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GEOLOGICAL SURVEY
Albuquerque, New Mexico

Availability of ground water near Arena, Luna County, New Mexico

By

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Open-file report

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Introduction

Irrigation from wells has been practiced in the Deming and Columbus areas of Luna County, southwestern New Mexico, since the turn of the century. East of Columbus, in Tps. 27 to 29 S., Rs. 5 and 6 W., in the southeastern corner of Luna County (fig. 1) is an area of about 174 square miles of rangeland that has never been developed for farming. This rangeland area, in this report, is called the Arena area. Arena is an abandoned railroad station and is the only named feature on most maps of the area.

The continual search in New Mexico for new land that can be irrigated has resulted in numerous inquiries to the New Mexico State Engineer about the availability and quality of the ground water in the Arena area and of the possibilities of utilizing the water for irrigation if it is available.

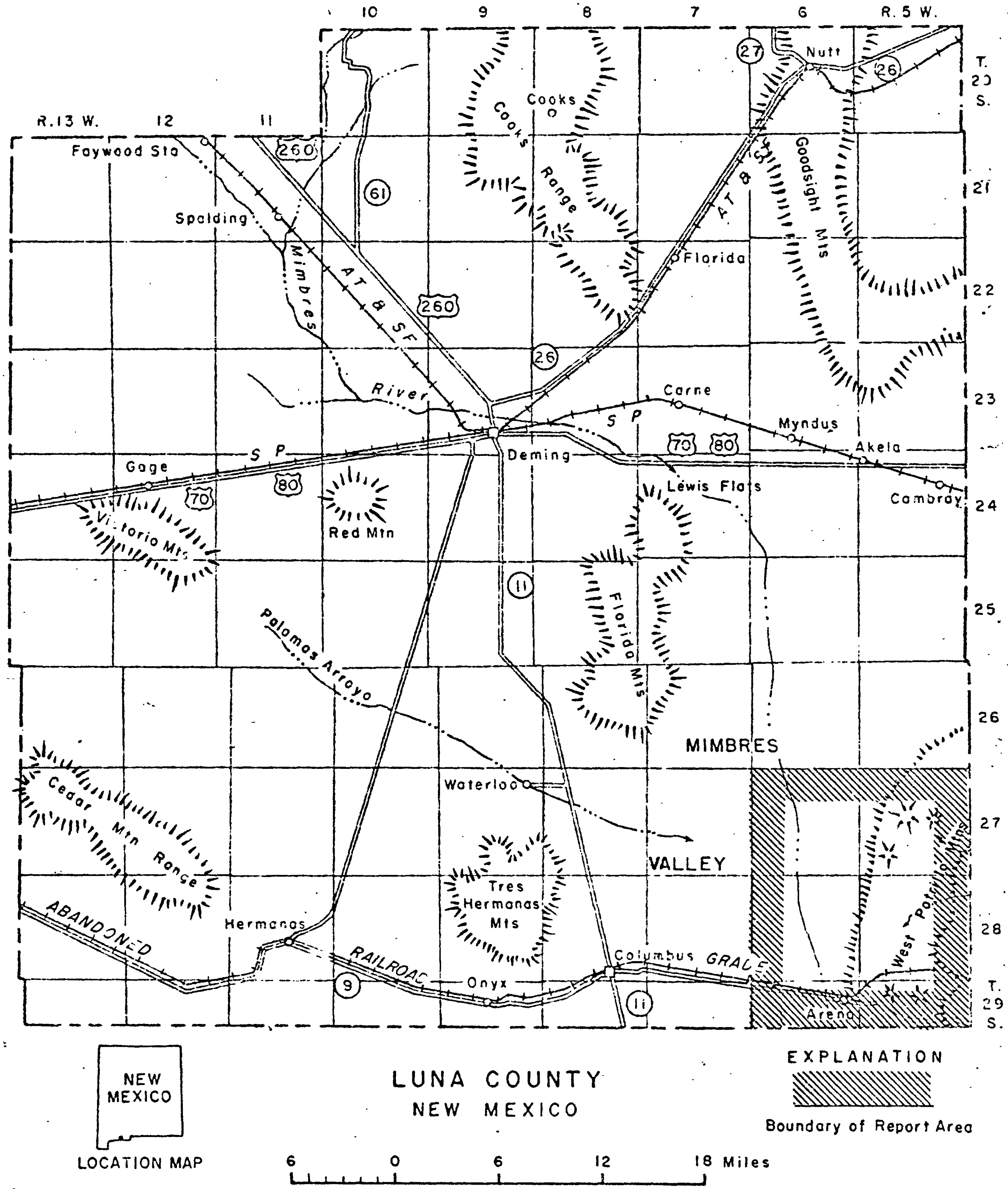

Figure 1.--Map showing Luna County and the location of the area studied.

To aid persons contemplating development of irrigation farming in the Arena area, the New Mexico State Engineer requested the U.S. Geological Survey to examine existing data on the geology and ground-water resources of the area and to provide information on the availability of ground water.

The principal previous investigation of water resources in this area is that of Darton (1916). Additional data pertaining to the irrigated areas near Deming and Columbus is included in the New Mexico State Engineer Office Biennial Reports 8 through 17 and in the U.S. Geological Survey Water-Supply Paper 637-B. These reports, as well as reports on the general geology and mineral resources of Luna County, have not dealt specifically with the area near Arena. The State Engineer Office in Deming has collected well information for many years in Luna County and provided many of the data used in preparation of this report.

Luna County is part of a broad alluvial plain interspersed with mountain ranges (fig. 1). The climate is arid. The principal drainage in the county is the Mimbres River and much of the lowland in the southeastern part of the county is referred to as the Mimbres Valley. The Mimbres River is ephemeral throughout most of its course in Luna County and is a perennial stream only in its upper reaches. Deming, the county seat, and Columbus are the principal settlements in the county. Farming and ranching are the activities upon which the economy of the county is most dependent. The highways and railroads traversing the area are shown on figure 1; the Southern Pacific Railroad across the southern part of the county has been abandoned for several years. The Arena area, like much of the county, is ranch land with a low population density.

The western half of the Arena area is in the lower part of the Mimbres Valley, a sandy plain of little topographic relief southeast of the Florida Mountains. The eastern half is in the foothills of the West Potrillo Mountains. A prominent scarp, 30 to 100 feet high, marks the transition from alluvial plain to foothills. Drainage into the area is southward and southeastward from the upper Mimbres River, Lewis Flats, and the Florida Mountains, and westward from the West Potrillo Mountains and eastward from Palomas Arroyo and the Tres Hermanas Mountains, thence southward along the base of the scarp toward Mexico (fig. 2).

The lower part of the Mimbres Valley is a part of a bolson between the Florida and Tres Hermanas Mountains on the west, and the West Potrillo Mountains to the east, and extending south into Mexico. The mountain masses have been faulted up and deeply eroded, exposing rocks as old as Precambrian, and the valley has been dropped down and covered with detritus eroded from the adjacent highlands (Kottlowski, 1965, p. 146; Spiegel, 1958). The upthrown mass of the West Potrillo Mountains includes capping layers of volcanic rocks of Quaternary-Tertiary age. The bolson part of the Arena area probably was a lake during prehistoric time (Reeves, 1965). Material filling the bolson consists of gravel, sand, and clay, and mixtures of these particle sizes, in beds of irregular shape, thickness, and array. Laterally extensive thin beds of sand, underlain and overlain by relatively thick beds of clay, probably were deposited as a part of the sequence of lake-bed deposition.

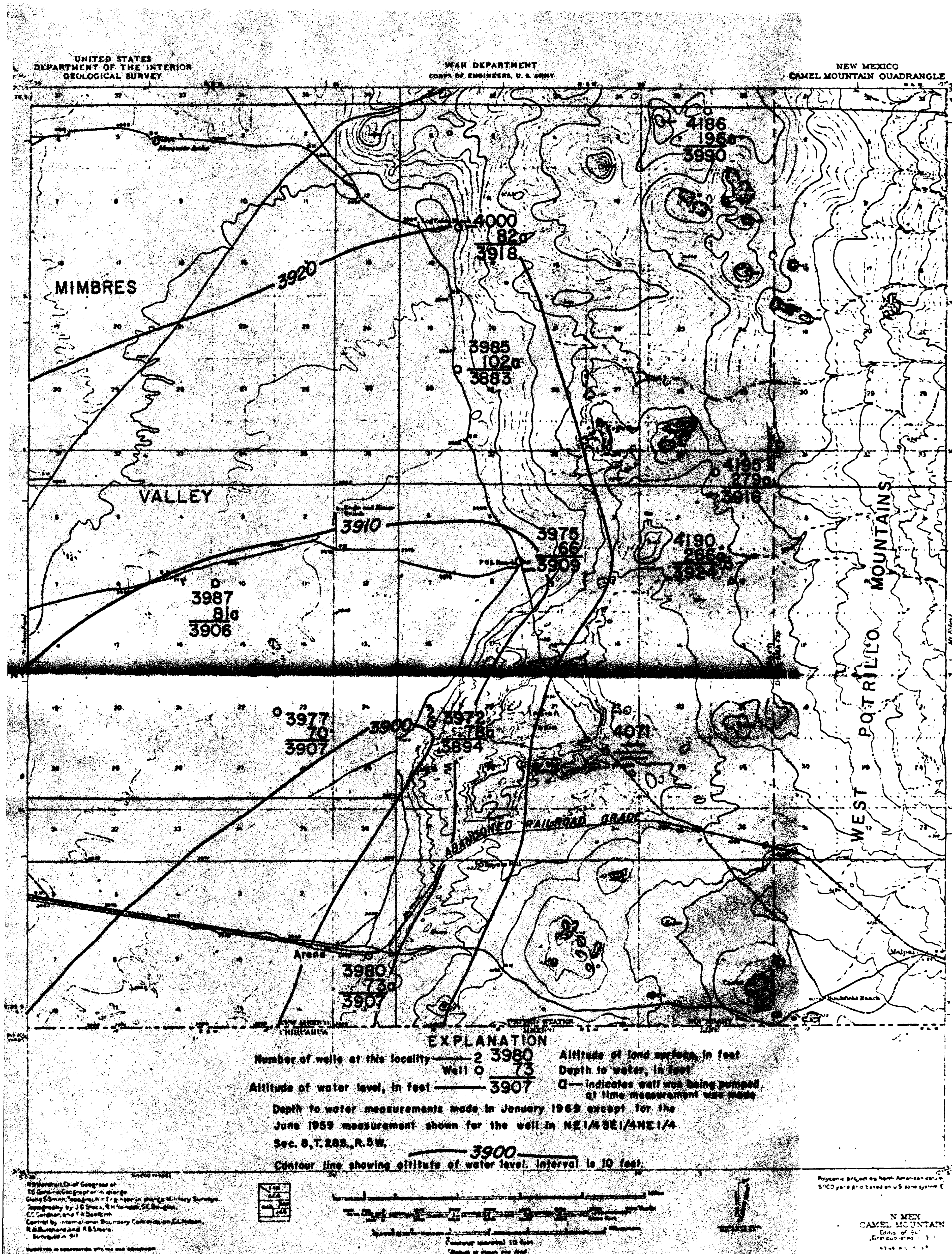

Figure 2.--Map showing wells, altitude of land surface, depth to water, and altitude of water level near Arena, Luna County, N. Mex.

Ground water

Ground-water in Luna County is derived from precipitation falling on the drainage area of the Mimbres Valley. Water is absorbed by permeable beds of sand and gravel and percolates down to the saturated zone. Ground water moves toward the Arena area from the north, east, and west. The two principal sources of recharge are the Mimbres River to the north and Palomas Arroyo to the west. The altitude of the water level in the few wells in the foothills of the West Potrillo Mountains suggests that ground water also moves westward from the hills toward the center of the Arena area. However, the water tapped by these wells may be perched and connected irreversibly with water in the topographically lower part of the area. In general, the ground-water movement is similar to surface drainage in this area.

Ground water is transmitted principally in permeable thin beds of sand, some of which are overlain by less permeable clay beds in the sequence of lake sediments underlying the lowland western part of the Arena area.

Natural discharge of ground water from the Arena area probably is by underground movement southward. No springs are known to exist in the area.

Possibly as much as 5,000 feet of saturated bolson deposits underlies most of the Arena area but only the upper few hundred feet have been prospected for water. In general, these upper few hundred feet yield little water to wells because the upper part of the bolson deposits consists mainly of fine-grained materials. Wells in the lowland part of the area generally yield only a few gallons per minute of water, a quantity sufficient only for stock or domestic use. It is possible that larger yields could be obtained at greater depths where deposits might be coarser.

Large yields of water have been reported from oil-test wells in secs. 19 and 27, T. 28 S., R 5 W., and in the old railroad water-test well drilled in sec. 12, T. 29 S., R. 6 W. The oil test in sec. 27 produced an estimated 350 to 400 gpm (gallons per minute) of water while drilling with air. The oil test in sec. 19 reportedly produced an estimated 210 gpm. The water from the well in sec. 19 was reported to be fresh but no analysis is available. The old water-test well at Arena (sec. 12, T. 29 S., R. 6 W.) reportedly produced in excess of 100 gpm (Darton, 1916, p. 156), but the quality was poor (table 2).

The depth to water in wells in the Arena area is tabulated in table 1 and the altitude of the water level in wells is shown in figure 2. The direction of water movement is downgradient. Pumping effects and the slight difference in water-level altitude between the few wells in the area makes interpretation uncertain. A 500-foot hole drilled for drilling water at the oil test in sec. 27, T. 28 S., R. 5 W. was reported as "dry"; however, whether the report of "dry" meant that no water was obtained, is not known.

Water levels in wells in the Arena area are believed to have declined since Darton's 1916 report, but evidence is not conclusive. The water level in a well at Arena was reported by Darton to be 66 feet below land surface in the period 1910-13. The level in the present well at Arena was 73 feet in 1969; whether or not it was the same well is not certain.

The water level has lowered many feet in two wells 700 feet deep just west of the Arena area within the last 17 years. The depth to water in the well in sec. 25, T. 27 S., R. 7 W. was 13 feet below land surface on March 22, 1956, and 81 feet below land surface on January 9, 1969, a decline of 68 feet in 13 years. On May 15, 1952, water was flowing from the discharge pipe 4 feet above land surface at the well in sec. 26, T. 28 S., R. 7 W. The depth to water on January 9, 1969, was 132 feet below land surface, a decline of 136 feet in 17 years.

Table 1.--Records of wells near Arena, Luna County, N. Mex.

EXPLANATION

Depth: m, measured; r, reported. Depth to water: a, well was being pumped at time measurement was made.

Location	Diameter (inches)	Depth (feet)	Depth to water (feet)	Date of measurement	Altitude of land surface[1/] (feet)	Altitude of water level[1/] (feet)	Use
T. 27 S., R. 5 W. Sec. 2, NE¼NE¼NE¼	6	214m	196a	1-23-69	4,186	3,990	Stock
Sec. 7, SE¼SE¼SE¼	6	85m	78a	5-27-54	4,000	--	Do.
	--	--	75	8-20-55	--	--	--
	--	--	79a	10-25-56	--	--	--
	--	--	77a	12-27-57	--	--	--
	--	--	80a	6-24-59	--	--	--
	--	--	75	1-22-60	--	--	--
	--	--	78a	1-26-65	--	--	--
	--	--	80a	1-17-66	--	--	--
	--	--	82a	1-23-69	--	3,918	--
Sec. 30, SE¼NE¼NE¼	6	320r	97a(?)	7-27-54	3,985	--	Stock
	--	--	87a(?)	12-27-57	--	--	--
	--	--	87a	6-24-59	--	--	--
	--	--	70	1-22-60	--	--	--
	--	--	74	3-15-62	--	--	--
	--	--	70	1-15-64	--	--	--
	--	--	102a	1-23-69	--	3,883	--
Sec. 36, NW¼SW¼SW¼	6	300r	279a	1-23-69	4,195	3,916	Stock

Table 1.--Records of wells near Arena, Luna County, N. Mex. - Concluded

Location	Diameter (inches)	Depth (feet)	Depth to water (feet)	Date of measurement	Altitude of land surface[1] (feet)	Altitude of water level[1] (feet)	Use
T. 28 S., R. 5 W. Sec. 8, NE¼SE¼NE¼	12	90r	65	9-20-55	3,975	--	Stock and domestic
	--	--	66	6-24-59	--	3,909	--
Sec. 12, SW¼NE¼NW¼	8	450r	266a	1-23-69	4,190	3,924	Stock
Sec. 19, NW¼SW¼SE¼	13-3/8	9,437r	--	--	3,972	--	Oil-test well plugged and abandoned.
Sec. 19, NW¼SW¼SE¼	8	--	78	1-24-69	3,972	3,894	Stock well drilled to supply rig water for oil-test well.
Sec. 27, NW¼SE¼NW¼	13-3/8	6,616r	--	--	4,071	--	Oil-test well plugged and abandoned.
T. 28 S., R. 6 W. Sec. 10, NW¼NW¼SW¼	8	600r	84	6-23-54	3,987	--	Stock
	--	--	87a	1- 2-62	--	--	--
	--	--	79	1-26-65	--	--	--
	--	--	88a	1-17-66	--	--	--
	--	--	80	2-13-67	--	--	--
	--	--	81a	1-23-69	--	3,906	--
Sec. 23, NW¼NW¼SW¼	12	--	70	1-24-69	3,977	3,907	Stock
T. 29 S., R. 6 W. Sec. 12, NW¼NW¼SE¼	4	99m	73a	1-23-69	3,980	3,907	Stock

1/ Altitude listed is shown on fig. 2.

The water-level changes in the two wells west of the Arena area probably reflect the effects of pumping for irrigation in the farmed area near Columbus about 4 miles farther to the west. The large water-level declines in these two wells suggest that the aquifers at depth beneath the Arena area are effectively confined so that the effects of pumping in the Columbus area may extend over wide areas within relatively short periods of time.

Quality of water

The results of chemical analyses of water samples from wells in the Arena area are listed in table 2. The percent of sodium is high in all the samples analyzed and use of the water for irrigation farming would require a compatible soil type, or corrective water, or soil treatment. For domestic use, the water ranges from poor to unpotable, being high in chloride, sulfate, or fluoride, or all three. On the basis of the limited number of analyses available, the quality of water seems to worsen with depth and to worsen from northwest to southeast.

The oil-test well in sec. 27, T. 28 S., R. 5 W., which produced the largest reported yield of water (350 to 400 gpm) of any well in the area also produced water of the worst quality from the greatest depth. The water of poor quality obtained from this oil test probably came from the lowermost part of the Quaternary-Tertiary bolson fill material and volcanic rocks, or from rocks of Cretaceous age or older which underlie the bolson fill and volcanics.

Water-quality data interpreted from the electric log of the oil test in sec. 19, T. 28 S., R. 5 W. suggest that the quality of water is relatively good from 1,200 to 1,600 feet, that the quality gradually worsens to 3,900 feet, and that below 3,900 feet the quality is very poor. Unfortunately, water-sample analyses are not available and the quality of water cannot be expressed quantitatively.

Table 2.--Chemical analyses of water samples from wells near Arena, Luna County, N. Mex.

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Analyses by Geological Survey, United States Department of the Interior
(parts per million)

Well location	T.27S., R.5W. sec. 7, SE¼SE¼SE¼	T.28S., R.5W. sec.8, NE¼SE¼NE¼	T.28S., R.6W. sec.10, NW¼NW¼SW¼	T.28S., R.5W. sec.27, NW¼SE¼NW¼	T.29S., R.6W. sec.12, NW¼NW¼SE¼
Date of collection	5-22-58	5-22-58	5-22-58	3- -62 1/	--- 2/
Silica (SiO_2)	35	30	29	23	45
Iron (Fe)	---	---	---	---	---
Manganese (Mn)	---	---	---	---	---
Calcium (Ca)	31	8.3	11	437	28
Magnesium (Mg)	17	3.6	2.9	61	14
Sodium (Na) Potassium (K)	252	422	707	4,820	757
Bicarbonate (HCO_3)	235	570	464	234	---
Carbonate (CO_3)	0	0	0	0	---
Sulfate (SO_4)	83	141	363	1,870	903
Chloride (Cl)	291	228	570	6,850	435
Fluoride (F)	1.4	4.4	4.4	2.6	---
Nitrate (NO_3)	2.8	7.8	2.0	3.0	---
Dissolved solids					
Calculated	817	1,100	1,860	14,200	2,564
Residue on evaporation at 180°C					
Hardness as $CaCO_3$	148	36	38	1,340	---
Noncarbonate hardness as $CaCO_3$	0	0	0	1,150	---
Alkalinity as $CaCO_3$	---	---	---	---	---
Specific conductance (micromhos at 25°C)	1,460	1,860	3,170	22,600	---
pH	8.0	8.0	7.9	7.6	---
Color	---	---	---	---	---
Percent sodium	79	96	98	89	---
SAR	9.0	31	50	57	---

1/ Sample collected from depth of 3,110 feet.

2/ 504 ft deep well at Arena; analysis reported in USGS Bull. 618. Sample collected and analyzed by El Paso and Southwestern Railroad prior to 1913.

Suggestions for future investigations

To fully define the ground-water potential for irrigation farming, a systematic and extensive program of test drilling and test pumping should precede any attempt to develop wells for irrigation in the Arena area. Such a program would determine whether wells of adequate yield could be obtained and would determine the areal and vertical change in water quality. Test wells should be drilled throughout the lowland part of the area where farming can be done with the least amount of land preparation. The test wells would provide information with which to design wells for maximum yield and minimum sand production. One or two test wells should be drilled in the higher eastern part of the area to determine hydraulic characteristic of the area.

The maximum potential yield of a well generally can be obtained by fully penetrating the aquifer. In the case of a thick aquifer such as the bolson fill, the yield of a well that only penetrates a part of the aquifer may be increased by penetrating a greater thickness of the aquifer. Data from the electric log of the oil test in sec. 19, T. 28 S., R. 5 W. suggests that water of relatively good quality is available to a depth of about 1,600 feet; therefore, it should be possible to construct wells of greater yield than the existing wells simply by drilling deeper. It is possible also that the position of the ancient lake changed from time to time as deposition continued in the bolson, and that beds of coarser particle size and greater permeability may be found at depth below the present low point in the bolson.

Aquifer characteristics should be determined by pumping from test wells and by monitoring water levels in the pumped well and in adjacent observation wells. When several test wells have been completed, long-term aquifer tests should be made to determine proper well spacing within the area and, if possible, the effects that pumping in the project area would have on water levels in wells in the irrigated areas near Columbus to the west, and near Lewis Flats to the north.

The directions of ground-water movement in the county and the response to pumping for irrigation of the two deep stock wells just west of the Arena area suggest that the water in the Arena area, especially deep water, is hydraulically connected with water in the aquifers in nearby irrigated areas. If the pumping of wells in the Arena area affects water levels in the older irrigated areas to the extent that the water rights of prior appropriators are damaged, the drilling of wells in the Arena area could be restricted or prohibited under New Mexico water law.

Water samples from the test wells should be collected from specific zones indicated by electric logs, and the quality of the water appraised for compatibility with the available soil. Water samples of the composite water produced by the completed test wells should be collected and the quality of water monitored carefully during aquifer tests to determine whether a change in quality with time of pumping occurs.

Conclusions

The available data are meager but do not indicate a large ground-water potential for irrigation farming in the Arena area. Yields ranging from 1 to about 200 gallons per minute have been obtained from wells in the lowland part of the Arena area. The quality of water from the existing wells ranges widely. Water from some of the wells would be of suitable quality for irrigation farming on some types of soil but water from other wells is not suitable for irrigation use. The change in water quality, areally and vertically throughout the area, is poorly defined by the available data.

An extensive test drilling program will be needed to determine whether wells of larger yield of acceptable quality water can be constructed. The test drilling program should be coupled with a program of test pumping to determine optimum spacing of wells within the area and the effects of long-term pumping on irrigated areas near Columbus and Lewis Flats.

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