Interim report on water wells, Gallup, N. Mex.

By

S. W. West

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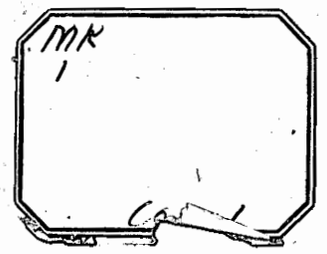

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

McKinley

INTERIM REPORT ON WATER WELLS, GALLUP, NEW MEXICO

By

S. W. West

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U. S. Geological Survey
GW-Albuquerque

Prepared in cooperation with the
NEW MEXICO STATE ENGINEER
and the
TOWN OF GALLUP

March 1957

57-120

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A study of the geology and ground-water conditions in the Gallup area (fig. 1) was started in 1955 in cooperation with the State Engineer and the Town of Gallup. A rapid increase in the population of Gallup in 1955 and 1956 coupled with a decline in well yields resulted in the maximum daily water demand approaching the maximum capacity of the well system. This situation created a pressing need for additional water in Gallup. The Board of Trustees of the town accordingly requested current information concerning wells in the town in order that immediate plans could be made by the town to develop additional water supplies. This interim report, presenting information on the wells in and adjacent to the town and a general discussion of the geology and ground-water conditions of the area, has been prepared in response to the immediate need for such information pending the preparation and release of a more comprehensive report on the Gallup area.

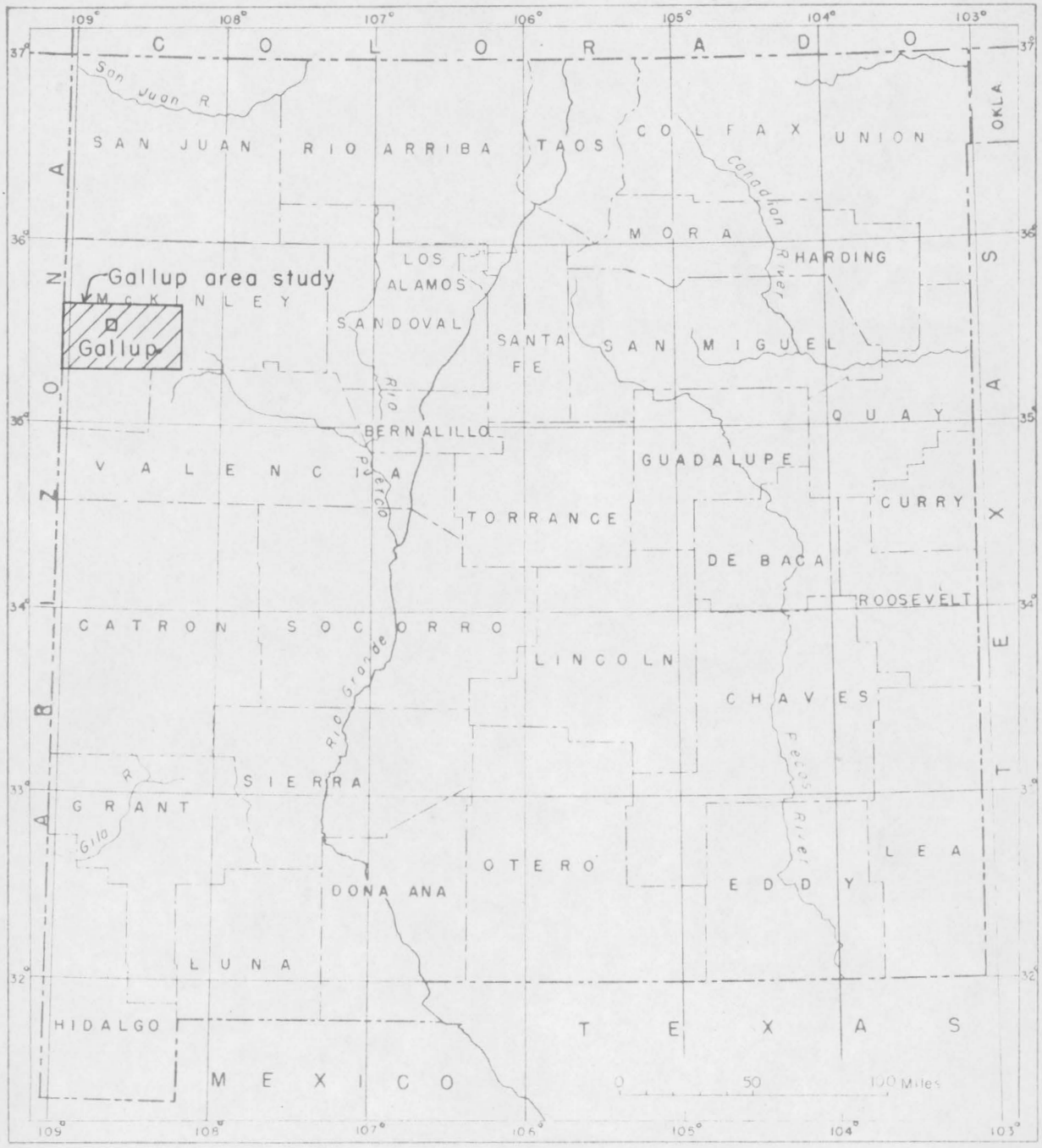

Figure 1.--Map of New Mexico showing location of Gallup area study.

WELL-NUMBERING SYSTEM

In the attached tabulations and diagrams the wells are designated both by the local designation, such as Gallup 2 (Ga 2) and the location number, the method used by the U. S. Geological Survey in numbering water wells in New Mexico. The location number is a description of the geographic location of the well, based on the public land survey system, and indicates the location of the well to the nearest 10-acre tract. The location number consists of a series of numbers corresponding to the township, range, section, and tract within a section as illustrated by fig. 2. If a well cannot be located within a particular tract, a zero is used for that part of the number.

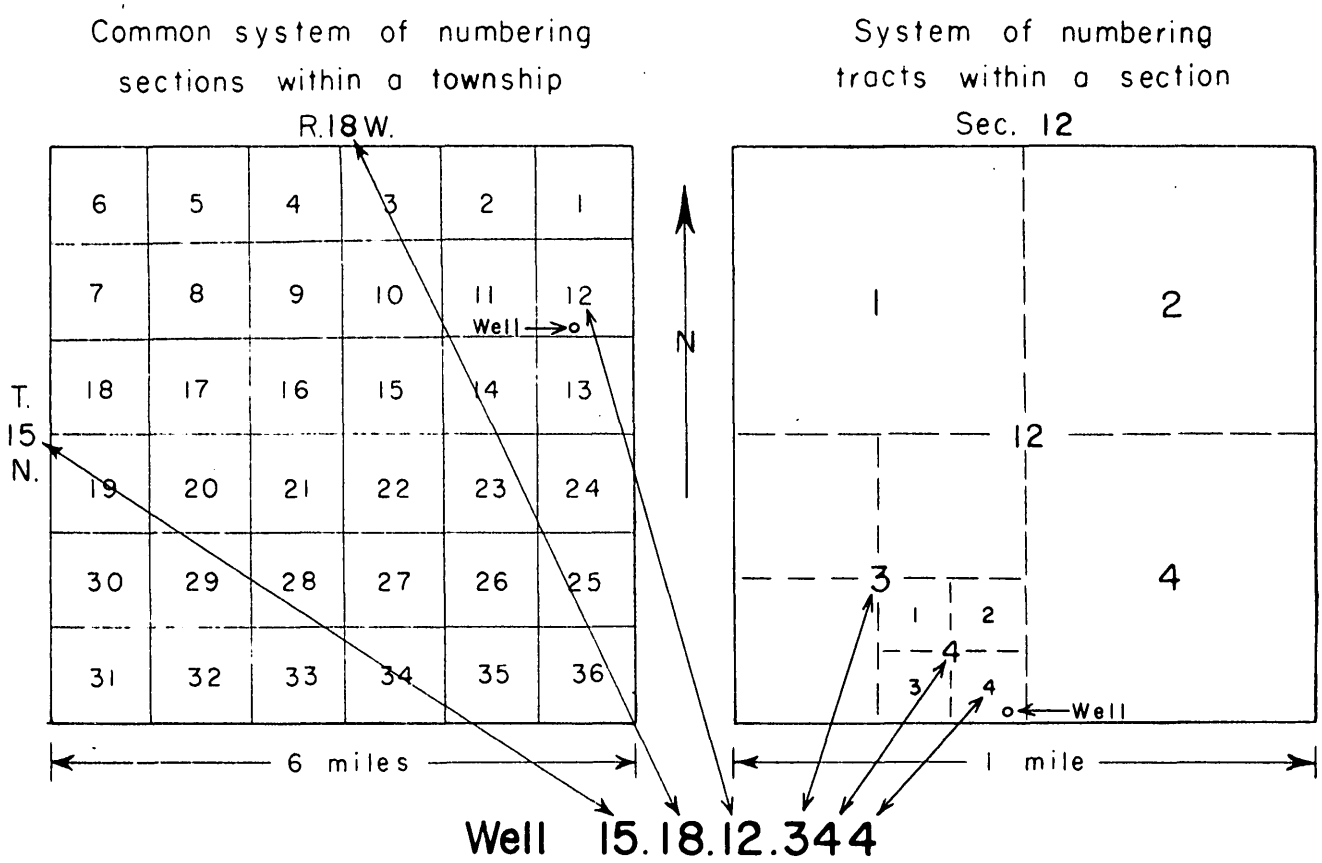

Figure 2. -- System of numbering wells in New Mexico

WATER-BEARING FORMATIONS

Three main water-bearing formations are within economic drilling depths at Gallup. The shallowest is the Gallup sandstone. At successively greater depths are the Dakota sandstone and the Westwater Canyon member of the Morrison formation. The Dakota sandstone lies on the Westwater Canyon member of the Morrison formation, and the two stratigraphic units can be considered generally as a single aquifer. The vertical positions of these formations in relation to other stratigraphic units is shown in table 1 and on plate 1.

The Gallup sandstone consists of about 350 feet of very fine- to very coarse-grained, firmly cemented beds of sandstone and thin to thick beds of shale. The grains of sand are angular and poorly sorted as well as being firmly cemented. Yields of water from individual wells that produce from the Gallup sandstone range from 45 to 200 gallons per minute (gpm). The Gallup sandstone crops out in small areas in Gallup, along the west side of the "hogback" east of Gallup, and in large areas to the south and southwest of Gallup. A relatively thin layer of unconsolidated silt and sand covers the Gallup sandstone along the Puerco River in the east part of Gallup and in certain areas south of Gallup. The formation is recharged in its outcrop areas by direct precipitation and by infiltration of runoff water. Locally, the formation is recharged by downward percolation of water from the overlying, unconsolidated sediments. The chemical quality of water in the Gallup sandstone generally is fair although the water from the municipal well field east of town commonly contains concentrations of dissolved solids, iron, and sulfates higher than recommended limits.

Table 1.--Generalized stratigraphic section in the Gallup area, N. Mex.

Age	Symbol	Stratigraphic unit	Thickness (feet)
Quaternary	Qal	Alluvium	0 to 200
		Unconformity	
Late Cretaceous	Kmf	Mesaverde group: Menefee formation:	
	Kma	Allison member	0 to 800
	Kcc	Crevasse Canyon formation:	
	Kgc	Gibson coal member	150 to 175
	Kbb	Bartlett barren member	330 to 400
	Kdc	Dilco coal member	240 to 300
	Kgs	Gallup sandstone	180 to 350
	Km	Mancos shale	500 to 700
	Kd	Dakota sandstone	125 to 250
		Unconformity	
Late Jurassic	Jm	Morrison formation:	
	Jmbb	Brushy Basin member	0 to 195
	Jmwc	Westwater Canyon member	100 to 220
	Jmr	Recapture member	0 to 60
	Jcs	Cow Springs sandstone	280 to 425
	Js	San Rafael group: Summerville formation	0 to 60
	Jt	Todilto limestone	0 to 5
	Je	Entrada sandstone	295 to 370
		Unconformity(?)	
Late Triassic	Trw	Wingate sandstone	75 to 360
	Trc	Chinle formation:	
	Trco	Owl Rock member	40
	Trcpu	Petrified forest member, upper part	880
	Trcps	Sonsela sandstone bed	20 to 65
	Trcpl	Petrified forest member, lower part	180
	Trcl	Lower member	235
	Trcs	Shinarump member	25
	Trm	Moenkopi formation	25 to 80
		Unconformity	
Permian	Psa	San Andres formation	0 to 100
	Psg	Glorieta sandstone	100 to 300
	Py	Yeso formation:	
	Pys	San Ysidro member	0 to 325
	Pym	Meseta Blanca sandstone member	0 to 100
	Pa	Abo formation	-
		Unconformity	
Precambrian	pC	Granitic rocks	-

The Dakota sandstone is separated from the Gallup sandstone by 500 to 700 feet of the relatively impervious Mancos shale. The Dakota consists chiefly of 115 to 250 feet of fine- to medium-grained sandstone with some beds of shale and coal, especially in the lower part. Because the Gallup sandstone is penetrated in drilling to the Dakota sandstone in the Gallup area and because the Dakota lies on the Westwater Canyon member of the Morrison formation, another principal aquifer, it is doubtful that the yield of the Dakota sandstone has been individually tested. The yield presumably is small, however, because the combined yield of the Gallup sandstone, the Dakota sandstone, and the Morrison formation to wells is only 150 to 225 gpm. The chemical quality of water in the Dakota sandstone is generally fair in the Gallup area.

The Westwater Canyon member, the principal water-bearing unit of the Morrison formation, is chiefly very fine- to very coarse-grained sandstone at Gallup. The Westwater Canyon member contains some gravel, and a white, clay-like material partly fills the interstices between the grains of sand and gravel. The yield of the Westwater Canyon member has not been individually tested in the Gallup area. The chemical quality of water in the Morrison is generally fair.

The depth below land surface to the water-bearing formations ranges widely, due to a sharp upward flexure of the rock strata along a north-south line through Gallup (see pl. 1). East of the flexure the depth to the top of the Gallup sandstone ranges from about 50 to 370 feet, the depth to the top of the Dakota sandstone ranges from about 925 to 1,350 feet, and the depth to the top of the Westwater Canyon member ranges from about 1,050 to 1,470 feet. The depths to the formations increase northward from the Puerco River. About a mile west of the flexure the depths to the top of the Gallup sandstone, the Dakota sandstone, and the Morrison formation are about 1,000 feet, 1,980 feet, and 2,100 feet respectively. Farther west, the depths to the formations decrease at a rate of about 70 feet per mile. (Pl. 1.)

The flexure of the formations along a line through Gallup created two structural basins -- a relatively shallow one to the east and a deeper one to the west. The earliest drilling of wells in Gallup, between 1900 and 1910, was on or near the top of the flexure. From 1916 to 1946, the Atchison, Topeka, and Santa Fe Railway drilled six wells to the west of the flexure. All but one of these wells produced water from the Gallup sandstone, the Dakota sandstone, and the Westwater Canyon member of the Morrison formation. About 1930, the Southwest Water Company, a public service company, drilled 3 wells east of the flexure to procure a supply of water for use in Gallup. The Town of Gallup acquired those wells from the Southwest Water Company and drilled 17 additional wells in the east basin, from 1939 to 1949. All the wells in the east basin produce water only from the Gallup sandstone.

CHANGES IN WATER LEVELS

Pumping of water from a well causes a cone of depression in the water level around the well, the size and shape of which depends on the character of the water-bearing formation, the pumping rate, and the interval of time since pumping began. Pumping from a well field causes the cones of depression around individual wells to coalesce, forming an irregular cone of depression around the entire well field. The size and shape of the cone of depression of the water level around a well field is influenced by the spacing of wells in addition to the factors affecting the cones of depression around an individual well. When pumping from a well is stopped, the water level in and near the well rises (fig. 3), but except under certain conditions, does not reach the level existing prior to the beginning of pumping.

The pumping rate from both the east and west well fields is regulated to meet the demand for water, causing the water levels to fluctuate as the demand for water changes with the seasons of the year (figs. 5 to 7). When ground-water withdrawal from a well field is primarily from ground storage, a continuing net decline of water levels in the wells is evidenced. The ground-water withdrawal in both well fields has been essentially from storage and declining water levels have been prevalent in both fields (table 2 and figs. 4 to 7). The total decline of water levels in the west field has been greater than in the east field because pumping began about 14 years earlier (in 1916) and the withdrawal rate per unit area was higher than in the east field. Because the depth to the water-bearing beds of the Gallup sandstone is shallow in the east well field, these beds have been partly dewatered in the vicinity of some wells and the yield of all the wells in the east field has decreased significantly. The water-bearing beds of the Gallup sandstone have not been dewatered in the west well field, because of the much greater depth to the Gallup sandstone and because the water is under sufficient natural pressure to cause it to rise several hundreds of feet above the sandstone.

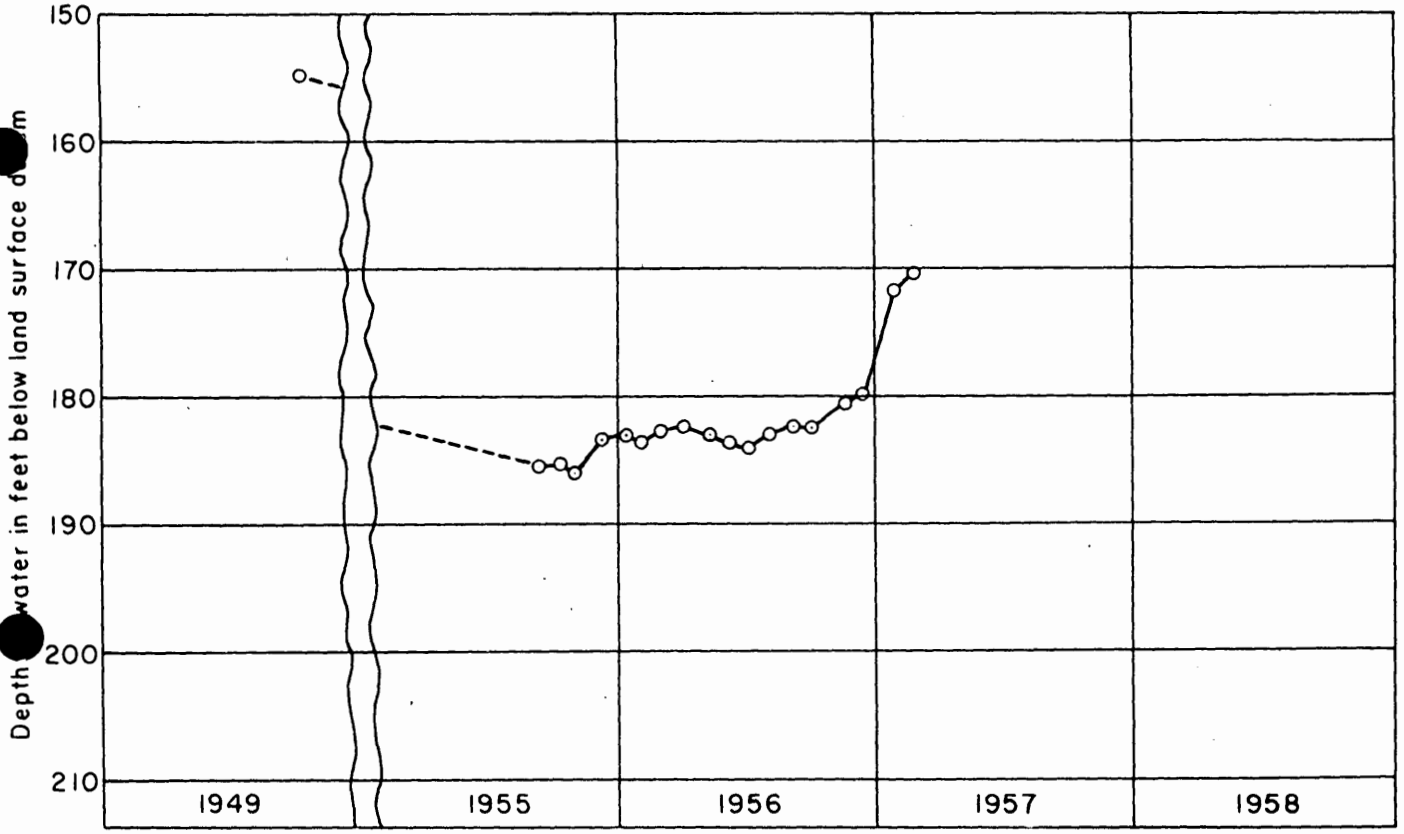

Figure 4.--Hydrograph of water levels in well 15.18.11.222 (Ga 19) Gallup, N. Mex.

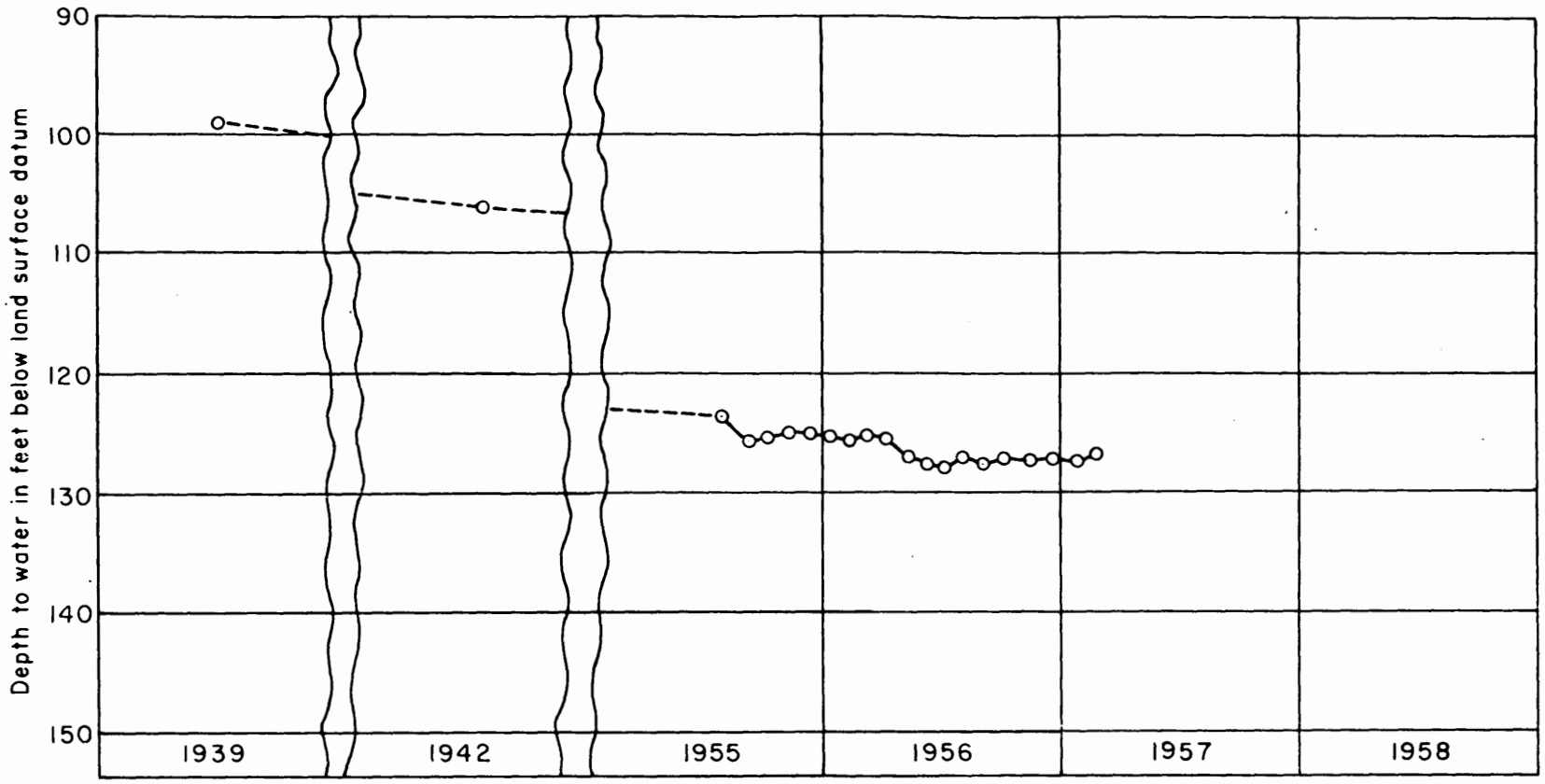

Figure 5.--Hydrograph of water levels in well 15.18.14.132 (Ga 10) Gallup, N. Mex.

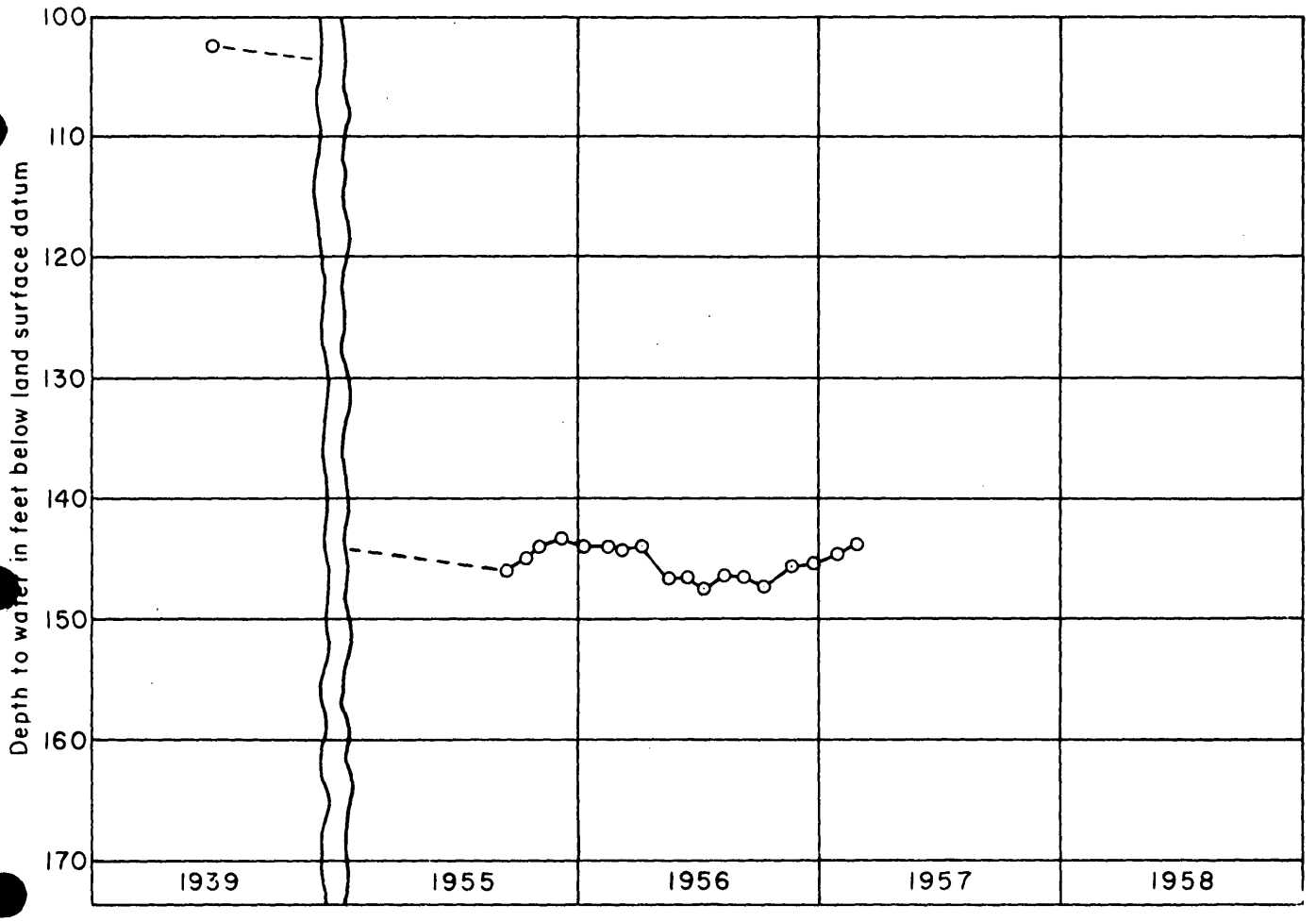

Figure 6.--Hydrograph of water levels in well 15.18.14.233 (Ga 9) Gallup, N. Mex.

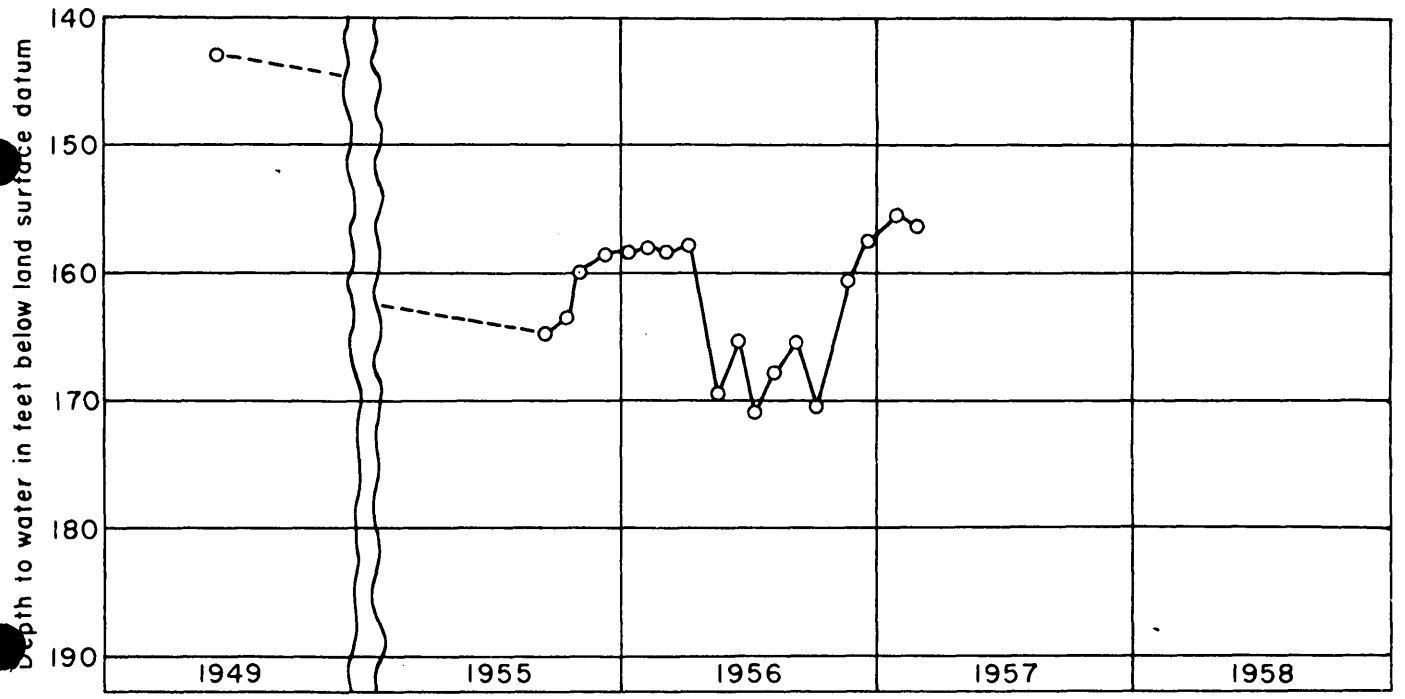

Figure 7.--Hydrograph of water levels in well 15.18.14.244 (Ga 18) Gallup, N. Mex.

CHEMICAL QUALITY OF WATER

The chemical quality of ground water in the Gallup area is generally fair for domestic needs. The quality varies vertically from one formation to another and areally in a given formation from one locality to another, as shown by the list of chemical analyses of water from wells at Gallup in table 2. The significance of the analyses is summarized in the following paragraphs by comparing the concentrations of dissolved materials in the water with the recommended limits of certain materials in public water supplies, as adopted by the New Mexico Department of Public Health in 1946. The Department of Public Health has not adopted recommended limits for all chemical constituents that occur generally in ground waters. Of the common constituents, limits for concentrations of only iron, magnesium, fluoride, chloride, sulfate, and total solids have been recommended.

The recommended limit for the concentration of iron in public water supplies is 0.3 ppm. The concentration of iron in 3 of 5 wells sampled in the east well field exceeded the recommended limit. The concentration of iron in water from these wells ranged from 0.17 to 1.9 ppm. The water from only one well in the west well field contained more than 0.3 ppm of iron. Water from well SF 1 contained 0.93 ppm of iron. The high concentration of iron in the water from the east well field is the cause of "red water" in parts of Gallup.

Limits on calcium in drinking water have not been adopted and the concentration of magnesium in water from both fields is much lower than the recommended limit of 125 ppm, ranging from 1.9 to 56 ppm. The concentration of calcium plus magnesium, the elements that determine the hardness of water, are appreciably higher in the water of the east well field (94 to 194 ppm) than in the west well field (6.7 to 91 ppm).

The concentration of sodium plus potassium is generally higher in the west well field (151 to 553 ppm) than in the east well field (81 to 239 ppm). A high ratio of sodium to calcium and magnesium in water makes it poor for agricultural purposes, but this ratio does not significantly affect the quality of the water for drinking and general household uses.

The concentration of bicarbonate is fairly uniform in the water from the municipal wells at Gallup, ranging from 234 to 535 ppm in the samples collected, except for one from the Airport well. The occurrence of free carbonate in the waters of the Gallup area is rare.

The recommended limit of sulfate in drinking water is 250 ppm. The concentration of sulfate in the samples of water from all the municipal wells is undesirably high, ranging from 261 to 514 ppm in the east field and 58 to 714 ppm in the west field. The water samples from only three wells (Ga 3, SF 4, and Airport) contained less than the recommended limit. The average concentrations of sulfate in the east well field does not differ greatly from that in the west well field. Sulfate concentrations greater than 250 ppm in drinking water do not have a lasting deleterious affect on most people, although water containing concentrations greater than 250 ppm is likely to be a laxative to people who are not accustomed to the water.

The recommended limit for concentrations of chloride in drinking water is 250 ppm. Concentrations of chloride in water from the municipal wells at Gallup range from 5 to 74 ppm.

The recommended limits for fluoride in drinking water is 0.5 to 1.5 ppm. Concentrations of fluorides in the water samples from all but 4 of the municipal wells is within the recommended limits. Those 4 samples contained concentrations of fluoride less than the recommended lower limit.

The concentrations of nitrates in all the samples are desirably low, ranging from 0.1 to 4.4 ppm.

Water containing more than 250 ppm of hardness is unsatisfactory for many industrial uses and makes large amounts of soap necessary in normal home use of the water. Municipal supplies of hard water are commonly treated in municipal softening plants, rather than the individuals softening the water with soap or cation-exchange softeners. Calcium-magnesium hardness in municipal water supplies preferably should be less than 100 ppm. The hardness exceeded 250 ppm in water from all the wells in the east well field, ranging from 280 to 600 ppm. In contrast, the hardness in the water from only 3 wells in the west well field exceeded 100 ppm. The hardness in the water from only one of these wells (Ga. 4) was greater than 250 ppm, and that well has not been used for several years because of physical defects. A soda-lime treatment plant was formerly operated by the Town of Gallup to soften the water from the east well field, but the filter system at the plant has been so seriously damaged by corrosion that is is unusable now.

The recommended drinking-water standards adopted by the State Department of Public Health state that, "Total solids not to exceed 500 ppm for water of good chemical quality. However, if such water is not available, a total solids content of 1,000 ppm may be permitted." The water sample from only one municipal well (SF 4) had a total concentration of dissolved solids less than 500 ppm, and that sample may not be representative, because of a short pumping interval before the sample was collected. The samples from only 4 wells contained more than 1,000 ppm of dissolved solids and 2 of those wells have been abandoned because of poor production. The concentration of dissolved solids does not vary appreciably from one well field to the other, being 740 to 968 ppm in the east field and 390 to 1,620 ppm in the west field.

The percent sodium and sodium adsorption ratio (SAR) values of water in relation to the specific conductance of the water, was developed by the U. S. Department of Agriculture to classify the suitability of water for irrigation. The specific conductance of water is an electrical measurement that is a general index of the concentration of dissolved solids in the water. Low values of specific conductance, percent sodium, and SAR indicate water of good irrigation quality and high values for any or all of these factors indicate water of poor irrigation quality. The quality of water from the east well field is fair for irrigation, but the quality of water from the west well field is poor for irrigation (see table 2). Because irrigation in the Gallup area is chiefly limited to watering of lawns, the irrigation quality of the water is not considered to be a serious problem. The soil alkalinity in small plots of land can be reasonably controlled, if necessary, with soil amenders.

RECORDS OF WELLS

Records of wells at Gallup date from 1916, when a sizable drilling program for the railroad commenced. A few wells were drilled in the area before 1916, but information on those wells is essentially nonexistent. Available information on the wells at Gallup is listed in table 3 and the locations of the wells are shown on plate 2. Thirty-three wells have been drilled for or acquired by the Town of Gallup, including the airport well, the Gallup Electric Power Company well at Gamerco, and the Santa Fe Railway wells, since 1916. Three of the wells were declared dry holes when the drilling was completed, because of very low yields, and were destroyed. Only 15 of the 33 wells were in use in 1956. The yield of wells Ga 11 and Ga 12, 2 of the currently used wells, is so small (10 to 15 gpm) as to make the feasibility of their use doubtful. The ownership of one well, formerly No. Ga 2, has been transferred to a private enterprise (The Elite Laundry).

The combined potential yield of the 13 wells that are now used by the town (this excludes the Power Company well at Gamerco, the Airport well, and the Elite Laundry well) is about 1,230 gpm, or 1,770,000 gallons per day (gpd). The amount of water pumped for use in Gallup in July 1956 was 35,121,000 gallons, an average of 1,130,000 gpd, which is 64 percent of the potential yield of all the wells. The peak daily demand for water in July undoubtedly was higher than the average demand and probably was near the potential yield of the wells. For a short time in June and July 1956, three pumps were out of order, during which time the amount of reserve water supply in the reservoirs declined markedly.

Table 3.--Records of wells at Gallup, New Mexico.

Well number or designation, USGS: see explanation of well-numbering system.

Altitude above sea level: all altitudes were determined with an altimeter and reported to nearest 5 feet.

Principal water-bearing bed: all the town wells produce from sandstones.
Depth to top of bed: determined by interpretation of driller's logs.
Geologic horizon: see table 1 for explanation of symbols.

Water level: reported depth to water given to nearest foot, measured depth given to nearest 0.1 foot.

Pump: Turb., deep well turbine; Sub., submersible.

Drawdown: change in depth to water during interval of time indicated.

Specific capacity: the pumping rate, in gallons per minute, divided by the drawdown, in feet.

A dash (-) in any column indicates that the information is not available.

The amount of water pumped for municipal use does not coincide with the amount delivered to the customers, owing to transmission losses in the distribution system, unmetered uses, and possibly faulty meters. For example, in July 1956 the amount of water pumped from the wells was 35,121,000 gallons, whereas the amount metered to the customers was 29,285,000 gallons. The record for the amount of water metered to customers covers a much longer period and is more complete than the record for the amount of water pumped, so the amount consumed is used as an index of the trend in water demand (fig. 8). The consumption rate in July 1956 was the highest of any month of record (fig. 8).

The depths of many of the wells is less now than when the wells were drilled. Silt and sand are commonly washed into a well, during the course of pumping, at a rate which is largely controlled by the size and shape of perforations in the casing and the nature of materials penetrated by the well. Part of the silt and sand is pumped from the well; the remainder settles to the bottom. Generally, the percentage of sediment that settles in the well increases with the depth of the perforations (the points of entry of the sediments) below the pump intake. However, for a particular well, consideration of the relative volume of water coming from each formation and the grain size of the sediments in relation to the velocity of water in the well need be considered. The sediments that accumulate in a well are likely to limit or even exclude the movement of water in the well below the upper level of sediment accumulation.

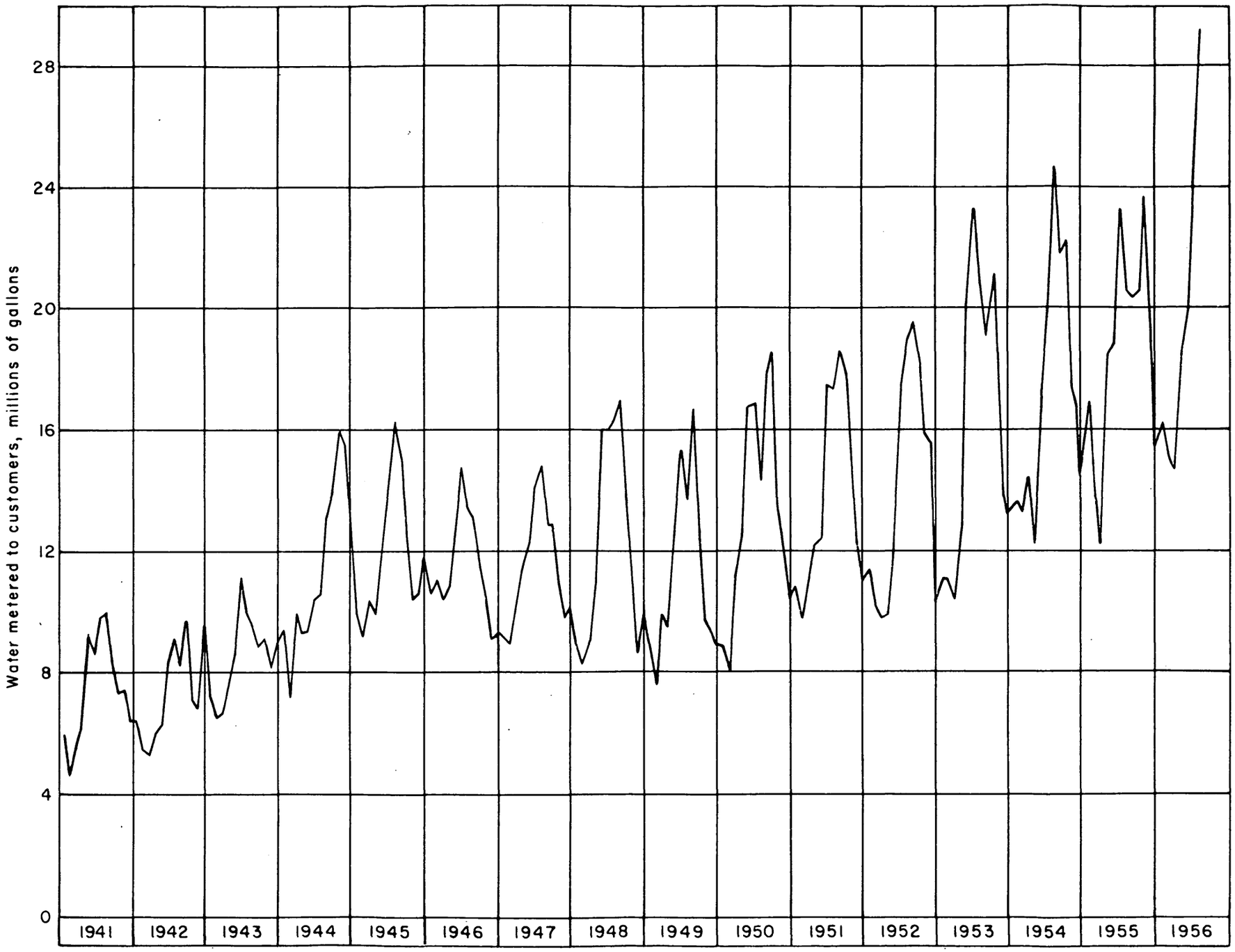

Figure 8.--Monthly deliveries of water to customers in Gallup, N. Mex., January 1941 to July 1956.

The depths of 12 municipal wells were measured in 1955 and 1956, and all but one of those was partly filled with sediment (see table 4). The Santa Fe Railway wells reportedly were cleaned about 10 years before the measurements were made, but records of the cleaning operations are not available to the writer. The other wells have not been cleaned since they were drilled. The effect of the sediments in the wells cannot be fully appraised at this time, owing to inadequate information on the yields of the wells relative to drawdown of water levels. Information on the capacity of the various aquifers to yield water to open wells also is inadequate.

A well cannot produce at the capacity of the water-bearing formations to transmit water unless the casing is adequately perforated adjacent to all the water-bearing zones. A comparison of the perforation records of wells SF 1 and SF 4 with an electric log of the new test well (SF 10) indicates that the casing was not perforated adjacent to all the water-bearing zones of the Gallup sandstone in those wells. Proper reconditioning of the wells now would require that radio-activity logs of the wells be made to locate the sandstone beds and the casing be perforated in place with a gun or knife perforator, in addition to removing the sediments.

Table 4.--Sediment in municipal wells, Gallup, N. Mex.

Well number	Year drilled	Depth when drilled (feet)	Depth in 1955-56 (feet)	Height of sediment in well (feet)
Ga 3	1918	1,580	1,417	163
Ga 6	-	435	134	301
Ga 7	1930	145	145	0
Ga 8	1930	325	253	72
Ga 9	1930	425	375	50
Ga 10	1942	320	304	16
Ga 15	1946	850	617	233
Ga 19	1949	850	489	361
SF 1	1917	2,315	1,338	977
SF 2	1916	1,345	951	394
SF 3	1917	2,300	1,980	320
SF 4	1923	2,110	1,870	240

CONCLUSIONS

The information on the municipal wells at Gallup was obtained from various sources, including copies of drillers' reports which date from 1916. Information on many of the wells is meager, so that it is impossible to reconstruct the ideas that suggested the method of completion for each well. Records of water levels, pumping rates, and the amount of drawdown in the wells during pumping are incomplete. Records of the amounts of water pumped from each well field also are incomplete. A comparison of current information on the wells with the early well records, however, shows a significant lowering of water levels in both well fields and a marked decrease in the yields of several wells, especially in the east well field. The lowering of water levels has increased the pumping lifts and the cost of pumping. The decreasing yields are caused by lowering water levels, partial to complete dewatering of shallow water-bearing strata, and accumulation of sediment in the wells. Some wells possibly have never produced at rates commensurate with the capacity of the water-bearing strata to yield water, because the well casings were not perforated adjacent to all the water-bearing zones penetrated.

The extent of pumping interference between wells has been established by frequent measurements of water levels since August 1955. The interference between closely spaced wells in the west well field is very pronounced (see fig. 3), but the pumping effects decrease markedly with increasing distances from the pumped wells. The distances between the railway wells in the west field range from 400 to 500 feet and the distance between wells Ga 3 and Ga 4 is only 270 feet. The optimum distance between wells in the field probably is 1,000 to 1,500 feet.

The quality of the ground water does not differ greatly in the east and west well fields, except for generally higher concentrations of iron and calcium-magnesium hardness in the water of the east well field. Higher concentrations of magnesium in combination with sulfate impart an undesirable taste to the water from the east well field that does not occur in the water from the west field. The analyses indicate that the quality of the water in the east field may have deteriorated slightly, since 1944.

The water from the west well field does not need treatment to reduce the hardness and the concentration of iron, whereas the water from the east field does.

The yields of existing wells are inconsistent, largely because part of the water-bearing zones in some wells are sealed off by non-perforated casing or by sediment in the wells. Lack of information as to which water-bearing zones are sealed off in individual wells makes it impossible to appraise the potential ground-water yield of the aquifers. The information to be obtained from the new test well (SF 10), in conjunction with available information on existing wells, should make possible an appraisal of the water-bearing characteristics of the different aquifers and the advisability of reconditioning old wells.

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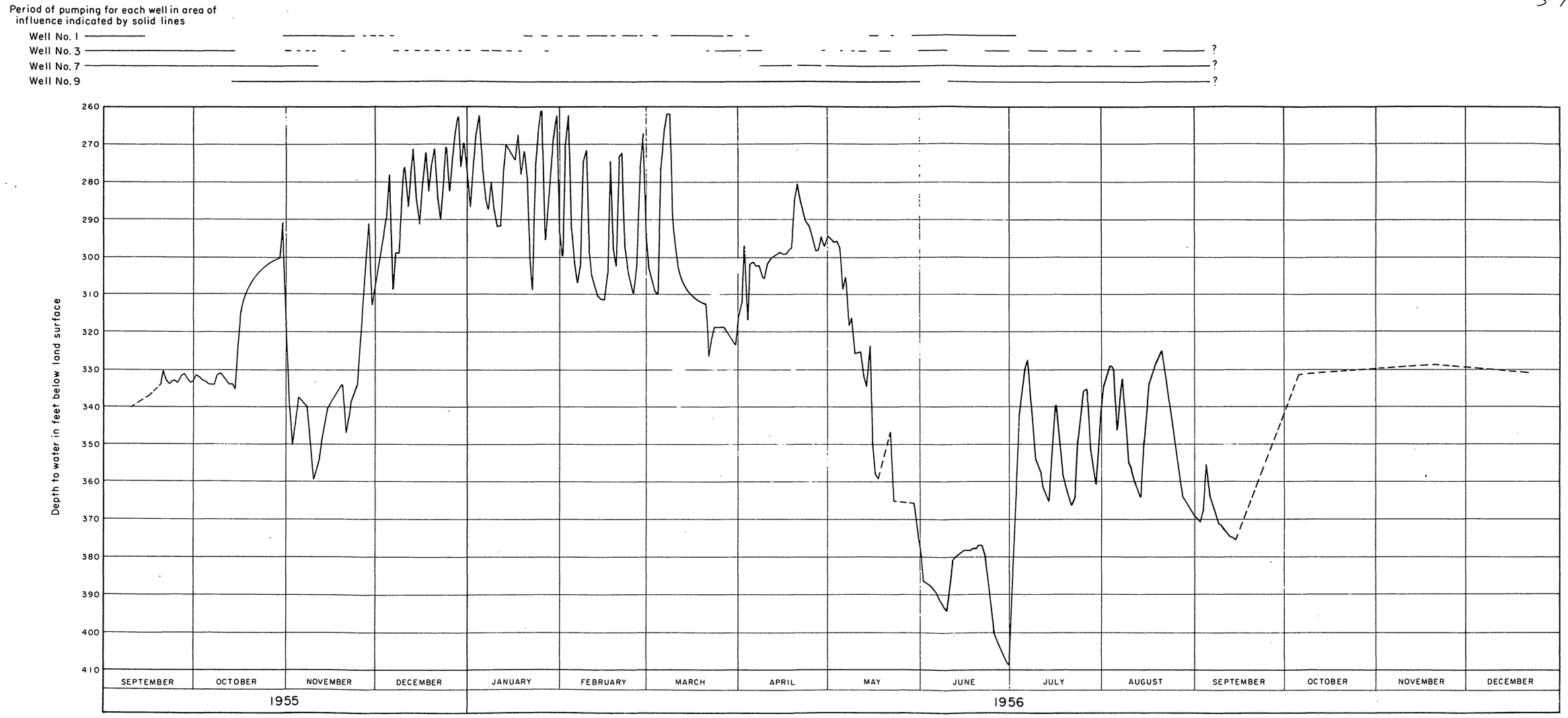

FIGURE 3 — Hydrograph of water level in Well 15.18.16. 341b(S.F.2) Gallup, N. Mex., showing changes caused by pumping from nearby wells

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Table 2.--Chemical analyses of water from wells at Gallup, New Mexico

(Analyzed by U. S. Geological Survey. Chemical constituents are in parts per million. Figures for dissolved solids are the sums of the determined constituents.)

Location number	Owner or name	Date collected	Stratigraphic unit	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Non carbonate	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Specific conductance (micromhos at 25° C)	Percent sodium	SAR	Temperature (°F)	pH
15.18.13.131	Gallup Well 16	8/11/48	Kgs	-	-	96	44	122		318	0	395	9.0	0.8	0.2		420	160	824	1.12	1,180	-	-	-	-
Do.	do.	4/14/56	do.	16	0.83	79	32	164	3.6	403	0	305	20	.6	.6		328	0	819	1.11	1,220	52	3.9	58	7.6
15.18.13.132	Ga 17	11/22/48	Kgs	14	-	129	34	81		326	0	345	8.0	.4	.4		462	195	772	1.05	1,100	-	-	-	7.7
Do.	do.	12/6/48	do.	18	-	122	45	94		300	0	416	10	.3	.4		490	244	854	1.16	1,200	-	-	-	7.6
Do.	do.	3/30/56	do.	20	1.9	148	56	82		278	0	514	10	.5	.8		600	372	968	1.32	1,340	23	1.5	60	7.3
15.18.14.132	Ga 10	9/-/42	Kgs	-	-	107	33	147		328	-	408	21	-	-		402	-	878	-	1,230	-	-	-	-
15.18.14.143	Ga 12	5/14/56	Kgs	12	.17	67	29	148		320	0	313	13	.6	.8		286	24	740	1.01	1,110	53	3.8	58	7.7
15.18.14.144a	Ga 11	10/-/42	Kgs	-	-	107	33	162		442	0	351	30	-	-		402	-	891	-	1,330	-	-	-	-
Do.	do.	2/6/56	do.	20	-	87	33	139		321	0	352	16	.1	1.9		352	90	807	1.10	1,160	46	3.2	60	7.5
15.18.14.222	Ga 14	8/30/44	Kgs	-	-	-	-	-		530	0	-	5	-	-		183	-	-	-	966	-	-	-	-
Do.	do.	9/29/44	do.	-	-	-	-	135		372	0	100	<5	.9	-		120	-	-	-	757	-	-	-	-
Do.	do.	11/28/55	do.	17	.34	66	28	185	3.6	434	0	261	33	.7	.8		280	0	808	1.10	1,210	59	4.8	60	7.5
15.18.14.232	Ga 8	11/28/55	Kgs	14	.24	83	29	198	3.5	482	0	306	20	.6	3.4		326	0	895	1.22	1,310	57	4.8	58	7.3
15.18.14.233	Ga 9	8/4/42	Kgs	-	-	146	50	104		373	0	446	18	-	-		570	-	948	-	1,280	-	-	-	-
15.18.14.242	Ga 13	7/10/44	Kgs	-	-	78	22	239		491	-	363	30	.5	.2		285	0	736	-	1,260	-	-	-	-
Do.	do.	11/28/55	do.	15	-	84	23	193	2.0	447	0	320	23	.5	4.4		304	0	892	-	1,320	58	-	57	7.9
15.18.15.312b	Elite Laundry	2/24/56	Kgs and Kd	16	-	22	7.1	272		302	6	309	67	.6	1.3		84	0	849	1.15	1,310	88	13	66	8.4
15.18.16.332a	Santa Fe well 4	9/7/56	Kgs, Kd, & Jm	46	.01	2.4	4.3	151		234	41	58	20	.6	.4		24	0	390	.60	663	93	14	77	9.1
15.18.16.332b	S.F. 7	4/14/56	Kgs, Kd, & Jm	19	.05	25	11	256		354	0	322	27	.6	.3		108	0	835	1.14	1,260	84	11	76	7.9
15.18.16.341a	S.F. 1	12/5/55	Kgs, Kd, & Jm	14	.93	15	3.8	550	2.6	535	0	714	52	.8	.3		53	0	1,620	2.20	2,280	95	33	78	7.5
15.18.16.341c	S.F. 3	12/13/55	Kgs, Kd, & Jm	15	.13	9.5	4.0	348	2.1	329	7	468	20	.4	.1		40	0	1,040	1.41	1,580	95	24	77	8.4
15.18.16.421a	Ga 4	7/12/47	Kgs, Kd, & Jm	-	-	70	21	299		436	0	430	74	.6	.3		261	0	1,110	1.51	1,670	-	-	-	7.9
15.18.16.421b	Ga 3	7/12/47	Kgs, Kd, & Jm	11	-	19	5.8	230		328	13	206	44	1.3	.1		72	0	692	.94	1,090	-	-	-	8.2
Do.	do.	5/11/56	do.	11	.09	31	10	235		354	0	240	60	1.4	1.4		118	0	764	1.04	1,210	81	9.4	76	8.0
15.18.17.444	S.F. 9	11/28/55	Kgs, Kd, & Jm	16	.00	8.0	1.9	290	1.0	344	4	303	30	.7	.6		28	0	839	-	1,250	96	-	78	8.3
15.18.19.244	Airport well	6/10/55	Qal or Kgc	12	-	23	5.9	409		1,030	0	85	25	1.0	.6		82	0	1,070	1.46	1,660	92	20	60	7.6
16.18.32.440	Gallup Electric Power Co. well	12/6/55	Kdc, Kgs, Kd, Jm, and Jcs	18	.24	14	3.8	226	2.9	271	0	366	20	.4	.1		50	0	824	1.12	1,220	91	16	89	8.1
Composite, treated	Town of Gallup	7/14/47	Kgs	11	-	25	21	175		181	12	312	25	-	.5		149	0	670	.91	1,020	-	-	-	8.1
Composite, untreated	do.	1/18/50	Kgs	-	-	85	36	144		408	0	293	24	-	.3		360	26	783	1.06	1,160	47	-	-	-
Composite, treated	Town of Gallup	1/18/50	Kgs	-	-	34	26	170		222	14	306	25	.2	1.2		192	0	686	.93	1,040	66	-	-	-
Composite, tap water	do.	12/5/55	do.	14	.98	80	29	192	3.4	465	0	309	27	.6	.1		318	0	884	1.20	1,300	56	4.7	53	7.8

Table 3.--Records of wells at Gallup, New Mexico-Continued

Well number or designation		Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Date of measurement	Diameter of well (inches)	Principal water-bearing bed			Depth to which well is cased (feet)	Water level		Pump		Yield		Draw Down		Specific capacity (gpm/ft drawdown)	Remarks
Town of Gallup	USGS							Depth to top of bed (feet)	Thickness (feet)	Geologic horizon		Depth below surface (feet)	Date of measurement	Type	Depth to intake (feet)	Rate (gpm)	Date of measurement	Amount (feet)	Duration of test (hours)		
Ga 1	15.18.15.312a	-	-	-	1,040	-	8	-	-	Kd,Jm(?)	940	Flowed 325	When drilled Feb. 1927	None	None	36	Feb. 1927	-	24	-	Abandoned and destroyed.
Ga 2	15.18.15.312b	-	-	-	1,250	-	8	-	-	Kd,Jm(?)	1,100	Flowed 325 50±	When drilled Mar. 1927 1950	Turb.	350	44.5 25	Mar. 1927 1955	- -	24 -	- -	Ownership transferred to Elite Laundry.
Ga 3	15.18.16.421b	George Myers	1918	6,500	1,580 1,417	1918 7/10/56	12	200 1,260 1,370	320 110 150	Kgs Kd Jm	1,580	338.5 180.1 198.2	July 1926 5/11/56 7/10/56	Sub.	790	132 116	Aug. 1919 July 1956	- -	- 24	- -	Used intermittently.
Ga 4	15.18.16.421a	Mr. Kertz	1918(?)	6,500	1,738	1918(?)	12	-	-	-	1,738	240 171.4 188.7	Jan. 1928 2/17/56 7/9/56	None	None	108.5	July 1918	230	-	0.47	Tools lost in well. Abandoned.
Ga 5	15.18.15.421c	Duffy and Sheldon	-	6,500	1,300	-	8	330 1,490 1,610	350 120 150	Kgs Kd Jm, Jcs	1,400	-	-	None	None	-	-	-	-	-	Abandoned. Possibly destroyed.
Ga 6	15.18.14.142c	-	-	-	435 134	- 9/12/55	-	-	-	-	-	Dry	9/12/55	None	None	24	1939	-	-	-	Abandoned.
Ga 7	15.18.14.142b	L. G. Hensley	Apr. 1930	6,545	145 145	Apr. 1930 1/11/56	5	82	63	Kgs	145	118 119.3 Dry	5/2/39 10/8/41 1/11/56	Turb.	-	250	1939	-	-	-	Abandoned. Pump motor worn out.
Ga 8	15.18.14.232	do.	1930(?)	6,565	325 253	1930(?) 6/28/56	8	194	131	Kgs	325	85 104 188.0 162.0	1930(?) 1939 12/15/55 2/14/56	Turb.	240	88 45	1952 Sept. 1955	- 20	- -	- 2.24	Pumping when water level measured.
Ga 9	15.18.14.233	do.	Apr. 1930	6,550	425 375	Apr. 1930 9/2/55	18	175	250	Kgs	85	103 183.4 143.3	1939 8/4/42 12/9/55	None	None	35 120	1939 8/4/42	- -	- -	- -	Abandoned. Water level measured while pumping 8/4/42.
Ga 10	15.18.14.132	Maher, Boardman, and Bertinetti	Aug. 1942	6,535	320 304	Aug. 1942 9/2/55	12	106	214	Kgs	320	106 123.4	8/25/42 9/2/55	None	None	52	Aug. 1942	58	96	.90	Abandoned. Old well, deepened in 1942.
Ga 11	15.18.14.144a	do.	Oct. 1942	6,545	355	Oct. 1942	16	81	274	Kgs	355	117 135.5	Oct. 1942 2/13/56	Turb.	220	300 11	Oct. 1942 2/13/56	- 40.6	- 6	- .27	Old well, deepened in 1942.
Ga 12	15.18.14.143	do.	July 1942	6,535	344	July 1942	12	55	240	Kgs	344	110	7/17/42	Turb.	210	118 30 10±	July 1942 1952 1955	- - -	- - -	- - -	
Ga 13	15.18.14.242	Ernest Boardman	1944	6,565	320	1944	10	219	101	Kgs	221	105 139 174.0	1944 Oct. 1947 2/20/56	Turb.	225	400 260 150	1944 1952 2/20/56	- - 31.4	- - 8	- - 4.78	

Table 3.--Records of wells at Gallup, New Mexico-Continued

Well number or designation		Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Date of measurement	Diameter of well (inches)	Principal water-bearing bed			Depth to which well is cased (feet)	Water level		Pump		Yield		Draw Down		Specific capacity (gpm/ft drawdown)	Remarks
Town of Gallup	USGS							Depth to top of bed (feet)	Thickness (feet)	Geologic horizon		Depth below surface (feet)	Date of measurement	Type	Depth to intake (feet)	Rate (gpm)	Date of measurement	Amount (feet)	Duration of test (hours)		
Ga 11	15.18.14.222	Ernest Boardman	Oct. 1944	6,585	335	Oct. 1944	10	247	88	Kgs	187	105	Oct. 1944	Turb.	310	79 66 62	1954 9/23/55 5/15/56	- - -	- - -	-	
Ga 15	15.18.12.111	do.	1946	6,565	850 617	1946 2/6/56	12	500	240	Kgs	650	135 129.2	1946 9/2/55	None	None	116 55 35	1946 1952 1954	- - -	48 - -	-	Abandoned.
Ga 16	15.18.13.131	do.	1948	6,560	505	1948	12	190	275	Kgs	190	140	1948	Turb.	360	70 65 41	1948 1952 5/15/56	- - -	- - -	-	
Ga 17	15.18.13.132	do.	1948	6,560	515	1948	10	222	278	Kgs	225	130 155.4	1948 10/19/55	Turb.	370	103 70 35 70	1948 1952 1954 3/30/56	- - - -	24 - - -	-	
Ga 18	15.18.14.244	do.	June 1949	6,555	535	June 1949	12	155	270	Kgs	170	143 157.8 170.9	June 1949 4/2/56 7/6/56	None	None	68	June 1949	-	67	-	Unused.
Ga 19	15.18.11.222	do.	Oct. 1949	6,655	850 489	Oct. 1949 3/8/56	10	425	265	Kgs	447	155 182.3	Oct. 1949 4/2/56	None	None	60	Oct. 1949	-	48	-	Unused.
Dry Hole	15.18.14.142a	-	Mar. 1939	-	155	Mar. 1939	-	-	-	Kgs	-	109	Mar. 1939	None	None	-	-	-	-	-	Destroyed.
Dry Hole	15.18.14.241a	-	-	-	425	-	-	-	-	-	-	-	-	None	None		-	-	-	-	Destroyed.
Dry Hole	15.18.14.144b	do.	May 1944	-	310	May 1944	-	-	-	-	--	-	-	None	None	-	-	-	-	-	Destroyed.
S.F. 1	15.18.16.341a	Gus Mulholland	July 1917	6,495	2,315 1,338	July 1917 5/14/56	15	1,000 1,920 2,090	350 110 150	Kgs Kd Jm	2,315	160 385.9	July 1917 5/14/56	Sub.	850	116	5/16/56	412	48	.28	
S.F. 2	15.18.16.341b	do.	Oct. 1916	6,505	1,345 951	Oct. 1916 7/9/56	15	980	320	Kgs	1,090	100 261.0 400.4	Oct. 1916 1/25/56 6/25/56	None	None	117	Oct. 1916	-	-	-	Unused.
S.F. 3	15.18.16.341c	do.	Mar. 1917	6,490	2,300 1,990	Mar. 1917 7/3/56	15	990 1,985 2,100	350 115 150	Kgs Kd Jm	1,980	50 384 421.0	Mar. 1917 9/22/54 7/5/56	Sub.	847	135 170 160	7/19/29 Jan. 1936 7/7/56	- - -	- - -	- - -	
S.F. 4	15.18.16.332a	Randolph and Steelsmith	Sept.1923	6,485	2,110 1,870	Sept. 1923 3/16/56		980 1,980 2,100	380 160 70	Kgs Kd Jm	1,862	100 506	Dec. 1923 10/12/55	Turb.	750	180 185 60	12/11/23 7/19/29 9/7/56	- - 130+	- - 1	- - .46	

Table 3.--Records of wells at Gallup, New Mexico-Continued

Well number or designation		Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Date of measurement	Diameter of well (inches)	Principal water-bearing bed			Depth to which well is cased (feet)	Water level		Pump		Yield		Draw Down		Specific capacity (gpm/ft drawdown)	Remarks
Town of Gallup	USGS							Depth to top of bed (feet)	Thickness (feet)	Geologic horizon		Depth below surface (feet)	Date of measurement	Type	Depth to intake (feet)	Rate (gpm)	Date of measurement	Amount (feet)	Duration of test (hours)		
S.F. 5	15.18.15.312d	Roscoe Moss Co.	Aug. 1925	-	1,400 3,300	Aug. 1925 May 1927	16	938	222	Kd	1,251	204	Aug. 1925	None	None	40	9/16/31	-	-	-	Abandoned.
S.F. 6	15.18.15.312c	Gus Hollholland	July 1910	-	460	July 1910	-	-	-	Qal	-	-	-	None	None	-	-	-	-	-	Plugged at 270 feet to shut out iron-sulfate water.
S.F. 7	15.18.16.332b	Moss Barker	1942	6,485	2,313	1942	15	965 1,965 2,090	350 125 150	Kgs Kd Jn	-	-	-	Sub.	890	225	6/14/56	-	-	-	
S.F. 8	15.18.15.310	-	1942	-	-	-	-	-	-	-	-	-	-	None	None	-	-	-	-	-	Abandoned.
S.F. 9	15.18.17.444	Mack Drilling Co.	1946	6,485	2,308	1946	15	960 1,960 2,080	350 120 150	Kgs Kd Jn	2,100	298.7	9/30/55	Sub.	840	167	6/14/56	-	--	-	Standby well; not in use.
Airport	15.18.19.244	Updike	-	-	150±	-	6	-	-	Qal, Kgc	-	77.2	11/4/55	None	None	-	-	-	-	-	Abandoned.
Gamerco	16.18.32.440	Chino Copper Co.	-	6,735	2,382	-	14	-	-	Kmu Kd Jn	2,882	-	-	Turb.	770	230	Mar. 1956	-	72	-	

STATUS OF REPORT

NAME OF REPORT: A preliminary Report on Municipal Water Wells, Gallup, New Mexico

AUTHOR(S): S.W. West

COOPERATOR(S): State Engineer and Town of Gallup

INITIAL DRAFT(including illustrations)

Submitted for review(date): 1-16-57

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A. T. Conner	2-12-57	2-13-57	Usually satisfactory, subcommittee
E.D. Gordon	2/12/57		

Returned to author(s) (final date): 2-18-57

INTERMEDIATE DRAFT (for submittal to Washington)

Submitted for review in District Office(date):

Reviewed by	From(date):	To(date):	Remarks
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C.S. Conner	2-22-57		Good, returned for consideration of topping

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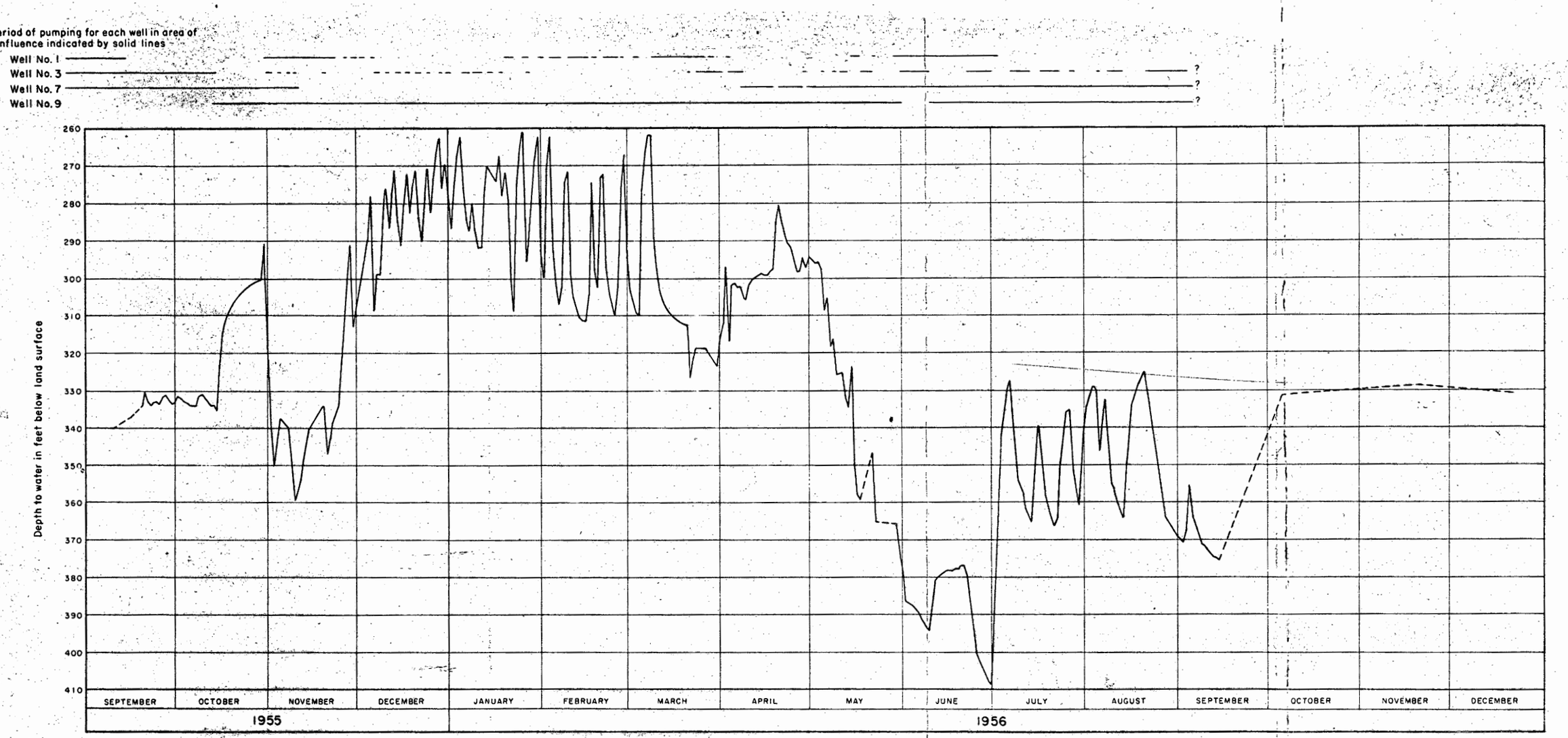

FIGURE 3 — Hydrograph of water level in Well 15.18.16. 341b (S.F.2) Gallup, N. Mex., showing changes caused by pumping from nearby wells

Table 3.—Records of wells at Gallup, New Mexico—Continued

Well number or designation		Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Date of measurement	Diameter of well (inches)	Principal water-bearing bed			Depth to which well is cased (feet)	Water level		Pump		Yield		Draw Down		Specific capacity (gpm/ft drawdown)	Remarks
Town of Gallup	USGS							Depth to top of bed (feet)	Thickness (feet)	Geologic horizon		Depth below surface (feet)	Date of measurement	Type	Depth to intake (feet)	Rate (gpm)	Date of measurement	Amount (feet)	Duration of test (hours)		
Ga 1	15.18.15.312a	-	-	-	1,040	-	8	-	-	Kd, Jm(?)	940	Flowed 325	When drilled Feb. 1927	None	None	36	Feb. 1927	-	24	-	Abandoned and destroyed.
Ga 2	15.18.15.312b	-	-	-	1,250	-	8	-	-	Kd, Jm(?)	1,100	Flowed 325 50±	When drilled Mar. 1927 1950	Turb.	350	44.5 25	Mar. 1927 1955	- -	24 -	- -	Ownership transferred to Elite Laundry.
Ga 3	15.18.16.421b	George Myers	1918	6,500	1,580 1,417	1918 7/10/56	12	200 1,260 1,370	320 110 150	Kgs Kd Jm	1,580	338.5 180.1 198.2	July 1926 5/11/56 7/10/56	Sub.	790	132 116	Aug. 1919 July 1956	- -	- 24	- -	Used intermittently.
Ga 4	15.18.16.421a	Dr. Kertz	1918(?)	6,500	1,738	1918(?)	12	-	-	-	1,738	240 171.4 188.7	Jan. 1928 2/17/56 7/9/56	None	None	108.5	July 1918	230	-	0.47	Tools lost in well. Abandoned.
Ga 5	15.18.15.421c	Duffy and Sheldon	-	6,500	1,300	-	8	330 1,490 1,610	350 120 150	Kgs Kd Jm, Jcs	1,400	-	-	None	None	-	-	-	-	-	Abandoned. Possibly destroyed.
Ga 6	15.18.14.142c	-	-	-	435 134	- 9/12/55	-	-	-	-	-	Dry	9/12/55	None	None	24	1939	-	-	-	Abandoned.
Ga 7	15.18.14.142b	L. C. Hensley	Apr. 1930	6,545	145 145	Apr. 1930 1/11/56	5	82	63	Kgs	145	118 119.3 Dry	5/2/39 10/8/41 1/11/56	Turb.	-	250	1939	-	-	-	Abandoned. Pump motor worn out.
Ga 8	15.18.14.232	do.	1930(?)	6,565	325 253	1930(?) 6/20/56	8	194	131	Kgs	325	85 104 138.0 162.0	1930(?) 1939 12/15/55 2/14/56	Turb.	240	88 45	1952 Sept. 1955	- 20	- -	- 2.24	Pumping when water level measured.
Ga 9	15.18.14.233	do.	Apr. 1930	6,550	425 375	Apr. 1930 9/2/55	18	175	250	Kgs	85	103 183.4 143.3	1939 8/4/42 12/9/55	None	None	35 120	1939 8/4/42	- -	- -	- -	Abandoned. Water level measured while pumping 8/4/42.
Ga 10	15.18.14.132	Maher, Boardman, and Bertinetti	Aug. 1942	6,535	320 304	Aug. 1942 9/2/55	12	106	214	Kgs	320	106 123.4	8/25/42 9/2/55	None	None	52	Aug. 1942	58	96	.90	Abandoned. Old well, deepened in 1942.
Ga 11	15.18.14.144a	do.	Oct. 1942	6,545	355	Oct. 1942	16	81	274	Kgs	355	117 135.5	Oct. 1942 2/13/56	Turb.	220	300 11	Oct. 1942 2/13/56	- 40.6	- 6	- .27	Old well, deepened in 1942.
Ga 12	15.18.14.143	do.	July 1942	6,535	344	July 1942	12	55	240	Kgs	344	110	7/17/42	Turb.	210	118 30 10±	July 1942 1952 1955	- - -	- - -	- - -	
Ga 13	15.18.14.242	Ernest Boardman	1944	6,565	320	1944	10	219	101	Kgs	221	105 139 174.0	1944 Oct. 1947 2/20/56	Turb.	225	400 260 150	1944 1952 2/20/56	- - 31.4	- - 8	- - 4.78	

Table 3.--Records of wells at Gallup, New Mexico-Continued

Well number or designation		Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Date of measurement	Diameter of well (inches)	Principal water-bearing bed			Depth to which well is cased (feet)	Water level		Pump		Yield		Draw down		Specific capacity (gpm/ft drawdown)	Remarks
Town of Gallup	USGS							Depth to top of bed (feet)	Thickness (feet)	Geologic horizon		Depth below surface (feet)	Date of measurement	Type	Depth to intake (feet)	Rate (gpm)	Date of measurement	Amount (feet)	Duration of test (hours)		
Ga 14	15.18.14.222	Ernest Boardman	Oct. 1944	6,565	335	Oct. 1944	10	247	88	Kgs	187	105	Oct. 1944	Turb.	310	79 66 62	1954 9/23/55 5/15/56	- - -	- - -	-	
Ga 15	15.18.12.111	do.	1946	6,665	850 617	1946 2/6/56	12	500	240	Kgs	650	135 129.2	1946 9/2/55	None	None	116 65 35	1946 1952 1954	- - -	48 - -	-	Abandoned.
Ga 16	15.18.13.131	do.	1948	6,560	505	1948	12	190	275	Kgs	190	140	1948	Turb.	360	70 65 41	1948 1952 5/15/56	- - -	- - -	-	
Ga 17	15.18.13.132	do.	1948	6,560	515	1948	10	222	278	Kgs	225	130 155.4	1948 10/19/55	Turb.	370	103 70 35 70	1948 1952 1954 3/30/56	- - - -	24 - - -	-	
Ga 18	15.18.11.244	do.	June 1949	6,555	535	June 1949	12	155	270	Kgs	170	143 157.8 170.9	June 1949 4/2/56 7/6/56	None	None	68	June 1949	-	67	-	Unused.
Ga 19	15.18.11.222	do.	Oct. 1949	6,655	850 489	Oct. 1949 3/8/56	10	425	265	Kgs	447	155 182.3	Oct. 1949 4/2/56	None	None	60	Oct. 1949	-	48	-	Unused.
Dry Hole	15.18.14.142a	-	Mar. 1939	-	155	Mar. 1939	-	-	-	Kgs	-	109	Mar. 1939	None	None	-	-	-	-	-	Destroyed.
Dry Hole	15.18.14.241a	-	-	-	425	-	-	-	-	-	-	-	-	None	None		-	-	-	-	Destroyed.
Dry Hole	15.18.14.144b	do.	May 1944	-	310	May 1944	-	-	-	-	--	-	-	None	None	-	-	-	-	-	Destroyed.
S.F. 1	15.18.16.341a	Gus Mulholland	July 1917	6,495	2,315 1,338	July 1917 3/14/56	15	1,000 1,220 2,090	350 110 150	Kgs Kd Jm	2,315	160 385.9	July 1917 5/14/56	Sub.	850	116	5/16/56	412	48	.28	
S.F. 2	15.18.16.341b	do.	Oct. 1916	6,505	1,345 951	Oct. 1916 7/9/56	15	990	320	Kgs	1,090	100 261.0 400.4	Oct. 1916 1/25/56 6/25/56	None	None	117	Oct. 1916	-	-	-	Unused.
S.F. 3	15.18.16.341c	do.	Mar. 1917	6,490	2,300 1,990	Mar. 1917 7/3/56	15	990 1,985 2,100	350 115 150	Kgs Kd Jm	1,980	50 384 421.0	Mar. 1917 9/22/54 7/5/56	Sub.	847	135 170 160	7/19/29 Jan. 1936 7/7/56	- - -	- - -	-	
S.F. 4	15.18.16.332a	Randolph and Steelsmith	Sept.1923	6,485	2,110 1,870	Sept. 1923 3/16/56		980 1,980 2,100	380 140 70	Kgs Kd Jm	1,862	100 506	Dec. 1923 10/12/55	Turb.	750	180 185 60	12/11/23 7/19/29 9/7/56	- - 130+	- - 1	- - .46	

Table 3.--Records of wells at Gallup, New Mexico-Continued

Well number or designation		Driller	Date completed	Altitude above sea level (feet)	Depth of well (feet)	Date of measurement	Diameter of well (inches)	Principal water-bearing bed			Depth to which well is cased (feet)	Water level		Pump		Yield		Drawdown		Specific capacity (gpm/ft drawdown)	Remarks
Town of Gallup	USGS							Depth to top of bed (feet)	Thickness (feet)	Geologic horizon		Depth below surface (feet)	Date of measurement	Type	Depth to intake (feet)	Rate (gpm)	Date of measurement	Amount (feet)	Duration of test (hours)		
S.F. 5	15.18.15.312d	Roscoe Moss Co.	Aug. 1925	-	1,400 1,300	Aug. 1925 May 1927	16	938	222	Kd	1,251	204	Aug. 1925	None	None	40	9/16/31	-	-	-	Abandoned.
S.F. 6	15.18.15.312c	Gus Hallholland	July 1910	-	460	July 1910	-	-	-	Qal	-	-	-	None	None	-	-	-	-	-	Plugged at 270 feet to shut out iron-sulfate water.
S.F. 7	15.18.16.332b	Ross Barker	1942	6,425	2,123	1942	15	965 1,965 2,090	350 125 150	Kgs Kd Jn	-	-	-	Sub.	890	225	6/14/56	-	-	-	
S.F. 8	15.18.15.310	-	1942	-	-	-	-	-	-	-	-	-	-	None	None	-	-	-	-	-	Abandoned.
S.F. 9	15.18.17.444	Mack Drilling Co.	1946	6,485	2,308	1946	15	960 1,960 2,080	350 120 150	Kgs Kd Jn	2,100	298.7	9/30/55	Sub.	840	167	6/14/56	-	-	-	Standby well; not in use.
Airport	15.18.19.244	Updike	-	-	150	-	6	-	-	Qal, Kdc	-	77.2	11/4/55	None	None	-	-	-	-	-	Abandoned.
Gamerco	16.18.32.440	Chino Copper Co.	-	6,735	2,382	-	14	-	-	Kmn Kd Jn	2,382	-	-	Turb.	770	230	Mar. 1956	-	72	-	

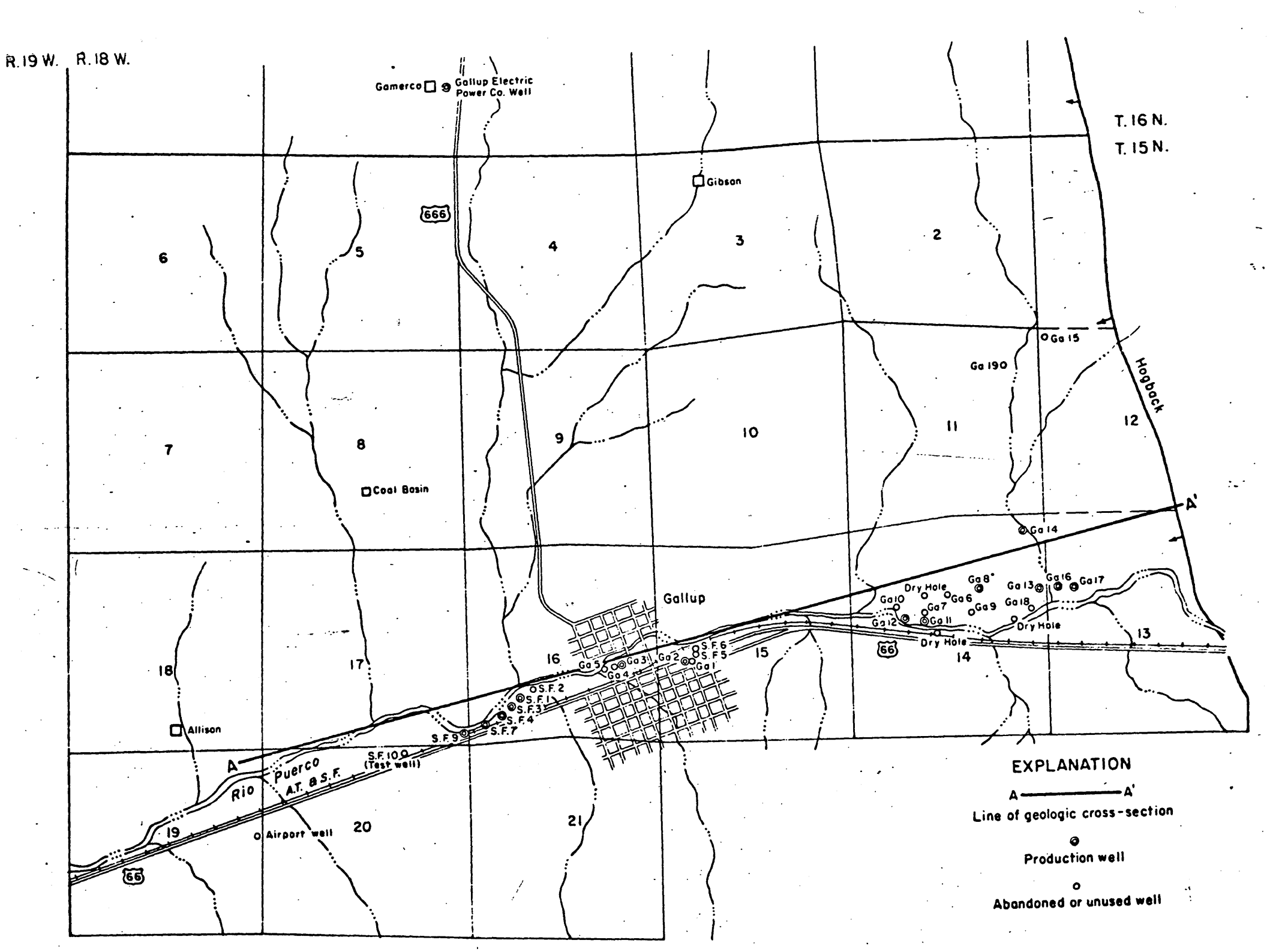

PLATE 2 – Locations of municipal wells, Gallup, N. Mex., 195?

Table 2.--Chemical analyses of water from wells at Gallup, New Mexico

(Analyzed by U. S. Geological Survey. Chemical constituents are in parts per million. Figures for dissolved solids are the sums of the determined constituents.)

Location number	Owner or name	Date collected	Stratigraphic unit	Silica (SiO_2)	Iron (Fe)	Calcium (Ca^{++})	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Non carbonate	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Specific conductance (micromhos at 25° C)	Percent sodium	SAR	Temperature (°F)	pH
15.18.13.131	Gallup Well 16	8/11/48	Kgs	-	-	96	44	122		318	0	395	9.0	0.8	0.2		420	160	824	1.12	1,180	-	-	-	-
Do.	do.	4/14/56	do.	16	0.83	79	32	164	3.6	403	0	305	20	.6	.6		328	0	819	1.11	1,220	52	3.9	58	7.6
15.18.13.132	Ga 17	11/22/48	Kgs	14	-	129	34	81		326	0	345	8.0	.4	.4		462	195	772	1.05	1,100	-	-	-	7.7
Do.	do.	12/6/48	do.	18	-	122	45	94		300	0	416	10	.3	.4		490	244	854	1.16	1,200	-	-	-	7.6
Do.	do.	3/30/56	do.	20	1.9	148	56	82		278	0	514	10	.5	.8		600	372	968	1.32	1,340	23	1.5	60	7.3
15.18.14.132	Ga 10	9/-/42	Kgs	-	-	107	33	147		328	-	408	21	-	-		402	-	878	-	1,230	-	-	-	-
15.18.14.143	Ga 12	5/14/56	Kgs	12	.17	67	29	148		320	0	313	13	.6	.8		286	24	740	1.01	1,110	53	3.8	58	7.7
15.18.14.144a	Ga 11	10/-/42	Kgs	-	-	107	33	162		442	0	351	30	-	-		402	-	891	-	1,330	-	-	-	-
Do.	do.	2/6/56	do.	20	-	87	33	139		321	0	352	16	.1	1.9		352	90	807	1.10	1,160	46	3.2	60	7.5
15.18.14.222	Ga 14	8/30/44	Kgs	-	-	-	-	-		530	0	-	5	-	-		183	-	-	-	966	-	-	-	-
Do.	do.	9/29/44	do.	-	-	-	-	135		372	0	100	<5	.9	-		120	-	-	-	757	-	-	-	-
Do.	do.	11/28/55	do.	17	.34	66	28	185	3.6	434	0	261	33	.7	.8		280	0	808	1.10	1,210	59	4.8	60	7.5
15.18.14.232	Ga 8	11/28/55	Kgs	14	.24	83	29	198	3.5	482	0	306	20	.6	3.4		326	0	895	1.22	1,310	57	4.8	58	7.3
15.18.14.233	Ga 9	8/4/42	Kgs	-	-	146	50	104		373	0	446	18	-	-		570	-	948	-	1,280	-	-	-	-
15.18.14.242	Ga 13	7/10/44	Kgs	-	-	78	22	239		491	-	363	30	.5	.2		285	0	736	-	1,260	-	-	-	-
Do.	do.	11/28/55	do.	15	-	84	23	193	2.0	447	0	320	23	.5	4.4		304	0	892	-	1,320	58	-	57	7.9
15.18.15.312b	Elite Laundry	2/24/56	Kgs and Kd	16	-	22	7.1	272		302	6	309	67	.6	1.3		84	0	849	1.15	1,310	88	13	66	8.4
15.18.16.332a	Santa Fe well 4	9/7/56	Kgs, Kd, & Jm	46	.01	2.4	4.3	151		234	41	58	20	.6	.4		24	0	390	.60	663	93	14	77	9.1
15.18.16.332b	S.F. 7	4/14/56	Kgs, Kd, & Jm	19	.05	25	11	256		354	0	322	27	.6	.3		108	0	835	1.14	1,260	84	11	76	7.9
15.18.16.341a	S.F. 1	12/5/55	Kgs, Kd, & Jm	14	.93	15	3.8	550	2.6	535	0	714	52	.8	.3		53	0	1,620	2.20	2,280	95	33	78	7.5
15.18.16.341c	S.F. 3	12/13/55	Kgs, Kd, & Jm	15	.13	9.5	4.0	348	2.1	329	7	468	20	.4	.1		40	0	1,040	1.41	1,580	95	24	77	8.4
15.18.16.421a	Ga 4	7/12/47	Kgs, Kd, & Jm	-	-	70	21	299		436	0	430	74	.6	.3		261	0	1,110	1.51	1,670	-	-	-	7.9
15.18.16.421b	Ga 3	7/12/47	Kgs, Kd, & Jm	11	-	19	5.8	230		328	13	206	44	1.3	.1		72	0	692	.94	1,090	-	-	-	8.2
Do.	do.	5/11/56	do.	11	.09	31	10	235		354	0	240	60	1.4	1.4		118	0	764	1.04	1,210	81	9.4	76	8.0
15.18.17.444	S.F. 9	11/28/55	Kgs, Kd, & Jm	16	.00	8.0	1.9	290	1.0	344	4	303	30	.7	.6		28	0	839	-	1,250	96	-	78	8.3
15.18.19.244	Airport well	6/10/55	Qal or Kgc	12	-	23	5.9	409		1,030	0	85	25	1.0	.6		82	0	1,070	1.46	1,660	92	20	60	7.6
16.18.32.440	Gallup Electric Power Co. well	12/6/55	Kdc, Kgs, Kd, Jm, and Jcs	18	.24	14	3.8	226	2.9	271	0	366	20	.4	.1		50	0	824	1.12	1,220	91	16	89	8.1
Composite, treated	Town of Gallup	7/14/47	Kgs	11	-	25	21	175		181	12	312	25	-	.5		149	0	670	.91	1,020	-	-	-	8.1
Composite, untreated	do.	1/18/50	Kgs	-	-	85	36	144		408	0	293	24	-	.3		360	26	783	1.06	1,160	47	-	-	-
Composite, treated	Town of Gallup	1/18/50	Kgs	-	-	34	26	170		222	14	306	25	.2	1.2		192	0	686	.93	1,040	66	-	-	-
Composite, tap water	do.	12/5/55	do.	14	.98	80	29	192	3.4	465	0	309	27	.6	.1		318	0	884	1.20	1,300	56	4.7	53	7.8

Table 2.--Chemical analyses of water from wells at Gallup, New Mexico

(Analyzed by U. S. Geological Survey. Chemical constituents are in parts per million. Figures for dissolved solids are the sums of the determined constituents.)

Location number	Owner or name	Date collected	Stratigraphic unit	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Hardness as CaCO3: Calcium magnesium	Hardness as CaCO3: Non-carbonate	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Specific conductance (micromhos at 25° C)	Color	pH	Temperature (°F)	pH
15.18.13.131	Gallup Well 16	8/11/48	Kgs	-	-	98	44	122		318	0	395	9.0	0.8	0.2		420	160	824	1.12	1,180	-	-	-	-
Do.	do.	4/14/56	do.	16	0.83	79	32	164	3.6	403	0	305	20	.6	.6		328	0	819	1.11	1,220	52	3.9	58	7.6
15.18.13.132	Ga 17	11/22/48	Kgs	14	-	129	34	81		326	0	345	8.0	.4	.4		462	195	772	1.05	1,100	-	-	-	7.7
Do.	do.	12/6/48	do.	18	-	122	45	94		300	0	416	10	.3	.4		490	244	854	1.16	1,200	-	-	-	7.6
Do.	do.	3/30/56	do.	20	1.9	148	56	82		278	0	514	10	.5	.8		600	372	968	1.32	1,340	23	1.5	60	7.3
15.18.14.132	Ga 10	9/-/42	Kgs	-	-	107	33	147		328	-	408	21	-	-		402	-	878	-	1,230	-	-	-	-
15.18.14.143	Ga 12	5/14/56	Kgs	12	.17	67	29	148		320	0	313	13	.6	.8		286	24	740	1.01	1,110	53	3.8	58	7.7
15.18.14.144a	Ga 11	10/-/42	Kgs	-	-	107	33	162		442	0	351	30	-	-		402	-	891	-	1,330	-	-	-	-
Do.	do.	2/6/56	do.	20	-	87	33	139		321	0	352	16	.1	1.9		352	90	807	1.10	1,160	46	3.2	60	7.5
15.18.14.222	Ga 14	8/30/44	Kgs	-	-	-	-	-		530	0	-	5	-	-		183	-	-	-	966	-	-	-	-
Do.	do.	9/29/44	do.	-	-	-	-	135		372	0	100	<5	.9	-		120	-	-	-	757	-	-	-	-
Do.	do.	11/28/55	do.	17	.34	66	28	185	3.6	434	0	261	33	.7	.8		280	0	808	1.10	1,210	59	4.8	60	7.5
15.18.14.232	Ga 8	11/28/55	Kgs	14	.24	83	29	198	3.5	482	0	306	20	.6	3.4		326	0	895	1.22	1,310	57	4.8	58	7.3
15.18.14.233	Ga 9	8/4/42	Kgs	-	-	146	50	104		373	0	446	18	-	-		570	-	948	-	1,280	-	-	-	-
15.18.14.242	Ga 13	7/10/44	Kgs	-	-	78	22	239		491	-	363	30	.5	.2		285	0	736	-	1,260	-	-	-	-
Do.	do.	11/28/55	do.	15	-	84	23	193	2.0	447	0	320	23	.5	4.4		304	0	892	-	1,320	58	-	57	7.9
15.18.15.312b	Elite Laundry	2/24/56	Kgs and Kd	16	-	22	7.1	272		302	6	309	67	.6	1.3		84	0	849	1.15	1,310	88	13	66	8.4
15.18.16.332a	Santa Fe well 4	9/7/56	Kgs, Kd, & Jm	46	.01	2.4	4.3	151		234	41	58	20	.6	.4		24	0	390	.60	663	93	14	77	9.1
15.18.16.332b	S.F. 7	4/14/56	Kgs, Kd, & Jm	19	.05	25	11	256		354	0	322	27	.6	.3		108	0	835	1.14	1,260	84	11	76	7.9
15.18.16.341a	S.F. 1	12/5/55	Kgs, Kd, & Jm	14	.93	15	3.8	550	2.6	535	0	714	52	.8	.3		53	0	1,620	2.20	2,280	95	33	78	7.5
15.18.16.341c	S.F. 3	12/13/55	Kgs, Kd, & Jm	15	.13	9.5	4.0	348	2.1	329	7	468	20	.4	.1		40	0	1,040	1.41	1,580	95	24	77	8.4
15.18.16.421a	Ga 4	7/12/47	Kgs, Kd, & Jm	-	-	70	21	299		436	0	430	74	.6	.3		261	0	1,110	1.51	1,670	-	-	-	7.9
15.18.16.421b	Ga 3	7/12/47	Kgs, Kd, & Jm	11	-	19	5.8	230		328	13	206	44	1.3	.1		72	0	692	.94	1,090	-	-	-	8.2
Do.	do.	5/11/56	do.	11	.09	31	10	235		354	0	240	60	1.4	1.4		118	0	784	1.04	1,210	81	9.4	76	8.0
15.18.17.444	S.F. 9	11/28/55	Kgs, Kd, & Jm	16	.00	8.0	1.9	290	1.0	344	4	303	50	.7	.6		28	0	839	-	1,250	96	-	78	8.3
15.18.19.244	Airport well	6/10/55	Qal or Kgc	12	-	23	5.9	409		1,030	0	85	25	1.0	.6		82	0	1,070	1.46	1,660	92	20	60	7.6
16.18.32.440	Gallup Electric Power Co. well	12/6/55	Kdc, Kgs, Kd, Jm, and Jcs	18	.24	14	3.8	226	2.9	271	0	366	20	.4	.1		50	0	824	1.12	1,220	91	16	89	8.1
Composite, treated	Town of Gallup	7/14/47	Kgs	11	-	25	21	175		181	12	312	25	-	.5		149	0	670	.91	1,020	-	-	-	8.1
Composite, untreated	do.	1/18/50	Kgs	-	-	85	36	144		408	0	293	24	-	.3		360	26	783	1.06	1,160	47	-	-	-
Composite, treated	Town of Gallup	1/18/50	Kgs	-	-	34	26	170		222	14	306	25	.2	1.2		192	0	686	.93	1,040	66	-	-	-
Composite, tap water	do.	12/5/55	do.	14	.98	80	29	192	3.4	465	0	309	27	.6	.1		318	0	884	1.20	1,300	56	4.7	53	7.8

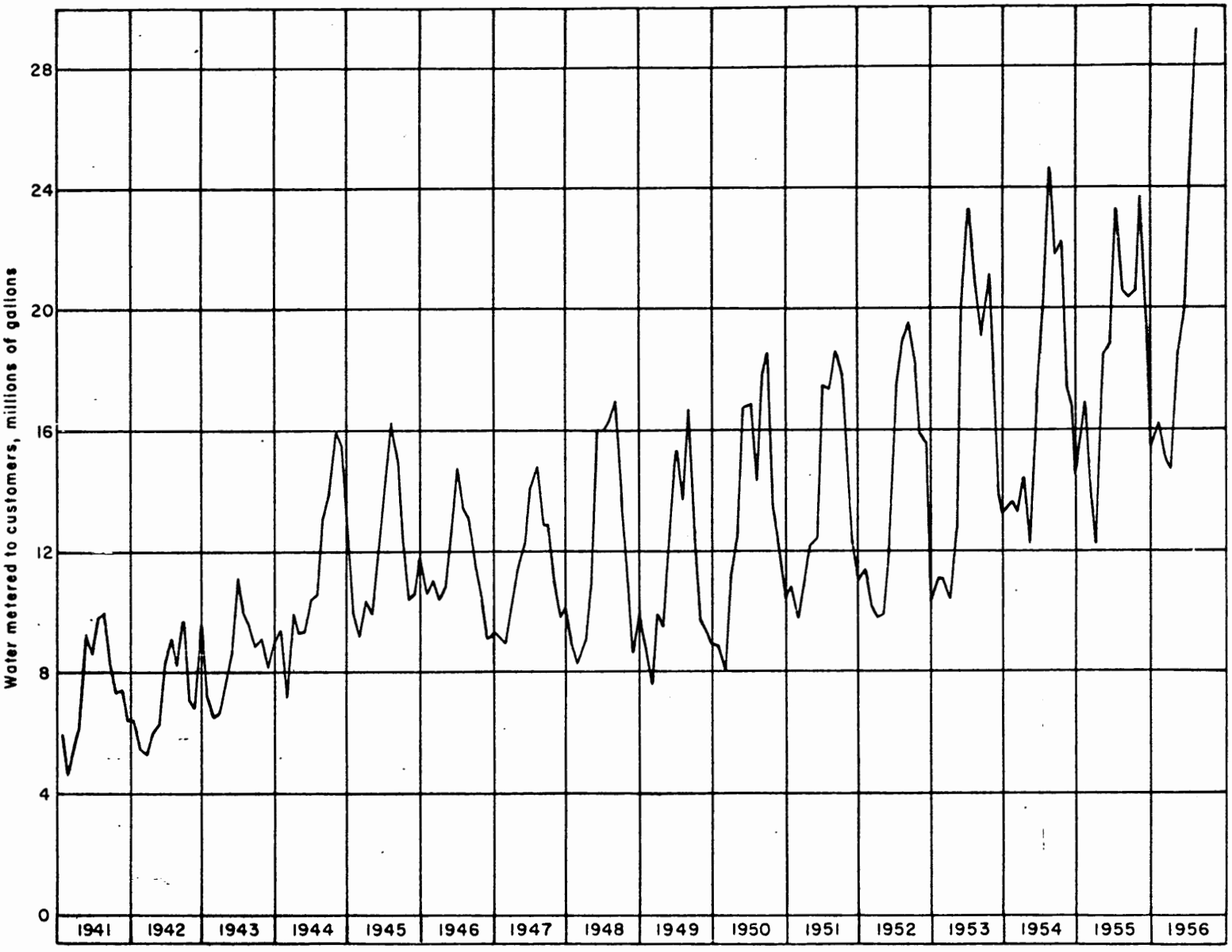

Figure 8.--Monthly deliveries of water to customers in Gallup, N. Mex., January 1941 to July 1956.