110

2N-22W-5dbb1. NW¼NW¼SE¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Shale, light-red	1	1
Shale, red	5	6
Shale, gray	6	12
Shale, blue	3	15
Shale, red	24	39
Gypsum	1	40
Shale, red	2	42
Gypsum	14	56
Limestone, blue	1	57
Shale, blue and red	8	65
Gypsum	11	76
Limestone, water-bearing	5	81
Shale, blue	5	86
Shale, red	17	103
Shale, blue	3	106
Shale, red	13	119
Shale, red and blue	2	121
Gypsum	11	132
Limestone, blue	1	133
Shale, blue	2	135

2N-22W-6cac1. SW¼NE¼SW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	8	8
Gypsum	17	25
Shale, blue and brown	9	34
Gypsum	19	53
Shale, brown	8	61
Gypsum	8	69
Limestone, water-bearing	5	74
Shale, red	16	90

(18-in. casing set at 8 ft.)

2N-22W-8dcb1. NW¼SW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	21	21
Gypsum	15	36
Shale, brown	7	43
Gypsum	7	50
Limestone, water-bearing	5	55
Shale, blue	5	60
Shale, red	1	61

2N-23W-2bab1. NW¼NE¼NW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil	10	10
Shale, brown	14	24
Gypsum	5	29
Shale, blue	4	33
Shale, brown	3	36
Gypsum	20	56
Shale, brown	9	65
Gypsum	9	74
Sand	2	76
Shale, brown	9	85
Limestone; shale, red	11	96

(Reported yield, 10-15 gpm.)

2N-23W-3cca1. NE¼SW¼SW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,439.

Description	Thickness	Depth
Shale, red	12	12
Sand	21	33
Shale, red and gray	12	45
Gypsum	6	51
Cavity	3	54
Shale, brown	8	62
Gypsum	6	68
Cavity	7	75
Limestone	4	79
Shale, brown	5	84
Gypsum	6	90
Sand	2	92
Shale, brown	5	97

(Reported yield, 1,800 gpm; 16-in. casing set at 97 ft.)

Thickness in feet. Depth in feet below land surface.

JACKSON COUNTY.--Continued

2N-23W-4acd1. SE¼SW¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	40	40
Limestone, water-bearing (15-20 gpm)	7	47
Gypsum	7	54
Cavity	2	56
Gypsum	2	58
Shale, blue and brown	13	71
Gypsum	9	80
Shale, brown	8	88
Gypsum	11	99
Limestone	2	101
Shale, red	6	107
(16-in. casing set at 77 ft.)		

2N-23W-4dcc1. SW¼SW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red	28	28
Shale, brown	5	33
Gypsum	1	34
Shale, brown	3	37
Gypsum, water-bearing	1	38
Limestone; shale, blue	1	39
Gypsum	12	51
Shale, blue	2	53
Shale, brown	5	58
Gypsum	22	80
Shale, brown	4	84
Gypsum, water-bearing	11	95
Limestone	4	99
Shale, blue	1	100
(Water too salty for irrigation; hole plugged with earth.		

2N-23W-10dbd1. SE¼NW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil and clay	18	18
Gypsum	5	23
Shale, blue	2	25
Shale, brown	8	33
Gypsum	19	52
Shale, blue	2	54
Shale, brown	6	60
Gypsum	9	69
Limestone	3	72
Shale, brown; limestone	13	85
Shale, red	19	104
Gypsum	1	105
Shale, brown	10	115
Gypsum	12	127
Limestone	2	129
Shale, blue	1	130
Shale, red	2	132
No sample	3	135

2N-23W-10abd1. SE¼NW¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	16	16
Gypsum	6	22
Shale, white	8	30
Shale, brown and blue	7	37
Limestone	13	50
Gypsum	11	61
Shale, brown	7	68
Gypsum	10	78
Limestone	3	81
Shale, blue	3	84
Shale, red	6	90
(18-in. casing set at 73 ft.)		

2N-23W-12aab1. NW¼NE¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil	2	2
Shale, red	18	20
Gypsum	28	48
Shale, blue	2	50
Shale, red	6	56
Gypsum	9	65
Limestone; shale, blue	9	74
No sample	16	90
(Reported yield, 810 gpm; 16-in. casing set at 31 ft.)		

2N-23W-12bda1. NE¼SE¼NW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil	8	8
Gypsum	11	19
Shale, blue and brown	21	40
Gypsum	12	52
Limestone, water-bearing	2	54
Shale, blue and brown	6	60
Gypsum	9	69
Limestone	2	71
Shale, blue and red	8	79
Shale, red	24	103
Shale, blue and brown	15	118
Gypsum	13	131
Shale, blue; sand	2	133

2N-23W-16aba1. NE¼NW¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Soil and shale	15	15
Gypsum	2	17
Cavity	6	23
Gypsum	5	28
Shale, blue	5	33
Shale, brown	6	39
Gypsum	3	42
Cavity	2	44
Gypsum	14	58
Shale, blue	2	60
Shale, brown	5	65
Gypsum	10	75
Limestone; shale, brown	24	99
Reported yield, 900 gpm; 18-in. casing set at 42 ft.)		

2N-23W-21abb1. NW¼NW¼NE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,433.

Description	Thickness	Depth
Shale, red	27	27
Shale, brown	7	34
Gypsum	5	39
Shale, blue	5	44
Gypsum	9	53
Shale, red	8	61
Gypsum	10	71
Limestone; shale, blue	3	74
Shale, red	10	84
(Yield 535 gpm, 3-20-52; 14-in. casing set at 34 ft.)		

2N-23W-21adb3. NW¼SE¼NE¼. Driller's log supplied by Ronald Owen

Description	Thickness	Depth
Soil	6	6
Limestone and shale	30	36
Gypsum	20	56
Shale, red	7	63
Gypsum	10	73
Limestone	3	76
Shale, red	24	100
Shale, blue and red	7	107
Gypsum	1	108
Shale, blue	9	117
Gypsum	12	129
Limestone	2	131
Shale, red	5	136

2N-23W-21aaa1. NE¼NE¼NE¼. Driller's log supplied by Ronald Owen. Altitude: land surface, 1,429.

Description	Thickness	Depth
Soil	4	4
Shale	36	40
Gypsum	3	43
Limestone and shale, water-bearing (100 gpm)	3	46
Shale, brown	9	55
Gypsum	10	65
Limestone	2	67
Shale, red	13	80
Shale, red	9	89

2N-23W-26c. SW¼. Driller's log supplied by Chester Anderson.

Description	Thickness	Depth
Shale and gypsum	35	35
Gypsum	19	54
Shale, red	11	65
Gypsum (lost drilling water at 71 ft)	6	71
Limestone	2	73
Shale, blue	2	75
Shale, red	35	110
(No water, test hole plugged.)		

Thickness in feet. Depth in feet below land surface.

JACKSON COUNTY.--Continued

3N-23W-19aaa1. NE¼NE¼NE¼. Driller's log supplied by Ronald Owen.

Description	Thickness	Depth
Soil and shale	23	23
Shale, blue	3	26
Gypsum	5	31
Shale, red and blue	24	55
Shale, blue	13	68
Shale, red	9	77
Gypsum	6	83
Shale, blue	8	91
Gypsum	10	101
Shale, blue and red	6	107
Gypsum	3	110
Shale, blue and red (8 gpm at 111 ft)	9	119
Gypsum	21	140
Shale, red	8	148
Gypsum	12	160
Limestone	4	164
Shale, red	13	177
(Not enough water for irrigation.)		

3N-23W-19bbb1. NW¼NW¼NW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,530.

Description	Thickness	Depth
Shale, brown	20	20
Gypsum	5	25
Shale, brown and blue	35	60
Shale, brown	13	73
Gypsum	11	84
Shale, brown and blue	4	88
Gypsum	9	97
Shale, brown and blue	3	100
Gypsum	15	115
Shale, blue and brown	7	122
Gypsum	20	142
Shale, brown	7	149
Gypsum, water-bearing (5: gpm)	12	161
Shale, blue	4	165
Shale, red	5	170

3N-23W-21aab1. NW¼NE¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Clay, brown	10	10
Clay, red	25	35
Gravel	3	38
Gypsum	9	47
Shale, blue and brown	9	56
Gypsum	16	72
Shale, blue and brown	6	78
Gypsum	6	84
Limestone	1	85
Gypsum	7	92
Shale, blue; sand, water-bearing (10-15 gpm)	1	93
Shale, blue	4	97
Shale, red and blue	31	128
Gypsum	4	132
Cavity, water-bearing (unable to lower with bailer)	1	133
Gypsum; shale, blue; sand	12	145
Shale, blue and red	8	153

3N-23W-22acd1. SE¼SW¼NE¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Clay, black	4	4
Shale, red	31	35
Shale, blue	5	40
Shale, red	18	58
Gypsum	4	62
Shale, blue and red	6	68
Gypsum	8	76
Shale, blue	6	82
Shale, brown	2	84
Gypsum	14	98
Shale, blue and red	3	101
Gypsum	18	109
Shale, blue and red	7	126
Gypsum	10	136
Limestone, water-bearing	3	139
Shale, blue	4	143
Shale, red	18	161
Shale, blue and red	14	175
(Not enough water for irrigation.)		

3N-23W-23aaa1. NE¼NE¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red	50	50
Shale, red and blue (20 gpm at 80 ft)	41	91
Gypsum	6	97
Limestone and clay	3	100
Shale	17	117
Gypsum	8	125
Shale, blue	3	128
Shale, blue and brown	17	145
Limestone	1	146
Shale, blue	4	150
(Not enough water for irrigation.)		

3N-23W-23dbb1. NW¼NW¼SE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown	28	28
Gypsum	1	29
Shale, brown and blue	21	50
Gypsum	11	61
Shale, blue	4	65
Gypsum	10	75
Shale, blue	4	79
Shale, brown	1	80
Gypsum	12	92
Shale, blue and brown	8	100
Gypsum	15	115
Shale, brown	9	124
Gypsum	11	135
Shale, mixed	40	175
Gypsum	15	190
Shale, blue and brown	5	195
(Not enough water for irrigation.)		

3N-23W-29ddd1. SE¼SE¼SE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,450.

Description	Thickness	Depth
Soil	3	3
Shale, brown	22	25
No sample	5	30
Gypsum, porous	7	37
Gypsum	3	40
Gypsum and shale	5	45
Gypsum	11	56
Shale, blue	3	59
Shale, brown	7	66
Gypsum	20	86
Shale, brown	7	93
Gypsum	7	100
Limestone	4	104
Shale, blue and red	9	113
(16-in. casing set at 53 ft. Perforated interval 30-40 ft.)		

3N-23W-29cba1. NE¼NW¼SW¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown and gray	23	23
Gypsum	13	36
Shale, blue	4	40
Shale, brown	4	44
Gypsum	22	66
Shale, blue and brown	9	75
Gypsum	5	80
Shale, blue; sand, water-bearing (10 gpm)	5	85
Shale, blue	5	90
Shale, red	12	102
Shale, red and blue	23	125
Gypsum	13	138
Shale, red and blue	16	154
(Not enough water for irrigation. Test hole plugged.)		

3N-23W-30aab1. NW¼NE¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, brown (75 gpm at 30 ft)	50	50
Gypsum	4	54
Shale, brown	1	55
Gypsum	15	70
Shale, blue and brown	7	77
Gypsum	6	83
Shale, blue	9	92
Shale, red	10	102
(Not enough water for irrigation. Test hole plugged.)		

Thickness in feet. Depth in feet below land surface.

JACKSON COUNTY.--Continued

3N-23W-30daa1. NE¼NE¼SE¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,453.

Description	Thickness	Depth
Soil; shale, brown	16	16
No sample	4	20
Shale, brown	10	30
Cavity, water-filled	5	35
Shale, brown	5	40
Gypsum	22	62
Shale, brown	8	70
Gypsum	5	75
Limestone, water-bearing	8	83
Shale, blue	3	86
Shale, red	4	90

(Reported yield, 1,000 gpm; 16-in. casing set at 41 ft.)

3N-23W-31cbb1. NW¼NW¼SW¼. Driller's log supplied by Clarence Trussler.

Description	Thickness	Depth
Shale, red, sandy	3	3
Shale, red	5	8
Shale, red, sandy	2	10
Shale, dark-red	14	24
Shale, blue and red	2	26
Sand, water-bearing	1	27
Shale	4	31
Limestone, blue	1	32
Shale, blue	2	34
Shale, red	10	44
Gypsum	5	49
Shale, blue and red	3	52
Gypsum	6	58
Cavity, water-bearing	4	62

(18-in. casing set at 38 ft; 16-in casing set at 62 ft. Perforated interval 31-62 ft.)

3N-23W-33abb1. NW¼NW¼NE¼. Driller's log supplied by Ivan Owen.

Description	Thickness	Depth
Shale, red and blue	10	10
Shale, red	9	19
Gypsum	6	25
Shale, blue	8	33
Gypsum	7	40
Shale, red	2	42
Gypsum	2	44
Shale, brown	9	53
Gypsum	8	61
Shale, blue	4	65
Shale, brown	4	69
Gypsum	1	70
Shale, brown and blue	3	73
Gypsum	16	89
Shale, brown	7	96
Gypsum	8	104
Limestone	3	107
Shale, blue	1	108
Shale, red	37	145
Shale, brown	3	148
Gypsum	17	165
Shale, blue	5	170

3N-23W-36bc1. SW¼NW¼. Driller's log supplied by Ivan Owen. Altitude: land surface, 1,450.

Description	Thickness	Depth
Shale, red	8	8
Limestone	1	9
Gypsum	4	13
Shale, blue and brown	8	21
Gypsum	9	30
Shale, blue	4	34
Gypsum	11	45
Shale, blue and brown	5	50
Gypsum	19	69
Shale, blue	1	70
Limestone	1	71
Shale, brown	5	76
Gypsum, water-bearing	11	87
Limestone	1	88
Shale, blue	2	90
Shale, brown	28	118
Limestone; shale, blue	2	120
Shale, blue and brown	5	125
Shale, blue; limestone layers	5	130
Gypsum	13	143
Shale, blue (water level 60 ft below land surface)	5	148
Shale, red	2	150