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GROUND-WATER IRRIGATION IN THE DUKE AREA,  
JACKSON AND GREER COUNTIES,  
OKLAHOMA

By Stuart L. Schoff

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- Mineral Report No. 17 -- Bibliography of Oil Pool Names in Oklahoma for 1942, by Alan G. Skelton. 1944. 48 pages.

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## GROUND-WATER IRRIGATION IN THE DUKE AREA, JACKSON AND GREER COUNTIES, OKLAHOMA

By Stuart L. Schoff

Prepared in cooperation between the  
Oklahoma Geological Survey and the  
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1948

This memorandum summarizes observations made in the Duke irrigation area, Jackson and Greer Counties, Oklahoma, on June 9, 1948. Reports reaching the Geological Survey, chiefly from the Division of Water Resources, Oklahoma Planning and Resources Board, had indicated the successful completion of irrigation wells near Duke, yet the available geologic maps and reports suggest no geological formations capable of yielding more than enough water for farm and stock wells. It had also been indicated that some wells in the area failed even though they were near other wells of large production.

### GEOLOGY

The town of Duke and the surrounding area of irrigation is underlain by the Blaine formation, of Permian age, which Clifton<sup>1/</sup> describes for Jackson County as a "series of three or more discontinuous gypsum beds, with interbedded . . . dolomite, red clay and shale," and for Greer County as "five or more beds of gypsum or dolomite, interbedded with red clays and shales."

In the present investigation, exposures of red and gray shale or clay were observed in secs. 4 and 5, T. 2 N., R. 23 W., and gypsum was observed in secs. 2, 4, 5, 10, and 11 of the same township, and also in secs. 11, 14, and 35, T. 3 N., R. 23 W., and secs. 6 and 7, T. 2 N., R. 22 W. The beds at all these locations

<sup>1/</sup> Clifton, R. L., Oil and Gas in Oklahoma; Geology of Harmon, Greer, Jackson and Tillman Counties: Oklahoma Geological Survey Bull. 40-Y, pp. 14 and 17, 1928.

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doubtless belong to the Blaine formation, and as they are a little less than half way across the outcrop area from east to west, they are probably a little below the middle of the formation stratigraphically.

Alluvium consisting principally of sand and silt occurs along Turkey Creek. It was deposited by the creek itself, and probably contains some ground water, but it is of limited extent, and probably is too thin and too fine-grained to yield water in large quantities. None of the irrigation wells visited is so situated that it could tap water in the alluvium.

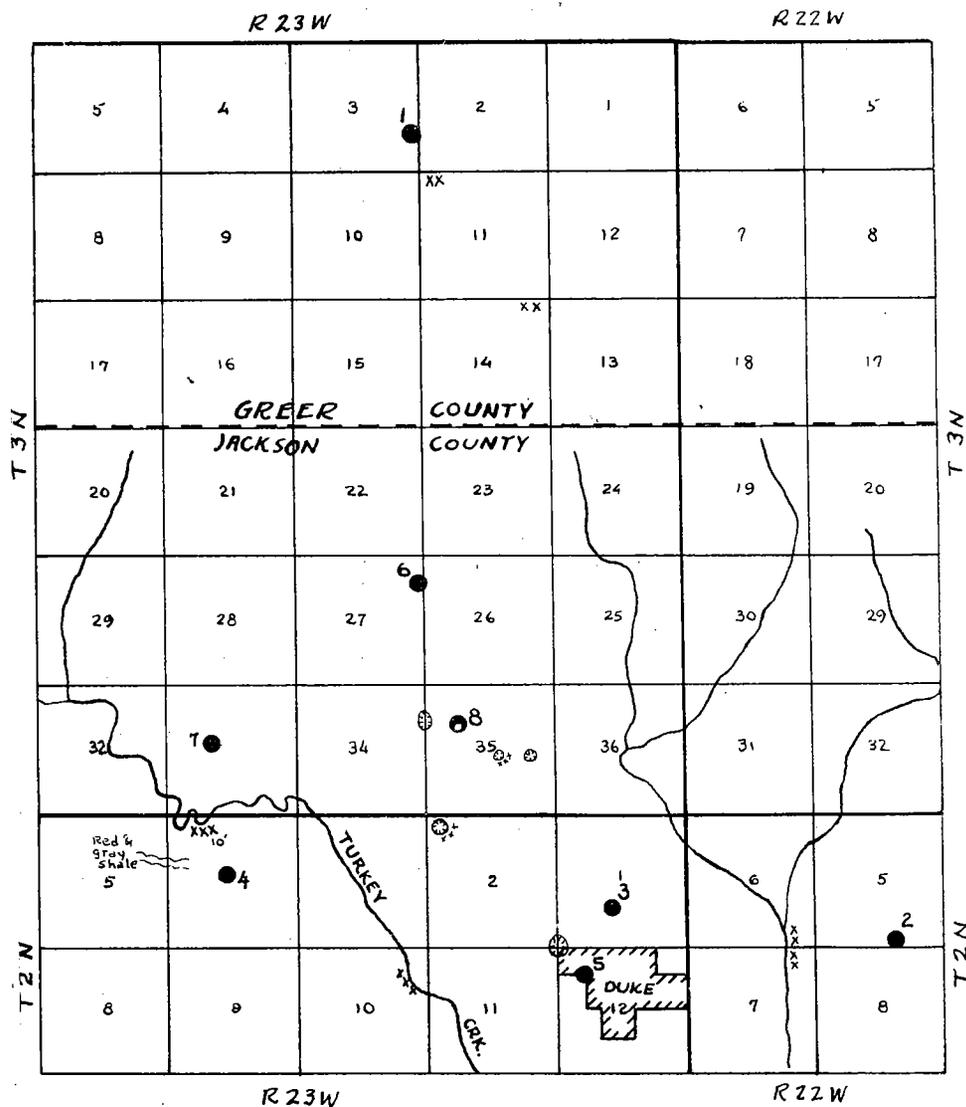
It had been considered that terrace deposits not shown on published geologic maps might possibly be the source of the ground water found in the successful irrigation wells. Terrace deposits generally consist of silt, sand, and gravel, in most instances laid down by streams as alluvium and left as a terrace when the streams cut their valleys to lower levels. Such deposits contain important reserves of ground water in some parts of Oklahoma, especially in the northwest, but no significant deposit of this character was observed near Duke. On the contrary, the exposures of red and gray shale and gypsum indicate that the Permian formations occur just below the land surface.

The rocks below the Blaine formation are, in descending order, the Chickasha formation, Duncan sandstone, and Hennessey shale of Permian age and the older Paleozoic formations. Within several hundred feet of the surface, none of the formations contain sandstone or other coarse material likely to yield water freely.

#### IRRIGATION WELLS

In all, eight irrigation wells have been completed successfully near Duke in an area about 5.5 miles wide from east to west and 6.5 miles from north to south. All the wells are equipped with turbine pumps, and yields ranging up to 1,700 gallons per minute are reported.

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- Irrigation well (number is same as used in table of well records)
- XXX Gypsum exposed at surface
- ⊗ Gypsum sinkhole

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Ivan Owen, himself a well-drilling contractor, drilled the first well (No. 5) immediately west of the town of Duke in 1942. He states that the well is 15½ inches in diameter and is uncased except for two oil drums just below the surface, that it is 90 feet in depth, and will yield a maximum of 1,700 gallons per minute. When the pump is operated at the rate of 1,000 gallons per minute, the water level drops 10 feet almost instantaneously and then remains constant. On June 10, 1948, the static water level was measured as 29 feet below the land surface, and as no water was found in the well until a depth of 48 feet had been reached, it is evident that the water occurs under artesian pressure. The well is equipped with a 1-stage turbine pump, set 40 feet below the surface, and a 25-horse power gasoline engine. It is used for the irrigation of approximately 50 acres of alfalfa. A partial analysis of water from this well, made in the Quality of Water Laboratory of the U. S. Geological Survey at Stillwater, Oklahoma, is given at the end of this memorandum.

The L. B. Heidenreich well (No. 3) was drilled just north of Duke by Clarence Trussler of Eldorado, Oklahoma. It is reported to be 70 feet deep and to have a static water level 38 feet below the surface.

The Otto Yates well No. 8 was completed in 1948 by Frank Jackson, of Childress, Texas. In all, three wells were drilled in this locality. The first well reached a depth of 217 feet, striking water at 40 feet, but large openings were not found and the yield was only 150 gallons per minute. The second well was about 150 feet north of the first, reached a depth of 155 feet, and yielded about as much water as the first. Some of the drill cuttings from the second well were still on the ground when the well was visited, and an abundance of gypsum fragments was noted in them. The third well is about 200 feet west of the first, and was drilled only to 92 feet, but it is said to yield 1,200 gallons per minute. The water comes from a "porous lime" at 80 feet. The pump is to discharge into a short ditch with closed ends, from which a centrifugal pump will pump water through portable pipe to sprinklers.

The Frank Johnston well (No. 2) is the easternmost of the irrigation wells. Completed by Ivan Owen in 1948, it is 135 feet in depth, cased with 14-inch casing to 120 feet, and uncased from 120 feet to the bottom. According to the owner, a hard rock was encountered at 120 feet, and when it had been penetrated at 132 feet, the water came into the well. This was about the "third water," but the first two water-bearing zones yielded relatively little and were cased out. The well is equipped with a turbine pump, which to date has been powered by a farm tractor. The yield is reported to be 1,000 gallons per minute. As water was not encountered until the well was 68 feet deep, and the static level on June 10, 1948, was measured as about 39 feet below the surface, it is evident that the water is under artesian pressure.

The Robertson well (No. 1) is the northernmost of the wells visited. It is cased with 6-inch casing and is equipped with a turbine pump driven with a belt from the power take-off of a jeep. On June 10, 1948, the static water level was about 26.5 feet below the surface.

The Buddy Bryant well (No. 6) is cased with casing about 12 inches in diameter, and equipped with a turbine pump powered by a gasoline engine. On June 10, 1948, the static water level was measured as about 30 feet below the surface.

The Finis Rosenbaum well (No. 4) and Marshall Carroll well (No. 7) were drilled by Ivan Owen, and both are equipped with turbine pumps. The water level in the Carroll well was about 25 feet below the surface on June 10, 1948. As the owners could not be interviewed, information as to yield was not obtained. It was reported by Ivan Owen that the water in the Rosenbaum well is saltier than that in the wells farther east.

#### SOURCE OF WATER

Although the ultimate source of the ground water of the Duke area is the rain or snow falling either in

the area or in some other area with which the rock formations connect, the way so much water becomes available near Duke cannot be fully understood without more investigation. Ivan Owen believes that the water occurs in caverns, and reported that in drilling wells he had known the bit to drop as much as 15 feet into subterranean openings. He expressed the opinion that water enters solution openings in the gypsum from Salt Fork of the Red River in the area north of Duke, that is, approximately in T. 4 N., Rs. 22 and 23 W. He also called attention to the gypsum sinkholes that dot the area, as openings through which water may go underground.

Mr. Owen's ideas show both observation and thought, and they merit further study. The suggestions for further work, given below, are in part designed to test his theory.

#### QUANTITY OF WATER AVAILABLE

The amount of ground water stored in the rocks of the Duke area and the amount that can be withdrawn without depleting the reservoir are complex problems not to be solved in one day of field work. The porosity of the water-bearing beds governs the quantity of water that can be stored in them; the precipitation in the area partly governs the quantity of water that goes underground through sinkholes; and flood flow in Salt Fork of Red River and other streams may govern the amount of water reaching the water-bearing formations indirectly from outside areas.

According to the U. S. Weather Bureau<sup>2/</sup> the average annual precipitation at Altus, the nearest reporting station, is about 25.5 inches. It is not possible to estimate the proportion that may seep into the ground. The sinkholes may absorb a large part of the rain water falling near them, but the shale at the surface in parts of the area doubtless admits very little. Probably not more than a few inches of the annual precipitation of about 25 inches finds its way to the ground-

<sup>2/</sup> Climatic Summary of the United States: Oklahoma section.

water reservoir. If it is as much as 5 inches per year, it would be equivalent to about 130,000 gallons of water per acre. If the water comes from streams, the average yield per acre might be considerably higher, but no data are available in this regard. The possibility must be considered that the water has accumulated over a long period of time in the cavernous zones in the rocks, and thus that current withdrawals may be largely from storage.

#### PROSPECTING FOR WATER

If it is true that the ground water of the Duke area occurs in solution openings in the gypsum beds, the drilling of a well involves an element of luck. If the well encounters one or more large openings full of water, a large yield may be obtained; if not, the yield may be adequate only for watering stock. Probably the surest way to find the water-filled openings is by test drilling, but possibly the electrical-resistivity method might be used to advantage.

#### FURTHER WORK

A thorough investigation of the ground-water resources of the Duke area should include the following:

a. The collection and study of all available logs of water wells in the area.

b. Performance tests of all the irrigation wells, including accurate measurements of the discharge of each well and of the drawdown caused by pumping.

c. An estimate of the total annual pumping in the area.

d. Measurements of the static water levels after irrigation is well under way, for comparison with the measurements made in the present investigation, to determine the effect of pumping on ground-water storage.

e. Determination of altitude above sea level of all of the wells, to permit construction of a map showing the slope of the water surface. This map will indicate the direction in which the water moves and, hence, the source area.

f. If the map of the ground-water surface indicates that water can come from Salt Fort of Red River,

the amount of water lost from the channel along selected stretches should be determined by gaging the flow. As Salt Fork is said to be dry much of the time, this gaging may have to be done at flood stage. Similarly, influent seepage along Turkey Creek and other creeks in the area should be investigated.

g. The location of all the gypsum sinkholes in the area, and the determination of the drainage area tributary to each. This phase of the work should include collection of data showing whether the sinkholes are open enough to take in water freely.

h. A limited survey by the electrical-resistivity method in a place known to have water in abundance, to determine whether the method can be used to locate the solution channels without test drilling.

#### Analysis of Water from Ivan Owen Well

Location: SE NW NW Sec. 12, T 2 N, R 23 W, Collected  
June 10, 1948

Hardness (calc.) . . . . .	1770
Total Dissolved Solids . . . . .	2740
Calcium (Ca) . . . . .	584
Magnesium (Mg) . . . . .	75
Sodium (Na) and Potassium (K). . . . .	66
Bicarbonate (HCO <sub>3</sub> ) . . . . .	55
Sulphate (SO <sub>4</sub> ) . . . . .	1610
Chloride (Cl). . . . .	122
Fluoride (F) . . . . .	0.4
Nitrate (NO <sub>3</sub> ). . . . .	18

Table I. Successful Irrigation Wells, Duke Area, Jackson and Greer Counties, Oklahoma.  
June 10, 1948

Well No.	Location	Name of Owner	Date Completed	Topography	Depth (ft)	Diam. (in)	Water Level (ft) <sup>a</sup>	Depth to Method of Lift <sup>b</sup>
Greer County								
1	T. 2N, R. 23W, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 3	Robertson	....	Hill	....	6	26.5	T, Gs
Jackson County								
2	T. 2N, R. 22 W, SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5	Johnston	1948	Flat	135	14	38.5 <sup>d</sup>	T, Gs
3	T. 2N, R. 23W, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 1	Heidenreich	....	Hill	70	....	38 <sup>c</sup>	T, Gs
4	SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4	Rosenbaum	....	Slope	....	15	....	T, Gs
5	SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 12	Owen	1942	Flat	90	15 $\frac{1}{2}$	29 <sup>e</sup>	T, Gs
T. 3N, R. 23W.								
6	SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 27	Bryant	....	Flat	....	12	29	T, Gs
7	SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 33	Carroll	....	Flat	....	....	24.8	T, Gs
8	S $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 35	Yates	1948	Flat	92	....	27 <sup>f</sup>	T, Gs

a/ Depth to water level is static water level, measured below land surface.

b/ Method of lift: T, turbine pump; Gs, gasoline power.

c/ Reported depth to static water level. Other levels measured by wetted-tape method.

d/ Struck water at 68'. Yield, 1,000 g.p.m.

e/ Struck water at 48'. Normal yield 1,000 g.p.m. Max. 1,700 g.p.m. Irrig. 50 acres.

f/ Struck water at 40'. Yield, 1,200 g.p.m. First two wells were inadequate.