Geology and Ground Water of the Luke Area Maricopa County, Arizona

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1779-P

Prepared in cooperation with the U.S. Army Corps of Engineers and the U.S. Air Force

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By R. S. STULIK *and* F. R. TWENTER

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

TABLES

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

GEOLOGY AND GROUND WATER OF THE LUKE AREA, MARICOPA COUNTY, ARIZONA

By R. S. STULIK and F. R. TWENTER

ABSTRACT

Luke Air Force Base, in the Salt River Valley in central Arizona, is within an intermontane basin—the Phoenix basin—in the Basin and Range lowlands province. The Luke area, the subject of this study, extends beyond the limits of the base.

Ground-water resources of the Luke area were studied to determine the possibility of developing a water supply of optimum quantity and quality to supplement the base supply. Several wells drilled for this purpose, prior to the study, either produced an inadequate supply of water or produced water that had a high dissolved-solids content.

The Phoenix basin is filled with unconsolidated to semiconsolidated Tertiary and Quaternary sedimentary rocks that are referred to as valley fill. Although its total thickness is unknown, 2,784 feet of valley fill—primarily consisting of clay, silt, sand, and gravel—has been penetrated.

Percentage-distribution maps of fine-grained materials indicate a gross-facies pattern and a selective depositional area of the valley-fill materials. The maps also indicate that the areal distribution of fine-grained materials increases with depth. In general, the better producing wells, regardless of depth, are in areas where the valley fill is composed of less than 60 percent fine-grained materials.

The water table in the area is declining because large quantities of water are withdrawn and recharge is negligible. The decline near Luke Air Force Base during the period 1941–61 was about 150 feet.

Ground water was moving generally southwest in the spring of 1961. Locally, changes in the direction of movement indicate diversion toward two major depressions.

The dissolved-solids content of the ground water ranged from about 190 to 6,300 ppm. The highest concentration of dissolved solids is in water from the southern part of the area and seems to come from relatively shallow depths; wells in the northern part generally yield water of good quality.

After a reconnaissance of the area, the U.S. Geological Survey located and supervised the drilling of two test wells—wells (B–2–1) 9bcb and (B–2–1)5abc—on Luke Air Force Base. The quantity of water produced by the wells was adequate. The dissolved-solids content of water from the wells was low, and the overall quality of water from well (B–2–1)5abc was good. When well (B–2–1)9bcb was perforated between 907 and 977 feet, the water had a fluoride concentration of 4.4 ppm; however, the fluoride concentration decreased to 2.8 ppm when new perforations were cut at a shallower depth, and it was decided that dilution with other base water supplies probably would alleviate any possible fluoride problem.

INTRODUCTION

LOCATION AND EXTENT OF AREA

Luke Air Force Base occupies an area of about 3 square miles in the western half of the Salt River Valley (fig. 1), a valley that comprises all the valley lands near Phoenix, Ariz. The west boundary of the Salt River Valley is west of the area shown in figure 1.

The limits of the Luke area (pl. 1) were chosen arbitrarily to encompass the El Mirage, Waddell, Perryville, and Tolleson quadrangles. The area is bounded on the west by the White Tank Mountains and on the south by the Sierra Estrella and is drained by the Gila, Salt, Agua Fria, and New Rivers. Included within the area are the towns of El Mirage, Litchfield Park, Tolleson, and Avondale. The area includes 238 square miles, most of which is used for agriculture. The major agricultural enterprise in the area is Goodyear Farms, which covers 13,000 acres, mostly in T. 2 N., R. 1 W.

The Luke area is in the arid region of the southwestern United States. The climate is characterized by long, hot summers and short, mild winters. The average annual precipitation at the Litchfield Park station of the U.S. Weather Bureau is 7.79 inches.

WELL-NUMBERING SYSTEM

The well numbers used by the Ground Water Branch of the Geological Survey in Arizona are based on the Bureau of Land Management's system of land subdivision. The land survey in Arizona is based on the Gila and Salt River meridian and base line, which divide the State into four quadrants (fig. 2). These quadrants are designated counterclockwise by the capital letters A, B, C, and D. All land northeast of the intersection of the base line and meridian is in A quadrant, that northwest is in B quadrant, that southwest is in C quadrant, and that southeast is in D quadrant. 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 lowercase letters a, b, c, and d after the section number indicate the well location within the section. The first letter denotes a particular 160-acre tract (fig. 2), the second the 40-acre tract, and the third the 10-acre tract. The letters are also assigned in a counterclockwise direction, beginning in the northeast quarter. If the location is known within a 10-acre tract, three lowercase letters are shown in the well number. In the example shown, well number (B-2-1)2baa designates the well as being in the NE¼NE¼NW¼ sec. 2, T. 2 N., R. 1 W. Where there is more than one well within a 10-acre tract, consecutive numbers beginning with 1 are added as suffixes.

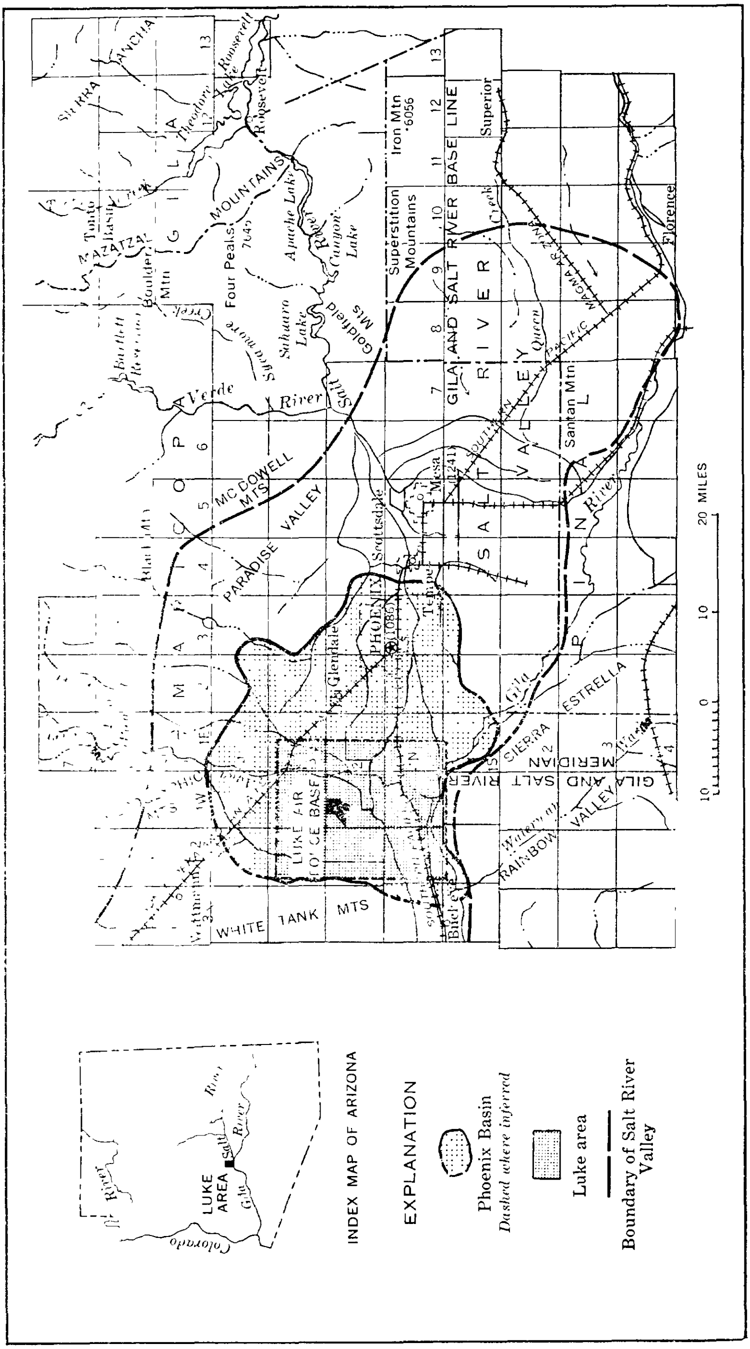

FIGURE 1.—Index map of the Luke area, Arizona.

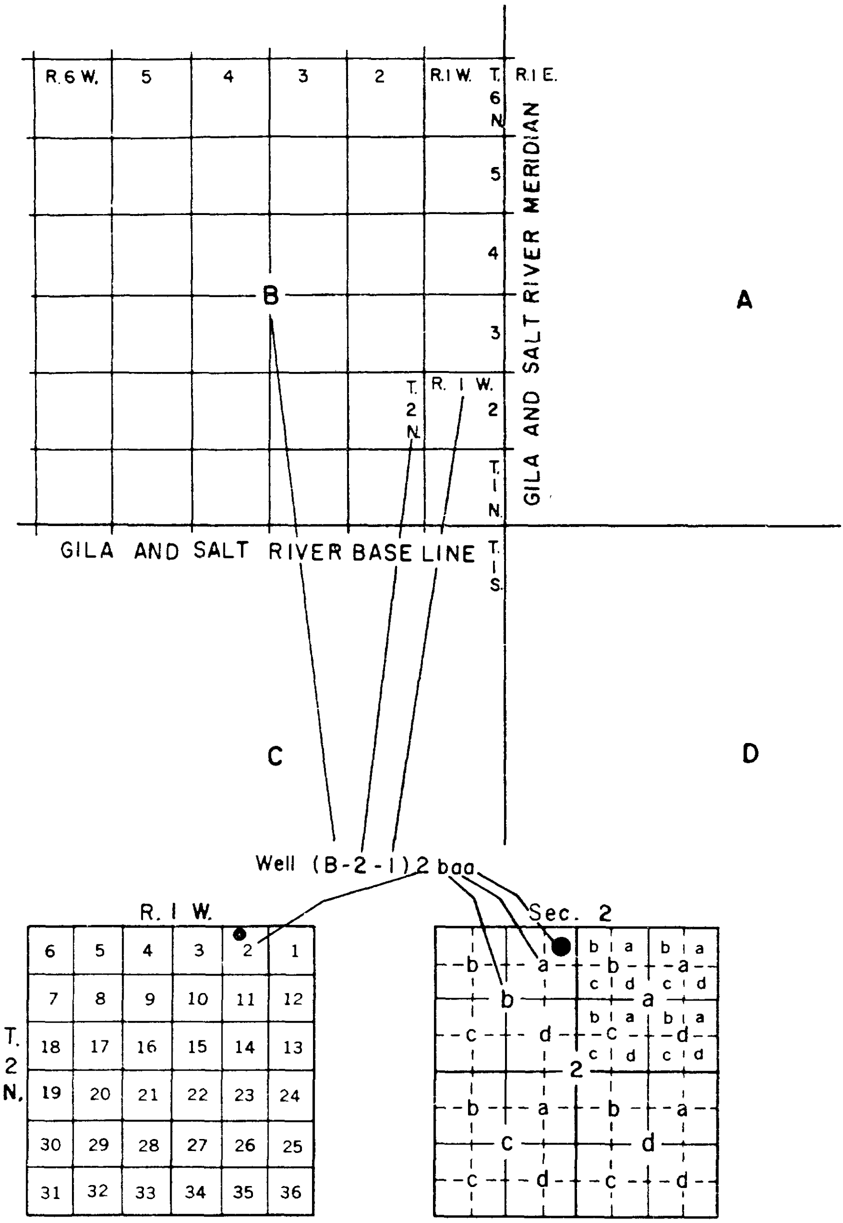

FIGURE 2.—Well-numbering system in Arizona.

PURPOSE OF INVESTIGATION

The primary objective of the study was to develop a water supply of optimum quantity and quality to supplement that of Luke Air Force Base. Prior to the study, the water supply for the base was obtained principally from two deep wells. Future development of the base will require more water than these two wells can produce.

Well (B-2-1)3cbb was drilled to a depth of 1,200 feet under the supervision of the Corps of Engineers in January 1959. The yield of the well proved adequate, but the water contained more than 1,300 ppm (parts per million) dissolved solids and was considered unsuitable for domestic use. Backfilling the well to different depths did not improve the water quality, and the well finally was destroyed.

Later in 1959, a second well—well (B-2-1)3dda$_1$—was drilled to a depth of 600 feet. The water was of suitable quality but the yield was inadequate. To increase the yield, the well was deepened to 1,060 feet; however, the dissolved-solids content increased, and an analysis of the water from 1,060 feet showed that the chloride content was more than 9,000 ppm. The well was then backfilled to 593 feet, and its yield was later added to that of another 600-foot well subsequently drilled nearby. The two wells produced about 900,000 gpd (gallons per day).

In August 1959, after completion of these wells, the Corps of Engineers formally requested the Geological Survey to make a study of the ground-water resources of the Luke area and to provide (1) the location and specifications for one well by October 1, 1959; (2) an interim report by November 1, 1960, on the ground-water resources of the area; (3) technical assistance in drilling and testing the well; (4) a second well location based on the results obtained from the first well; and (5) a final report on the ground-water resources of the area incorporating the results obtained from the two wells.

PREVIOUS INVESTIGATIONS

W. T. Lee, one of the first to study ground-water conditions in the Salt River Valley, stated that the purpose of his paper (1905, p. 11) was "to bring together the facts, so far as known, regarding the underground waters of the Salt River Valley, with a view to ascertaining their available quantity, the areas where they occur sufficiently near the surface for economic pumping, and their adaptability for irrigation." Although the primary subject of that report is ground water, it also contains chapters on geology and physiography.

Meinzer and Ellis (1915) made a study of the ground-water conditions in Paradise Valley (fig. 1). Other subjects discussed in their report are physiography, geology, soil and vegetation, climate, and irrigation.

C. P. Ross presented information on the Salt River Valley in his report (1923, p. 1), which was "designed, first, to give specific information in regard to watering places and routes of travel within the region covered, and second, to give general information in regard to the geography, geology, and hydrology of the region."

The geology and ground-water resources of the Salt River Valley area were described in a report by McDonald and others (1947). Some of the topics discussed in the section on geology are landforms, geologic history, structure, pediments, and rock formations. Topics discussed in the section on ground water include occurrence and movement, recharge, discharge, fluctuations of the water table, and quality of water.

METHODS OF INVESTIGATION

Well inventory.—The inventory of wells in the Luke area consisted of collecting information regarding depths of wells; casing data, including perforated zones; depths to water; pumping levels; use of the wells; type of pumps; and, yields of the wells. Drillers' logs and drill cuttings also were collected and analyzed. Most of this information appears in table 2. Depth-to-water measurements were made in about 30 wells during January 1961. The water-table contours (pl. 5) were based on these measurements and reported measurements by Goodyear Farms.

Specific conductance.—The chemical quality of the water from the wells previously drilled for the base supply made it obvious that water quality was a major problem in the Luke area. Quality is best determined by chemical analysis of the water; however, where chemical analyses were not readily available, specific-conductance measurements were made, and, from the data obtained, the dissolved-solids content was approximated. The approximation was determined from the relation between specific conductance and dissolved solids. This relation is expressed as:

Specific conductance (micromhos at 25°C) A = Dissolved solids (parts per million)

Hem (1959, p. 40) noted that usually "* * * A has a value between 0.55 and 0.75 unless the water has an unusual composition." A comparison of the chemical analyses with specific-conductance measurements of water in the Luke area indicated that the factor A generally has a value of about 0.6, and this value was used to estimate the dissolved solids, which are underlined on plate 6.

Water samples.—About 30 water samples were collected from wells in the Luke area for this study. The analyses of these samples are shown in table 4. Also shown are analyses of samples collected in conjunction with the basic-data collection program in the Salt River Valley and reported data from samples collected and analyzed by Goodyear Farms.

Test drilling.—Two test wells [(B–2–1)9bcb and (B–2–1)5abc] were drilled for the Luke Air Force Base under the supervision of the U.S.

Geological Survey and are now used as a part of the base water-supply system. During the drilling of the two wells samples of materials penetrated were collected, specific-conductance measurements of water were made, bailer and pumping tests were conducted, and water samples were obtained at selected horizons. The accuracy of the data thus obtained was increased by several steps taken during construction of the well. The well was drilled with a cable-tool rig and cased with blank casing, which was kept as tight as possible against the sides of the hole and was kept close to the bottom of the hole during drilling. This procedure permitted the recovery of truer samples of the materials penetrated because it prevented contamination from overlying beds.

When field analysis of the rock samples indicated a potentially productive zone, the casing was driven to the top of the zone, and a bailer test was made. After the well was bailed for a long enough time to insure that most of the water in the well was from the selected zone, a water sample was collected for analysis.

PERSONNEL AND ACKNOWLEDGMENTS

Personnel of the Ground Water Branch of the U.S. Geological Survey who participated in the study for this report include: J. M. Cahill, original project chief and author of an interim report; Ann C. Hill, who compiled a considerable part of the data; and D. G. Metzger and William Kam, geologists successively in charge of the Phoenix area office.

The authors wish to thank the many persons outside of the Geological Survey who have contributed information and assistance during the field investigation and preparation of this report. In particular, thanks are expressed to Carroll Parkman, water engineer of Goodyear Farms, who supplied information and data from Goodyear Farms' records, and to the personnel of Weber Drilling Co. and Roscoe Moss Drilling Co. who were especially helpful during the test drilling.

Irrigation districts, government agencies, and companies who provided information and assistance include Goodyear Farms, Maricopa County Municipal Water Conservation District No. 1, Roosevelt Irrigation District, U.S. Air Force, U.S. Army Corps of Engineers, and the U.S. Weather Bureau.

GEOLOGY OF VALLEY FILL

GENERAL FEATURES

The Luke area is in the Basin and Range lowlands province and is a part of an intermontane basin which, in this report, is called the Phoenix basin (fig. 1). The rocks that form the mountains surrounding the basin are chiefly Precambrian granite, gneiss, and schist, which locally are overlain by Tertiary volcanic and sedimentary rocks. The White Tank and Sierra Estrella Mountains, which are along the west and south boundaries of the report area, are composed of Precambrian rocks. The basin contains an unknown thickness of Tertiary and Quaternary sedimentary rocks.

EXTENT OF VALLEY FILL

The term "valley fill," as used in this report, includes all sediments and sedimentary rocks penetrated by wells in the Luke area (pl. 1), and also the surficial deposits, including those in the stream channels and flood plains of the Salt, Gila, Agua Fria, and New Rivers. The valley fill is the surface formation in more than 95 percent of the area described in this report.

Although there are more than 500 wells in the area, the geologic interpretations described herein are from about 150 wells (pl. 1), which were selected on the basis of well depth and completeness of data. Wells that are less than 250 feet deep and wells for which the lithologic data are meager are not included. The total thickness of the valley fill is unknown, but well (B–2–1)19baa—the deepest well in the area—penetrated 2,784 feet of sedimentary rock without reaching basement rock.

LITHOLOGY

The valley fill is composed primarily of unconsolidated to semiconsolidated clay, silt, sand, and gravel, which locally contain caliche and evaporites.

Lithologic and stratigraphic studies of the valley-fill material indicated that, in general, the material is in lenticular layers or beds that apparently are not widely distributed horizontally. Only in the southeastern part of the area, where a 100- to 300-foot thickness of sand and gravel overlies a 600-foot thickness of clay and silt, is there some indication of horizontal continuity of the material.

Because of the lack of extensive horizontally correlative beds in most of the valley fill, another approach to the study of the geohydrologic and geochemical features of the Luke area was necessary. A study of the lithologic data for the selected wells indicated a gross-facies pattern of the valley-fill materials. Therefore, percentage-distribution maps (pls. 2 and 3) were constructed that show the percentage of fine-grained materials (silt, clay, and evaporites) and which, in turn, delineate the areas of coarse-grained materials (sand and gravel). The maps were drawn primarily on the basis of data from drillers' logs. The drillers' terminology was interpreted and generalized into uniform terms that could be applied to percentage groups of fine-grained materials. These percentages were estimated as follows:

Lithology	*Percent of fine-grained materials*
Clay and (or) silt	100
Clay, sandy	100
Caliche	100
Clay and silt, some gravel	80
Clay, some gravel	80
Sand, silt, and clay	65
Clay and gravel	50
Gravel, sand, and silt	35
Gravel, some clay	20
Sand and (or) gravel	0

The entire procedure for computing the percentage of fine-grained materials in a well is shown in table 1, where it is applied to the driller's log for well (B–1–1)3baa. The computed quantity of fine-grained materials in this well is 380 feet, which is 53 percent of the total depth of 714 feet.

Plate 2 shows the distribution of coarse- and fine-grained materials by plotting and contouring the percentage of fine-grained materials from land surface to a datum plane 700 feet above mean sea level; the map is referred to as the 700-foot altitude percentage-distribution map. Plate 3 shows the distribution of coarse- and fine-grained materials by plotting and contouring the percentage of fine-grained materials from land surface to the bottom of the wells (only wells more than 500 feet deep were used); the map is referred to as the total depth percentage-distribution map. To obtain a complete geologic picture of the area it would be necessary to construct percentage-distribution maps at closely spaced vertical intervals for the entire Phoenix basin. However, the two maps included in this report provide a generalized picture of geologic conditions in the Luke area, and they may serve as a framework for future more detailed geohydrologic studies.

A comparison of plates 2 and 3 shows that the percentage of fine-grained materials increases with depth; therefore, the percentage of coarse-grained materials decreases. At depths of 800 feet to about 1,200 feet, few coarse-grained materials are present in the valley fill. The trend of the areal pattern formed by the coarse-grained materials is very similar on both maps, indicating a selective depositional area for the materials during part of Tertiary and Quaternary time.

In most of Tertiary and Quaternary time, the Phoenix basin was subsiding. The lithologic characteristics of most materials indicate a typical intermontane basin, fed entirely by fresh-water streams flowing from the north and east. For the most part, the coarse-grained sediments were deposited in stream channels crossing the

TABLE 1.—*Driller's log and estimated percentage of fine-grained materials from well (B–1–1)3baa*

Driller's log		Interpreted log			Estimated percentage of fine-grained materials	Computed quantity of fine-grained materials (ft)
Depth (ft)	Materials penetrated	Depth (ft)	Materials penetrated	Thickness (ft)		
0–18	Adobe	18	Clay	18	100	18
18–105	Sand and gravel	105	Sand and gravel	87	0	0
105–112	Sand	127	Sand and gravel, some clay.	22	15	3
112–114	Gravel and clay					
114–117	Sand					
117–127	Sand and gravel					
127–140	Gravel and clay	140	Gravel and clay	13	50	6
140–149	Sand and gravel	162	Sand, some gravel	22	0	0
149–158	Sandstone					
158–162	Sand and gravel					
162–175	Sandstone	200	Sand	38	0	0
175–200	Sand					
200–210	Sand and gravel	210	Sand and gravel	10	0	0
210–218	Clay and gravel	218	Clay and gravel	8	50	4
218–220	Sandstone	250	Sand, some gravel	32	0	0
220–228	Sand					
228–237	Sand and gravel					
237–250	Sand					
250–260	Clay with sand and gravel.	282	Clay, some sand and gravel.	32	75	24
260–265	Clay					
265–282	Clay with gravel					
282–291	Gravel	291	Gravel	9	0	0
291–295	Clay	314	Clay, some sand	23	80	18
295–299	Sandstone					
299–314	Clay					
314–328	Sand and gravel	328	Sand and gravel	14	0	0
328–384	Clay and gravel	384	Clay and gravel	56	50	28
384–394	Sand	394	Sand	10	0	0
394–404	Clay	404	Clay	10	100	10
404–422	Sandy clay	422	Clay, sandy	18	100	18
422–425	Sand	435	Clay, sand, and gravel	13	30	4
425–428	Gravel					
428–435	Clay					
435–448	Clay with gravel	448	Clay, some gravel	13	80	10
448–450	Sand	462	Sand, some clay	14	20	3
450–457	Sandstone					
457–459	Clay					
459–462	Sandstone					
462–510	Clay	510	Clay	48	100	48
510–524	Clay with gravel	524	Clay, some gravel	14	80	11
524–537	Clay	537	Clay	13	100	13
537–542	Fine sand	560	Clay, some sand	23	80	18
542–560	Clay with sand					
560–602	Clay with gravel	602	Clay, some gravel	42	80	34
602–610	Clay	650	Clay	48	100	48
610–620	Hard clay					
620–638	Clay					
638–639	Sand					
639–650	Clay					
650–660	Clay with gravel	660	Clay, some gravel	10	80	8
660–672	Clay	714	Clay	54	100	54
672–673	Hard clay					
673–702	Clay					
702–703	Hard sand					
703–714	Clay					

subsiding basin. Along the margin of the White Tank Mountains, some coarse-grained materials were spread out from the mountains basinward by smaller streams. In areas outside of the channels, where circulation was restricted, the fine-grained sediments, including shallow-water lacustrine deposits, were laid down. Locally, evaporites are interbedded with the fine-grained sediments.

Most evaporites, especially in the upper 1,500 feet of the valley fill, are gypsum. However, the material at depth in well (B–2–1)-

19baa is largely halite; material from 2,350 feet was more than 97 percent halite.

Thick and thin zones of evaporites in the valley fill that occur at different altitudes are shown below.

Well	Thickness of zone containing evaporites (ft)	Altitude at top of zone (ft; datum is mean sea level)	Well	Thickness of zone containing evaporites (ft)	Altitude at top of zone (ft; datum is mean sea level)
(A-1-1)6cbb	195	−40	(B-2-1)12cad	13	630
(B-1-2)9ada	219	959	14abd	740	193
16bbb	21	939	14cbb	75	470
	13	843	19baa	1,502+	−224
(B-2-1)2bbb$_2$	260	28	23dcc	19	833
3cbb	250	799	(B-2-2)25abb	18	227
3dda$_1$	105	134	25cbb$_2$	460	335
8dba$_1$	50	483			

EARTH CRACKS

In recent years several earth cracks have appeared in the Phoenix basin. At least two conspicuous cracks (pl. 1) are within the Luke area (Robinson and Peterson, 1962, p. 4). The movements that produced the earth cracks also caused local damage, including collapse of the casings in nearby wells. The cracks probably are due to the dewatering of the valley fill, which has caused compaction and subsidence of the materials therein; however, they may be the surface expression of deep-seated structural movement.

GROUND WATER

HISTORY AND USE

In 1960 more than 2,000,000 acre-feet of ground water was used to irrigate lands within the Salt River Valley. Ground water is also the chief source of water for homes, industries, and military installations throughout the valley. The quantity of ground water withdrawn from the Luke area is not known; however, Goodyear Farms used about 51,000 acre-feet in 1960.

Irrigation in the Salt River Valley, of which the Luke area is a part, dates back to the time of prehistoric Indian tribes. Ancient hand-dug irrigation canals are evidence that the Indians made use of crude dams to divert water from perennial streams. Later, white settlers also used dams and canals to bring water from the Salt River to adjacent farmlands. By 1892, there were at least 10 such canals and more than 100,000 acres of land under cultivation. In 1901, the first deep irrigation well was put into use near Mesa, Ariz. The success of this well resulted in the construction of other wells, and today ground water is the major source of irrigation water.

THE WATER TABLE

The most important source of ground water in the Luke area is the valley fill; the water in the pore spaces of the sediments constitutes a ground-water storage reservoir. The upper surface of the saturated part of the valley fill is referred to as the water table; the position of this surface can be approximated by measuring the depth to water in wells penetrating the valley fill. A change in the water level in a well generally indicates a change in storage in the ground-water reservoir that the well penetrates. When recharge exceeds discharge, water levels in wells rise, and when discharge exceeds recharge, water levels decline.

Table 2 is a compilation of well data collected from about 235 wells in the Luke area. These data and data that were collected prior to the study were used to determine the position and declines of the water levels. The depth and perforation data contained in table 2 were essential to the study of quality of water in the area.

The water table in the Luke area is declining because large quantities of water are withdrawn and recharge is negligible. During 1941–61 the water levels in the immediate vicinity of Luke Air Force Base declined about 150 feet. The annual rate of decline during the past few years has been about 13 feet.

Water-level anomalies were observed in two wells. In December 1960 the water level in well (B–2–1)14cbb was 80 feet above the main water table. The well was drilled in 1960 and was abandoned because the water had a high dissolved-solids content. The driller's log provided no information on possible artesian conditions during drilling, but such an anomalous water level might be due to artesian pressure. However, data from well (B–2–1)21abb, which was started in September 1961, virtually eliminated artesian pressure as the cause of the anomaly. This well reached water at a depth of 100 feet—a level which was about 130 feet above the main water table—and as drilling progressed the water remained at about this same level. Data are insufficient to explain conclusively the anomalous water-level phenomena, but several possibilities are indicated. Interpretation of drillers' logs shows that clay and silt lenses of low permeability occur throughout the area. The anomalous water levels might be the result of water from rainfall, irrigated fields, and the Agua Fria River, piling up on the surface of these relatively impermeable lenses. The anomalous water levels also may be produced by residual water that has been trapped temporarily as the water table declines.

TABLE 2.—*Records of selected wells*

Well number: For explanation see section "Well-numbering system."
Owner: R.I.D., Roosevelt Irrigation District; S. R. V. W. U. A., Salt River Valley Waters Users' Association; B. I. C., Buckeye Irrigation Co.; M. C. M. W. C. D. No. 1, Maricopa County Municipal Water Conservation District No. 1.
Depth of well: Given in feet below land surface: all depths are reported.
Depth to water: Given in feet below land surface; M, measurements made by Maricopa County Municipal Water Conservation District No. 1; G, measurements made by Goodyear Farms; R, measurements made by Roosevelt Irrigation District.
Type of pump: T, turbine; N, none.
Type of power: E, electric; NG, natural gas; N, none; D, diesel.
Use of well: I, irrigation; N, not used; Dom, domestic; T, test well; D, destroyed; PS, public supply.
Remarks: Ca, sample collected for chemical analysis.

Well	Owner	Year completed	Altitude of land surface (ft)	Depth of well (ft)	Diameter of casing (in)	Reported zone of perforated casing (ft)	Depth to water (ft)	Date of water-level measurement	Pump		Use of well	Remarks
									Type	Power		
(A-1-1) 3bbb	R. I. D		1,025	850	20	200-834			T	E	I	
6aaa	M. A. Treguboff		1,012				130.7	2- 3-60	T	E	I	
6cbb	S. R. V. W. U. A	1952	995	1,230	20	225-1,215			T	E	I	
16aaa	Isabell-Hartner	1940	1,002	937	20	160-700			T	NG	I	
19dcd	A. L. Levi		965	100	16		52.5	2-27-61	T	E	I	
(A-2-1) 4bba	R. I. D	1951	1,084	800	20	140-780			T	E	I	
4ddd	do	1952	1,077	800	20	145-784	158.3	1- 8-59	T	E	I	
8caa	do	1943	1,052	1,000	16	60-988			T	E	I	
9cbb	do	1951	1,060	800	20	150-780			T	E	I	
17baa	do	1951	1,049	800	20	160-780			T	E	I	
18aaa	Stanley Fruit Co	1939	1,041	470	20	90-456	163.5	2-15-61	T	E	I	
20bcc	R. I. D		1,027	696	24	100-680			T	E	I	
28bdd	Dean Stanley		1,037	640	20	150-626			T	E	I	
29caa	R. I. D	1951	1,023	800	20	112-780			T	E	I	
30caa	do	1951	1,014	800	20	126-780			T	E	I	
32dab	do	1951	1,024	775	20	140-750			T	E	I	
33acc	do	1943	1,028	1,000	20	65-986			T	E	I	
33cdd	do	1951	1,023	800	20	140-786			T	E	I	
(A-3-1) 21ada	S. R. V. W. U. A	1951	1,134	785	20	180-750			T	E	I	
31bbb	Spur Feeding Co	1960	1,083	615	10	310-600					D	
(B-1-1) 1bbc	Fred Boyd		988	406	16	204-384			T	E	I	
2bbb	R. I. D		994	800	20	150-650			T	E	I	
3baa	Goodyear Farms	1948	993	714	20	135-696	118.5G	1- 1-61	T	E	I	Ca.
4aab	do	1948	991	702	20	140-684	116.0G	1- 1-61	T	E	I	Ca.
6abb	T. C. Rhodes		1,012	572	16	138-563	156.2	2- 9-60	T	E	I	
6bba	Goodyear Farms	1951	1,013	802	20	240-786	159.0G	1- 1-61	T	E	I	
7aba	R. I. D	1950	993	990	20	200-970			T	E	I	
8bba	Borg Ranch No. 1		987	650	20	200-636			T	E	I	
9aab	Goodyear Farms	1920	990	120	26	40-98			N	N	N	
9dab	do	1925	980	218	26	53-175	96.0G	1- 1-61	T	E	I	Ca.
$10aaa_1$	R. I. D		983	210	20	70-200	106.5	2-16-60	N	N	N	
$10aaa_2$	do	1956	983	900	20		87.0	1-16-56	T	E	I	Ca.
12baa	Thayer Collier	1934	980	600	20	140-400			T	E	I	

TABLE 2.—*Records of selected wells*—Continued

Well	Owner	Year completed	Altitude of land surface (ft)	Depth of well (ft)	Diameter of casing (in)	Reported zone of perforated casing (ft)	Depth to water (ft)	Date of water-level measurement	Pump		Use of well	Remarks
									Type	Power		
(B-1-1) 16dbb	U.S. Navy	1952	958	1,800	30-16				T	D	PS	
17aaa	R. I. D	1937	976	221	20	45-218	97.6	3-16-61	N	N	N	
17bcb	R. R. Wood	1958	967	417	20	172-342			T	E	I	
21aba	H. T. Cuthbert	1951	962	304	16	198-214			T	E	I	
25bab	E. H. and L. D. Shumway	1958	939	325	20	190-302			T	E	I	
28cdc	B. I. C	1959	908	421	20	55-416			T	E	I	
30dbb	do	1959	909	475	30	70-300			T	E	I	
(B-1-2) 1baa	Goodyear Farms	1951	1,012	648	20	155-630	159.0G	1- 1-61	T	E	I	Ca.
1bbb	do	1953	1,017	756	20	245-730	179.0G	1- 1-61	T	E	I	Ca.
1cbb	do	1920	1,004	315	26	110-290	131.0G	1- 1-61	T	E	I	
2baa	W. J. Williams	1951	1,024	630	16	180-622			N	N	N	
2bbb2	Able Brothers	1958	1,028	1,520	20				T	E	I	Ca; electric log on file.
3dbb2	McCulley		1,022	1,141	20				T	E	I	
4cad	Howard Bendalin	1952	1,034	330	16	190-328			T	E	I	
5cbb	Unknown		1,065		20		215.4	3-16-61	N	N	N	
8bcc	Leo Accomazzo	1960	1,027	800	16	150-761			T	E	I	
8cbb	do	1937	1,024	310	20		154.4	2-16-61	N	N	N	
9ada	R. I. D		1,000	260	20	55-256			N	N	N	
10bbb	Johnson	1953	1,011	350	12		145.7	3-16-61	T	E	I	
11baa	Allen Belluzzi		995	1,004	20	220-1,000	134.9	2- 2-59	T	E	I	
13adc	R. I. D		960	155	20	40-130	79.1	3-16-61	T	E	I	
13bca	Allen Belluzzi		956	470	20	160-367			T	E	I	
13dcd	R. I. D		951	1,176	20	150-1,123			T	E	I	
15bbb	Ed Ambrose	1951	976	873	20	204-873	131.3	2-10-60	T	E	I	
16bbb	J. L. Hodges		987	1,008	20	700-998			T	E	I	
22aba	do	1951	942	290	20	150-200	91.6	2-10-60	T	E	I	
23cad	H. T. Kiefer		914	200	20		69.0	3-16-61	T	E	I	
25bbc	R. K. Cooper	1946	908	288	20	136-228			T	E	I	
27cbb	B. I. C	1948	893	246	20	110-210			T	E	I	
28cbc	do	1951	890		20		44.3	2-10-60	T	E	I	
36bcb	Don Munro	1951	891	180	20	35-164	36.4	1-21-59	T	E	I	
(B-2-1) 1ccc	U.S. Air Force	1960	1,069	660	8	360-588			T	E	Dom	Ca; sewage-treatment plant.
2aba	Goodyear Farms	1937	1,080	368	20	70-276	237.0G	1- 1-61	N	N	N	
2aca	do	1955	1,073	840	20	262-730	235.5G	1- 1-61	T	E	I	Ca.
2baa	do	1948	1,080	720	20	190-704	245.0G	1- 1-61	T	E	I	
2bbb	do	1950	1,087	866	20	235-840	257.0G	1- 1-61	T	E	I	Ca.
2bbc	do	1957	1,087	772	20	295-744	256.0G	1- 1-61	T	E	I	Ca.
2bbd	do	1936	1,086	294	20	120-240	253.0G	1- 1-61	T	E	I	Ca.
3baa	Claude Mayer and J. W. Ellingson.	1928	1,094	272	20				T	E	I, Dom	
3bba	J. W. Ellingson	1959	1,096	396	10	290-382			T	E	Dom	Ca.
3cbb	U.S. Air Force	1959	1,089	1,190							D	Ca.

3dda₁	do	1959	1,084	593	16	280–580			T	E	PS	Ca; well drilled to 1,060 ft and then backfilled to 593 ft.
3dda₂	do	1958	1,084	600	16	285–580			T	E	PS	Ca.
3ddd	Roach and Baker	1959	1,084	600	8	380–600	251.1	12–29–60	N	N	N	Intended for domestic use.
4dad₁	U.S. Air Force		1,085	501	20				T	E	PS	Ca; base-supply well.
4dad₂	do		1,085	502	20				T	E	PS	Do.
5abc	do	1960	1,108	1,000	16	362–392 407–412 442–452 477–482 492–497 582–597 607–612 617–622	281.2	9– 9–60	T	E	PS	Ca; base-supply well; drilling supervised by U.S. Geological Survey personnel.
5bbb	Hatch		1,120	514	20	150–514	310.7	12–30–60	T	E	I	Ca.
6abb	Goodyear Farms	1945	1,128	746	20		306.0G	1– 1–61	T	E	I	Ca.
6bcb	do	1937	1,131	602	20		313.0G	1– 1–61	N	N	N	Ca.
6cbb	do	1949	1,123	898	20	230–857	318.0G	1– 1–61	T	E	I	
6dbb₂	do	1950	1,117	1,010	20	342–990	305.5G	1– 1–61	T	E	I	Ca.
7abb	do	1946	1,105	700	20	200–684	293.5G	1– 1–61	T	E	I	Ca.
7bbb₂	do	1946	1,112	746	20	255–728	291.7	2– 9–60	T	E	I	
7bbc	do	1959	1,106	565	12				T	E	Dom	
7cad	do	1954	1,089	540	20	250–528	296.5G	1– 1–61	T	E	I	
7cbb	do	1945	1,100	422	20	130–399	302.0G	1– 1–61	T	E	I	
8bbb	A. F. Harter	1951	1,097	486	20	202–470			T	E	I	
8dba₁	Goodyear Farms	1952	1,078	900	6				N	N	D	Test well.
8dba₂	do	1952	1,078	578	20	498–538	244.0G	1– 1–61	T	E	PS	Ca.
9bcb	U.S. Air Force	1960	1,080	1,200	12	535–561 564–572 907–924 969–977	235.4	2–22–60	T	E	PS	Ca; base-supply well; drilling supervised by U.S. Geological Survey personnel.
10bba	Col. D. Bumstead		1,083	506	20	140–492	249.5	12–29–60	T	E	I	Ca.
12bdb	Goodyear Farms	1948	1,045	992	20	170–670	185.0G	1– 1–61	T	E	I	Ca.
12bdd	do	1953	1,046	1,002	20	352–419 518–976	187.0G	1– 1–61	T	E	I	
12cad	do	1960	1,041	1,140	20	190–625 639–1,084			T	E	I	
13cca	James Bond		1,027	250	20		162.8	12–30–60	T	E	I	
14abd	Goodyear Farms	1956	1,043	753	20	300–748	250.5G	1– 1–61	T	E	I	Drilled to 1,605 ft and plugged at 753 ft because of high salt content.
14cba₂	Dr. F. X. Laubner	1957	1,060	520	12		225.0	12–29–60	N	N	N	
14cbb	do	1960	1,057	708	12	145–690	144.2	12–29–60	N	N	N	Ca; abandoned because of high salt content.
14dbb	Goodyear Farms	1948	1,044	720	20	160–704	254.0G	1– 1–61	T	E	I	
17bbc	E. Jarnigan	1954	1,073	586	20	280–574			T	E	I	Ca.
18abb	Goodyear Farms		1,085	252	20		252.4	3–25–59	N	N	N	
18acc	do	1955	1,073	714	20	322–662	274.5G	1– 1–61	T	E	I	Ca.
18bbb₂	do	1951	1,089	1,120	20	400–1,093	299.0G	1– 1–61	T	E	I	Ca.
18cbb₂	do	1960	1,078	737	16	326–720	289.5G	1– 1–61	T	E	I	Ca.
19aab	do	1920	1,057	280	26		267.0G	1– 1–61	T	E	I	Ca.
19aba	do	1957	1,057	722	20	320–566	267.0G	1– 1–61	T	E	I	

TABLE 2.—*Records of selected wells*—Continued

Well	Owner	Year completed	Altitude of land surface (ft)	Depth of well (ft)	Diameter of casing (in)	Reported zone of perforated casing (ft)	Depth to water (ft)	Date of water-level measurement	Pump: Type	Pump: Power	Use of well	Remarks
(B-2-1) 19baa	Goodyear Farms		1,058	2,784	20	264-1,218	267.0G	1- 1-61	T	E	I	Ca; plugged at 1,282 ft because of high salt content.
19bbb$_2$	do		1,065	842	20	290-814	273.7	3- 1-61	T	E	I	Ca.
19cbb$_2$	do	1949	1,057	966	20	180-948	286.5G	1- 1-61	T	E	I	Ca.
19dbb	do	1958	1,048	627	20	274-597	257.0G	1- 1-61			I	Ca.
20bba	do	1949	1,053	752	20	150-730	259.0G	1- 1-61	T	E	I	Ca.
21abb	do	1961	1,067								I	
21ccb$_2$	do	1957	1,036	740	20	256-600	184.5G	1- 1-61	T	E	I	
21dda	do	1941	1,036	463		182-448	176.0G	1- 1-61	T	E	I	Ca.
23dcc	do	1941	1,029	502		90-487	179.0G	1- 1-61	T	E	I	Ca.
24bbc	R. I. D.		1,022	1,200	20	150-910	162.6	12-30-60	T	E	I	
26aca	do		1,013				157.5R		T	E	I	
26bca	do		1,022	800	20	150-600			N	N	D	
26cbc$_2$	Goodyear Farms	1948	1,016	702	20	175-686	173.5G	1- 1-61	T	E	I	Ca.
27abd	do	1946	1,019	402	12	220-365			T	E	Dom	Ca.
27caa	do	1917	1,014	214	26	92-174			T	E	Dom	
27cbc	do	1952	1,008	902	20	180-876	138.0G	1- 1-61	T	E	I	Ca.
27dcc	do	1952	1,007	930	20	160-900	151.0G	1- 1-61	T	E	I	
28dcb	do	1917	1,009	274	26	103-260	142.0G	1- 1-61			I	Ca.
29bab	do	1950	1,028	800	20	197-647	203.5G	1- 1-61	T	E	I	Ca.
30aba	do	1941	1,037	442		120-427	227.5G	1- 1-61	T	E	I	Ca.
30caa	do	1941	1,033	564		105-550	216.0G	1- 1-61	T	E	I	Ca.
31abb$_2$	do	1951	1,027	766	20	180-748	198.0G	1- 1-61	T	E	I	Ca.
31bba$_2$	do	1952	1,031	914	20	220-884	219.5G	1- 1-61	T	E	I	Ca.
31caa	do	1946	1,018	470	20	150-452	184.5G	1- 1-61	T	E	I	Ca.
31dba	do	1954	1,014	930		200-904	179.0G	1- 1-61	T	E	I	Ca.
33bbb	do	1944	1,009	318	20	110-278	146.8	3- 1-61	T	E	I	Ca.
33bcc	do	1917	1,002	224	26	100-186	133.0G	1- 1-61	T	E	I	Ca.
33bdd	do	1917	999	926	26	194-912	129.0G	1- 1-61	T	E	I	Ca.
34aad	do	1940	1,003	386	20	146-362	138.5G	1- 1-61	T	E	I	Ca.
34caa$_2$	do	1951	998	1,014	20	150-992	132.0G	1- 1-61	T	E	I	Ca.
34dda	do	1954	996	926	20	186-900	128.5G	1- 1-61	T	E	I	Ca.
36cba$_2$	Austin	1953	991	650	20	142-635			T	E	I	
(B-2-2) 1aba	Goodyear Farms	1951	1,143	1,058	20	380-1,045	348.5G	1- 1-61	T	E	I	
1acb	do	1946	1,138	710	20	215-686	346.0G	1- 1-61	T	E	I	
1bbb	Spill and Adami	1951	1,157	1,010		250-986			T	E	I	Surging.
3aaa	M.C.M.W.C.D. No. 1		1,196	495	20	170-485	394M	1961	T	E	I	
3bbb	do		1,220	551	20	194-540	397M	1961	N	N	N	
5aab	State of Arizona		1,260	747	12	320-740					D	
10baa	M.C.M.W.C.D. No. 1		1,170	995	20	170-485 500-980	385M	1961	T	E	I	
10dcc	do		1,145	1,000	20	154-1,000			T	E	I	

11baa	do		1,150	1,000	20	265–980	364M	1961	T	E	I	
11bbb	Bishop Patterson		1,160	880	20	340–868			T	E	I	
12abb	Goodyear Farms	1945	1,122	656		194–632	326.0G	1-1-61	T	E	I	Ca.
13abb	do	1948	1,098	752	20	225–734	316.0G	1-1-61	T	E	I	
14bcc	Allen Ranches, Inc	1951	1,118	980	20	355–965			T	E	I	
15aaa	M.C.M.W.C.D. No. 1		1,131	500	20	144–484	355M	1961	T	E	I	
21abb	do		1,149	504	20	178–488	397M	1961	T	E	I	
22aaa	do		1,112	492	20	125–280	343M	1961	T	E	I	
22abb	Drake and Howe	1951	1,119	1,340	20	220–1,276			T	E	I	
22bbb	do	1951	1,132	1,194	20	200–1,160			T	E	I	
24baa	Goodyear Farms	1951	1,074	922	20	232–910	292.5G	1-1-61	T	E	I	
24bbb	do	1948	1,085	582	20	126–565	309.0G	1-1-61	T	E	I	Ca.
24cbb	do	1949	1,077	788	20	180–740	309.0G	1-1-61	T	E	I	Ca.
$24dbb_2$	do	1950	1,066	956	20	194–938	286.5G	1-1-61	T	E	I	
$25aaa_2$	do	1949	1,048	762	20	175–742	230.5G	1-1-61	T	E	I	Ca.
25abb	do	1956	1,057	928	20	344–873	279.0G	1-1-61	T	E	I	
$25bbb_2$	do	1941	1,067	564	20	100–550	317.0G	1-1-61	T	E	I	
$25cbb_2$	do	1949	1,055	1,720	20		282.0G	1-1-61	T	E	I	Ca.
25daa	do	1949	1,039	712	20	160–696	249.0G	1-1-61	T	E	I	
$25dbb_2$	do	1949	1,045	578	20	175–558	265.0G	1-1-61	T	E	I	
27aaa	Waddell Ranch	1950	1,086	800	20	290–786			T	E	I	
27baa	M.C.M.W.C.D. No. 1		1,096	500	20	180–488	338M	1961	T	E	I	
27ccc	do		1,084	502	20	138–488	342M	1961	T	E	I	
28aaa	do		1,112	502	20	140–486	357M	1961	T	E	I	
28abb	do		1,133	524	20	165–508	366M	1961	T	E	I	
33abb	Waddell Ranch	1948	1,102	920	20	200–500			T	E	I	
34baa	do		1,068	954	20	192–954			T	E	I	
35bbb	do	1951	1,057	900	20	280–880			T	E	I	
36abb	Goodyear Farms	1953	1,035	902	20	195–887	228.5G	1-1-61	T	E	I	Ca.
$36bbb_2$	do	1946	1,044	510	20	170–460	252.0G	1-1-61	T	E	I	Ca.
$36cbb_2$	do	1949	1,028	1,032	20	210–1,014	225.0G	1-1-61	T	E	I	Ca.
$36dbb_2$	do		1,022	648			198.5G	1-1-61	T	E	I	Ca.
(B-3-1)7abb	American Christian Institute.	1951	1,244	1,025	20	180–1,025			T	E	I	
8abb	Westside Farms		1,217	1,200	20	200–1,190	310.4	1-23-58	T	E	I	
10acb	M. B. M. Farms	1946	1,174	810	20	160–810			T	E	I	
11bbb	Flora S. Ludden		1,168	558	20	232–540			T	E	I	
12bbb	Rubinstine Construction Co.	1959	1,151	1,000	20	365–935			T	E	I	
13dbb	John J. Phillips	1953	1,117	590	20	216–486			T	E	I	
14bbb	Manuel M. Leyva		1,152	810	20	232–810			T	E	I	
17bbb	B and M Farms	1950	1,214	1,468	20	225–1,468			T	E	I	
18bbb	R-D-B Farms		1,222	800	20	310–786	355.1	2-9-60	T	E	I	
18bbc	Unknown	1959	1,219	1,490							I	
19abb	D. Stanley and J. McDaniels.		1,194	782	20	240–770			T	E	I	
21abb	Percy Smith		1,161	530	20	200–518			T	E	I	
22bcc	Rancho Santa Maria	1950	1,142	575	20	260–562			T	E	I	
$23cbb_2$	Hinton		1,126	550	20	200–538			T	E	I	
$24bbb_2$	A. and M. G. Morena		1,118	505	20	165–505			T	E	I	
$25bbb_2$	J. C. Watt	1959	1,107	638	20	260–630			T	E	I	
26bbb	Western Cotton Co		1,118	500	20	200–475	272.8	12-30-60	T	E	I	
$26cbb_2$	Anderson Clayton and Co.	1957	1,108	1,000	22	450–850			T	E	I	Ca.

TABLE 2.—*Records of selected wells*—Continued

Well	Owner	Year completed	Altitude of land surface (ft)	Depth of well (ft)	Diameter of casing (in)	Reported zone of perforated casing (ft)	Depth to water (ft)	Date of water-level measurement	Pump: Type	Pump: Power	Use of well	Remarks
(B-3-1) 27abb	William Bennett	1951	1,124	752	20	300–735	284.2	1- 6-61	T	E	I	
27cbb$_2$	Col. D. Bumstead	1951	1,123	800	20	300–788			T	E	I	Ca.
28bbb	Justice Brothers		1,152	445	20	320–430	322.7	12-30-60	T	E	I	
29bbb	Fred Faver		1,161	1,140	20	163–1,005	330.0	2- 9-60	T	E	I	
29ccb	do	1961	1,148	1,093	16	300–1,085					I	
31bbb	Rhodes Ranch		1,161	600	20	300–586			T	E	I	
32bab	J. E. Cooper	1958	1,137	1,032	20	400–1,013	316.0	1- 6-61	T	E	I	Ca.
32cbb	Scott L. Libby	1951	1,132	700	20	300–680	283.4	1-21-58	T	E	I	Ca.
33abb	Charles E. Sparks		1,126	1,012	16	440–1,000	287.1	1- 6-61	T	E	I	
34dbb	Roach and Baker		1,100	350	20	180–340	237.3	1-25-57	T	E	I	
35aab	Western Cotton Co		1,102	550	20	200–535	237.9	12-30-60	T	E	I	
(B-3-2) 11cbb	G. V. Stanley	1951	1,292	1,400	20	600–1,249			T	E	I	
12aaa	M. C. M. W. C. D. No. 1		1,251	736	20	204–714	414M	1961	T	E	I	
13baa	do		1,235	1,000	20	184–484 500–980	399M	1961	T	E	I	
14baa	do		1,266	547	20	190–531	424M	1961	T	E	I	
14bcb	Hargrove Farms		1,275	1,400	20	300–1,110	423.3	1-19-59	T	E	I	
14bdd	M. C. M. W. C. D. No. 1		1,258	512	20	250–498	414M	1961	T	E	I	
15aaa	do		1,287	1,007	20	216–566 585–993	437M	1961	T	E	I	
21abb	do		1,332	534	20	280–412	392.8	3- 1-61	N	N	N	
22abb	Boswell Cotton Co	1951	1,284	1,100	20	450–1,088			T	E	I	
23aaa	M. C. M. W. C. D. No. 1		1,232	531	20	210–515	413M	1961	T	E	I	
23baa	do		1,248	500	20	199–484	417M	1961	T	E	I	
24abb	Taylor and Moore	1951	1,215	900	20	380–880			T	E	I	
25baa	M. C. M. W. C. D. No. 1		1,198	1,002	20	171–486 500–990	396M	1961	T	E	I	
25dbb	Wayne Thornburg		1,187	588	20	260–575	380.7	12-30-60	T	E	I	
26baa	M. C. M. W. C. D. No. 1		1,226	1,000	20	210–488 500–988	421M	1961	T	E	I	
27aaa	do		1,249	530	20	250–518	437M	1961	T	E	I	
27abb	do		1,269	550	20	224–534	424M	1961	T	E	I	
34abb	Drake and Howe	1952	1,240	1,320	20	115–1,320			T	E	I	
34bbb	Valley National Bank	1952	1,253	1,202					N	N	D	Test well.
35aaa	M. C. M. W. C. D. No. 1		1,192	1,050	16–20	169–534 560–1,040			T	E	I	
35bbb	do		1,220	501	20	171–486	413M	1961	T	E	I	
36baa	do		1,177	510	20	160–496	371M	1961	T	E	I	

AQUIFER CHARACTERISTICS

Although many cubic feet of valley fill in the Luke area has been dewatered, a great thickness of the material is still saturated. The thickness of the saturated valley fill is not known; however, several wells were still in saturated materials at depths of 1,200 feet, and one well was in saturated materials at a depth of 2,700 feet. The maximum depth to water in the area is now about 400 feet; thus, a considerable amount of water remains in the reservoir.

One of the most important aquifer characteristics of the valley fill is its permeability—a measure of the aquifers' ability to transmit water. Well-sorted coarse-grained materials have large interconnected interstices and release water readily; therefore, these materials can transmit large volumes of water. Fine-grained materials, such as silt and clay, and poorly sorted materials, which have small interstices, do not readily release water; therefore, these materials can transmit only small quantities of water. The percentage-distribution maps (pls. 2 and 3) show the distribution of fine-grained materials in the Luke area and, in effect, show the relative differences in permeability throughout the area.

Permeability, in turn, affects the specific capacity (yield in gallons per minute per foot of drawdown) of a well. Well depth, construction, type and number of perforations, and thoroughness of well development also affect the specific capacity. However, when the construction of wells is similar, differences in specific capacities may be attributed mainly to differences in the permeability of the material penetrated. Thus, other factors being equal, a well in an area where the penetrated materials are predominantly coarse grained will have a greater specific capacity than a well in an area where the materials are predominantly fine grained. Specific capacities of about 60 wells were computed from data reported by Goodyear Farms (table 3) and were plotted on the total depth percentage-distribution map (pl. 4). The specific capacities ranged from about 3 to 55 gpm per foot of drawdown. In most places, regardless of depth, wells that had specific capacities of 20 or greater are in areas where the valley fill is composed of less than 60 percent fine-grained materials. A notable exception is in the southwest corner of T. 2 N., R. 1 W. and the southeast corner of T. 2 N., R. 2 W., where several wells have specific capacities lower than expected from the indicated lithology. The reasons for this occurrence may be related to differences in well construction or to the limited control inherent in the method used to determine the geology. In general, however, specific-capacity data corroborate the interpretation of the geologic data that were used to draw the percentage-distribution maps.

TABLE 3.—*Specific capacities of selected wells*

[Depths to water given on table 2]

Well number: For explanation see section on "Well-numbering system."
Pumping lift; Discharge: All figures reported except those indicated by M.
Specific capacity: All figures rounded.

Well	Pumping lift (ft)	Discharge (gpm)	Specific capacity (gpm per ft of drawdown)	Date of pumping-lift and discharge measurements
				1961
(B-1-1)3baa	193	1,935	26	Aug. 18
4aab	208	1,953	21	Aug. 3
6bba	315	1,545	10	Aug. 25
(B-1-2)1baa	283	1,140	9	Aug. 8
1bbb	359	1,140	6	July 19
(B-2-1)2aca	311	1,046	14	Sept. 11
2baa	364	1,697	14	July 17
2bbb	326	2,092	30	July 3
2bbc	344	1,344	15	Do.
2bbd	362	1,181	11	Do.
				1960
5abc	334M	1,230M	23	Sept. 9
				1961
6abb	368	1,634	26	Sept. 7
6cbb	371	1,369	26	Aug. 7
6dbb$_2$	353	1,733	37	Aug. 9
7abb	345	1,639	32	Aug. 4
7cbb	356	1,322	25	Do.
8dba$_1$	356	1,098	10	Aug. 31
				1960
9bcb	302M	945M	14	Feb. 23
				1961
12bdb	386	1,158	6	July 18
12bdd	352	1,818	11	July 6
14abd	400	1,316	9	July 1
14dbb	398	1,315	9	Aug. 29
18bbb$_2$	330	956	31	July 3
18cbb$_2$	321	1,836	59	Aug. 30
19baa	329	2,038	33	Aug. 15
19cbb$_2$	322	1,984	55	Aug. 22
19dbb	348	1,500	16	July 28
20bba	445	870	5	July 11
				1961
(B-2-1)21ccb$_2$	292	669	6	Aug. 10
21dda	309	341	3	June 1
23dcc	239	1,311	22	July 3
26cbc$_2$	254	1,787	22	July 18
28dcb	188	1,217	27	July 2
29bab	279	1,446	19	Aug. 17
30aba	281	1,536	29	July 13
30caa	332	1,271	11	May 5
31abb$_2$	298	1,347	14	July 25
31bba$_2$	370	1,280	9	July 1
31caa	302	929	8	July 17
31dba	305	1,136	9	Aug. 11
33bbb	184	1,495	32	July 28
33bdd	199	1,926	28	July 7
34aad	206	1,558	23	May 26
34caa$_2$	194	1,729	28	Apr. 5
34dda	201	2,061	28	July 25
(B-2-2)1aba	393	1,455	32	Aug. 7
1acb	392	1,841	40	Do.
12abb	393	1,796	27	Sept. 6
13abb	363	1,428	30	Aug. 11
24baa	370	1,917	25	July 12
24bbb	334	1,239	50	Aug. 30
24cbb	365	1,284	23	July 31
24dbb$_2$	331	1,760	39	June 7
25aaa$_2$	312	1,396	27	July 5
25abb	383	1,131	11	Aug. 16
25bbb$_2$	375	1,491	26	Apr. 24
25cbb$_2$	375	1,800	19	June 6
25daa	331	1,087	13	July 5
25dbb$_2$	374	1,289	12	Aug. 10
36abb	363	1,073	8	July 18
36bbb$_2$	380	1,468	12	July 1
36cbb$_2$	474	1,253	5	Apr. 17
36dbb$_2$	341	1,293	9	Aug. 2

The specific-capacity data also suggest that the permeability of the coarse-grained materials decreases with depth. Examination of well data showed that deepening a shallow well or replacing a shallow well with a deeper well generally did not increase the specific capacity. One new deep replacement well, which was not perforated above 300 feet, had a specific capacity that was less than the specific capacity of the shallow well it replaced. At present a more detailed investigation in the area is designed to study this situation.

The percentage-distribution maps show that much of the Luke area is underlain by predominantly fine-grained materials, which do not yield water readily, and that their areal distribution increases with depth. The permeability of the predominantly coarse-grained materials also decreases with depth. Therefore, specific capacities of wells will decrease at an increasing rate as the water table declines, and the annual rate of water-table decline will increase as the volume of saturated coarse-grained materials decreases with depth.

MOVEMENT

Ground-water movement through an aquifer is controlled by the permeability of the material and the gradient of the water table. The direction and the rate of the movement also is influenced by pumping. A contour map of the water table depicting the general configuration of the water table by contour lines drawn through points of equal water-table altitude may be used to show direction of ground-water movement. Ground water moves from high to low altitudes in a direction perpendicular to the contour line. The contour map of the water table in the Luke area (pl. 5) shows that in the spring of 1961 the ground water in the Luke area was moving generally southwest.

In spring 1961 ground water in the area was moving toward two conspicuous depressions—one in T. 2 N., R. 1 W., and one in T. 2 N., R. 2 W. The depression in T. 2 N., R. 1 W., apparently is the result of the pumping of wells (B–2–1)14dbb and (B–2–1)14abd. The wells are about a quarter of a mile apart and are between 700 and 750 feet deep. During the summer of 1960, well (B–2–1)14dbb was producing about 1,300 gpm and well (B–2–1)14abd was producing about 1,600 gpm. Both wells were pumping from about 400 feet below the land surface. Plate 5 shows that the wells are in a peripheral area of predominantly fine-grained materials. The flatness of the water table west of the cone and the steepness of the cone suggest that the fine-grained materials retard the movement of water to the cone of depression. Most water moves to the cone from the east and the south. The axis of the limb of the troughlike depression in T. 2 N., R. 2 W., is primarily in an area of fine-grained materials and heavy pumping. This depression is the combined result of low permeability and pumping. The area of fine-grained materials becomes more extensive with depth, and the present cones of depression probably will expand at an accelerated rate each succeeding year.

CHEMICAL CHARACTER

The high dissolved-solids content of ground-water samples taken from several wells drilled for Luke Air Force Base prior to this study indicated that the vertical and areal distribution of poor-quality ground water on the base and in the Luke area should be determined.

Chemical analyses of the ground water from wells in the Luke area are given in table 4. The current standards (U.S. Public Health

Service, 1962) for preferable concentration limits of some of the chemical constituents in public and domestic water supplies are as follows:

Constituent	*Concentration (ppm)*
Magnesium	125
Chloride	250
Sulfate	250
Fluoride	1.5
Total dissolved solids:	
Good quality	500
Where no better water available	1,000

A lithologic study of the valley fill revealed, as previously mentioned, that evaporite-bearing zones occur at random. Consequently, the areas having ground water of poor quality were delineated initially on the basis of the sum of the dissolved solids in the water. The sum of dissolved solids computed from chemical analyses and specific-conductance measurements of samples collected during 1959 were plotted on a map, and isopleths were drawn through points of equal dissolved-solids content (pl. 6). Only wells of 1,000-foot depth or less were used.

The map shows that the water in the northern half of the Luke area is generally of good quality. The dissolved-solids content increases southward, and data (not included in this report) from shallow wells indicate ground water of very poor quality in the southernmost part of the Luke area.

To determine if there existed prominent and correlative zones of valley-fill materials that produced ground water of poor quality, an attempt was made to establish a relation between the dissolved-solids content and the zones yielding water to wells based on an analysis of well-casing perforation data. The well data delineated by the isopleths showed that the shallow and deep wells yield poor-quality water. Table 5 is a compilation of data collected from wells that are between the 1,000- and 2,000-ppm isopleths.

Table 5 shows that the poor-quality water yielded by wells (B–2–1)28dcb, (B–2–1)33bbb, and (B–2–1)33bcc enters these wells at relatively shallow depths. The table also shows that these three shallow wells have specific capacities that are greater than or similar to the specific capacities of the deeper wells. This may indicate that all the wells listed in table 5 obtained their water from relatively shallow depths. Most of the wells that lie outside of the 1,000-ppm isopleth are perforated in the same shallow zone but produce water of good quality, indicating that salinity is a relatively localized problem. The area of high salinity apparently is expanding because a study of analyses collected during 1946 shows that the quality of water

TABLE 4.—*Chemical analyses of ground water from selected wells in the valley fill*

[Analyses in parts per million except as indicated]

Well	Date of collection	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (sum)	Hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	Remarks
(B-1-1)3baa	9- 1-58			191	66	137	303	0	300	336		15	1,350		28		Reported by Goodyear Farms.
4aab	9- 1-59			254	112	244	293	0	480	620		13	2,020		33		Do.
9dab	9- 1-59			487	190	424	239	0	1,380	903		16	3,630		32		Do.
10aaa₂	7-16-58	73	19	208	56	77	177	0	179	395	0.3	34	1,060	750	18	1,840	
(B-1-2)1baa	8-13-59			244	99	238	190	0	500	620		22	1,910		34		Do.
1bbb	8-13-59			155	58	159	141	0	260	412		24	1,210		35		Do.
2bbb₂	8-13-58	114	38	8	1.2	149	112	0	57	125	7.0	3.0	443	25	93	847	
(B-2-1)1ccc	11-25-59	76	27	34	15	60	167	0	31	72	.8	5.2	327	146		565	
2aca	9- 3-59	87	25	13	4.0	160	167	0	28	157	1.9	4.1	475	49	88	829	
2bbb	9- 2-59	79	30	101	36	45	178	0	119	156	.4	12	587	402	20	1,010	
2bbc	9- 3-59	82	29	87	32	58	162	0	111	155	1.1	6.8	560	349	27	962	
2bbd	9- 3-59	90	24	20	4.6	221	151	0	36	268	2.3	4.2	654	69	87	1,180	
3bba	9-22-59	76	34	122	49	39	172	0	155	198	.3	13	695	508	14	1,180	
3cbb	1-24-59		10	230	54	127	200	0	310	408	.3	11	1,360				Well plugged at 1,143 ft; reported by Corps of Engineers.
3dda₁	2-13-61	82	19	26	8.0	181	126	0	49	230	2.4	8.0	585	98		1,060	
3dda₂	2-13-61	82	19	24	8.8	182	126	0	48	230	2.4	9.4	586	96		1,060	
4dad₁	11-24-59	75	28	76	29	32	174	0	75	109	.3	5.6	441	310		770	
4dad₂	11-24-59	74	29	74	30	29	172	0	66	109	.3	5.9	428	306		754	
5abc	7-28-60	83	25			73	153	0	79	127	.8	5.5		234	40	802	Depth, 312 ft.
	7-28-60	84	25			71	159	0	68	118	.9	6.7		221	41	768	Depth, 337 ft.
	7-28-60	84	19			70	165	0	68	103	.9	6.2		207	42	723	Depth, 375 ft.
	7-29-60	84	26			72	158	0	74	108	.9	5.6		210	43	749	Depth, 402 ft.
	8- 2-60	84	18			75	147	0	79	118	.9	5.9		213	43	771	Depth, 487 ft.
	9-14-60	88	28	23	9.4	61	182	0	34	27	1.4	2.5	275	96	58	442	Depth, 1,000 ft.
	2-14-61	80	28	30	9.5	46	184	0	25	22	.8	3.8	255	114		400	
5bbb	9- 1-59	85	31	33	12	59	183	0	34	45	.9	7.2	312	130	50	509	
6abb	9- 2-59	85	27	32	11	59	176	0	39	44	.6	9.8	309	127	50	505	
6bcb	4-29-59			24	10	60			40	31	.4	4.0	276	102			Reported by Goodyear Farms.
6dbb₂	9- 2-59	84	29	38	14	58	178	0	41	55	.7	11	335	152	45	557	
7abb	9- 2-59	92	26	32	15	47	180	0	33	38	.7	8.4	289	143	42	480	
8dba₂	9- 3-59	81	32	32	10	35	176	0	20	21	.5	4.3	242	123	38	386	
9bcb	12- 8-59	75				83	176	0	57	58	.8	7.2		113	61	586	Depth, 271 ft.
	12-10-59	74				41	151	0	27	27	.8	4.4		105	46	383	Depth, 307 ft.
	12-14-59	74				40	133	0	56	92	.5	1.7		213	29	615	Depth, 350 ft.

TABLE 4.—*Chemical analyses of ground water from selected wells in the valley fill*—Continued

Well	Date of collection	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (sum)	Hardness as $CaCO_3$	Percent sodium	Specific conductance (micromhos at 25°C)	Remarks
(B-2-1) 9bcb	12-21-59	74	------	------	------	37	142	0	65	113	.3	4.5	------	268	23	717	Depth, 500 ft.
	12-24-59	74	------	------	------	46	143	0	64	101	.5	4.1	------	231	30	683	Depth, 557 ft.
	12-29-59	71	------	------	------	51	126	0	65	102	.6	2.4	------	208	35	670	Depth, 601 ft.
	12-31-59	75	------	------	------	56	154	0	71	110	.6	3.1	------	237	34	735	Depth, 676 ft.
	1-1-60	69	------	------	------	48	160	0	71	116	.5	5.0	------	270	28	761	Depth, 712 ft.
	1-4-60	73	------	------	------	46	141	0	71	116	.6	3.2	------	257	28	738	Depth, 760 ft.
	1-5-60	73	------	------	------	47	145	0	71	116	.6	4.8	------	260	28	739	Depth, 812 ft.
	1-7-60	73	------	------	------	49	137	0	68	112	.7	2.9	------	239	31	717	Depth, 855 ft.
	1-8-60	76	------	------	------	44	150	0	65	111	.6	3.8	------	255	27	735	Depth, 914 ft.
	1-12-60	74	------	------	------	52	136	0	68	109	.6	1.6	------	225	34	719	Depth, 951 ft.
	1-14-60	74	------	------	------	38	162	0	24	20	1.0	3.9	------	109	43	377	Depth, 1,005 ft.
	1-15-60	73	------	------	------	52	170	0	29	23	1.1	2.6	------	93	55	411	Depth, 1,032 ft.
	1-19-60	75	------	------	------	55	144	0	63	103	.5	4.3	------	215	36	692	Depth, 1,102 ft.
	1-21-60	74	------	------	------	87	139	0	67	146	.5	3.9	------	205	48	839	Depth, 1,160 ft.
	2-11-60	94	19	9.5	2.3	99	152	0	50	41	4.3	3.2	303	33	87	490	Depth, 1,200 ft; perforated from 907–924, 969–977 ft.
	2-23-60	89	22	12	4.4	83	155	0	36	36	2.8	3.4	276	48	78	446	Depth, 1,200 ft; perforated from 535–561, 564–572, 907–924, 969–977 ft.
	2-13-61	83	18	9.5	2.6	102	149	2	52	45	3.8	3.0	311	34	------	513	
10bba	10-5-59	80	32	74	28	49	149	0	36	172	.6	3.3	468	300	26	863	
12bdb	9-1-59	------	------	49	24	49	217	0	40	68	------	14	455	------	32	------	Reported by Goodyear Farms.
14cbb	------	------	------	860	32	1,310	117	0	2,370	------	------	------	6,280	------	------	------	Reported by owner.
17bbc	9-2-59	82	35	32	13	41	172	0	26	34	.8	4.8	272	133	40	427	
18acc	9-9-59	84	28	34	12	60	175	0	39	52	1.1	5.3	317	135	49	522	
18bbb₁	------	------	------	254	96	148	------	------	502	430	.3	116	1,780	------	------	------	Reported by Goodyear Farms.
18cbb₂	4-29-59	------	------	34	13	57	------	------	28	57	.4	.1	315	------	------	------	Do.
19aab	9-2-59	88	26	26	8.3	127	169	0	41	128	2.4	9.4	451	99	74	771	
19baa	8-20-51	------	------	90	41	83	168	0	170	182	.6	------	734	394	------	------	Depth, 315± ft; reported by Goodyear Farms.
	10-15-51	------	------	90	30	71	154	0	120	172	------	10	647	348	------	------	Depth, 920 ft; reported by Goodyear Farms.
	11-7-51	------	------	98	23	93	161	0	150	170	.4	12	707	336	------	------	Depth, 1,012 ft; reported by Goodyear Farms.
	2-4-52	------	------	60	8.0	942	78	0	460	1,180	2.8	------	2,740	181	------	------	Depth, 1,340 ft; reported by Goodyear Farms.
	2-16-52	------	------	38	4.0	565	85	0	320	658	------	------	1,670	109	------	------	Depth, 1,418 ft; reported by Goodyear Farms.
	4-4-52	------	------	60	4.0	346	76	0	440	280	3.6	0	1,210	166	------	------	Depth, 1,596 ft; reported by Goodyear Farms.
	4-10-52	------	------	825	19	535	51	0	2,550	426	1.6	0	4,410	2,140	------	------	Depth, 1,725± ft; reported by Goodyear Farms.

	5- 4-52			98	15	349	63	0	550	310	2.4	0	1,380	305			Depth, 1,868 ft; reported by Goodyear Farms.
	5-20-52			68	8.0	212	85	0	220	254	2.0	0	847	200			Depth, 1,936 ft; reported by Goodyear Farms.
	5-20-52			75	8	297	88	0	310	330	3.2	0	1,110	218			Depth, 1,980 ft; reported by Goodyear Farms.
	5-26-52			60	8	298	63	0	280	342	4.0	0	1,050	181			Depth, 2,054 ft; reported by Goodyear Farms.
	7-18-52			450	23	1,430	32	0	1,540	1,900	4.0		5,380	1,210			Depth, 2,098 ft; reported by Goodyear Farms.
	7-17-52			420	23	1,370	39	0	1,520	1,770	3.6	0	5,140	1,140			Depth, 2,175± ft; reported by Goodyear Farms.
													191,000				Depth, 2,350 ft; reported by Goodyear Farms.
	9- 2-59	84	25	54	22	73	153	0	48	137	1.2	16	451	225	41	810	Well plugged at 1,282 ft.
19bbb₂	8-13-59			38	17	91	173	0	70	88		32	508		54		Reported by Goodyear Farms.
19cbb₂	8-13-59			33	14	129	142	4	110	114		34	610		67		Do.
19dbb	8-13-59			17	8	107	144	2	80	12		6.0	376		76		Do.
20bba	8-13-59			42	14	170	147	2	130	195		7.0	707		70		Do.
21dda	8-13-59			126	55	161	208	0	470	159		16	1,200		39		Do.
23dcc	9- 1-59			28	15	112	176	0	75	101		14	521		65		Do.
26cbc₂	9- 1-59			34	17	121	188	0	75	121		19	575		63		Do.
27abd	4-29-59			25	12	90			56	80	1.2	10	354				Do.
27cbc	9- 1-59			183	75	262	454	0	440	342		28	1,780		43		Do.
27dcc	9- 1-59			172	63	155	325	0	250	342		22	1,330		33		Do.
28dcb	3- 7-59												2,300				Do.
29bab	8-13-59			112	47	116	195	0	210	250		7.0	937		35		Do.
30aba	8-13-59			118	46	126	171	0	215	286		6.0	968		36		Do.
30caa	9- 1-59			256	117	248	181	0	720	525		26	2,070		32		Do.
31abb₂	9- 1-59			277	117	266	171	0	660	642		29	2,160		33		Do.
31bba₂	9- 1-59			50	20	233	117	0	200	249		46	905		70		Do.
31caa	9- 1-59			242	100	201	173	0	460	580		16	1,770		30		Do.
31dba	9- 1-59			294	138	299	198	0	780	682		20	2,410		33		Do.
33bbb	9- 1-59			296	132	257	330	0	540	712		11	2,280		32		Do.
33bcc	9- 1-59			296	132	396	395	0	625	823		10	2,680		40		Do.
33bdd	9- 1-59			265	149	201	249	0	500	695		10	2,070		26		Do.
34aad	9- 1-59			154	63	66	208	0	250	241		22	1,000		18		Do.
34caa₂	9- 1-59			406	151	229	371	0	700	760		32	2,650		23		Do.
34dda	9- 1-59			86	38	64	183	0	125	155		15	646		27		Do.
(B-2-2) 12abb	4-29-59			20	10	67			51	43	.5	12	279				Do.
24bbb	9- 1-59			20	13	87	112	1	40	89		34	395		65		Do.
24cbb	8-13-59			19	9	80	120	2	40	60		20	350		67		Do.
25aaa₂	9- 1-59			59	32	142	151	0	110	231		28	753		53		Do.
25cbb₂	8-13-59			27	10	99	98	1	70	101		38	444		66		Do.
25daa	9- 1-59			33	15	160	142	0	110	161		39	660		71		Do.
36abb	8-13-59			30	9.0	117	110	4	100	95		14	479		68		Do.
36bbb₂	8-13-59			28	7.0	104	115	1	65	101		30	451		70		Do.
36cbb₂	8-13-59			41	16	142	93	1	160	148		38	639		65		Do.
36dbb₂	8-13-59			107	43	175	141	0	300	274		28	1,070		46		Do.
(B-3-1) 26cbb₂	9- 2-59	85	29	17	8.9	58	152	0	30	30	1.4	3.0	252	79	61	401	
27cbb₂	9- 2-59	84	33	30	12	59	163	0	38	46	2.0	13	313	126	50	505	
32bab	9- 2-59	91	28	19	11	85	144	0	66	59	1.4	4.1	344	92	67	549	
32cbb	9- 2-59	85	31	27	13	61	179	0	36	41	1.0	8.0	306	119	53	490	

TABLE 5.—*Quality of water and well-casing data from selected wells*

Well	Altitude (ft, datum is mean sea level)			Total dissolved solids in 1959 (ppm)	Specific capacity in 1959
	Bottom of well	Perforations	Water-table surface in 1959		
(B-1-1)4abb	289	851-307	883	2,016	30
(B-2-1)28dcb	735	906-749	881	2,299	24
30caa	469	928-483	826	2,073	----------
31abb	261	847-279	843	2,162	25
31caa	548	868-566	846	1,772	14
33bbb	691	899-731	881	2,278	32
33bcc	778	902-816	882	2,677	50
33bdd	73	805-87	881	2,069	28
34caa$_2$	−16	848-6	875	2,649	26

in this area has generally deteriorated between 1946 and 1959. Also, the configuration of the isopleths is, in general, similar to the configuration of the ground-water contour lines in the area. It is therefore possible that the area of poor-quality water delineated by the isopleths is caused by poor-quality water moving northward through the relatively shallow coarse materials.

The occurrence of poor-quality water in wells (B–2–1)3cbb and (B–2–1)3dda$_1$ is not related to the area previously discussed. No water samples were collected during drilling, so the altitude of zones containing poor-quality water is not known; however, the water probably came from below 600 feet. Well (B–2–1)3dda$_1$ yielded water of good quality before it was deepened from 600 to 1,060 feet. An analysis of the water collected from the well after it had been deepened showed that the chloride concentration was in excess of 9,000 ppm, so the well was backfilled to 593 feet. The well now yields water of good quality. Well (B–2–1)3dda$_2$, drilled to a depth of 600 feet, also yields water of good quality. Wells (B–2–1)4dad$_1$ and (B–2–1)4dad$_2$, less than a quarter of a mile from well (B–2–1)3cbb, also yield water of good quality; these wells are only 500 feet deep.

Well (B–2–1)18bbb yields water of poor quality; this well is considerably deeper than the surrounding wells that yield water of good quality. Well (B–2–1)19baa contained highly saline water when drilled to a depth of 2,784 feet. It was plugged at a depth of 1,282 feet and now yields water of good quality. The bottom of well (B–2–1)18bbb is almost 200 feet above the horizon at which well (B–2–1)19baa was plugged; the two wells apparently are not obtaining water of high salinity from the same depth. Although these wells and wells (B–2–1)3cbb and (B–2–1)3dda$_1$ obtained water of poor quality from relatively deep zones, it does not follow that all deep wells in the Luke area would yield poor-quality water; several that are deeper than 1,000 feet yield water of good quality.

Both of the wells previously mentioned as having anomalous water levels contain water of poor quality. Water from well (B–2–1)14cbb was reported to be of poor quality, and conductivity measurements made during the drilling of well (B–2–1)21abb indicated a dissolved-solids content as high as 1,800 ppm at a depth of 140 feet. In this well it is apparent that the shallow part of the aquifer contains water of poor quality.

In summary, poor-quality water is not distributed uniformly throughout the Luke area. In general, wells in the southern half of the area seem to obtain poor-quality water from relatively shallow depths. Most wells in the northern half of the area yield water of good quality; however, the water from five of these wells is high in dissolved solids. In these wells the zones of poor-quality water occur at random depths. Insufficient data have been accumulated to accurately predict which locations and depths might yield water of poor quality. Therefore, drilling and sampling techniques, such as those used during the construction of test wells (B–2–1)9bcb and (B–2–1)5abc, should be used during the construction of wells in the future.

LUKE AIR FORCE BASE TEST WELLS

Two test wells were drilled at Luke Air Force Base under the supervision of the U.S. Geological Survey. The first was drilled in sec. 9, T. 2 N., R. 1 W., and was completed in January 1960; the second was drilled in sec. 5, T. 2 N., R. 1 W., and was completed in August 1960.

FIRST TEST WELL

The site for the first test well (B–2–1)9bcb was selected on the basis of availability of water and access to the water system. Although the northwestern part of the base showed the greatest promise for a well of optimum quality and quantity of water, no waterlines were available on that part of the base. As a result, the well site was located in the NW¼ sec. 9, T. 2 N., R. 1 W., a location which satisfied both requirements.

The well was drilled and cased to a depth of 1,200 feet. During construction of the well, drill-cutting samples were collected at intervals of 5 feet. A bailer test was made whenever field analysis of the cuttings indicated the possibility of a productive zone. Specific-conductance measurements were taken of the bailer water every 5 feet to determine quality-of-water zones. Water samples were taken during each bailer test and chemical analyses were made (table 4).

Specific-conductance measurements, laboratory analyses of drill cuttings, and data from the bailer tests were compiled and used to position casing perforations. The casing was first perforated from

907 to 924 feet and from 969 to 977 feet, because bailer tests had indicated that coarse-grained beds at these depths might yield an adequate amount of water. The bottom of the hole was plugged with cement, a pump was installed, and the well was surged for several hours. The water level was allowed to recover, and the well was then tested by pumping at a rate of 330 gpm for 9 hours. The test was discontinued because the water level had drawn down 200 feet to the pump bowls, which were at 440 feet. An analysis of the water sample collected at the end of the test showed a fluoride content of 4.4 ppm. This is considerably above the standard maximum of 1.5 ppm (U.S. Public Health Service, 1962).

Because the well did not yield sufficient water, new perforations were cut from 535 to 561 feet and from 564 to 572 feet. A second pumping test was run at a rate of about 950 gpm for 24 hours. At the end of 24 hours the drawdown was 66 feet. Analyses of water samples collected during the test showed a fluoride content of 2.8 ppm. Although the fluoride content was still high, it was decided that mixing this water with the water in the system would dilute the fluoride content sufficiently to produce water acceptable for domestic use.

SECOND TEST WELL

The second test well, (B-2-1) 5abc, was drilled to a depth of 1,000 feet and was constructed in the same manner as the first well. The well casing was perforated at selected zones (table 2), and the well was developed by sand-pumping and surging for several days.

A pumping test was made after the well was developed. The test consisted of measuring the drawdown periodically during continuous pumping at different rates of discharge. The well was pumped first at 1,000 gpm for 8 hours. For the next 8 hours, the well was pumped at 1,250 gpm, and for the last 8 hours, it was pumped at 1,500 gpm. When the well had been pumped for 24 hours, periodic measurements of the recovery of the water level were made.

The first 8 hours of pumping at 1,000 gpm produced a maximum drawdown of about 44 feet. During the 8 hours of pumping at 1,250 gpm, the drawdown increased about 10 feet; the 8 hours of pumping at 1,500 gpm increased the drawdown an additional 15 feet. Six hours after pumping had been discontinued, the water level had recovered to within 2 feet of its original level.

The step-drawdown test did not lend itself readily to analysis because of difficulty in controlling the discharge rate. Estimates of the coefficient of transmissibility [1] ranged from about 40,000 to

[1] The coefficient of transmissibility may be expressed as the number of gallons of water per day transmitted through each section of aquifer 1 mile wide extending the height of the aquifer under a hydraulic gradient of 1 foot per mile at the prevailing temperature.

68,000. An analysis of water collected during the test showed a total dissolved-solids content of 269 ppm and a fluoride content of 1.4 ppm (table 4).

CONCLUSIONS

Ground water in the Luke area has been and will continue to be the most important source of domestic and irrigation water supplies. The water levels in the Luke area declined about 150 feet during the 20-year period 1941–61. The amount of annual decline is now about 13 feet.

There are several areas of predominantly fine-grained materials within the Luke area. Wells that obtain their water from these areas generally have specific capacities of 15 or less. Wells that obtain their water from predominantly coarse-grained materials generally have specific capacities of 20 or greater.

The areal distribution of fine-grained materials increases with depth, and specific-capacity data indicate the permeability of the coarse-grained materials decreases with depth. Therefore, as the volume of saturated coarse-grained materials decreases with depth, the annual rate of decline will increase and the specific capacities of wells will decrease.

In recent years several earth cracks have occurred in the Phoenix basin. The authors believe these cracks may be the result of dewatering of the valley fill, thereby causing compaction and subsidence. Severe damage to well casings observed near these cracks may be caused by the movement which caused the cracks. As the water table continues to decline, the valley-fill materials may continue to undergo compaction and subsidence, and, consequently, more well casings and other construction may suffer damage.

Chemical quality of water varies throughout the Luke area. Wells in the southern half of the area yield water of poor quality from shallow depths. While wells in the northern half of the area generally yield water of good quality, analyses from several wells showed a high dissolved-solids content, and data for these wells indicated that they obtained their poor-quality water from zones at random depths.

If it is necessary to drill new wells to supplement the Luke Air Force Base water supply, these wells should be located in the northwest corner of the base. Wells located here would have good specific capacities because this part of the base is in an area of predominantly coarse-grained materials. Also, quality-of-water data indicate that water of suitable quality would be obtained more easily in the northwest corner than elsewhere on the base; however, drilling and sampling techniques such as those used during the construction of the two Luke Air Force Base test wells should be used to construct future wells.

719–174—64——3

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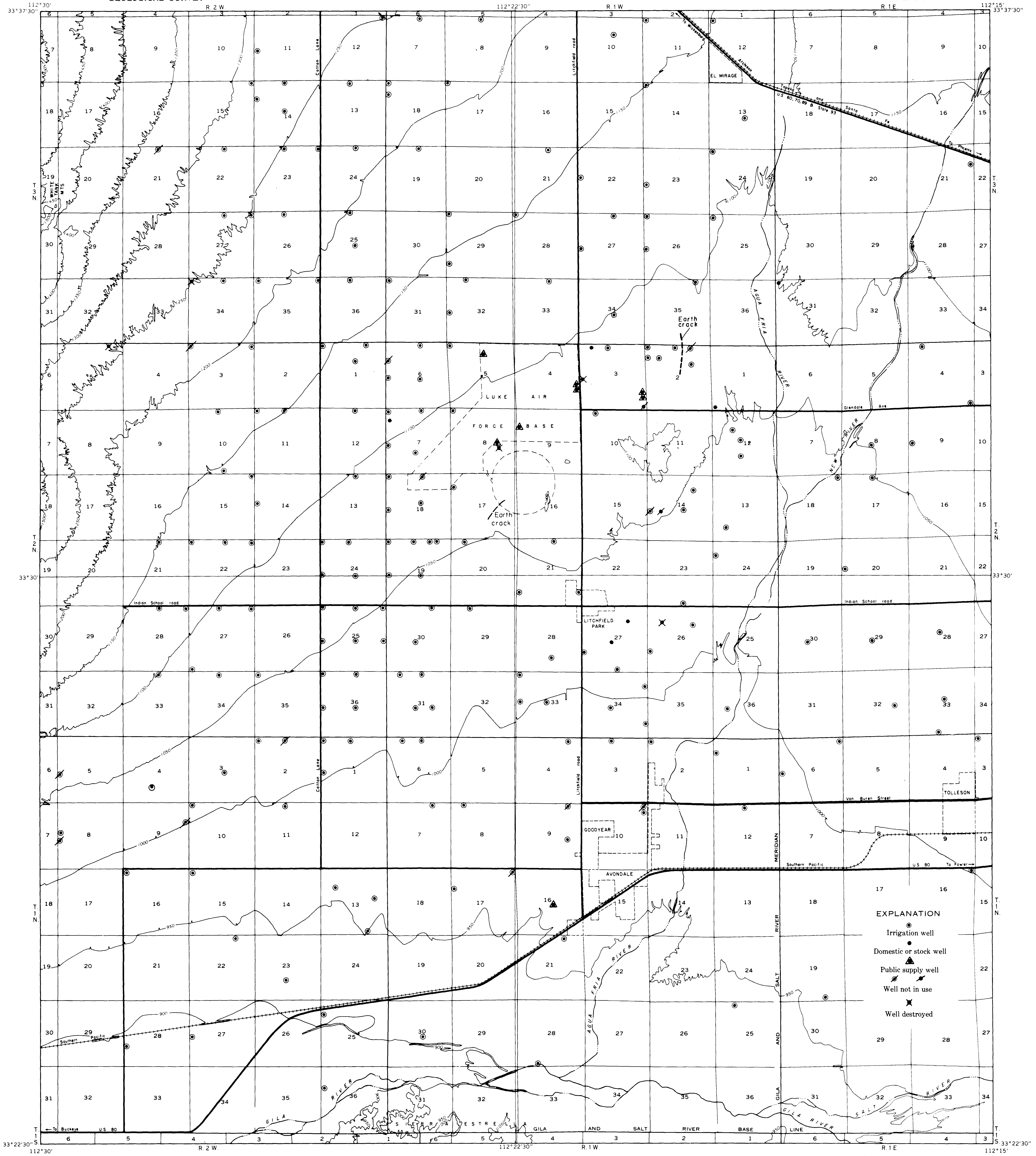


Base from U.S. Geological Survey topographic maps: El Mirage, 1957; Perryville, 1957; Tolleson, 1957; and Waddell, 1957

Hydrology by R. S. Stulik, 1961

MAP SHOWING LOCATION OF WELLS, LUKE AREA, MARICOPA COUNTY, ARIZONA

TRUE NORTH
MAGNETIC NORTH
14°
APPROXIMATE MEAN DECLINATION, 1963

1 ½ 0 1 2 3 4 5 MILES

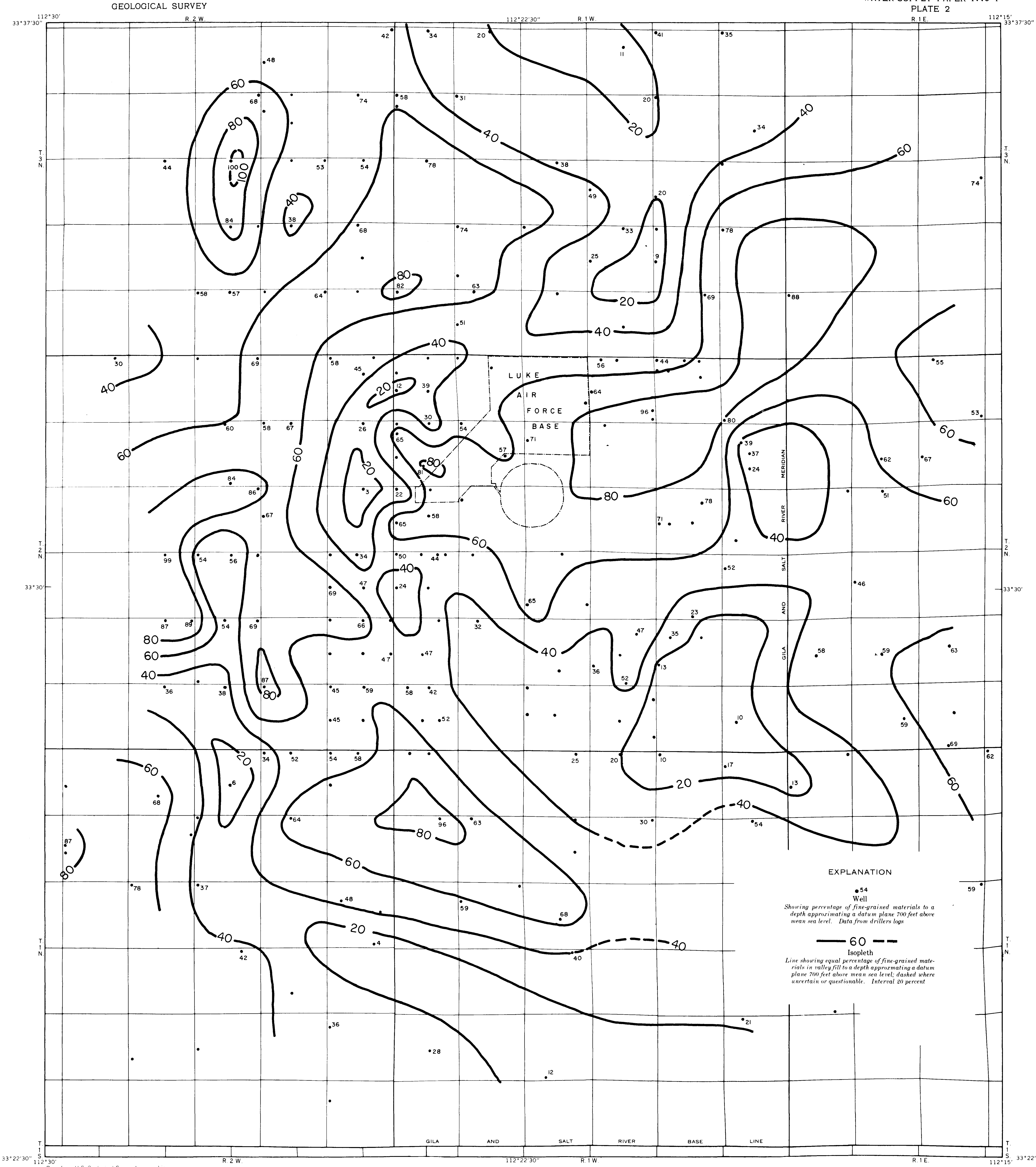
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

719-174 O - 64 (In pocket)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER-SUPPLY PAPER 1779-P
PLATE 2



Base from U.S. Geological Survey topographic maps: El Mirage, 1957; Perryville, 1957; Tolleson, 1957; and Waddell, 1957

MAP SHOWING PERCENTAGE DISTRIBUTION OF FINE-GRAINED MATERIALS ABOVE 700-FOOT ALTITUDE LUKE AREA, MARICOPA COUNTY, ARIZONA

Geology by F. R. Twenter, 1961

APPROXIMATE MEAN DECLINATION, 1964

5 MILES

5 KILOMETERS

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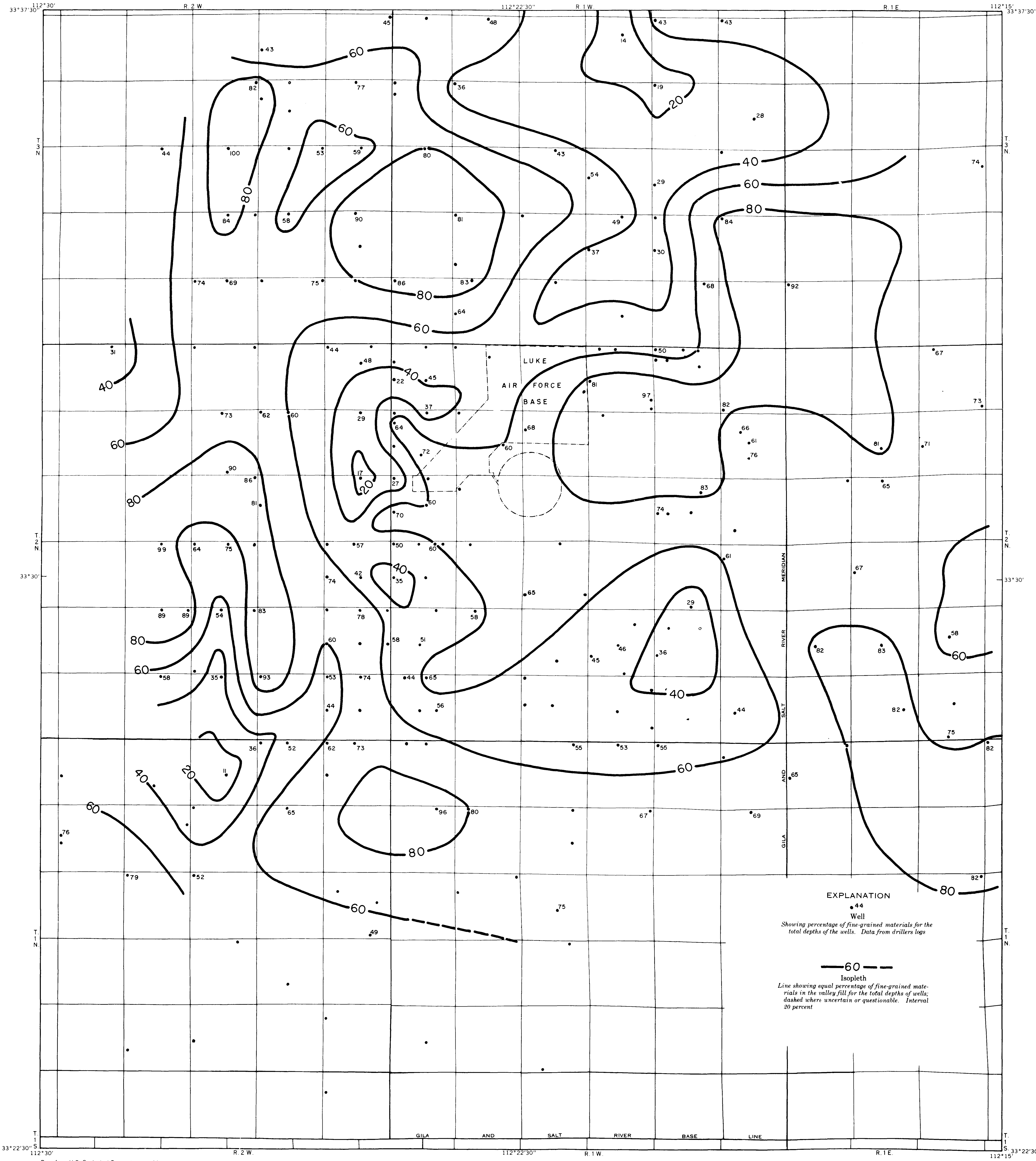


Base from U.S. Geological Survey topographic maps: El Mirage, 1957; Perryville, 1957; Tolleson, 1957; and Waddell, 1957

MAP SHOWING PERCENTAGE DISTRIBUTION OF FINE-GRAINED MATERIALS FOR TOTAL DEPTHS OF WELLS LUKE AREA, MARICOPA COUNTY, ARIZONA

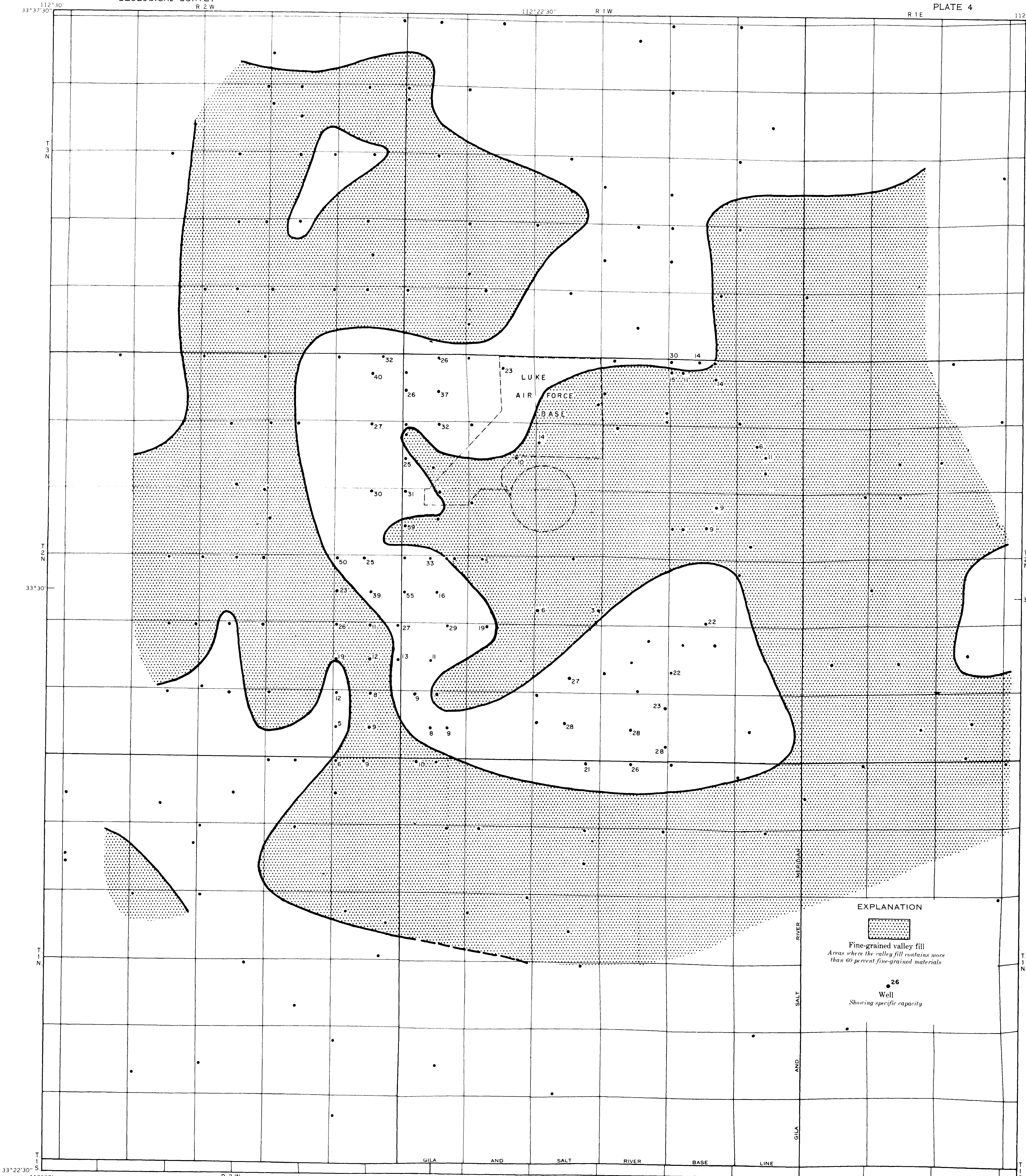
Geology by F. R. Twenter, 1961

TRUE NORTH
MAGNETIC NORTH
14°
APPROXIMATE MEAN DECLINATION, 1964

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

719-174 O - 64 (In pocket)



Base from U.S. Geological Survey topographic maps: El Mirage, 1957; Perryville, 1957; Tolleson, 1957; and Waddell, 1957

MAP SHOWING RELATION BETWEEN SPECIFIC CAPACITIES OF WELLS AND AREAS OF PREDOMINANTLY FINE-GRAINED MATERIALS FOR TOTAL DEPTHS OF WELLS, LUKE AREA, MARICOPA COUNTY, ARIZONA

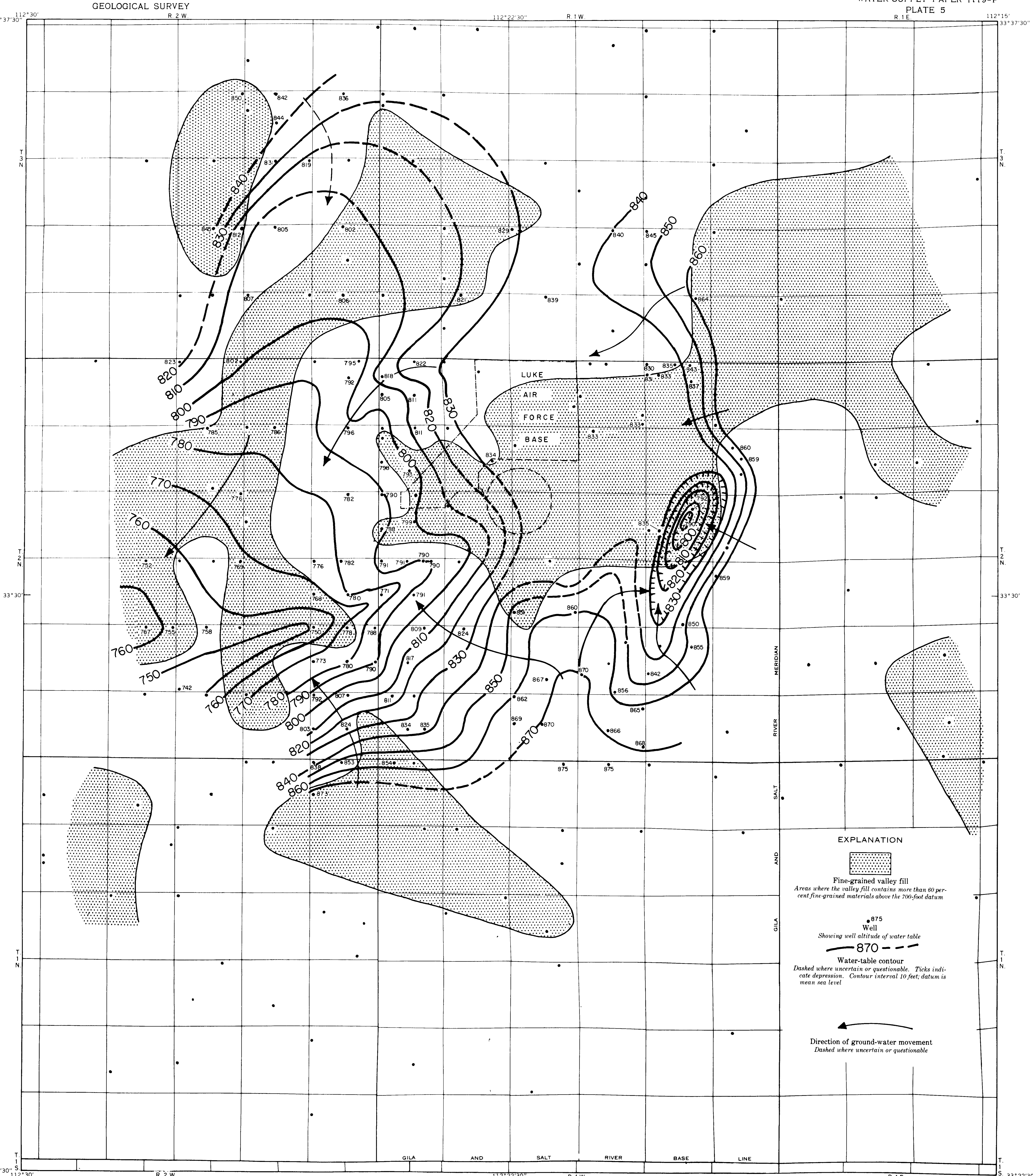
Geology by F. R. Twenter, 1961
Hydrology by R. S. Stulik, 1961

APPROXIMATE MEAN DECLINATION, 1961

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

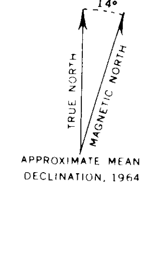
719-174 O - 64 (In pocket)

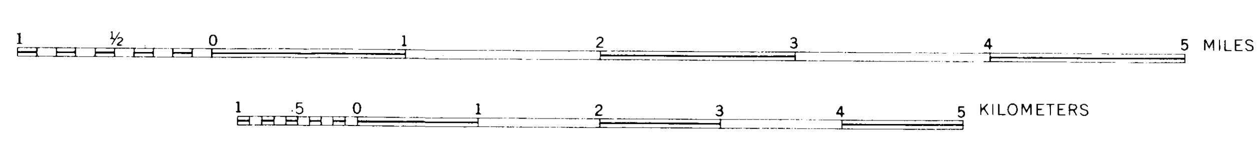


Base from U.S. Geological Survey topographic maps: El Mirage, 1957; Perryville, 1957; Tolleson, 1957; and Waddell, 1957

CONTOUR MAP OF THE WATER TABLE FOR SPRING 1961 SHOWING GROUND-WATER MOVEMENT AND ITS RELATION TO AREAS OF PREDOMINANTLY FINE-GRAINED MATERIALS ABOVE 700-FOOT ALTITUDE DATUM
LUKE AREA, MARICOPA COUNTY, ARIZONA

Geology by F. R. Twenter, 1961
Hydrology by R. S. Stulik, 1961





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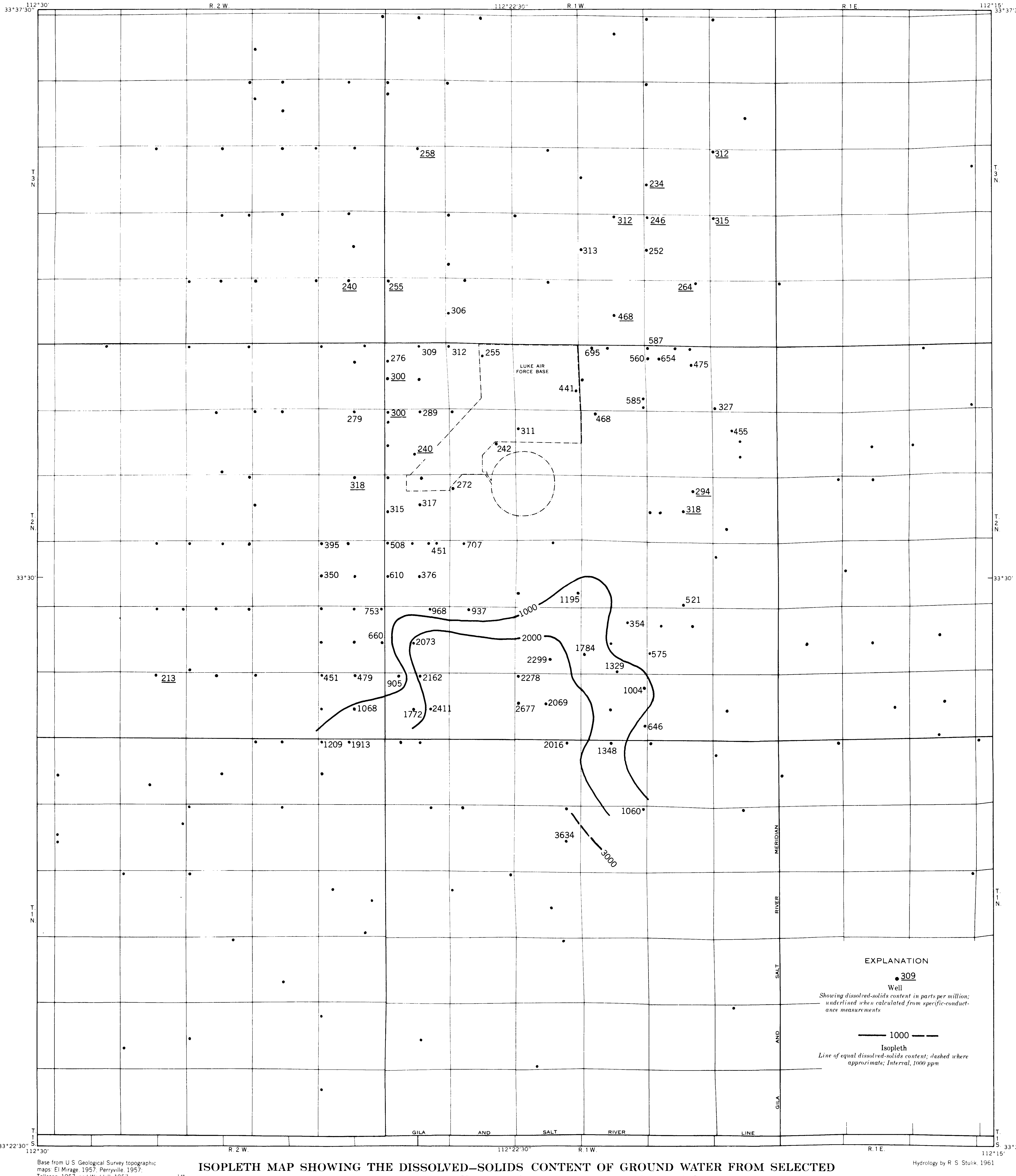

Base from U.S. Geological Survey topographic maps: El Mirage, 1957; Perryville, 1957; Tolleson, 1957; and Waddell, 1957

Hydrology by R. S. Stulik, 1961

ISOPLETH MAP SHOWING THE DISSOLVED-SOLIDS CONTENT OF GROUND WATER FROM SELECTED WELLS DURING 1959, LUKE AREA, MARICOPA COUNTY, ARIZONA

14°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1964

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

719-174 O - 64 (In pocket)