GEOLOGY AND GROUND-WATER RESOURCES OF TORRANCE COUNTY, NEW MEXICO

GROUND-WATER REPORT *5*

Geology and Ground-Water Resources of Torrance County, New Mexico

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Prepared cooperatively by the United States Geological Survey, New Mexico Bureau of Mines & Mineral Resources, and the State Engineer of New Mexico

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Abstract

Torrance County, in central New Mexico, has an area of about 3,340 square miles and a population of 8,012 (1950). Estancia Valley, which ranges from about 6,000 feet to 7,500 feet in altitude, is the largest physical feature in the county. This valley is bordered on the west by the Manzano Mountains (altitude 7,500 — 10,000 feet), on the east by the Pedernal Hills and eastern uplands (altitude 6,000 — 7,600 feet), and on the south by the north end of Chupadera Mesa (altitude about 6,500 — 7,250 feet). The northern end of Estancia Valley, which reaches an altitude of about 6,400 feet, merges with a plateau in southern Santa Fe County. The surface of the eastern uplands, in the eastern part of Torrance County, is indented by the relatively shallow and small Encino and Pinos Wells drainage basins. The altitudes of these drainage basins range from about 6,100 to 6,500 feet.

The surface drainage of most of the county is into closed basins, of which the principal ones are Estancia Valley and the Encino and Pinos Wells basins. The surface drainage on Chupadera Mesa is into sinks, and that of the southeast corner of the county into sinks and a closed drainage basin centering in Guadalupe County. Near the southwest corner of the county the surface drainage is into the Jornada del Muerto and the Rio Grande. Surface drainage in the northeastern part of the county is into the Rio Grande by way of the Pecos River.

The average annual precipitation in the county is about 14 inches, according to records at localities in or near the county. It is 11.58 inches at Otto and 19.54 inches at Tajique. Agriculture is the principal occupation in the county, and irrigation by ground water has become increasingly important since 1947.

Precambrian rocks crop out in the higher part of the south end of the Manzano Mountains, in the Pedernal Hills, in Cerrito del Lobo, and in Chameleon Hill and areas north of that hill. The Precambrian rocks furnish small to moderate quantities of water to wells in their larger areas of exposure and to some wells in adjacent areas where the Precambrian rocks are overlain by Permian rocks. The oldest sedimentary rocks in Torrance County are those of the Magdalena group of Pennsylvanian and Permian age, which includes the Sandia formation and the overlying Madera limestone of Pennsylvanian age and the Bursum formation of Permian age. In this investigation the Bursum formation was mapped with the overlying Abo formation for convenience. The upper arkosic limestone member of the Madera limestone is the principal aquifer in the northern part of the Manzano Mountains and eastward to Estancia Valley. It furnishes water of satisfactory quality to stock and domestic wells. Overlying the Magdalena group is the Abo formation of Permian age, which furnishes water to stock and domestic

wells between the Manzano Mountains and Estancia Valley in the area south of Manzano and north of Chupadera Mesa.

The Yeso formation of Permian age, which overlies the Abo formation, is the principal aquifer in about half the county. It furnishes water to stock wells over most of its outcrop area, to public-supply wells near Mountainair, and to irrigation wells in a small area of fractured rock south of Cerrito del Lobo. The chemical quality of the water from most of the wells in the Yeso formation is undesirable for drinking or irrigation but is usable for stock. The overlying Glorieta sandstone member of the San Andres formation of Permian age furnishes water to irrigation wells north of Moriarty in an area where is is fractured. The limestone member and upper clastic member of the San Andres formation do not yield water in Torrance County.

The beds of the Dockum group of Triassic age bear water of good quality at depths of less than 300 feet in the northeast corner of the county. No wells were noted that obtain water from the Ogallala formation of Pliocene age, but perched water may be found where the Ogallala is comparatively thick and overlies relatively impervious rocks in the eastern part of the county. The alluvial fill of Estancia Valley, of late Tertiary(?) and Quaternary age, furnishes water to irrigation and other wells in most of the valley.

The county has been subdivided into six ground-water areas on the basis of the distribution of water-bearing geologic units, geologic structure, and ground-water occurrence. These areas are the Estancia Valley, Manzano Mountains, Pedernal Hills and eastern uplands, Chupadera Mesa, Encino basin, and Pinos Wells basin.

In Estancia Valley, a closed drainage basin, the valley fill is the principal aquifer for irrigation, stock, domestic, and community-supply wells. The present development of irrigation in Estancia Valley began in 1940, but the development was relatively insignificant until about 1947. Observations of water levels show a maximum decline in water level from 1941 to 1952 of nearly 13 feet. Most of the wells range in depth from 100 to 300 feet. The non-pumping water levels in most of the irrigation wells range from 10 to 150 feet, and in most of the stock wells from 10 to 250 feet, below the surface. In general, the water from wells in Estancia Valley west of State Highway 41 is chemically satisfactory for drinking, domestic, stock, and irrigation use. However, in areas east of the highway, particularly in the vicinity of the playas, the water is generally undesirable to unsatisfactory for drinking, most domestic use, and irrigation, but is satisfactory for stock.

In most of the Manzano Mountains area ground water is obtained from the arkosic limestone member of the Madera limestone. In the southern part of the Manzano Mountains and in Abo Canyon the Abo formation is the principal aquifer. Wells in the Manzano Mountains area are as deep as 1,080 feet, and water levels in wells for which data were obtained range from 6 to 412 feet below the surface. Aquifers in the area furnish water to stock and domestic wells, but the probability of obtaining sufficient water for irrigation is small. Chemically the water is satisfactory for drinking, stock, domestic, and irrigation use.

The igneous and metamorphic rocks of the Pedernal Hills furnish water principally to stock and domestic wells. In this area the wells range from 53 to 405 feet in depth, and water levels in the wells range from 34 to 360 feet below the surface. Chemically the water from the wells is generally satisfactory for stock, irrigation, and most domestic use, but some of it is undesirable for drinking.

In the eastern uplands the Yeso formation is the principal aquifer in about 90 percent of the area and yields sufficient water for windmill wells. The depths of the wells in this area range from 75 to 3,600 feet, and water levels range from 72 to 940 feet below the surface. The water from wells in the eastern uplands has a great range in chemical quality; the worst is unsatisfactory for drinking and most domestic purposes, but satisfactory for stock and irrigation.

On the northern end of Chupadera Mesa in Torrance County the Yeso formation is the principal aquifer. Wells range from 250 to about 970 feet in depth, and water levels in the wells range from 200 to about 750 feet below the surface. Chemically the water is suitable for stock but is unsatisfactory for drinking or domestic use.

In the Encino drainage basin the Precambrian rocks are the principal aquifer in the western third of the basin and the Yeso formation in the remainder. The wells, which are used for stock and domestic purposes and for railroad supply, range in depth from 24 to 640 feet, and water levels range from 18 to 540 feet below the surface. Chemically the water from the wells is satisfactory to unsatisfactory for drinking, domestic use, and irrigation, but satisfactory for stock.

Introduction

LOCATION AND AREA

Torrance County, in central New Mexico, has an area of about 3,340 square miles or 2,138,000 acres. The dimensions of the county are about 54 miles from north to south and about 62 miles from east to west. The area discussed in this report (fig 1) does not include the relatively small part of Torrance County west of the crest of the Manzano Mountains; however, Corona and the surrounding region in Lincoln County and parts of Bernalillo and Santa Fe Counties adjacent to the northwestern part of Torrance County are discussed in the report.

The relation of some political and geographic features of Torrance County to such features in surrounding counties is shown in Figure 2.

SCOPE OF INVESTIGATION

This investigation was made by the U. S. Geological Survey in cooperation with the New Mexico Bureau of Mines and Mineral Resources and the State Engineer of New Mexico. It was under the general supervision of A. N. Sayre, chief of the Ground Water Branch, U. S. Geological Survey, and under the direct supervision of C. V. Theis, former district geologist, and C. S. Conover, present district engineer in charge of ground-water investigations for the U. S. Geological Survey in New Mexico.

In the Pinos Wells drainage basin the principal aquifer is the Yeso formation, which furnishes water to stock wells. The wells range from 60 to 525 feet in depth, and water levels in the wells range from 27 to 345 feet below the surface. Chemically the water is unsatisfactory for drinking and most domestic use and undesirable to unsuitable for irrigation, but it can be used for stock.

The Estancia, Moriarty-Buford, Willard, McIntosh, Encino, and Negra communities in Torrance County appear to have no community water-supply problem, insofar as available quantity is concerned. These communities should be able to obtain additional supplies of water when needed by drilling additional wells. The communities of Mountainair, Torreon, Tajique, Chilili, Punta de Agua, Manzano, and Pedernal may find it necessary to supplement the present supply of water by additional wells but may experience difficulty in obtaining an adequate quantity of water. The communities of Corona, Duran, Abo, Torrance, Varney, Gran Quivira, Cedarvale, Progresso, and Pinos Wells are situated where it is improbable that a community supply of water of suitable quality could be obtained from wells in the immediate areas. However, Duran may be able to obtain sufficient water from a well about 2 miles southeast of the village.

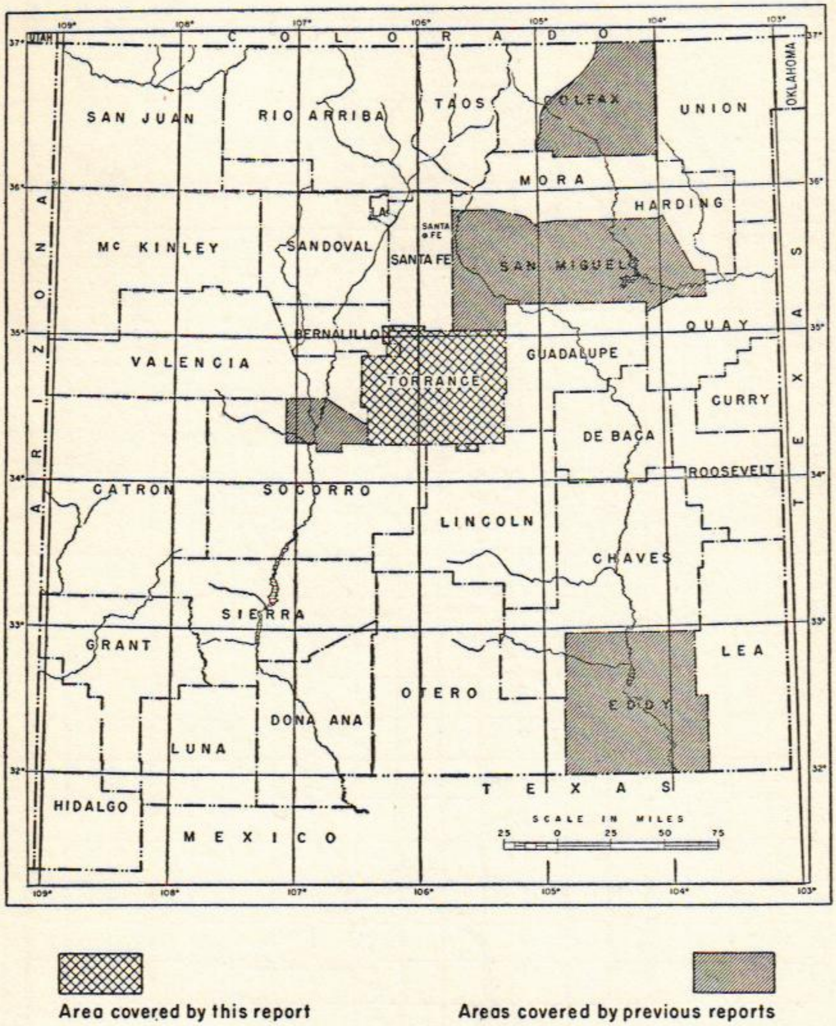

Figure 1

AREAS IN NEW MEXICO DISCUSSED IN GROUND-WATER REPORTS PUBLISHED AS PART OF THE COUNTY PROGRAM IN COOPERATION WITH THE NEW MEXICO BUREAU OF MINES AND MINERAL RESOURCES AND THE NEW MEXICO STATE ENGINEER.

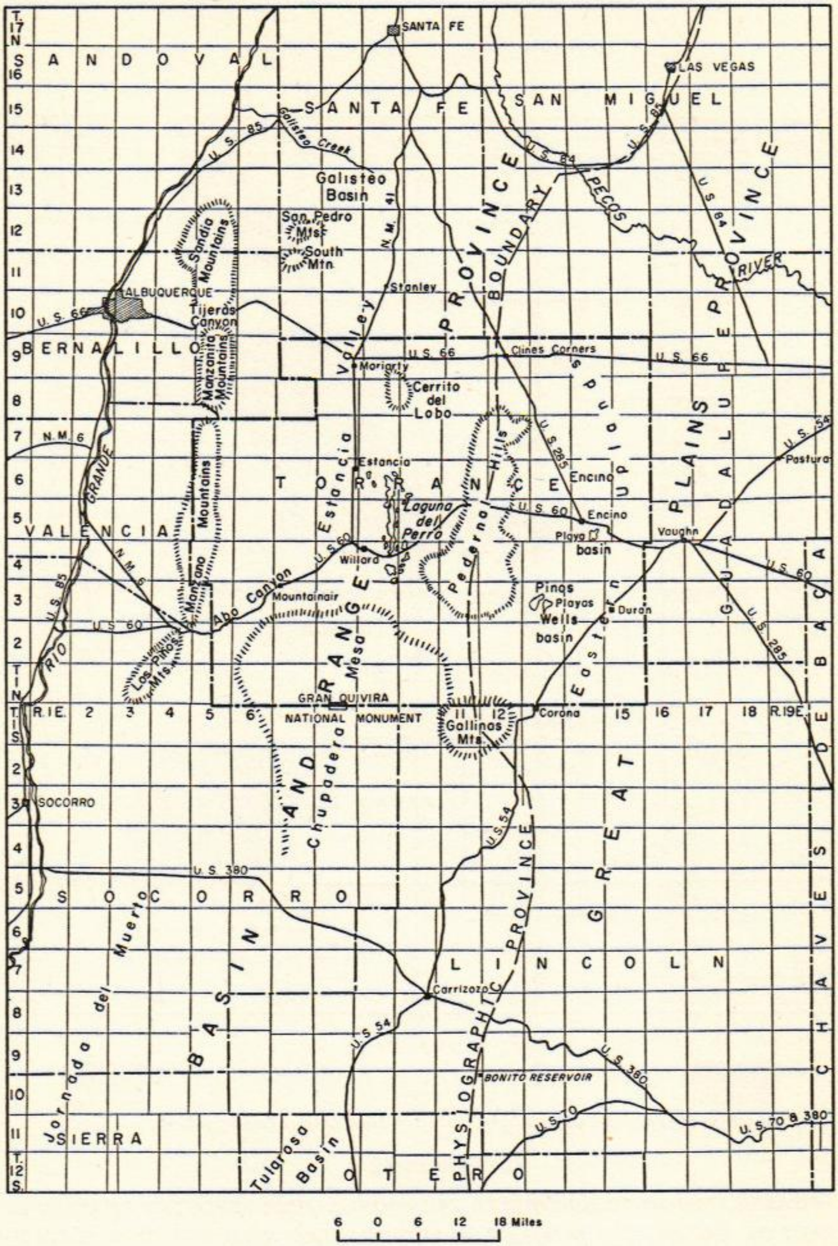

Figure 2

GEOGRAPHIC FEATURES OF CENTRAL NEW MEXICO.

The geology and ground-water resources of a large part of Torrance County are discussed by Meinzer (1911) and by others in several reports which are listed at the end of this report. Information from these previous investigations has been used in preparing this report. Well logs from the files of the office of the State Engineer were used in preparing the map of the depth to bedrock and the discussion of the water-bearing formations in Estancia Valley. Chemical analyses of water (table 16) collected from 1944 to 1953 were made at the Quality of Water Laboratory of the U. S. Geological Survey, at Albuquerque.

The geologic map of Torrance County (pl 1) accompanying this report was compiled from several sources. Oil and Gas Investigations Preliminary Map 21 (Read et al., 1944) was adapted for the northwest, north-central, central, and west-central parts of the county, and Oil and Gas Investigations Preliminary Map 61 (Wilpolt et al., 1946) was adapted for the southwest part. The remaining part of the county was mapped in reconnaissance fashion by R. E. Smith and Zane Spiegel, and a small part of the eastern portion of the county by Alfred Clebsch, Jr. The names of all geologic units on the map conform to terminology currently used by the U. S. Geological Survey. The terminology in the well logs, with minor exceptions, is that used in the original source. The stratigraphic designations in the well logs were determined for use in the report on the basis of the available data.

Field work was done by R. E. Smith from November 1949 to September 1950, assisted by W. L. Champion from June to September 1950. During the investigation data were collected for more than 400 wells (see table 14). Depths to water were measured in these wells wherever possible, and samples of water were collected from representative wells for chemical analysis. Discharge rates and specific capacities of some wells were determined. Elevations were determined with an aneroid barometer. Members of the Albuquerque office of the Ground Water Branch contributed helpful suggestions during the course of the investigation and gave further help in critically reviewing the report. The sections on "Structure" and "General Principles of Geology and Ground Water" were written essentially by E. H. Herrick.

After the first draft of the report was completed, considerable effort was expended by personnel of the Albuquerque office in revising the well table and the maps (pls 2 and 3), utilizing the topographic sheets of part of western Torrance County that had become available after completion of the field work. Also some of the hydrologic interpretations for the eastern part of the county were revised by Alfred Clebsch, Jr. as a result of data collected in Guadalupe County in 1955. The office of the State Engineer of New Mexico furnished numerous drillers' logs of wells in Estancia Valley, without which the map (pl 1) of the thickness of the valley fill could not have been made.

ACKNOWLEDGMENTS

The well drillers of the area furnished well logs, samples of well cuttings, and other ground-water information, and farmers and ranchers were helpful in supplying information concerning their wells. Their cooperation is greatly appreciated. The author gratefully acknowledges the help of those in the Albuquerque office who contributed to the review and revision of the report.

WELL-NUMBERING SYSTEM

The system of numbering water wells in this report is that used in New Mexico by the U. S. Geological Survey and is based on the common system of subdivision of public land into sections. The well number, in addition to designating the well, locates it to the nearest 10-acre tract in the land net (fig 3). The number is divided into four segments by periods. The first segment denotes the township north or south of the New Mexico base line; the second denotes the range east or west of the New Mexico principal meridian; and the third denotes the section. The southern boundary line of Torrance County coincides with the base line of the State; consequently, in the discussion of wells south of the county line the letter "S" is added to the first segment of the well number.

The fourth segment of the number, which consists of three digits, denotes the particular 10-acre tract of the section in which the well is situated. For this purpose, the section is divided into four quarters numbered 1, 2, 3, and 4, in the normal reading order, for the northwest, northeast, southwest, and southeast quarters respectively. The first digit of the fourth segment gives the quarter section, which is a tract of 160 acres. Similarly, the quarter section is divided into four 40-acre tracts numbered in the same manner, and the second digit denotes the 40-acre tract. Finally, the 40-acre tract is divided into four 10-acre tracts, and the third digit denotes the 10-acre tract. Thus, well 7.7.12.342 in Torrance County is in the NEV$_I$SE1/SW1/4 sec. 12, T. 7 N., R. 7 E. Letters a, b, c, and so on, are added to the last segment to designate the second, third, fourth, and succeeding wells listed in the same 10-acre tract. If a well cannot be located accurately to a 10-acre tract, a zero is used as the third digit, and if it cannot be located within a 40-acre tract, zeros are used for both the second and third digits. If a well cannot be located more closely than the section, the fourth segment of the well number is omitted.

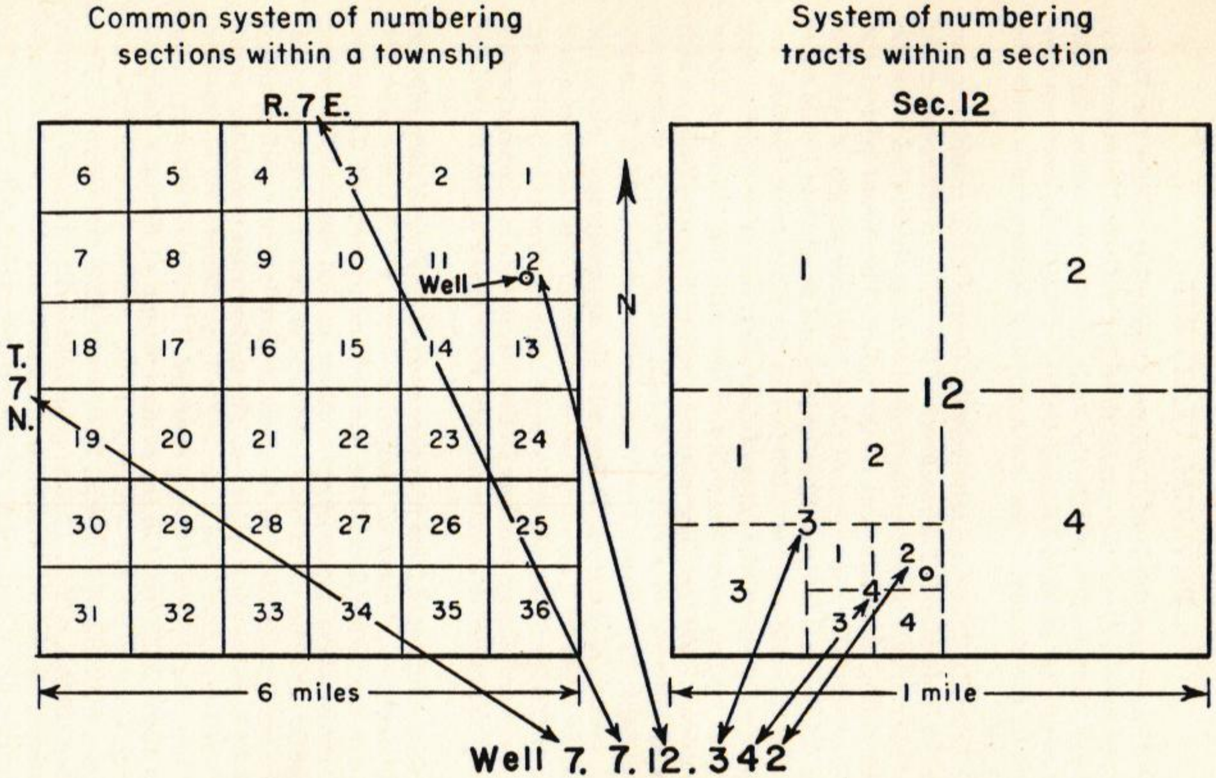

Figure 3

SYSTEM OF NUMBERING WELLS IN NEW MEXICO.

Geography

PHYSICAL FEATURES

The western two-thirds of Torrance County lies within the Basin and Range province, and the eastern third in the Great Plains province (Fenneman, 1931, pp 393-394). In the Basin and Range province in Torrance County the basin of Estancia Valley, of which the southern two-thirds is in the county, is the main physical feature and covers the largest area.

The Estancia Valley is a relatively flat-floored basin completely surrounded by higher land. The main axis of the valley trends north-south; arms of the valley extend southwestward and southeastward from the southern end of *the* main part of the valley. The lowest part of the valley is occupied by a number of playa lakes, the largest of which is Laguna del Perro; it is about 12 miles long and as much as 1 mile wide. The lowest altitude is about 6,000 feet in the playa area; altitudes increase gradually toward the edges of the valley, becoming highest along the western border, where the valley merges with the Manzano Mountains at about 7,500 feet. The northern end of Estancia Valley, which reaches an altitude of about 6,400 feet, merges with a plateau in southern Santa Fe County. The Manzano Mountains, which form the western border of Estancia Valley and lie approximately along the western boundary of Torrance County, range in altitude from about 7,500 to 10,000 feet. This mountain range is the easternmost major range in the Basin and Range province in this latitude. It is characterized by very steep slopes on its western side and more gentle slopes toward the east.

Looking southward from near the center of Estancia Valley, one sees the prominent escarpment of Chupadera Mesa, which rises about 500 feet above the valley floor. The northern escarpment of Chupadera Mesa is cut in several places by open valleys, so that much of the surface drainage from the northern end of the mesa is toward the Estancia Valley. The northeastern part of the mesa surface is gently rolling and is marked by broad shallow sinkholes. The surface rises toward the southeast, where Chupadera Mesa joins the Gallinas Mountains. The western part of Chupadera Mesa is deeply dissected. The highest altitude on the mesa is about 7,250 feet. On the eastern margin of Estancia Valley in Torrance County are the Pedernal Hills,[1] which include Pedernal Mountain, the Hills of Pedernal, Rattlesnake Hill, and Cerro del Pino of Darton (1928-b, p 283). This range of hills is characterized by gentle, grass-covered slopes in its marginal areas and has, in general, the subdued appearance of an ancient, weathered mountain range. Even in the crest area the local relief is moderate. The Pedernal Hills range in altitude from about 6,200 to 7,600 feet and mark the boundary between the

1 Also called Pedernal Mountains.

Basin and Range province and the Great Plains province. The Gallinas Mountains, whose northern end projects into Torrance County, also are on the boundary between these provinces.

The principal physical feature in the Great Plains province in Torrance County is the eastward sloping eastern uplands, whose surface is indented by the relatively shallow and small Encino and Pinos Wells drainage basins and still smaller adjoining basins. The altitudes of the eastern uplands range in Torrance County from about 6,000 to 7,000 feet. The altitudes of the Encino and Pinos Wells basins range from about 6,100 to 6,500 feet.

East and southeast of these two closed drainage basins, isolated buttes stand above the general level of the sinkhole-marked country in the southeastern portion of the county. Similar topographic features are prominent in the northeastern part of the county also. Upland surfaces are, in general, gently rolling; valley walls, particularly those of Pintada Canyon and its tributaries, are steep and rocky. The eastward trending valleys draining the eastern slopes of the Pedernal Hills are broad, open features that become more rugged toward the eastern boundary of the county.

The locations of the principal physical features in Torrance County and surrounding areas are shown in Plate 1 and Figure 2.

The surface drainage of most of the county is into closed basins, of which the principal ones are Estancia Valley, Encino basin, and Pinos Wells basin. In these basins the surface drainage ends in playas. Water is on the surface of these playas only after heavy rains, and remains on the playas until it evaporates. Because heavy rains are infrequent, the playas are dry most of the year. The surface drainage on Chupadera Mesa is into sinks. Near the southeast corner of the county the drainage is into sinks and a closed drainage basin centering in Guadalupe County. Near the southwest corner of the county the surface drainage is into the Jornada del Muerto and the Rio Grande. Surface drainage in the northeast part of the county is into the Rio Grande by way of the Pecos River. Inasmuch as most of the surface runoff in Torrance County flows into closed drainage basins within the county, precipitation that is not evaporated or transpired soon after it falls is recharged to groundwater reservoirs, and even that is eventually evaporated or transpired.

CLIMATE

The climate of Torrance County is semiarid. The average annual precipitation (table 1), according to records of the U. S. Weather Bureau, ranges from 12.59 inches at Estancia, near the middle of the irrigated area in the county, to 19.54 inches near Tajique, on the east side of the Manzano Mountains. The record of annual precipitation in the mountains is limited to the period 1910-1919 at the Rea ranch, in the Manzano Mountains, about 9 miles west of Tajique. Precipitation at the Rea ranch (altitude 9,200 feet) averaged 26.20 inches annually for the 10-year period.

The average annual precipitation for 12 stations in and near Torrance County (table 1) shows that there is a general increase in precipitation with increase in altitude, but the influence of topographic features other than altitude also is important. A comparison of the precipitation at Tajique and Palma illustrates the influence of topography. Although the altitudes of Tajique and Palma are about the same, the precipitation at Tajique is appreciably greater. Tajique is near the base of the Manzano Mountains, which influence storms, whereas Palma is about 45 miles eastward on an upland whose effect on storms is not much different from that of the surrounding lower area. The average precipitation given for Pedernal probably is somewhat low, as most of the record is for the drought years since 1942.

Precipitation is greatest in July and August, the monthly average for the 12 stations given in the table being 2.49 inches in July and 2.46 inches in August. More than half the annual precipitation occurs in the form of showers in the 4 summer months from June to September, when the temperatures and the evaporation rates are highest. Precipitation is the least in the late fall and winter, the average for the 12 stations given in the table being 0.57 inch in November and 0.63 inch in January. Ordinarily the snowfall and low temperatures in the winter are not sufficient for snow to remain on the ground, except in the mountains, for more than a few days at a time. Precipitation records from 1924 through 1953 show that there is considerable fluctuation from the annual and monthly averages for the 12 stations. The extent of the fluctuation, as revealed in the data, is summarized in Table 2. The greatest monthly fluctuation occurs during the summer months, when the precipitation also is usually the greatest. Thus, it is probable that in the Torrance County area little, if any, ground-water recharge occurs in the drier years, whereas a large part, if not most, of the recharge occurs during the years or extended periods in which the precipitation is appreciably greater than average.

Although extreme temperatures at the weather stations in the area range from around —20°F to almost 100°F, the average January temperatures range from 24°F at Tajique to 34°F at Corona, on the southern county line, and the average July temperatures range from 65°F at Tajique to 72°F at Vaughn (U. S. Weather Bureau, 1953).

Excluding the higher mountain areas, the average date of the last killing frost in the spring ranges from April 24, at Duran, in the southeastern part of the county, to May 17, at Tajique. The average date of the first killing frost in the fall ranges from October 19, at Duran, to October 3, at Tajique. At Estancia the average date of the last killing frost in the spring is May 13 and of the first killing frost in the fall, October 8; thus, the Valley has an average growing season of 148 days.

The nearest U. S. Weather Bureau evaporation stations are at Albuquerque and Santa Fe. The average annual pan evaporation, which may be defined as the average amount of water that will evaporate annually from the Weather Bureau pan of water in a given area, is 76 inches at

TABLE 1. AVERAGE PRECIPITATION IN AND NEAR TORRANCE COUNTY, N. MEX.*

(In inches)

STATION	ALTITUDE IN FEET	YEARS OF RECORD AS OF 1953	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
Vaughn	6,050	42	0.40	0.42	0.51	0.77	1.55	1.47	2.16	2.19	1.88	0.99	0.38	0.57	13.29
Estancia	6,107	34	.58	.61	.59	1.00	.70	.90	2.29	2.17	1.47	1.11	.46	.71	12.59
Otto CAA AP	6,226	40	.46	.43	.47	.64	.96	1.00	2.35	1.99	1.39	.99	.37	.53	11.58
McIntosh	6,250	26	.48	.52	.55	.74	1.45	.98	2.39	2.73	1.59	.90	.42	.49	13.24
Progresso	6,250	23	.62	.62	.59	.69	1.07	1.26	2.89	2.62	1.79	.77	.55	.72	14.19
Duran	6,272	36	.42	.57	.79	.90	1.29	1.39	2.41	2.60	1.61	.98	.49	.71	14.16
Pedernal	6,419	15	.49	.58	.55	.75	.99	1.22	2.56	2.41	1.20	.85	.60	.55	12.75
Mountainair	6,500	43	.82	.88	.86	1.02	1.13	1.01	2.70	2.77	1.58	1.07	.74	1.06	15.64
Gran Quivira Nat. Monument	6,620	24	.72	.62	.69	.65	1.12	1.24	2.43	2.93	1.96	.95	.67	.64	14.62
Corona	6,664	44	.82	.83	.84	1.01	1.28	1.30	2.50	2.53	1.71	.97	.54	.76	15.09
Palma	7,000	36	.61	.73	.99	.85	1.06	1.03	2.13	1.72	1.29	.89	.68	.70	12.68
Tajique	7,100	36	1.09	1.26	1.40	1.48	1.76	1.25	3.03	2.85	2.01	1.37	.92	1.12	19.54

* From records of the U. S. Weather Bureau.

TABLE 2. FLUCTUATION OF PRECIPITATION IN AND NEAR TORRANCE COUNTY, N. MEX., 1924-1953 *

STATION	YEARS OF RECORD AVAILABLE DURING 1924-1953	AVERAGE AS DETERMINED THROUGH 1953 (INCHES)	MINIMUM PRECIPITATION † (INCHES)	PERCENT OF AVERAGE	YEAR	MAXIMUM PRECIPITATION † (INCHES)	PERCENT OF AVERAGE	YEAR	MEAN DEVIATION FROM AVERAGE FOR THE YEARS OF RECORD DURING 1924-1953 (INCHES)	(PERCENT)
Vaughn	25	13.29	5.10	38	1934	29.95	225	1941	3.74	28
Estancia	29	12.59	5.99	48	1951	23.63	188	1941	2.80	22
Otto CAA AP	11	11.58	5.72	49	1945	18.75	162	1941	3.90	34
McIntosh	16	13.24	6.98	53	1951	22.30	168	1941	3.86	29
Progresso	18	14.19	5.13	36	1945	30.74	217	1941	4.60	32
Duran	11	14.16	9.40	66	1925	31.72	224	1941	3.95	28
Pedernal	8	12.75	8.47	66	1950	15.82	124	1949	2.85	22
Mountainair	20	15.64	6.82	44	1934	27.00	173	1941	3.49	22
Gran Quivira Nat. Monument	13	14.62	8.52	58	1945	20.77	142	1939	2.97	20
Corona	27	15.09	9.48	63	1924	36.11	239	1941	4.26	28
Palma	23	12.68	6.27	49	1925	30.85	243	1941	3.68	29
Tajique	30	19.54	10.88	56	1934	32.21	165	1941	4.09	21

* Based on records from the U. S. Weather Bureau.

† The maximum and minimum annual precipitation given during the 30-year period may not be the true maximum and minimum, as several years of record are missing for most of the stations. This condition is particularly true for the maximum for Pedernal and Gran Quivira National Monument, there being no records for 1941. It is probable that the maximum precipitation at Pedernal and Gran Quivira was in 1941, as it was for the other stations.

Albuquerque, based on records for the period 1927 to 1932, and 65 inches at Santa Fe, based on records for the period 1917 to 1926 (U. S. Weather Bureau, undated). As the altitude of much of Torrance County lies between the altitudes of Albuquerque and Santa Fe, the average pan evaporation probably would be between those figures.

AGRICULTURE AND NATURAL RESOURCES

The principal occupations in Torrance County are stock raising and farming. According to the 1950 census (U. S. Census Bur., 1952), there were more than 30,000 cattle and calves, 28,000 sheep and lambs, and 22,000 thickens in Torrance County in that year, and the total value of livestock was about 60 percent greater than the total value of crops. Most of the stock ranches are in the eastern half of the county and south of Mountainair and Willard.

The natural vegetation of Torrance County, according to a map by Cockerill, Hunter, and Pingrey (1939, p 32), consists of short grass in most of Estancia Valley, the eastern uplands area, and Chupadera Mesa; of woodland, principally juniper and pinon, in the Pedernal Hills, the slopes of the Manzano Mountains, and the area west of Chupadera Mesa; and of forest, principally Ponderosa pine, spruce, and fir, in the higher parts of the Manzano Mountains. The area west of Chupadera Mesa, most of the Manzano Mountains, the Gallinas Mountains, and the eastern part of Chupadera Mesa are part of the Cibola National Forest.

The United States census of agriculture for 1945 (U. S. Census Bur., 1946), lists the cropland in the county as 148,670 acres, of which 80 percent was in seed beans (mostly pinto beans), grown dry. The dry-farmed seed-bean acreage in the county was just over half the acreage for that crop in the entire State. Most of the remaining cultivated acreage in the county was in corn, sorghum, and wheat. Sugar beets were introduced in the irrigated area about 1950. A field check by personnel of the Geological Survey in the fall of 1950 indicated that about 800 acres was planted with sugar beets. Irrigation in the Estancia Valley is done with water from wells. The irrigated acreage increased from about 725 acres in 1946 to about 19,000 acres in 1950. Other than farming, the principal occupations of the inhabitants are servicing the farms and ranches and catering to the tourist trade.

Carbon dioxide gas was encountered in 6 of 9 wells drilled about 10 miles northwest of Estancia between 1931 and 1940. The gas occurred in rocks of the Magdalena group at depths of 305 to 1,271 feet below the surface. The initial daily production from the 6 individual wells ranged from 140,000 to 860,000 cubic feet and average about 460,000 cubic feet. A plant for the production of dry ice from the carbon dioxide was built about 5 miles north of Estancia at a locality known as Witt. The amount of dry ice produced at this plant is unknown, and the plant and carbon dioxide wells were abandoned prior to 1949.

The office of the State Inspector of Mines has no record of production of minerals or rocks in Torrance County since 1939. The only written record found regarding mineral production in the county concerns salt from the playas east of Estancia and carbon dioxide from the wells northwest of Estancia. Although there are verbal reports of mining in the county, it is unlikely that production has been significant. It is possible that additional prospecting might uncover some mineral deposits of economic value. Northrop (1942) lists 15 of the minerals that occur in Torrance County; 9 of those described are reported from the playas of Estancia Valley.

Halite (sodium chloride, common salt) is the only mineral known to have been removed from the playas for commercial use. The playas have been a source of halite for centuries, and in the days of Spanish rule the salt was transported as far as 700 miles to silver mines in Chihuahua, Mexico (Northrop, 1942, p 168). In modern times the salt was first worked commercially in 1915 at Laguna Salina, about 2 miles east of Laguna del Perro, and, at the time of a report by Talmage and Wootton (1937, p 146), was still being worked as a private enterprise. The principal difficulty in commercial mining of the salt from Laguna Salina was said to be insufficient financing rather than any lack of salt of good quality.

Rocks of possible economic value in Torrance County include limestone, sandstone, clay, gypsum, and gravel. The quality of these rocks for commercial use is questionable; however, because access is difficult, it is unlikely at present that they could be quarried profitably except for local use.

POPULATION

The population of Torrance County in 1950 was 8,012 (U. S. Census Bur., 1951). This is a decrease for the county of 27.3 percent between 1940 and 1950, whereas the population of the State increased 28.1 percent during that period. However, the population of Torrance County is considered as rural, and the increase of the rural population for the State from 1940 to 1950 was only 3.1 percent. A large part of the decrease in population in Torrance County for the 10-year period can be attributed to the general trend of movement of population from rural to urban areas.

The largest municipality in the county is Mountainair, which had a population of 1,477 in 1940 and 1,418 in 1950. The second largest is Estancia, the county seat, which had a population of 668 in 1940 and 916 in 1950. The increase in population in Estancia is probably attributable mainly to the increase in irrigation in the Estancia Valley. The population in 1950 of other communities in the county listed by the Bureau of Census was 408 for Encino and 296 for Willard; corresponding figures in 1940, were 652 for Encino and 462 for Willard.

General Principles of Geology and Ground Water

The occurrence of ground water in any area depends to a large extent upon the local geology, and an understanding of geological principles is essential to a clear interpretation of ground-water conditions. Several excellent reference books dealing with elementary geology are available in most public and university libraries, and the reader is referred to such books for a more complete discussion of the subject.

The rocks in Torrance County are described in later sections of this report and are summarized in Table 3. Brief descriptions of the water-bearing characteristics of each rock unit accompany its description. Many details of the relation of ground water to geology are deferred to the descriptions of the various areas in the county.

The occurrence of water in the ground is governed by principles which must be understood if ground water is to be developed most efficiently. The principles governing the occurrence of ground water have been discussed by Meinzer (1923), Tolman (1937), and others, to whose works the reader is referred for a detailed consideration of the subject.

Water is contained in the rocks of the earth's crust in openings, generally called interstices or pores. Interstices are of several types, depending upon the character of the rocks. The particles of unconsolidated sedimentary rock, such as alluvial deposits containing sand and gravel, and the particles of sandstone are not fitted together perfectly, and thus an appreciable amount of water may be stored in the spaces between the particles. Soluble sedimentary rocks, such as limestone and gypsiferous rock, may contain solution cavities formed by the dissolving activity of circulating ground water. Consolidated rocks, such as limestone, sandstone, and granite, contain fractures, such as joints and faults, which are produced by structural stresses in the earth's crust and by cooling and contraction. These openings also store and transmit ground water. The percentage of the total volume of a rock that is occupied by interstices is called the porosity of the rock. Initial porosity may be modified by secondary processes, such as solution or cementation by ground water.

If ground water is to be available, a rock must be not only porous but also permeable; that is, the interstices must be interconnected and sufficiently large that ground water may move freely to wells or springs. A shale or clay may be very porous and yet have a low permeability because the interstices are so small as to retard the movement of ground water. On the other hand, a firmly cemented sandstone of low permeability may be rendered more permeable by fractures.

TABLE 3. GENERALIZED SECTION OF THE GEOLOGIC FORMATIONS OF TORRANCE COUNTY, N. MEX.

ERA	SYSTEM	SERIES	SUBDIVISIONS	THICKNESS (FEET)	PHYSICAL CHARACTER	WATER-BEARING CAPACITY AND QUALITY OF WATER
Cenzoic	Quaternary	Recent and Pleistocene	Dune deposits	0 to 100	Pale yellowish-gray clay	Not known to yield water to wells.
		Pleistocene	Lake deposits	0 to 80±	Thin-bedded clay or shale, some layers of sand and gypsum	Not known to be exploited. Probably would furnish sufficient water for stock wells, but chemical quality unsatisfactory.
	Quaternary and Tertiary	Recent to Pliocene	Valley fill	0 to 340±	Sand, gravel, and clay, lensing, commonly consolidated by caliche	Furnishes water to irrigation wells in large part of Estancia Valley. Chemical quality of water in eastern part of valley unsatisfactory for irrigation.
			Upland surficial deposits	0 to 100±	Sand, gravel, and silt; capped by caliche in many places	Not known to yield water to wells but may be water bearing in places.
	Tertiary	Miocene(?) Oligocene(?) and Eocene	Intrusive igneous rocks		Mostly dikes and sills	Not known to yield water to wells.
		Unconformity				
Mesozoic	Triassic	Upper Triassic	Dockum group	0 to 300±	Gray and conglomeratic sandstone, red shale, and some limestone conglomerate	Furnishes water to stock and domestic wells in northeastern Torrance County and nearby in San Miguel County.
		Unconformity				
Paleozoic	Permian		San Andres formation: Upper clastic member	0 to 50	Tan or gray friable sandstone, and red or pink and buff siltstone	Not known to yield water to wells in Torrance County.
			San Andres formation: Limestone member	0 to 200	Finely crystalline limestone, massive white gypsum, and white to yellow medium-grained sandstone	Not known to yield water to wells in Torrance County.
			San Andres formation: Glorieta sandstone member	150 to 280	Usually well-cemented, white to yellow sandstone	Furnishes water to irrigation wells north of Moriarty, where the rocks are fractured. Furnishes water to stock and domestic wells in Cerrito del Lobo area and east of Corona. Chemical quality varies with area.

TABLE 3. GENERALIZED SECTION OF THE GEOLOGIC FORMATIONS OF TORRANCE COUNTY, N. MEX. *(continued)*

ERA	SYSTEM	SERIES	SUBDIVISIONS			THICKNESS (FEET)	PHYSICAL CHARACTER	WATER-BEARING CAPACITY AND QUALITY OF WATER
Paleozoic	Permian			Yeso formation		600 to 1,000±	Orange-red, buff, and yellow sandstone, white and gray gypsum, red to pink and gray siltstone, and gray limestone	Furnishes water to irrigation wells south of Cerrito del Lobo, but generally only to windmill wells. Chemical quality of water usually unsatisfactory for drinking and domestic use and undesirable for irrigation.
				Abo formation		800±	Dark-red shale, dark-red sandstone and arkose, conglomerate, and lime-pellet conglomerate	Furnishes water to stock and domestic wells, but dry holes in these rocks are common. Chemical quality satisfactory in southwest part of county; information limited elsewhere in county.
			Magdalena group	Bursum formation *				
	Pennsylvanian		Magdalena group	Madera limestone	Arkosic limestone member	500 to 850	Alternating red or brown arkosic sandstone, arkosic limestone, gray limestone and shale	Furnishes water to irrigation wells along part of western margin of Estancia Valley, but yield is not dependable. Chemical quality satisfactory.
			Magdalena group	Madera limestone	Lower gray limestone member	300 to 700±	Gray cherty limestone and calcareous shale	Not known to have been tested for water in Torrance County because of depth.
		Unconformity	Magdalena group	Sandia fm.	Upper clastic member	150 to 250±	Dominantly clastic beds, many of which are carbonaceous	Do.
Proterozoic	Precambrian						Mostly quartzite and other metamorphic rocks; some igneous rocks in northern Manzano Mountains and southern Pedernal Hills	Where tested (Pedernal Hills), furnishes water to stock and domestic wells. Sufficient water for irrigation wells not to be expected. Chemical quality usually satisfactory.

* For convenience the Bursum formation has been mapped with the Abo formation in this report.

In most areas the rocks of the earth's crust are saturated with water below a certain depth. The zones of saturated rock that will yield water to wells are termed aquifers. The upper surface of the saturated zone, if not confined, is called the water table. The water table slopes from an area of recharge, where the water enters the rock, to an area of discharge where the water leaves the rock. The water table generally has a form which is essentially a modification of the overlying topography. If the ground water is confined by an impermeable stratum overlying the permeable material, artesian conditions exist. Under artesian conditions water in a tightly cased well will rise above the zone of saturation to the piezometric surface, an imaginary surface to which the water from a given aquifer will rise under its full head.

Under certain conditions a ground-water body may be separated from an underlying body of ground water by an unsaturated bed. For example, two sandstone beds, both saturated in their lower parts, may be separated by shale upon which the topmost water body is said to be perched. Under such conditions, if a well is drilled to the underlying aquifer and is uncased, or the casing is perforated opposite the saturated zones, the perched water will drain to the underlying partially saturated sandstone bed.

The replenishment of a ground-water reservoir by water is called recharge and is dependent upon many factors. The ultimate source of recharge is precipitation. Part of the precipitation upon the earth's surface flows into surface drainage channels and ultimately to lakes and the ocean, and some is absorbed by the soil. A large part of the water absorbed may be evaporated or transpired by plants, but ordinarily in favorable areas a small part moves downward to recharge the ground-water body. Recharge is added also by seepage from streams that flow at an elevation above the water table. In certain places, aquifers may be recharged by subsurface movement of water from other aquifers.

Natural discharge of ground water from saturated beds may be by spring flow or seepage into a surface water body, or by evaporation and transpiration. Under natural conditions ground-water bodies are essentially in a state of equilibrium; that is, the rate of discharge from the ground-water basin is equal to the rate of movement of water through the saturated zone, which in turn is equal to the average recharge. The movement of ground water in unconsolidated sediments is generally slow, on the order of a few feet or less per day.

Quality of Ground Water

The quality of water is affected by the presence of bacteria or other micro-organisms and of dissolved mineral matter in the water. Ground-water supplies, when properly developed, generally are less likely to be biologically contaminated than surface-water supplies. The soil and rocks through which ground water moves act as filters and tend to remove bacteria that may have been present in the water. However, contamination is possible, particularly in shallow ground water. As contaminating material moves in the direction of ground-water flow, wells should be constructed up the slope of the water table from possible sources of contamination. The casings of wells drilled in formations that may contain contaminated shallow water should be tightly sealed to prevent the contaminated water from entering the wells. Though biologic contamination of ground water is uncommon, well water should be given a bacteriologic test before it is used for domestic purposes. The bacteriological quality of water is outside the scope of this report. Several reports dealing with the proper construction of wells to prevent contamination are available (Fiedler, 1936; U. S. Public Health Service, 1946-b, 1950).

Ground water, although derived initially from precipitation, always carries mineral matter that has been taken into solution as the water moves through the soil and rocks. The chemical quality largely determines the usefulness of ground water for various purposes.

During the period 1944-1953 samples of water were obtained from about 270 wells and 2 springs in Torrance County, and chemical analyses of these samples were made at the Quality of Water Laboratory of the U. S. Geological Survey, Albuquerque, N. Mex. These analyses appear in Table 16. The chemical analyses of the water from the wells are discussed under each area and are discussed briefly in the description of the rock units under geology. Abbreviated chemical analyses of the water are given in the discussion of each area.

The chemical quality of the water is considered with respect to its use for drinking, other domestic purposes, stock, and irrigation. Because of the general absence of industries in Torrance County, the chemical quality of the water for industrial use in the various areas in the county is not discussed; however, the ground water in the county would require treatment for most industrial uses. The standards of the U. S. Public Health Service (1946-a) for drinking water used on interstate carriers and for public supplies are followed for drinking water; they recommend that the following minerals in water to be used for human consumption should not exceed the concentrations given: iron and manganese together, 0.3 ppm (parts per million); sulfate, 250 ppm; chloride, 250 ppm; magnesium, 125 ppm; fluoride, 1.5 ppm; dissolved solids, 500 ppm (1,000 ppm permissible when water of better quality is not available). One part per million (1 ppm) equals one part, by weight, of the constituent per million parts, by weight, of the water. It is recognized that human beings can tolerate a higher mineral content. These standards are set with intentionally low mineral content in order to provide a factor of safety, especially for travelers who are not accustomed to the local water. It should be remembered that a chemical analysis does not indicate the extent to which the water may be polluted; however, a high nitrate content, such as that found in the water from some of the wells in the county (see table 16), suggests the possibility of pollution.

Sulfate in high concentrations is found in the water from wells in parts of Estancia Valley and also in a large part of the remainder of Torrance County. In some parts of the county the water is unfit for most purposes because of the high sulfate content. Chloride also is present in large quantities in some water samples analyzed from Torrance County, especially in samples from the playa-lake area. In cases where the water from the wells contained more than 125 ppm of magnesium, it usually contained sulfate much in excess of 250 ppm.

Fluoride concentrations of about 1 ppm in drinking water have proved to be beneficial in the reduction of tooth decay in growing children. Fluoride in excess of 1.5 ppm generally is considered undesirable for human consumption because children's teeth may acquire permanent staining and disfigurement (American Water Works Association, 1951). Many of the water samples analyzed from Torrance County contained fluoride in excess of 1.5 ppm.

Hardness is caused almost entirely by compounds of calcium and magnesium. The hardness of the water is reported herein in parts per million as calcium carbonate. Water having a hardness between 120 and 200 ppm is considered hard, and laundries and those industries in which hardness is detrimental may profitably soften the water supply. Water having a hardness of more than 200 ppm usually requires some treatment for reduction of hardness before being satisfactory for most purposes. Although most of the water analyzed from Torrance County had a hardness of more than 200 ppm, some of this water was used for domestic purposes without treatment. A more complete discussion of the various constituents and properties determined in typical chemical analyses can be found in several U. S. Government publications dealing with the subject.

The tolerance of livestock to dissolved mineral matter is much greater than that of human beings, and very few wells in Torrance County produce water unfit for stock use. The effect of the various mineral constituents on irrigation is discussed in the section dealing with the chemical quality of water in Estancia Valley.

Description of Rock Units

PRECAMBRIAN ROCKS

Crystalline igneous and metamorphic rocks that probably are Precambrian occur principally in the higher parts of the Manzano Mountains and in a large area on the east side of Estancia Valley, called the Pedernal Hills. Scattered smaller outcrops occur in the area southeast of the Pedernal Hills and in a small knob (Cerrito del Lobo) northwest of the Pedernal Hills (see pl 1). Precambrian rocks are present also at depth below all areas underlain by younger sedimentary rocks; but except in a few localities the Precambrian rocks are deep beneath the surface, are hard to drill, and do not yield appreciable water.

Topographically high areas of Precambrian rocks persisted in Torrance County throughout late Paleozoic time (Read et al., 1944) and contributed detrital materials to rock units which lapped upon them. The existence of these positive areas is responsible at least in part for the many outcrops of Precambrian rocks in eastern Torrance County and for the several instances of pinching out and overlapping of Permian rocks. A Precambrian sequence of slightly metamorphosed clastic sediments and acidic and basic volcanic rocks intruded by a granitic stock is overlain by the Magdalena group in the Manzanita and northern Manzano Mountains (Reiche, 1949) west of, and in, western Torrance County. At the high south end of the Manzano Mountains metamorphic rocks, principally quartzite, form the crest of the range, and metamorphosed sedimentary rocks and metamorphosed rhyolite intruded by granite crop out in the lower, west-facing slopes and at the south tip of the mountains (Stark and Dapples, 1946).

Darton (1928-b, p 283) gives the following description of the crystalline rocks near the central part of Torrance County:

> On the east side of Estancia Valley there is a ridge of Precambrian white quartzite which culminates in Pedernal Mountain. . . . A short distance to the west are the Hills of Pedernal, and 15 miles to the northwest is the Cerrito del Lobo, all consisting of the same kind of quartzite. . . . The Pedernal Mountain ridge extends only a short distance south of the peak, but outcrops of Precambrian crystalline rocks appear at intervals to the south, notably in the ridges extending from Rattlesnake Hill to Cerro del Pino and also at Chameleon Hill. . . . They are also found underground in wells at Lucia [Lucy], Negra, and other places. To the north the prevailing rock is white quartzite, in part schistose; to the south are granite, gneiss, diorite, and other crystalline rock. Rattlesnake Hill, 12 miles southeast of Willard, consists of black amphibolite. . . . Cerro del Pino and Chameleon Hill are made up of coarse massive granite.

A black schist is found in a valley 4 or 5 miles north of Negra. An examination of the crystalline rock in the Chameleon Hill area shows the rock to be a granitic gneiss. About 5 miles north of Chameleon Hill a small area of metamorphic rock is exposed, which probably is of the same age as the rock of Chameleon Hill and at least is related in origin to, if it is not of the same origin as, the rock of Chameleon Hill.

Several windmill wells derive water from crystalline igneous and metamorphic rocks in the Pedernal Hills (see area pC, pl 2). Such rocks furnish an adequate supply of water for stock and domestic wells, but enough water for irrigation wells is not to be expected. The highest known yield of a well obtaining water from crystalline rocks in Torrance County is the Atchison, Topeka & Santa Fe Railway well about 3 miles north of Negra. Reportedly, when this well was test pumped at 100 gpm, the drawdown was 60 feet. Chemical analyses of the water from wells in the crystalline rock of eastern Torrance County indicate that the water is satisfactory to undesirable for drinking, but that it is satisfactory for stock, irrigation, and most domestic uses.

PENNSYLVANIAN AND PERMIAN SYSTEMS

MAGDALENA GROUP

The Magdalena group, as present at the surface in Torrance County, is of Pennsylvanian and Permian age and lies unconformably on the Precambrian crystalline rocks of the Manzano Mountains (Reiche, 1949, p 1198). Thus, it is the oldest un-metamorphosed sedimentary rock that crops out in the county. The Magdalena group crops out near the western boundary of the county between the outcrop belts of the Precambrian crystalline rocks of the Manzano Mountains on the west and the valley fill of Estancia Valley on the east. Magdalena rocks form the crest of the northern part of the Manzano Mountains. Rocks of the Magdalena group in Torrance County dip eastward and lie beneath the valley fill of Estancia Valley in an area approximately north of a line between Manzano and Estancia and west of New Mexico State Highway 41 (see pl 1). According to sections measured by Read et al. (1944), the Magdalena group ranges in thickness from about 1,000 to 1,600 feet. This group in Torrance County consists of three formations, which in ascending order are the Sandia formation and the Madera limestone, both of Pennsylvanian age, and the Bursum formation of Permian age.

Sandia Formation

The Sandia formation is divided into a discontinuous lower limestone member and an upper clastic member. The lower limestone member is not known to occur in Torrance County. The upper clastic member of the Sandia formation crops out only in small areas in the higher parts of the Manzano Mountains, but it should be present below the Madera limestone in most of the extent of the Magdalena group. The upper clastic member can be expected to occur generally at a depth of 300 to 1,000 feet in parts of the lower slopes of the Manzano Mountains, but generally at depths of more than 800 feet in areas farther east. Although no wells were found that derived water from the upper clastic member, under favorable conditions the member probably would yield sufficient water for windmill wells.

Madera Limestone

The marine Madera limestone of Pennsylvanian age conformably overlies the Sandia „formation. It is usually divided into a lower gray limestone member and an overlying arkosic limestone member. The gray limestone member of the Madera limestone consists mostly of a sequence of gray cherty limestones and calcareous shales. The member is present at depths of less than 200 feet in parts of the lower slopes of the Manzano Mountains, but generally lies at depths of more than 400 feet in areas farther east. The arkosic limestone member, which ranges from about 500 to 850 feet in thickness in the Manzano Mountains area, consists of alternating red or brown arkosic sandstone, arkosic limestone, gray limestone, and shale.

A generalized section of the arkosic limestone member of the Madera limestone in Abo Canyon is given below as modified from a section by Bates et al. (1947, pp 17, 18).

GENERALIZED SECTION OF THE ARKOSIC LIMESTONE MEMBER OF THE MADERA LIMESTONE MEASURED ALONG RAILROAD IN ABO CANYON AND IN NORTH TRIBUTARIES, SOCORRO AND VALENCIA COUNTIES, N. MEX.

Material	Thickness (feet)	Depth (feet)
Limestone, gray massive	12.0	12.0
Shale, olive-green, silty	10.0	22.0
Limestone, medium- to light-gray, with chert nodules	50.0	72.0
Shale, in upper one-third; limestone, in lower two-thirds	20.0	92.0
Shale, light-red, marly	5.0	97.0
Limestone, medium-gray, with partings of shaly limestone	28.0	125.0
Shale, olive-green and red, becoming gray to yellow-buff above	11.0	136.0
Limestone, gray, nodular, marly	1.5	137.5
Shale, olive-green	5.0	142.5
Limestone, medium-gray	1.5	144.0
Sandstone, olive-green, fine, micaceous	5.0	149.0
Shale and siltstone, light olive-green	12.0	161.0
Shale, gray, carbonaceous, fissile	1.0	162.0
Sandstone, olive-green, massive	4.0	166.0
Shale, silty, grading upward into sandy shale and thin-bedded platy sandstone	10.0	176.0
Limestone, medium-gray, silty and sandy	1.0	177.0
Shale, red and gray to olive-green	12.0	189.0
Limestone, medium- to light-gray	42.0	231.0
Sandstone and shale, olive-green to buff	10.0	241.0
Limestone, medium-gray, massive	6.0	247.0
Sandstone and shale, olive-green	25.0	272.0
Shale, olive-green, sandy	10.0	282.0
Limestone, light-gray	3.0	285.0
Shale, gray	5.0	290.0
Sandstone, gray to buff, fine, micaceous	1.0	291.0
Shale, gray	4.0	295.0
Covered	9.0	304.0

GENERALIZED SECTION OF THE ARKOSIC LIMESTONE MEMBER OF THE MADERA LIMESTONE MEASURED ALONG RAILROAD IN ABO CANYON AND IN NORTH TRIBUTARIES, SOCORRO AND VALENCIA COUNTIES, N. MEX.
(continued)

Material	Thickness (feet)	Depth (feet)
Limestone, light-gray	1.5	305.5
Shale, olive-green, silty	5.0	310.5
Sandstone, olive-green to buff	11.0	321.5
Covered; probably shale	4.0	325.5
Sandstone, olive-green to gray	10.0	335.5
Shale, dark-gray	27.0	362.5
Sandstone, olive-green to buff-gray	13.0	375.5
Shale, gray	20.0	395.5
Covered	42.0	437.5

A road cut in the arkosic limestone member of the Madera limestone at the south edge of Tajique illustrates the change that can occur vertically in a few feet in the member. A section measured at this road cut as shown in the illustration (pl 4) is given below.

SECTION OF A PART OF THE ARKOSIC LIMESTONE MEMBER OF THE MADERA LIMESTONE MEASURED IN A ROAD CUT ALONG STATE HIGHWAY 10 AT SOUTH EDGE OF TA JIQUE, TORRANCE COUNTY, N. MEX.

Material	Thickness (feet)	Depth (feet)
Top of section covered with about 3 feet of soil and rock; merges with shale and limestone beds to left.		
Limestone, medium-gray on fresh surface, finely crystalline; 3 beds 0.5 to 0.6 foot thick separated by light-gray shale beds up to 0.2 foot thick.	2.0	2.0
Limestone, medium-gray on fresh surface, finely crystalline, fossiliferous; 6 beds 0.1 to 0.25 foot thick separated by light-gray shale beds up to 0.05 foot thick.	1.4	3.4
Limestone, medium-gray on fresh surface, finely crystalline, fossiliferous.	2.8	6.2
Shale, light-gray, silty; iron-stained layer near bottom; fossiliferous in upper 0.2 foot. Base concealed.	1.7	7.9

Although the lower gray limestone member crops out over only a small area in the Manzano Mountains, appreciable recharge probably is contributed to the member here by melting snow and storm runoff. Ground water in the lower gray limestone member probably discharges into the overlying arkosic limestone member. The arkosic limestone member crops out over an area of about 250 square miles in the Manzano Mountains, and this is one of the principal recharge areas for the ground-water body of Estancia Valley.

Ground water in the Madera limestone occurs in joints and solution channels. Some of the channels are large, and there are some caves in the area in which the formation crops out. The Madera limestone

OUTCROP OF ARKOSIC LIMESTONE MEMBER OF MADERA LIMESTONE IN ROAD CUT, SOUTH EDGE OF TA JIQUE, N. MEX.

A. VIEW WESI ACROSS SOUTHERN END OF LAGUNA DEL FERRO TOWARD MANZANO MOUNTAINS.

B. GENTLY SLOPING UPLAND SURFACE OF NORTHERN PART OF CHUPADERA MESA.

PHYSIOGRAPHIC FEATURES

furnishes water to wells and springs in this area; as it underlies the Tertiary(?) and Quaternary valley fill in Estancia Valley, it furnishes at least part of the water in many of the valley wells (see IP m, p12). Most of the ground water in the formation, however, is discharged into the overlying valley-fill deposits of Estancia Valley.

The general sequence of limestone, sandstone, and shale beds at various localities can be correlated. (See graphic sections by Read et al., 1944.) The part of the section present in a particular area can be estimated from the geologic map and from correlation of outcrops with these graphic sections; the depth to the thicker beds of limestone and sandstone can be inferred from the sections. The distribution of fractures and solution channels in the Madera limestone is apparently not predictable; therefore, production of water from the limestone beds is sometimes erratic. It is sometimes necessary to drill to deeper strata if no water is encountered in the shallower limestone beds. Solution channels in the limestone are generally not large enough or sufficiently interconnected to yield large quantities of water for irrigation.

The specific conductance of water from 15 wells that derive their water from the rocks of the Madera limestone ranges from 431 to 861 micromhos. Water within this range of specific conductance is generally suitable for domestic, stock, and irrigation use, though it may be hard, iron-bearing, or otherwise objectionable.

Specific conductance is the reciprocal of the resistance of a water sample to an electric current. Although the conductance determination does not indicate the chemical nature of the material in solution, it does indicate approximately the concentration of dissolved solids in water. In general, the greater the concentration of dissolved solids in water, the greater its specific conductance. The specific conductance of a water in micromhos multiplied by 0.7 is approximately equal to the sum of the dissolved constituents in parts per million.

Bursum Formation

The Madera limestone in most places in western Torrance County has a gradational contact with the Abo formation and interfingers therewith. Along the western county line at the south end of the Manzano Mountains transitional beds were mapped as the Bursum formation by Wilpolt et al. (1946), but in this report they are mapped with the Abo formation for convenience. The Bursum formation has not been described elsewhere in the county, but correlative beds may exist in the subsurface.

PERMIAN SYSTEM

ABO FORMATION

The Abo formation crops out over about 50 square miles in Torrance County at the foot of the east slope of the south end of the Manzano Mountains and south from the town of Manzano for a distance of about 17 miles. The Abo formation directly underlies the valley fill of Estancia Valley in an area lying approximately south of a line between Manzano and Estancia and west of Laguna del Perro, and north of Estancia in a general north-south belt near New Mexico State Highway 41. (See pl 1.) Data are insufficient to determine the location of the contact between the Abo and the Yeso formations below the valley fill.

> Wilpolt et al. (1946) state that the Abo formation consists of dark-red shale, dark-red sandstone and arkose, conglomerate, and lime-pellet conglomerate. The continental origin of the formation is shown by the red color, mud cracks, current ripple marks, cross bedding, tracks of land vertebrates, plant impressions, and the lenticular character of the sandstone beds. The shales erode easily; in contrast the coarser elastics are highly resistant and form prominent ridges and cuestas.

In the type section of the Abo formation in Abo Canyon, in and near the southwestern part of Torrance County, the formation is 810 feet thick (Bates et al., 1947, p 27) and consists of about 60 percent red shale and about 40 percent sandstone, with some arkose and conglomerate. The sandstone ranges from fine grained to coarse grained and conglomeratic and from quartzose to arkosic, and is interbedded with shale.

The section of the Abo formation in Abo Canyon given below is modified from a section by Needham and Bates (1943, pp 1, 656).

Only a few wells in Torrance County derive their water from the Abo formation. These wells are in two areas (see Pal, Pat, pl 2): one area extends from about 7 miles east of Punta de Agua (sometimes called Punta) west to the county line and thence south along the county line into T. 2 N., R. 5 E. The boundary of the other area (T. 9 N., R. 12 E.) is somewhat questionable, and it is not certain that the Abo is the aquifer in this area. On the east edge of Punta de Agua a well intended for irrigation was drilled to a depth of 300 feet, where the hole bottomed in the Abo formation. The only known water-bearing zone, encountered at 76 feet, probably was valley fill. The well was reported to yield 600 gpm when tested, but would pump dry in 15 minutes. The sustained pumping rate was 20-25 gpm. In 1950 this well was abandoned and the equipment removed. In February and March 1951 the New Mexico State Department of Public Health drilled a well for the Punta de Agua community about a quarter of a mile west of the abandoned irrigation well. The well was drilled entirely in the Abo formation to a depth of more than 400 feet. The yield of the proposed community well was about 3 gpm. Although there are several dug wells in the village area, there is no reliable information as to the yield of these wells. About 1 mile west of the Quarai State Monument, which is about half a mile west of Punta de Agua, water from a spring that discharges from the Abo is diverted by a ditch to the village. According to some reports, the spring is dry during the summer season.

Data from irrigation wells penetrating the Abo formation below the valley fill in Estancia Valley indicate that the water in these wells comes from the valley fill and not from the Abo formation. On the basis

SECTION OF THE ABO FORMATION IN ABO CANYON, VALENCIA AND TORRANCE COUNTIES, N. MEX.

Material	Thickness (feet)	Depth (feet)
Shale, red	3.0	3.0
Sandstone, light-pink, medium-grained	2.0	5.0
Shale, pink	8.0	13.0
Sandstone, buff, thin-bedded and shaly, fine-grained	18.0	31.0
Shale, red	25.0	56.0
Sandstone and shale, buff	15.0	71.0
Sandstone, pink, medium-grained	25.0	96.0
Shale, buff, partly covered	32.0	128.0
Sandstone, pink	16.0	144.0
Sandstone and shale, pink and red, interbedded	45.0	189.0
Shale, red, partly covered	48.0	237.0
Sandstone, red, shaly	12.0	249.0
Sandstone, red, medium-grained, crossbedded	4.5	253.5
Shale, yellow-gray	.5	254.0
Sandstone, red, fine, shaly, extremely crossbedded	27.0	281.0
Shale and sandstone, red, partly covered	26.0	307.0
Sandstone, red, medium-grained, crossbedded	6.0	313.0
Shale, red, partly covered	70.0	383.0
Sandstone, red, coarse, crossbedded	16.0	399.0
Conglomerate; limestone pebbles in red sandstone	5.0	404.0
Shale, red, partly covered	16.0	420.0
Sandstone, red, slabby	3.0	423.0
Mostly covered; some red sandy shale	172.0	595.0
Sandstone and arkose, dark-red, coarse	10.0	605.0
Covered; probably red shale	52.0	657.0
Sandstone, red, arkosic, coarse	6.0	663.0
Sandstone, red, shaly, arkosic	10.0	673.0
Covered; probably red shale	11.0	684.0
Sandstone, red-brown, coarse, arkosic, conglomeratic	6.0	690.0
Covered; probably red shale	70.0	760.0
Arkose and sandstone, red-brown, thick-bedded, with fragments of limestone	15.0	775.0
Sandstone and shale, interbedded, partly covered	35.0	810.0

of available information concerning the lithology of the Abo formation, well data, and limited field observations, the Abo formation in Torrance County is considered to be unsatisfactory as a source of enough water for irrigation and uncertain even for domestic or stock water.

The specific conductance of samples of water from 5 wells deriving their water from the Abo formation in the Abo Canyon area ranged from 405 to 792 micromhos. The specific conductance of samples of water from 2 wells in the Abo formation in the Clines Corners area was 1,180 and 1,320 micromhos. Water of this chemical quality is generally usable for domestic, stock, and irrigation use.

YESO FORMATION

In the southern part of Torrance County, where the Yeso formation crops out in a general east-west band along the escarpment of Chupadera Mesa and the slope of the Gallinas Mountains, the Yeso overlies the Abo formation with apparent conformity. In the northeastern part of the county the Yeso overlaps older strata and rests directly upon the Precambrian igneous and metamorphic rocks of the Pedernal Mountains (Read et al., 1944). In the southeastern part of the county the Yeso may pinch out against isolated Precambrian rocks. The Yeso formation is exposed on the west and south sides of the old lake bed south of Encino (see Encino drainage basin, p 80) and along U. S. Highway 54 near Torrance. The area of outcrop of the Yeso formation in the county is about 650 square miles. The formation directly underlies the valley fill of Estancia Valley (see pl 1) in an area lying approximately southeast of a line between Mountainair and Willard and east of a line between Willard and Cerrito del Lobo. The data are insufficient to determine the location of the contact between the Abo and Yeso formations below the valley fill.

The Yeso formation has been divided into four members. As described by Wilpolt et al. (1946) the four members in the southwestern part of the county are: the Meseta Blanca sandstone member at the base, 104-222 feet thick, consisting of uniformly bedded red-brown and variegated sandstone and sandy shale; the Torres member, 350-600 feet thick, consisting of alternating beds of orange-red and btiff sandstone and siltstone, gray limestone, and gypsum; the Callas gypsum member, as thick as 103 feet, consisting mostly of white gypsum and some gypsiferous siltstone and limestone; and the Joyita sandstone member at the top, 60-90 feet thick, consisting of orange-red, buff, and yellow sandstone, silty sandstone, and siltstone. In a composite section (Bates et al., 1947, pp 29-31), which is given below in modified form, the Yeso formation near the southwest corner of Torrance County is 678 feet thick and consists of about 47 percent sandstone, 23 percent gypsum, 8 percent siltstone, 7 percent limestone, and 1 percent shale. Fourteen percent of the section is concealed.

The thickness of the Yeso formation in the eastern part of Torrance County is unknown, but according to Griggs and Hendrickson (1951, p 24) about 600 feet of the Yeso was logged in well 10.14.20.400 in San Miguel County, about 3 miles north of the Torrance County line. The examination of scattered outcrops of the Yeso in the eastern part of Torrance County indicates the presence of the red sandstone, gypsum, and gray limestone and shale that are characteristic of the formation in the western part of the county. The thickness of the Yeso formation near the Gallinas Mountains is about 1,000 feet.

The Yeso formation is the principal aquifer in the northern part of Chupadera Mesa, in a belt from 1 to 7 miles wide at the north base of Chupadera Mesa, and in the eastern and north-central parts of the county — a total area of about 1,700 square miles, or half of Torrance County. The locations of these areas in the county are shown by Pyl, Py2, Py3, Py4, Py5, Py6, Py7, and Py8 on Plate 2. In most of these areas the Yeso formation furnishes water to windmill wells.

GENERALIZED COMPOSITE SECTION OF THE YESO FORMATION NEAR THE SOUTHWEST CORNER OF TORRANCE COUNTY, N. MEX.

Material	Thickness (feet)	Depth (feet)
Joyita sandstone member		
Siltstone and fine sandstone, pink and gray	62.0	62.0
Cañas gypsum member		
Gypsum, white and gray	6.0	68.0
Siltstone, red, gypsiferous, muddy	2.0	70.0
Gypsum, white and gray; sandstone and limestone in basal 6 feet	55.0	125.0
Sandstone, pink, gypsiferous	2.0	127.0
Gypsum, white and gray	40.0	167.0
Torres member		
Limestone, dark-gray, silty	8.0	175.0
Gypsum, white	8.0	183.0
Siltstone and fine sandstone, pink	32.0	215.0
Gypsum, white and gray	24.0	239.0
Limestone, gray, finely porous	4.0	243.0
Limestone, gray, medium-bedded, sandy	5.0	248.0
Limestone, gray	7.0	255.0
Sandstone, fine	36.0	291.0
Gypsum, gray	3.0	294.0
Limestone, gray, impure, interlaminated with gypsum	9.5	303.5
Sandstone, gray-buff to bright-orange, medium to fine	50.5	354.0
Gypsum, predominantly gray	17.0	371.0
Limestone, gray, irregular bed	.5	371.5
Sandstone, buff and orange, medium-grained	29.0	400.5
Gypsum, greenish-gray and red	3.0	403.5
Sandstone, buff and orange, fine, silty; base not exposed	53.0	456.5
Limestone, medium-gray, argillaceous	4.0	460.5
Covered	42.0	502.5
Limestone, medium- to light-gray, argillaceous	7.0	509.5
Silt, gray and yellow, sandy	6.0	515.5
Covered; gypsite and pink silty soil	54.0	569.5
Meseta Blanca sandstone member		
Sandstone, varies from white to pink to light colored	52.0	621.5
Shale, pink, sandy	7.0	628.5
Sandstone, pink, buff, and red	45.5	674.0

Under favorable conditions, however, the Yeso formation furnishes larger quantities of water (part of Py2, pl 3). The water supply for Mountainair in 1952 was from two wells (well 4.7.23.312 and well 4.7.23.312a) about 4 miles northeast of Mountainair. Water from these wells is derived from limestone, which apparently contains cavities, in the Yeso formation. These wells are equipped with turbine pumps. According to the superintendent of the Mountainair water-supply system, meter readings of the wells showed an original yield in 1944 of 500 gpm for well 4.7.23.312a and a yield in 1951 of 240 gpm, a decrease of about 50 percent. Well 4.7.23.312 had a yield of 460 gpm originally and of 133 gpm in 1951, a decrease of about 60 percent. Well 9.11.6.311, drilled to 516 feet for the Corps of Engineers in 1950, about 10 miles west of Clines Corners, is finished in the Yeso formation. When this well was test-pumped at 90 gpm for 24 hours, the drawdown was about 30 feet.

Between Cerrito del Lobo and Laguna del Perro (see Py4, p1 3), in an area of at least 17 square miles, the principal aquifer is fractured rock of the Yeso formation. The fracturing of the rocks in this area may have been caused by movement along the major structural axis of Cerrito del Lobo. In this area, well 7.10.18.431 was reported to have pumped 3,000 gpm, and well 7.10.19.112, in a test, is reported to have pumped 2,250 gpm, the maximum capacity of the pump used for the test. Although these wells of relatively high yield were in the Yeso formation, the yield of most wells deriving water from the Yeso formation is less than 15 gpm, on the basis of reports received. Only in the areas of fractured rock (Py4) or limestone cavities (Py2) should yields greater than 15 gpm generally be expected from the Yeso formation.

Recharge to the ground-water body in the Yeso formation in most areas in Torrance County can be expected to occur only occasionally. When recharge does occur it is from local precipitation in some areas, and from surface runoff, or discharge from an aquifer adjoining the Yeso formation, in other areas. On Chupadera Mesa local precipitation percolates through the San Andres formation to recharge the ground-water body in the Yeso formation (Py3, pl 2). The movement of ground water beneath most of Chupadera Mesa is southward. Eventually the water discharges into the overlying valley fill of Tularosa Basin. The presence of a low ground-water divide extending northwest-southeast from T. 3 N., R. 8 E., into T. 2 N., R. 10 E., suggests somewhat more concentrated recharge in that area. North of the divide ground water moves toward the main part of Estancia Valley.

Recharge to the ground-water body of the Yeso formation in the area south of Cerrito del Lobo (Py4, pl 3) is by inflow from the Glorieta sandstone member of the San Andres formation east of the area and probably to some extent from the valley fill west of the area. Incomplete data indicate that the ground water in this area discharges to the south into the valley fill of Estancia Valley.

The recharge to the ground-water body of the Yeso formation in the eastern and north-central parts of Torrance County (Py5, Py6, Py7, and Py8, pl 2) apparently is mostly from local precipitation, although some recharge is from surface runoff and ground-water discharge from crystalline rocks of the Pedernal Hills. The movement of the ground water through the Yeso formation west of a north-south line through the Pedernal Hills is westward; east of this line, the movement is eastward. West of the line the ground water of the Yeso formation discharges into the fill of Estancia Valley; east of the line the ground water moves eastward out of the county through the Yeso formation.

The specific conductance of samples of water from 57 wells deriving water from the Yeso formation ranged from 335 to 5,150 micromhos. The specific conductance of water from 40 of these wells ranged from

1,730 to 5,150 micromhos. The water from only 14 wells can be considered fit to drink, and in some of these wells the water is undesirable for drinking. Thus, water derived from rocks of the Yeso formation is generally unsatisfactory for drinking or domestic use. Wells 4.7.23.312 and 4.7.23.312a, which furnish water to Mountainair, are the only wells in the county yielding water suitable for drinking and domestic use that unquestionably derive water from the Yeso formation. If gypsum beds are not encountered in drilling in the Yeso formation, and if gypsum beds are not adjacent to the water-bearing limestone or sandstone beds in the well, there is a good chance of obtaining water that is satisfactory for drinking and domestic use. The quality of water from the Yeso formation ranges from satisfactory to undesirable for irrigation; some of it is unsatisfactory. Water from *the* Yeso formation nearly always is satisfactory for stock.

SAN ANDRES FORMATION

The San Andres formation is divided into three members: the Glorieta sandstone member at the bottom, a middle limestone member, and an upper fine-grained clastic member.

Glorieta Sandstone Member

The Glorieta sandstone member of the San Andres formation lies conformably on the Yeso formation. It crops out over about 425 square miles in Torrance County. The area of outcrop is mainly in the eastern half of the county, and also along the escarpment of Chupadera Mesa. The Glorieta sandstone member is a white to yellow sandstone, with a red surface coating in some places where exposed. Usually it is well sorted, well cemented, and resistant to erosion. Frequently it forms mesas or escarpments. Massive beds and cross bedding are common. The thickness of the Glorieta in the county ranges from about 150 feet near the northern county line to about 280 feet at the north end of Chupadera Mesa, south of Willard. The contact of the Glorieta with the underlying Yeso formation is gradational, and some units in the Yeso are almost identical lithologically with the Glorieta. Consequently, the units are difficult to distinguish in much of eastern Torrance County. Small depressions caused by wind erosion of less-cemented phases of the sandstone or overlying sandy soil occur locally.

The Glorieta sandstone member of the San Andres formation is the principal aquifer over about 130 square miles of Torrance County. In most of the remaining area in Torrance County where the Glorieta sandstone member occurs, it is above the zone of saturation; that is, above the water table. On Chupadera Mesa recharge to the Yeso formation from precipitation percolates through the Glorieta. On the east side of the Gallinas Mountains, the Glorieta is above the zone of saturation, and most wells obtain water from the underlying Yeso formation. North and south of the mesa east of Corona, however, some wells derive water from high-level zones in the Glorieta (Psg3, pl 2). The Glorieta is the principal aquifer in an area of about 80 square miles in the eastern part of Estancia Valley, southeast, east, northeast, and north of Cerrito del Lobo (Psg2, p13).

North and northeast of Moriarty the member furnishes water to irrigation wells (Psgl, pl 3). Under usual conditions the permeability of the sandstone is not sufficient to yield an adequate quantity of water for irrigation wells. Drillers' logs of the irrigation wells, however, indicate that the Glorieta sandstone member is fractured. The fracturing of the rocks in this area may be related to movement along the major structural axis of Cerrito del Lobo. The drawdown measured in well 10.8.35.211, which obtains its water from the Glorieta, was 6 feet when the well was being pumped at more than 3,000 gpm.

Recharge to the ground-water body in the Glorieta sandstone member in Torrance County is mostly from local precipitation and surface runoff. However, recharge occurs only when precipitation persists long enough to permit infiltration beyond the root zone. Near Corona, recharge to the Glorieta is largely from local precipitation east of the town, although some recharge is by surface runoff from the mesa. Ground-water movement in this area is generally southward, out of the county.

In the area southeast, east, and north of Cerrito del Lobo, the recharge to the Glorieta is by local precipitation, by percolation through overlying valley fill, and possibly by inflow from the Yeso formation to the east. In this area the dip of the strata to the west seemingly is greater than the slope of the water table. The water moves generally southwestward, discharging into the valley fill and then into the playa area of Estancia Valley.

In the irrigated area north of Moriarty in which the Glorieta sandstone member is the aquifer, the recharge is mostly by inflow from the valley fill north of the area, and the ground water moves through the Glorieta sandstone member to discharge into the valley fill south of the area.

The specific conductance of water from 8 wells in the Glorieta sandstone member ranged from 891 to 6,040 micromhos; the specific conductance of water from 5 of these wells ranged from 891 to 1,910. The specific conductance of water from 3 of the wells was from 3,040 to 6,040 micromhos. For drinking and domestic use the water from 5 of the wells is satisfactory to undesirable, and that from 3 of the wells is unsatisfactory. The water from the 8 wells is satisfactory for stock and from all but the well having the specific conductance of 6,040 (well 7.10.35.111) is satisfactory for irrigation use.

Limestone Member

The limestone member of the San Andres formation forms the surface of Chupadera Mesa. It crops out also along the eastern Torrance County line in an irregular north-south belt, in the vicinity of Clines

Corners, and in outliers east and south of Cerrito del Lobo. The total area of outcrop of the limestone member in Torrance County is approximately 500 square miles. On Chupadera Mesa the limestone member is about 200 feet thick and consists of fine crystalline limestone containing numerous solution channels, massive white gypsum, and white to yellow medium-grained sandstone. In the eastern part of Torrance County the limestone member consists largely of gray limestone and some gypsum. Near Clines Corners the limestone member is about 100 feet thick.

In the vicinity of Derramadero the limestone member dips gently eastward and forms a cuesta ridge, which is conspicuous for its pock-marked appearance. The narrow belt of outcrop is pitted with small sinkholes and collapsed caverns. Cave breccias are common. One large mass of cave breccia northwest of Derramadero contains, in addition to limestone blocks, light-colored sandstone blocks, which are probably remnants of the upper clastic member of the San Andres formation. Sinkholes containing remnants of the upper clastic member are common in this area. The Dockum group lies unconformably upon the pock-marked surface. Therefore, the extensive solution of the limestone and development of a karst topography took place possibly in Early Triassic time, after the deposition of the upper clastic member, but before the deposition of the Dockum group. However, in other areas collapse of the Dockum group into caverns and sinks in the Permian rocks indicates some later solution.

The thickness of the limestone varies in the belt along the eastern county line. Locally it is more than 100 feet in the areas where it apparently has not been affected by solution. The limestone member has been removed entirely by solution in an area of several square miles northeast of Encino.

The limestone member of the San Andres formation in Torrance County is everywhere above the water table, and no wells are known to derive water from it. 'Wherever the limestone is at the surface, precipitation and surface runoff are absorbed readily.

Upper Clastic Member

The upper clastic member of the San Andres formation apparently has been eroded from Chupadera Mesa (Wilpolt et al., 1946), although it may be present locally in the form of collapsed blocks in sinkholes. It is present in the vicinity of Clines Corners, where it consists of about 50 feet of pink and buff siltstone, and near the eastern county line, where it consists of about 40 feet of dark-red shale and siltstone. In the vicinity of Derramadero, scattered remnants of the upper clastic member were observed in collapsed areas, but details of the stratigraphic relations were not apparent. Most of the sections consisted of tan or gray friable fine-grained sandstone and siltstone, but a small outcrop of red siltstone lying on the limestone member of the San Andres was noted at Derramadero.

The total area of outcrop of the upper clastic member in the county is probably less than 40 square miles. No wells are known to derive water from the member. It is not likely to be water bearing in Torrance County, as it is underlain by the very permeable limestone member and is above the water table. Because of its limited areal extent and small influence upon the occurrence of ground water, the clastic member was not differentiated from the limestone member on Plate 1.

TRIASSIC SYSTEM

DOCKUM GROUP

Coarse-grained gray and white sandstone, commonly containing pebbles of limestone and quartz, is mapped as the Santa Rosa sandstone in the type locality of that unit 40 miles east of Torrance County, and in adjacent areas. Overlying this sandstone section, which is locally as much as 350 feet thick, is the Chinle formation, a thick section of red shale containing thin interbedded sandstone strata lithologically similar to the Santa Rosa. These two units generally constitute the Dockum group of Late Triassic age in eastern New Mexico. The sandstone and shale facies have not been mapped individually for this report and are designated as the Dockum group. In Torrance County the Dockum group is composed mostly of gray conglomeratic sandstone, red shale, and some limestone conglomerate.

The Dockum group crops out in scattered areas near Cerrito del Lobo, from the vicinity of Clines Corners east to Palma, and in the northeast corner of Torrance County, north of a line between Palma and Derramadero. The total area of outcrop is about 90 square miles. In the vicinity of Derramadero gray thick-bedded lenticular sandstone, weathering dark-gray or reddish-gray and interbedded with dark-red shale, forms a prominent escarpment. Approximately 300 feet of the Dockum group is present here; higher beds of the group are present in the adjacent outcrop area east of Torrance County. The general dip of the Dockum group is eastward, but locally it is disturbed owing to collapse into caverns and sinks in the underlying Permian rocks. The Dockum group unconformably overlies the San Andres formation and at Cerrito del Lobo lies directly on Precambrian rocks (Read et al., 1944).

Specific data were obtained on only two wells (9.15.14.134 and 9.15.32.241) deriving water from the Dockum group in Torrance County. The water is of relatively good chemical quality (see table 16). Some wells a few miles north of the county line (see Trd, p12) probably obtain water from sandstone in the Dockum group (well 10.11.35.122, in the southeast corner of Santa Fe County, and wells 10.15.34.113 and 10.15.19.220, in San Miguel County, near the northeast corner of Torrance County). These wells furnish adequate water for stock and domestic purposes. The water is reported satisfactory chemically for domestic use. Water in these sandstone beds apparently is separated by the red shale at or below the base of the Dockum group from water of poorer quality in underlying Permian aquifers. The Dockum group is, therefore, important in providing geologic conditions favorable for the accumulation of potable perched ground water at appreciably shallower depths than are prevalent in underlying Permian aquifers. It is probable that potable water sufficient to supply windmill wells can be obtained in much of the area where the Dockum group crops out in Torrance County. However, if the perched water is not encountered, it probably will be necessary to drill to a depth of 800-1,000 feet to the main body of water in the Yeso formation.

TERTIARY AND QUATERNARY SYSTEMS

Although Jurassic and Cretaceous rocks may have been deposited over much of Torrance County, they were removed by erosion during Tertiary time. No sedimentary rocks of early Tertiary age are known to be present in Torrance County, and it is presumed that basins of deposition did not form in Torrance County during this time.

INTRUSIVE ROCKS

A swarm of hornblende diorite and diabase dikes and sills were described and mapped in Gran Quivira quadrangle (southwestern Torrance County, northeastern Socorro County, and southeastern Valencia County), by Bates et al. (1947, pp 36-40). The dikes and sills intrude the Yeso and San Andres formations, and sills commonly have entered along the contact between these two units. In the Encino-Duran area numerous outcrops of igneous rocks form an igneous center (see pl 1). These igneous rocks are mostly fine grained. It is probable that the rocks are from a sill or a series of sills which are early Tertiary in age and may be related to the Gallinas Mountains intrusive center. Several dikes also occur north of Pedernal Mountain. The dikes and sills in southwestern Torrance County are probably early Tertiary in age and probably equivalent to the intrusives of the Gallinas Mountains and to the several intrusives in southern Santa Fe County. The data available are insufficient to show in detail the effect of these intrusive rocks on the occurrence and movement of ground water in the county.

UPLAND SURFICIAL DEPOSITS

Remnants of sand, silt, and gravel occurring at high levels at scattered localities in the county are correlated in part with the Ogallala formation of the Llano Estacado to the east, on the basis of general lithologic similarity and topographic position. Sediments correlated with the Ogallala formation, which is Pliocene in age, lie unconformably upon Precambrian quartzite near the peak of Pedernal Mountain, upon the Yeso formation north of Negra, on the San Andres formation along the eastern county line, and on the Dockum group in the northeast corner of the county. Other upland unconsolidated or poorly consolidated deposits are probably reworked Ogallala material.

Darton (1928-a) mapped the Ogallala formation southeast of the peak of Pedernal Mountain, and Bretz and Horberg (1949, p 482) identified other deposits of the Ogallala in the county along U. S. Highway 60. Numerous other scattered deposits of the Ogallala formation were found east of the Pedernal Hills during the field work for this investigation. The total area of outcrop of the Ogallala formation in Torrance County probably is less than 25 square miles.

The Ogallala formation in Torrance County is well consolidated in some places. The gravel of the Ogallala consists largely of fragments of quartzite, some of cobble size. The thickness of the Ogallala formation in Torrance County is not known, but it is much less than the 200-300 feet typical of the Llano Estacado. In the northeast corner of the county it may exceed 100 feet in small areas. Where the Ogallala formation rests on the San Andres formation and beds of the Dockum group, thicknesses are extremely variable because of deposition on the rough topography resulting from continued solution of Permian rocks and collapse of overlying strata. In the vicinity of Palma many good outcrops show the Ogallala to be essentially horizontal in collapse depressions where steeply dipping beds of the Dockum group are exposed. Remnants of the Ogallala were not found west of the Pedernal Hills, and it is probable that during Pliocene time this area contributed detritus to the Ogallala formation farther east.

No wells were noted in Torrance County that were finished in the upland surficial deposits, as they are all above the main water table. However, it is possible that sufficient water to supply windmill wells could be obtained from perched ground-water bodies in this material in some areas where the beds are underlain by an impermeable bed such as shale of the Dockum group or the Yeso formation.

VALLEY FILL

Estancia Valley is underlain by sand, gravel, silt, and clay. These materials were deposited in a structural basin which formed as a result of mild downwarping related to late stages of the development of the adjacent Rio Grande trough. Uplift of the Manzano Mountains west of Estancia Valley provided a source area for the sediments deposited in the valley, but the thickness of these sediments is less than the thickness of equivalent beds of the Santa Fe group in the Rio Grande trough, because the downwarping of Estancia Valley was relatively small compared to the depth of the Rio Grande trough. The fill in Estancia Valley is more than 300 feet thick in some places (see pl 1).

The valley fill of Estancia Valley, which extends north into Santa Fe County about 15 miles, is probably equivalent to the upper beds of the Santa Fe group (Zane Spiegel and Brewster Baldwin, personal communication, 1956) north of Galisteo Creek. The upper beds of the Santa Fe group are locally unconformable on Miocene and Pliocene beds **of** the Santa Fe group in the Rio Grande trough, but they interfinger with younger units of the group which are of late Pliocene(?) and Pleistocene age. Therefore, the fill in Estancia Valley is considered to be of late Pliocene(?) and Pleistocene age.

The fill in Estancia Valley is the aquifer tapped by most of the irrigation wells in the valley. The valley fill is recharged by water from infrequent local precipitation and floods, and by discharge from underlying consolidated deposits. All wells drilled in the valley below the water table have yielded water. However, wells that do not yield sufficient water for irrigation but furnish an abundant supply for stock and domestic use sometimes are spoken of in the valley as "dry holes." West of New Mexico Highway 41, in the Torrance County portion of Estancia Valley (see TQl, pl 3), the water from wells in the valley fill is satisfactory for drinking and domestic use. East of the highway the water from the valley fill becomes progressively more mineralized as the playa area is approached. Most of the water east of the highway (see TQ2, pl 3), is unsatisfactory for drinking and domestic use, and some of it is unsatisfactory for irrigation and undesirable for stock. The poorer quality of the water in the playa area is the result of the concentration of the minerals dissolved in the water by evaporation.

LAKE AND DUNE DEPOSITS

Lake deposits of Pleistocene age in Estancia Valley cover an area of about 300 square miles and overlie the late Pliocene(?) and Pleistocene valley fill. An examination of well logs indicates that the lake deposits probably range in thickness from 30 to 80 feet near the center of the area that was occupied by the lake. The lake deposits consist largely of clay or shale, with some layers of sand. As the lake progressively dried, gypsum was deposited. The wind has removed part of the lake deposits and deposited them as dunes considered to be Pleistocene and Recent in age. Additional details concerning the lake deposits are discussed in the section on Estancia Valley. The salt basin south of Encino also is near the center of an ancient lake of Pleistocene age. Deposits similar to those formed by the lake in Estancia Valley were formed in the Encino basin and are of about the same age.

The lake deposits are not known to furnish water to any irrigation wells, and, because of their low permeability, these deposits cannot be expected to furnish water in quantities sufficient for irrigation. The lake deposits furnish water, however, to some windmill wells.

RECENT STREAM DEPOSITS

Outside Estancia Valley, Recent stream deposits are present in some of the deep drainage channels. Ground water sufficient for windmill wells may occur locally in lenses in these stream deposits where they overlie older deposits consisting of relatively impermeable beds, such as clay or shale. Where, however, the alluvium overlies permeable rocks, such as sandstone or limestone, such ground-water bodies are not present.

Structure

Torrance County is bounded on the west by the Manzano Mountains, which extend south from the northwestern corner of the county along the county line to the southern part of T. 4 N., and then southwest across the southeastern corner of Valencia County. The Manzanos are block-fault mountains, and their high, westward facing escarpment exposes Precambrian granite and metamorphic rocks capped by eastward dipping rocks of the Magdalena group, which consist principally of limestone but contain some sandstone and shale. In the vicinity of Chilili the outcrop area of the Magdalena group is about 15 miles wide and extends nearly to the middle of Estancia Valley. In the vicinity of Manzano Peak (altitude, 10,086 feet), in the northwestern part of T. 4 N., R. 5 E., the eastward dip of the Magdalena rocks is steeper, and the area of outcrop of these rocks is correspondingly narrower. Numerous faults, most of which trend generally north-south, extend along the higher parts of the range and its west slope. A thrust fault, named the Paloma fault by Stark and Dapples (Bates et al., 1947, p 42), extends as far north as T. 6 N., R. 5 E., in Torrance County and marks the eastern structural boundary of the Manzano Mountains.

East of the Manzano Mountains is Estancia Valley, a broad closed basin that occupies the central part of the west half of Torrance County and extends northward into southern Santa Fe County. Much of the surface of the valley lies at an altitude between 6,100 and 6,400 feet. Essentially, the valley is a structural basin, bounded on the west by the eastward dipping monocline of the Manzano Mountains and on the east by resistant ridges of Precambrian quartzite which form the Pedernal Hills and Cerrito del Lobo. The central part of Estancia Valley is covered by gravel, sand, and clay, which are partly lacustrine in origin. The maximum thickness of these deposits is more than 300 feet. The underlying Pennsylvanian and Permian strata dip gently eastward and abut against the crystalline rocks east of the valley. The surface of the basin rises gently northward, and in the southern part of Santa Fe County the valley is bounded on the north by Upper Cretaceous sandstones and shales, which extend southward a short distance under the valley deposits.

South of Estancia Valley is the northward facing escarpment of Chupadera Mesa, which rises about 500 feet above the floor of the valley. Chupadera Mesa extends across the eastern part of Socorro County and the southwestern part of Torrance County. Structurally, Chupadera Mesa is a broad, very shallow syncline in which rocks of the Yeso and San Andres formations dip very gently to the south and east. The mesa is capped by the limestone member of the San Andres formation and contains numerous sinkholes.

In the southwestern corner of Torrance County the strata between Chupadera Mesa and the Los Pilios Mountains, in Socorro County, dip gently to the southeast. Several dikes and sills have been mapped in the area. The dikes cut the Yeso formation and the lower part of the Glorieta sandstone member of the San Andres formation. Most of the dikes trend northeast, and they are responsible for several minor folds that interrupt the gentle southeast dip of the strata. The sills are in both the Yeso and San Andres formations and are nearly horizontal. These igneous intrusions are probably Tertiary in age.

East of Estancia Valley and south of Pedernal Mountain are several outcrops of Precambrian rock that differ lithologically from the white quartzite that forms Pedernal Mountain. Rattlesnake Hill, in the western part of T. 4 N., R. 11 E., consists largely of black amphibolite. Cerro del Pino, in the southwestern part of T. 3 N., R. 12 E., is made up of coarse-grained massive granite (Darton, 1928-b, p 283), and Chameleon Hill, southeast of Torrance in T. 1 N., R. 14 E., consists of granite gneiss.

The Gallinas Mountains are mostly in Lincoln County but extend northward into Torrance County southwest of Torrance. Their structure is that of a complex dome formed by the intrusion of laccoliths and sills into Permian rocks, probably during early Tertiary time.

East of Pedernal Mountain the Permian rocks dip very gently to the east or southeast and form a wide plateau in eastern Torrance County and southwestern Guadalupe County. To the west the Permian rocks overlap the Precambrian quartzite of the Pedernal Hills. To the northeast, in northeastern Torrance County, the Permian rocks dip beneath Triassic beds of the Dockum group.

Geology and Ground Water by Areas

In the following discussions Torrance County is subdivided into 6 areas on the basis of the distribution of water-bearing geologic units, geologic structure, and ground-water occurrence. The areas are the Estancia Valley, Manzano Mountains, Pedernal Hills and eastern uplands, Chupadera Mesa, Encino basin, and Pinos Wells basin. Figure 4 shows the approximate boundaries of the various areas in the county and important subdivisions within each area. The boundaries of these areas do not coincide exactly with the boundaries of the physiographic features. Table 4 summarizes the distribution of the county population, lists the communities within each area, and gives the principal uses of ground water in each of the areas.

For each area the geology, principal aquifers, and ground-water recharge, movement, discharge, availability, and use are discussed. The important chemical constituents in water from representative wells are summarized in a table for each area. Although information was not obtained for all wells in the county, the discussion based on the wells for which information was obtained should give a reliable indication as to the availability, chemical quality, and use of the ground water in each area.

The Estancia Valley area is the most important ground-water area of the county because of the availability of large supplies of ground water and the irrigation development that has taken place. As Estancia Valley receives water from adjacent ground-water areas, particularly the Manzano Mountains area, the valley is not a complete hydrologic unit.

ESTANCIA VALLEY

Estancia Valley is a wide, relatively flat-floored basin of interior drainage. The valley proper is about 50 miles long from north to south and ranges in width from about 12 miles near Moriarty to 30 miles near Willard, averaging about 16 miles. On the north the valley extends about 15 miles into Santa Fe County. The area of the valley floor is about 900 square miles, of which about 650 square miles is in Torrance County. The surface drainage area of Estancia Valley includes about 2,000 square miles. On the north, Estancia Valley merges with a gravel-veneered plateau that overlooks the drainage area of Galisteo Creek. On the south it is bordered by Chupadera Mesa. On the west it merges with the east slopes of the Manzano Mountains. On the east it is bordered by the Precambrian rocks of the Pedernal Hills and by Permian sedimentary rocks. On the southwest the valley is separated from Abo Canyon by a low divide underlain by Permian rocks, and on the south-

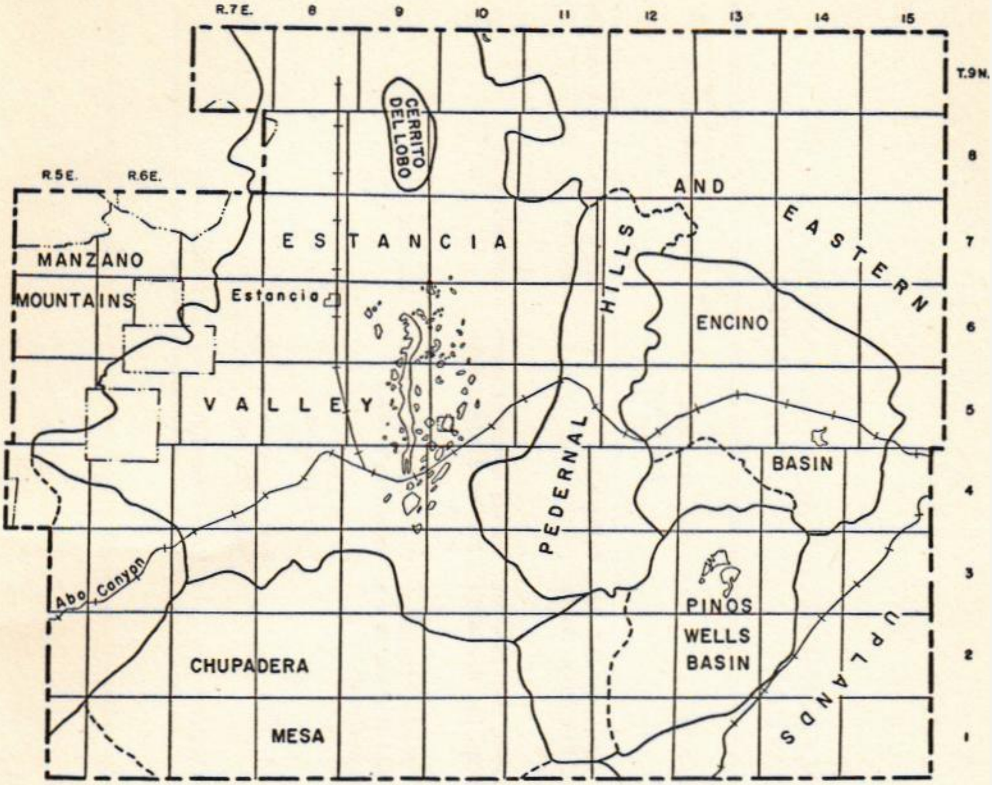

Figure 4

BOUNDARIES OF GROUND-WATER AREAS IN TORRANCE COUNTY, N. MEX., AS DISCUSSED IN THIS REPORT. DASHED LINES INDICATE IMPORTANT SUBDIVISIONS WITHIN THE GROUND-WATER AREAS.

east it is separated by a low divide from small basins just west of the Pinos Wells basin.

East of New Mexico State Highway 41, in Estancia Valley, are numerous playas or relatively dry lake beds and associated windblown deposits. The playas in Estancia Valley occupy about 19 square miles or 12,000 acres. Laguna del Perro (pl 5A), by far the largest of these playas, occupies an area of about 7 1/2 square miles or 4,800 acres. The playas contain little or no surface water except after heavy rain or snow. After a heavy downpour, surface water from as far away as the east slope of the Manzano Mountains may flow into the westernmost of the playa lakes.

TABLE 4. POPULATION DISTRIBUTION, COMMUNITIES, AQUIFERS, AND WATER USE IN GROUND-WATER AREAS OF TORRANCE COUNTY, N. MEX.

AREA	APPROXIMATE PERCENTAGE OF COUNTY POPULATION	COMMUNITIES	PRINCIPAL AQUIFER	PRINCIPAL USE OF GROUND WATER
Estancia Valley	60	Estancia, McIntosh, Moriarty and Buford, Mountainair, Progresso, Punta de Agua, and Willard	Valley fill	Irrigation; also stock and domestic
Manzano Mountains area	15	Abo, Manzano, Torreon, and Tajique; and Chilili, nearby in Bernalillo County	Arkosic limestone member of Madera limestone	Domestic, stock
Pedernal Hills and eastern uplands	10	Duran, Torrance, Varney, Derramadero, and Palma; and Corona, at the county line in Lincoln County	Yeso formation and Precambrian rocks	Stock, domestic
Chupadera Mesa	5	Gran Quivira	Yeso formation	Stock
Encino basin	5	Encino, Pedernal, and Negra	Yeso formation and Precambrian rocks	Stock, domestic
Pinos Wells basin	5	Cedarvale and Pinos Wells	Yeso formation	Stock

GEOLOGY

Estancia Valley is underlain by valley fill deposits of sand, gravel, and clay, in which caliche has been developed locally. The valley fill is underlain by bedrock of varied lithologies. The bedrock dips gently to the east, so that successively younger strata (from west to east the Madera limestone, the Abo formation, the Yeso formation, and the Glorieta sandstone member and the limestone member of the San Andres formation) underlie the valley fill. The approximate positions of the contacts between the Madera limestone and the Abo formation and between the Yeso formation and the San Andres formation beneath the valley fill, as determined by well logs and surface geology, are shown in Plate 1. The valley fill is made up largely of material eroded from the mountains to the west and, to a lesser extent, of material from the Pedernal Hills area to the east, Chupadera Mesa to the south, and the higher areas to the north in Santa Fe County. The valley fill, as mentioned previously (see p 39), is considered to be of late Pliocene(?) and Pleistocene age. Well logs indicate that the valley fill attains a thickness in Torrance County of at least 340 feet, as shown in the log of well 8.9.19.133, about 6 miles south of Moriarty. In Santa Fe County, about 2 miles southwest of Stanley (see fig 2), the valley fill is at least 405 feet thick. The well log given below indicates the type of material that can be expected when drilling into the valley fill. The log is from the files of the New Mexico State Engineer.

In the south-central part of Estancia Valley, lake sediments of Pleistocene age overlie stream deposits of the valley fill. The area covered by the lake sediments is about 375 square miles, and examination of a limited number of logs of wells drilled in the last 5 years indicates that the lake deposits may be as much as 80 feet thick.

Evidence of the presence of a lake in Estancia Valley during the Pleistocene epoch includes lake deposits, sea cliffs, terraces, beach ridges, spits, and bars. The shore features were made at various stages of the lake (Meinzer, 1911, pp 19-22) and became smaller and less pronounced as the lake gradually decreased in size and then dried completely. After the lake dried, modification of the central playas began. In the area now occupied by the playas, wind erosion cut into the lake sediments and removed the fine-grained lake deposits as the ground-water level dropped. These fine-grained materials were re deposited as dunes by the prevailing winds, on the margins of the playas, principally on the east or leeward side. The original lake sediments are exposed in many places as cliffs below the overlying eolian hills. Considerable gypsum derived from the lake deposits is contained in the eolian deposits. At the time deflation (wind erosion) was taking place, some of the gypsum and limestone from the Yeso formation below the lake deposits was being dissolved and brought to the surface by ground water. The gypsum in the

LOG OF WELL 9.8.26.430, 2 MILES SOUTH OF MORIARTY

Material	Thickness (feet)	Depth (feet)
Quaternary and Tertiary(?) valley fill		
Soil	3	3
Caliche	9	12
Clay, sticky	28	40
Clay, sandy	31	71
Sand and gravel; water	5	76
Clay	22	98
Sand and gravel; water	4	102
Clay	10	112
Gravel; water	6	118
Clay	10	128
Sand and gravel; water	6	134
Clay, sandy	21	155
Sand and gravel	8	163
Clay	8	171
Sand and gravel	9	180
Gravel	12	192
Clay	6	198
Sandstone shells	4	202
Gravel	8	210
Sand and gravel	5	215
Gravel	5	220
Conglomerate	21	241
Clay and gravel	7	248
Conglomerate	23	271
Clay	7	278
Probably Abo formation		
Clay, light-red	4	282
Sandstone, red	5	287
Clay, red	6	293
Conglomerate	7	300
Red bed	3	303

lake sediments exposed near the playas came largely from the underlying Yeso formation.

Meinzer (1911, pp 26, 27) believed that both the playas (salt basins) and the associated clay hills are the work of the wind, and that the material excavated from the salt basins was deposited to form the hills. According to Meinzer the excavation by the wind proceeded to the ground-water level but could be carried no deeper; the result was the flat, miry, "alkali"-floored salt basins or playas. The materials of which the hills are constructed are thoroughly sorted and contain nothing coarser than the wind can handle. Because southwest winds have prevailed in this region, the hills are best developed on the east and north sides of the playas.

Deflation, admittedly, is taking place still, but it is probable that the playas as they are today are a result of the combined action of solution, subsidence, and deflation. Available well logs and other geologic evidence indicate that the bedrock underlying the area covered by the playas is the Yeso formation,' which consists largely of red sandstone interbedded with gypsum, gray limestone, and some shale. Ground water moving through the Yeso formation gradually dissolves the gypsum and discharges naturally at the surface, where the water evaporates and the dissolved mineral matter is deposited, to be removed later by the wind.

PRINCIPAL AQUIFERS

Although some wells in Estancia Valley obtain part of their water from bedrock, the Tertiary(?) and Quaternary valley fill is the principal aquifer in about 90 percent of the part of the valley in Torrance County (see pl 3). The valley fill ranges in thickness in Torrance County from a featheredge at its margins to at least 340 feet in well 8.9.19.133, about 6 miles south of Moriarty. Plate 1 indicates the thickness of the valley fill as determined from well logs. The fill, which consists of sand, clay, and gravel lenses of varying extent and thickness, was deposited under varying conditions, so that layers of sand are commonly separated by layers of clay and silt in these deposits. Consequently, the valley fill contains numerous water-bearing beds of local extent that are separated by relatively impermeable beds. As a result, it is not unusual to encounter water under water-table, artesian, and perched conditions in different places, or even at successively greater depths at the same place. According to well logs, caliche was encountered in most of the wells and usually was less than 20 feet thick. The log of well 6.8.10.433 and the log of an Atchison, Topeka & Santa Fe Railway well at Willard, both given below, illustrate the heterogeneous nature of the valley fill where it furnishes water to wells.

The arkosic limestone member of the Madera limestone is the principal aquifer in Estancia Valley along the western margin of the valley fill in a belt about 1-3 miles wide extending from Manzano northward into Santa Fe County. In this belt the arkosic limestone member contains water under artesian pressure. Valley fill covers most of this belt but is generally less than 100 feet thick. As an aquifer the arkosic limestone member is much less reliable for yield and permanence than is the valley fill to the east. One well (8.8.28.311a) had a reported initial yield of 1,100 gpm. A year and a half later, however, the output of this well had decreased to a sustained yield of about 300 gpm.

In the northeastern part of Estancia Valley in Torrance County and the adjoining part of Santa Fe County (pl 3, Psgl, Psg2), the Glorieta sandstone member of the San Andres formation, which there is highly fractured, is the principal aquifer. The fractured zone in this area appears to be related to movement along the major structural axis of Cerrito del Lobo. In the area designated Psgl, the Glorieta is recharged from the valley fill to the north and furnishes sufficient water for irriga-

LOG OF WELL 6.8.10.433, ABOUT 2 MILES WEST OF ESTANCIA

Material	Thickness (feet)	Depth (feet)
Quaternary and Tertiary(?) valley fill		
Soil	3	3
Adobe clay	12	15
Clay, red, and gravel	21	36
Clay and gravel; water	2	38
Clay and gravel	7	45
Sand, gravel, and clay	20	65
Clay, yellow, and sand	3	68
Clay, yellow, sand, and gravel	7	75
Clay, red, and gravel	12	87
Sand and gravel	3	90
Clay	10	100
Gravel and clay	10	110
Clay, red	20	130
Sand and gravel; water	5	135
Clay	5	140
Gravel, clay, and sand	5	145
Probably Quaternary and Tertiary(?) valley fill		
Clay, red	28	173
Boulder rock	2	175
Probably Abo formation		
Clay, red bed	25	200

LOG OF ATCHISON, TOPEKA & SANTA FE RAILWAY WELL AT WILLARD*

Material	Thickness (feet)	Depth (feet)
Quaternary and Tertiary(?) valley fill		
Clay, light-red, and gravel	35	35
Gravel, coarse; struck water at 35 feet	5	40
Clay, light-red, and gravel	90	130
Gravel, coarse; struck water at 135 feet, rose to 33	22	152
Sand and gravel; struck water at 223 feet	160	312
Yeso formation		
Sand rock, red	128	440

* The well was scaled in 1907 at 152 feet and at 100 feet was pumped at 100 gpm without an appreciable lowering of the water level. The length of the test is not known.

tion wells. A drawdown of about 6 feet was measured in well 10.8.35.211 while it was being pumped at a rate of more than 3,000 gpm. The performance of this well indicates that the sandstone is fractured, as the specific capacity of wells elsewhere in the Glorieta is much less. In the area designated Psg2 the Glorieta furnishes water to stock and domestic wells. The log of well 10.8.36.111, in which the Glorieta is the principal water-bearing unit, is given below.

The Yeso formation is the principal aquifer in parts of Estancia Valley. It is about 700 feet thick in a section measured at the surface near the southwest corner of Torrance County. Between Cerrito del

LOG OF WELL 10.8.36.111, ABOUT 3½ MILES NORTH OF MORIARTY

Material	Thickness (feet)	Depth (feet)
Quaternary and Tertiary(?) valley fill		
Soil	8	8
Caliche	37	45
Sand; water	10	55
Glorieta sandstone member of San Andres formation		
Sandstone, brown	10	65
Sandstone, yellow	10	75
Sandstone, red	5	80
Sandstone; water	10	90
Sandstone, yellow; water, large quantity	70	160
Yeso formation		
Red bed	5	165
Rock, red	25	190
Gravel, red, and sand; water	40	230
Shale	2	232
Sand, yellow; water	18	250
Shale	5	255
Anhydrite	5	260
Sand and lime shells	20	280
Chalk and sand, broken	20	300
Limestone	9	309

Lobo and Laguna del Perro, and about 9 miles northeast of Estancia (see pl 3, Py4), is an area of about 17 square miles in which the principal aquifer is fractured rock of the Yeso formation. The fractured zone in this area also appears to be related to movement along the major structural axis of Cerrito del Lobo.

The Yeso formation is the principal aquifer in a belt about 7 miles wide at the base of Chupadera Mesa, and also along the eastern border of Estancia Valley in the northern part of Torrance County (pl 3, Py2, Py3, and Py5). In an oil-test well in sec. 32, T. 4 N., R. 7 E., north of Mountainair, the Yeso formation is 380 feet thick, the upper part of the formation having been removed by erosion. About 4 miles northeast of the oil-test well are two of Mountainair's water-supply wells. These wells derive their water from limestone in the Yeso formation; each yields more than 100 gpm. The log of well 4.7.23.312a, which has the higher yield of the two Mountainair wells, is given below.

Only in the southwestern part of Estancia Valley is the Abo formation a principal aquifer; it supplies water to stock and domestic wells in T. 4 N., Rs. 6 and 7 E.

RECHARGE

The mean annual precipitation, as averaged for five weather stations in Estancia Valley (Estancia, McIntosh, Mountainair, Otto C.A.A. AP, and Progresso) and the weather station at Tajique, is 14.46 inches. About two-thirds of the precipitation occurs during the period April-

Log of well 4.7.23.312a, about 4 miles northeast of Mountainair

Material	Thickness (feet)	Depth (feet)
Quaternary and Tertiary(?) valley fill		
Soil	3	3
Gravel	14	17
Gravel, sandy	12	29
Sand and gravel	26	55
Yeso formation		
Rock, hard	6	61
Rock, hard, and sand	9	70
Rock, hard	5	75
Rock, red, sandy	10	85
Rock, red, and clay	40	125
Rock, red	5	130
Limestone	5	135
Limestone, crevice; water	4	139
Limestone, sandy; water	20	159
Clay, red, soft	2	161
Rock, sandy, red	9	170
Rock, red, and clay	5	175

September, the heaviest precipitation occurring during July and August. A large amount of the precipitation in Estancia Valley comes as short, heavy downpours. Such downpours cover limited areas and occur at irregular and, commonly, infrequent intervals.

Recharge to the ground-water body of Estancia Valley comes from local precipitation and from surface-water runoff from the east slopes of the Manzano Mountains, the west slopes of the Pedernal Hills and eastern uplands, the slopes of South Mountain and the San Pedro Mountains in Santa Fe County, and the northern rim area of Chupadera Mesa. Only exceptional precipitation on the valley floor itself is capable of producing significant direct ground-water recharge; thus, the direct recharge from precipitation in the average year is probably small. A large part of the recharge to the valley fill comes from ground water in the Madera limestone, derived originally from precipitation and, in the summer, flood runoff on the east slope of the Manzano Mountains. A small amount of recharge can be expected from runoff on the west slopes of the Pedernal Hills and from ground water moving westward through the Yeso formation and the Glorieta sandstone member of the San Andres formation. The surface runoff from the Manzano Mountains to Estancia Valley reaches the valley in a matter of hours, or, at the most, a matter of days. However, the rate of movement of ground water from the Manzano Mountains to Estancia Valley can be expected to be only a few feet a day. Thus, the local recharge from precipitation or surface runoff to the ground-water body in Estancia Valley may have a noticeable effect on the water levels within a short time, but recharge to the valley fill from the ground-water body of the Manzano Mountains may have no noticeable effect upon ground-water levels in the valley for some years.

The hydrographs of representative wells in the valley (see fig 5) show a pronounced rise of the water level after the unusually heavy rainfall in the basin during 1941, in some of the wells within a short period and in others over a period of several years. The U. S. Weather Bureau reported 23.63 inches of precipitation at Estancia for 1941, 11.04 inches above average; 22.30 inches at McIntosh, 9.06 inches above average; and 32.21 inches at Tajique, 12.67 inches above average. The average precipitation in 1941 at the three stations was 26.05 inches. This figure is 178 percent of the average for the three stations for the period of record. (See table 2.)

The average rate of recharge for the entire drainage area of Estancia Valley (about 2,000 square miles) is estimated at about half an inch a year (see p 52) on the basis of the estimated natural discharge from the playas. The recharge is not constant from year to year nor in all areas of the valley. There is considerable variation from area to area, and it is expected that on the average the recharge in or at the edge of the mountainous areas generally exceeds half an inch, whereas in the lower areas it is less. However, in particularly wet years, such as 1941, the recharge even in the lower areas may exceed half an inch. The average annual recharge in an area of about 115 square miles south of Santa Fe, where the topography, climate, and geology are similar to those of Estancia Valley, has been estimated at approximately half an inch (Zane Spiegel and Brewster Baldwin, personal communication, 1956). Theis (1937) previously computed the average annual recharge to the ground water of the High Plains in eastern New Mexico and western Texas to be somewhat less than half an inch, using several different methods applicable there.

MOVEMENT AND DISCHARGE

The shape and slope of the water table in Estancia Valley are shown on Plate 3 by means of contour lines. The direction of movement of the ground water is perpendicular to the contour lines and down the slope of the water table. The shape and slope of the water table depend upon several factors. Generally speaking, the smaller the interconnected interstices of a saturated formation the lower the permeability and the greater must be the slope or gradient of the water table for a given quantity of water to be transmitted through the aquifer. Thus, other factors being equal, a steep water-table gradient indicates an aquifer of relatively low permeability, and a gentle gradient indicates an aquifer of relatively high permeability.

The slope of the water table is dependent, in part, upon the configuration of the surface of rocks of lower permeability beneath the aquifer. If valley fill is underlain by relatively impermeable bedrock, whose surface is essentially horizontal, the water table will tend to be flatter, and the zone of saturation thicker, than if the underlying bedrock has a considerable slope.

The relative altitudes of the water levels in wells in the drainage area of Estancia Valley show the general movement of ground water to be toward the playa area (see pl 3). Available information on water levels in wells indicates that there is no movement of ground water out of the valley; but data on water levels in wells in and beyond the southeastern part of the valley are sparse. However, if ground water moves southeastward out of the valley, the chloride content of the water should increase in that direction, as mineralization of the water increases by solution of the materials in the aquifers as it moves. Chemical analyses of water collected from wells around the edges of Estancia Valley show that the concentration of chloride increases only toward the center of the basin. Therefore, it is inferred that ground water does not move out of the valley to the southeast, and that the natural discharge of the ground water in Estancia Valley is entirely by evapotranspiration in the vicinity of the salt lakes.

Chemical analyses of samples of water taken at 3 depths from well 7.10.19.112 (table 16, Yeso) in the playa area show a decrease in the concentration of dissolved solids with an increase in depth. They indicate that the ground water is moving upward and are further evidence that the playas are the area of natural discharge for the ground water in Estancia Valley. Except for short periods after rains, surface water generally is not present on the playas. However, the material immediately beneath the surface of the playas is always moist. An observation well was dug to a depth of about 10 feet at a distance of about 200 feet west of the edge of the Laguna del Perro in sec. 11, T. 4 N., R. 9 E. The water in this well was under artesian pressure and rose in the well to a level about 10 feet above the surface of the lake. The artesian conditions in this well and the seepage of water during the winter from the western margins of the playa onto the playa surface indicate that the ground water is under pressure beneath the lake surface and discharges through the relatively impermeable lake beds at a rate that, on the average, is equal to the rate of evaporation from the playa surface.

The pan evaporation in Estancia Valley is probably between 65 and 76 inches per year (see p 12, 15). The evaporation from the playas is less than the pan evaporation. One reason is that the evaporation from a large water surface is less than that from a small pan. Another is that the ground water is salty and therefore evaporates more slowly at a given temperature than would fresh water. A possible third reason is that during a large part of the year a free water surface does not exist on the playas, and the water must be drawn up from the zone of saturation by capillarity before it can be evaporated. For purposes of estimation it is assumed that 50 inches per year of ground water evaporates from the playas. As the playa surfaces total about 12,000 acres, the annual natural discharge is about 50,000 acre-feet, exclusive of some transpiration by vegetation on the surrounding higher lands. As the total drainage area of Estancia Valley is about 2,000 square miles, an average recharge rate of about half an inch per year is indicated.

In any aquifer, pumping of wells constitutes a new discharge superimposed upon the natural equilibrium between recharge, movement, and discharge. At first, most of the water pumped is withdrawn from storage in the aquifer near the wells. If water continues to be taken from storage, water levels in the area will decline. In order for a new equilibrium to be established, recharge to the ground-water body must be increased, or natural discharge must be decreased, or both, in a total amount equal to the amount of water removed by pumping. Otherwise, water will be removed continuously from storage, and water levels will continue to decline.

DEVELOPMENT OF IRRIGATION

Numerous attempts have been made in the past to develop ground water for irrigation in Estancia Valley. Such attempts in the first decades of the present century were unsuccessful largely because of the poor efficiency of pumping equipment and because the attempts at development were restricted chiefly to the central part of the valley, where conditions were unfavorable for such development. The revival of interest in irrigation resulted in studies of ground water in the area by the office of the State Engineer of New Mexico, beginning in 1923 and extending through 1930. The results of these investigations have been published in the 6th, 7th, 8th, and 9th Biennial Reports of the State Engineer (New Mexico State Engineer, 1924, 1926, 1928, 1930).

Interest in the development of the ground-water resources of Estancia Valley again diminished in 1930, but revived in 1940. This renewed interest resulted in the program of observation of ground-water levels in Estancia Valley which began in 1941. The program has consisted largely of measuring water levels but has included also the obtaining of data on the wells that have been drilled. Estimates of the amount of land irrigated with ground water have also been made yearly. In spite of considerable interest in ground-water irrigation, little development occurred between 1941 and 1944, when about 200 acres was being irrigated and about 200 acre-feet of water was being used. The rate of development of irrigation is indicated by the following data.

YEAR	IRRIGATED AREA (acre)	WATER USED (acre-feet)
1944	200	200
1945	250	500
1946	725	1,000
1947	5,000	5,000
1948	6,000	5,400
1949	10,000	8,000
1950	19,000	19,000
1951	20,000	40,000
1952	22,000	33,000
1953	21,000	36,500
1954	23,000	33,000

In 1948 there were about 60 irrigation wells in the Torrance County portion of Estancia Valley and 10 wells in the Santa Fe County portion.

Figures for irrigated area except for 1952 are based on information provided by the County Agent of Torrance County. In 1952 a partial field check was made by personnel of the U. S. Geological Survey. Figures for water used were determined from data on the number of wells, length of pumping period, and average rate of pumping. In January 1950 the State Engineer of New Mexico declared Estancia Valley as a ground-water basin subject to control under the State law. In 1951 about 80 percent of the irrigated area in Estancia Valley was in Torrance County. It is estimated that this percentage holds for 1949, 1950, and the period 1952-1954.

FLUCTUATION OF WATER LEVEL

The Albuquerque office of the U. S. Geological Survey has made periodic measurements of water levels in selected wells in Estancia Valley since 1941, in cooperation with the New Mexico State Engineer. These data have been published annually in U. S. Geological Survey water-supply papers (1943-1945; 1947; 1949-a, b; 1951-a, b; 1952-1954). Water levels have been measured annually, usually in February, beginning with about 50 wells in 1941 and increasing to about 120 in 1952, as the development of irrigation wells increased. These annual measurements, when compared, show the net changes in ground-water level brought about by variations in pumping and recharge. In addition to the annual measurements, water levels have been measured periodically, generally every 3 months, in a number of wells, to determine the seasonal changes in the water table.

The fluctuations in water level since 1941 in five selected observation wells are shown in Figure 5. The characteristics of fluctuations of water levels depend upon conditions at and near each particular well. In well 7.8.27.221 the fluctuations of water level were minor in the first few years of record, and there was a small upward trend resulting from the heavy rains of 1941. The effects of installation of irrigation wells in the vicinity of the well are apparent beginning in 1946, as evidenced by the characteristic lowering of water level in the summer during the pumping season and rise in the winter, and a general overall downward trend. Well 4.8.24.222 is somewhat distant from irrigation wells, and the fluctuation of water level is minor, only long-term natural trends due to changes in recharge being evidenced. The water level in this well reached a peak level in 1948, about 7 years after the heavy rains of 1941. Generally the graphs exhibit the increased rate of decline of water levels resulting from the increase in pumping of ground water for irrigation.

From 1941 to 1952 the maximum decline in the water table in Estancia Valley, as indicated by water-level measurements in wells, was a little less than 13 feet. This decline was in the heavily pumped area about 7 miles southwest of Estancia. As shown in Figure 6, most of this decline was in the period from 1947 to 1952, after the heavy pumping began. Other heavily pumped areas that showed a relatively large decline from 1947 to 1952 are the area 3 miles north of Estancia, where there was a maximum decline of more than 8 feet, and the area 9 miles north of Estancia, where there was a maximum decline of more than 6 feet.

Figure 7 shows the net change in water levels in 1951, as determined by comparing water levels measured in wells in February 1951 with those in February 1952. The areas of maximum decline of water levels are generally the same as from 1947 to 1952. However, the decline in 1951 was greater than the average annual decline for the 5-year period, 1947 to 1952. This is the result of increasing development of irrigation. For instance, development which began in 1948 in the area about 4 miles north of Moriarty, and in 1949 in the area about 2 miles southwest of Willard, gradually has expanded.

A quantitative evaluation of the changes in water level as related to pumpage and the ground-water supply in Estancia Valley is beyond the scope of this report. However, in an area where the average annual recharge is estimated at 50,000 acre-feet and the natural discharge continues in like amount, not yet having been affected by pumping, the significance of pumping at an increasing rate that already is approaching the rate of recharge is obvious.

AVAILABILITY

The availability and character of ground water in the Estancia Valley area depend upon the aquifer. The Tertiary(?) and Quaternary valley fill is the principal aquifer that furnishes water for irrigation in most of Estancia Valley. The arkosic limestone member of the Madera limestone, the Glorieta sandstone member of the San Andres formation, and the Yeso formation also furnish water to irrigation wells in Estancia Valley. The Abo formation furnishes water to stock and domestic wells in the valley. An example of the relation of geologic units and the water table in Estancia Valley is shown by the cross-section from west of Manzano to east of Willard (see pl 2).

In the area in which ground water is obtained principally from the valley fill, the stock and domestic wells generally are not as deep as the irrigation wells. Water levels range from at or near the surface, in the central part of the valley, to more than 100 feet below the surface, in the irrigation wells near the west edge of the valley, and to more than 200 feet below the surface in the stock and domestic wells near the west edge.

The arkosic limestone member of the Madera limestone furnishes water to irrigation wells and to stock and domestic wells along the western border of Estancia Valley. The Glorieta sandstone member of the San Andres formation furnishes water to irrigation wells and to stock and domestic wells north and northeast of Cerrito del Lobo, and

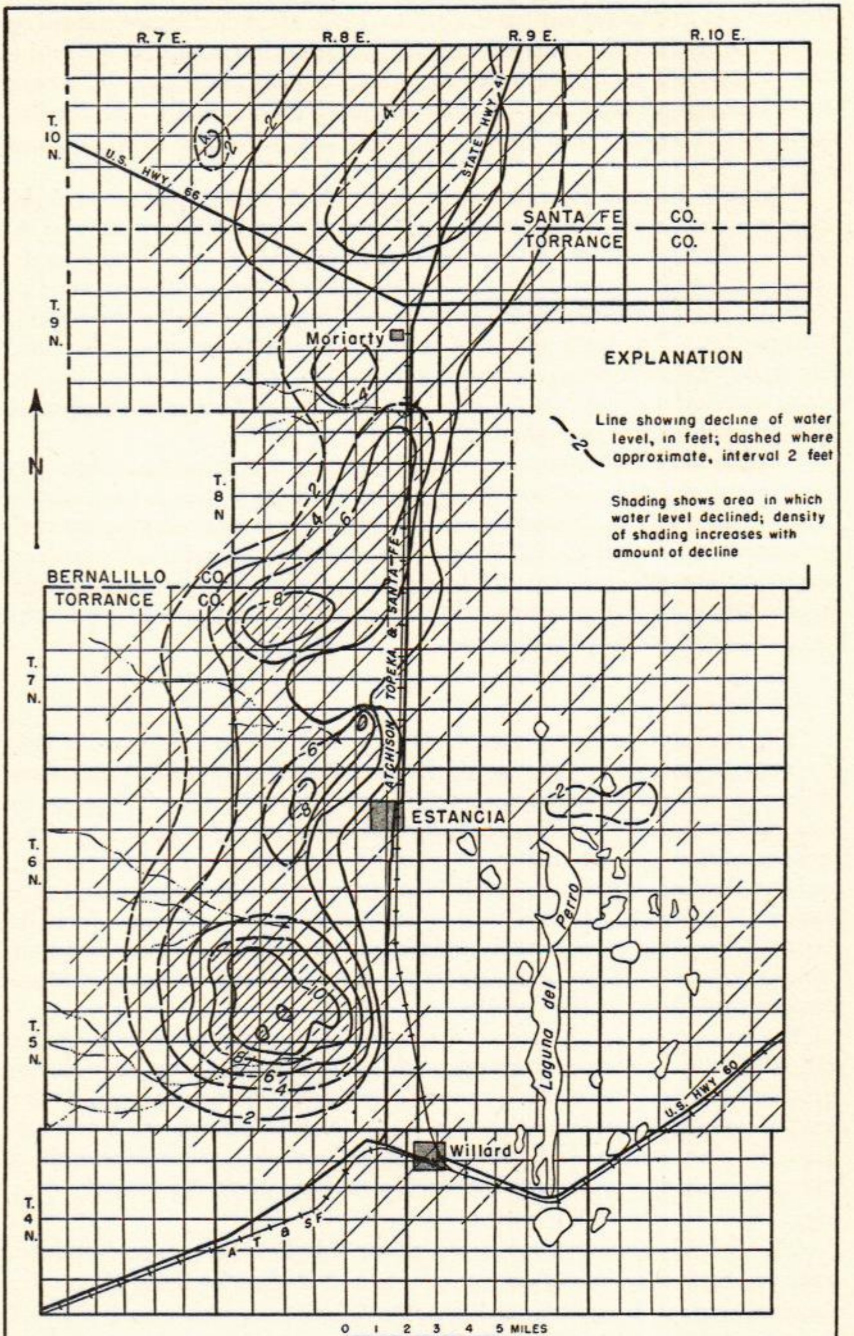

Figure 6

CHANGE IN GROUND-WATER LEVEL FROM FEBRUARY 1947 TO FEBRUARY 1952 IN ESTANCIA VALLEY, N. MEX.

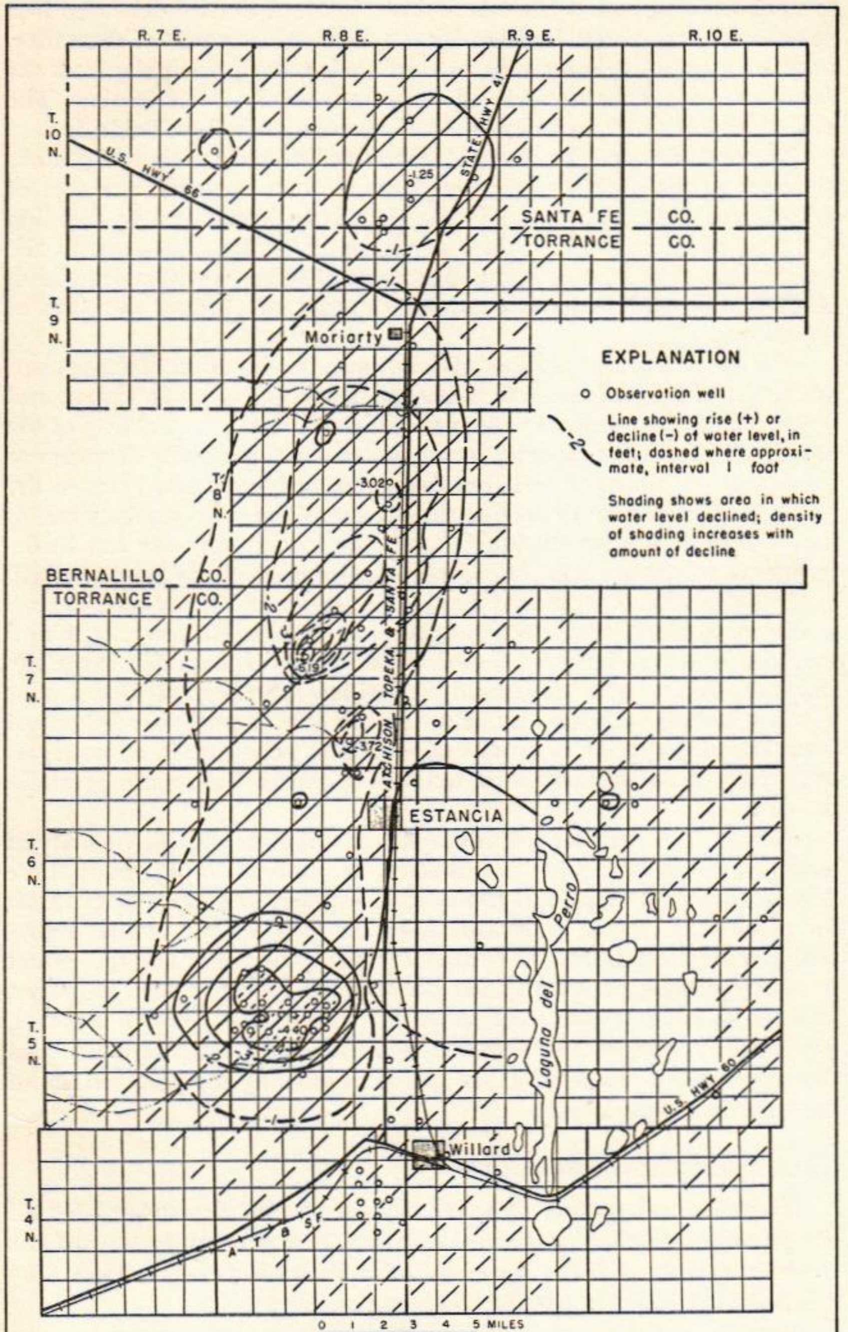

Figure 7

CHANGE IN GROUND-WATER LEVEL FROM FEBRUARY 1951 TO FEBRUARY 1952 IN ESTANCIA VALLEY, N. MEX.

to stock and domestic wells east and southeast of Cerrito del Lobo in a belt-shaped area about 5 miles wide. In the southwest part of the valley, north of Mountainair, wells that derive their water principally from the Abo formation have not proved to be satisfactory for irrigation. The availability of water in Estancia Valley is summarized in Table 5.

The specific capacity of a well is defined as the number of gallons of water per minute that can be pumped from the well, per foot of drawdown of the water level in the well. It is determined by dividing the yield of the well, in gallons per minute, by the drawdown of the well, in feet. A well being pumped at a rate of 500 gpm with a drawdown of 50 feet is said to have a specific capacity of 10 gpm per foot of drawdown.

The yield of a well per foot of drawdown is a function of many characteristics of the well, such as diameter, depth, openings in casing, and degree of development, as well as the thickness and permeability of the aquifer. The specific capacity is not constant but generally decreases as the length of time the well has been pumped increases, because the water level continues to decline slowly, though at a decreasing rate, as the cone of depression expands. A reliable specific capacity can be determined only when a fairly constant pumping level has been reached.

Little has been published concerning the relation between permeability of aquifers and specific capacities of wells. However, it is well established that in fully developed wells high average specific capacities indicate a highly permeable aquifer, and low specific capacities, a poor aquifer. Therefore, some idea of the nature of an aquifer can be gained from knowing specific capacities of wells that penetrate it. Some representative specific capacities of wells in Estancia Valley are given in Table 5.

Most of the available information regarding the specific capacity of wells in Torrance County is restricted to Estancia Valley; even there data are limited. Although the specific capacity has been determined for many wells in the valley, many of the data are not strictly representative or comparable, as neither the pumping times nor the extent to which pumping levels had become stabilized were known. However, as most of the drawdown of water level in a well while it is being pumped generally occurs within a relatively short time, it is believed the values given in the table are useful in showing the productivity of the wells in a general way.

CHEMICAL QUALITY AND USE

The chemical quality of water from wells was determined for all the principal aquifers in Estancia Valley. The general pattern of the chemical quality of the water in Estancia Valley is shown in Plate 3 by means of lines of equal specific conductance (see p 27).

Because of the range in the mineral content of the ground water, the size of the valley, the importance of ground water to the economy

TABLE 5. AVAILABILITY OF GROUND WATER IN ESTANCIA VALLEY, TORRANCE AND SOUTHERN SANTA FE COUNTIES, N. MEX.

AQUIFER	USE OF WATER*	RANGE IN DEPTH (feet)	NUMBER OF WELLS†	RANGE IN DEPTH TO WATER (feet)	NUMBER OF WELLS†	SPECIFIC CAPACITY (gpm per foot of drawdown)	REPORTED RANGE IN DEPTH TO TOP OF WATER-BEARING BEDS (feet)
Quaternary and Tertiary(?) valley fill	I	75-695	85	0-135	94	25 after 2½ hours for well 5.8.5.344; average 20± in 4 wells north of Moriarty	10-335
		100-300	65				
	S, D	10-445	63	0-227	83	Average 25± for 40 wells, Moriarty-Estancia Average 30± for 3 wells, 6± miles east of Estancia Average 40± for 22 wells, Estancia-Willard Average 40± for 4 wells southwest of Willard	
		<200	58				
Glorieta sandstone member of San Andres formation	I	165-309	5	35-65	5	80 for well 9.9.11.341 250 - well 10.8.35.411 500 - well 10.8.32.211 Pumping time unknown	60-200
	S, D	46-250	11	43-188	11		
Yeso formation	I	280-288	2	24-34	3	No data available	135-312, southern Torrance County; 160-305, irrigation wells south of Cerrito del Lobo; 343, well 7.11.9.120
	S, D	165-343	13	93-315	13		
Abo formation	S, D	10 to ca. 300	11	5-242	11	No data available	10-324
				<140	10		
Arkosic limestone member of the Madera limestone	I	160-272	9	50-172	9	65 after 10 hours for well 8.8.28.311	60-240
		200-230	5				
	S, D	93-385	14	67-346	14	50-170 for 4 wells, pumping time unknown	
		<280	12	<200	11		

* D, domestic; I, irrigation; S, stock.

† Figures indicate number of wells within the particular depth range.

of the valley, and the number of wells for which the water has been analyzed chemically, Estancia Valley has been divided into subareas, as shown in Table 6, according to the chemical quality of the water.

The chemical quality of ground water from the Tertiary(?) and Quaternary valley fill of Estancia Valley differs considerably with the locality. In general, as the ground water moves from the outer edges of the valley to the playa area, the mineral content becomes progressively higher. In the stretch from Estancia to Willard, a distance of about 4 miles, the mineral content of the ground water increases markedly eastward, from a specific conductance (see p 27) of about 500 micromhos, near the highway, to more than 4,000 micromhos, near the playas. (See p13.)

The water is much better chemically in the western part of Tps. 4, 5, and 6 N. in Estancia Valley than in the eastern part. The same is true in Tps. 7, 8, 9, and 10 N., but in these townships the division between the water of comparatively good quality, to the west, and the water of poorer quality, to the east, is not so distinct. Just north of the county line, in Santa Fe County, the chemical quality of the water from the valley fill of Estancia Valley is better in the northern part of T. 10 N., R. 9 E., than in the southern part.

Repeat analyses have been made of waters from 22 wells in Estancia Valley after intervals ranging from 1 to 6 years, in order to determine any changes in mineral content. In most of these wells the mineral content of the second sample of water showed little or no change from that of the first sample. A significant decrease in the mineral content of the water occurred, however, in the second sample from 4 of the wells, and an increase occurred in the water from 4 of the wells. Additional chemical analyses of the water from these wells are needed to establish any definite trend in the mineral content of the water from the valley fill. Comparative analyses of the water from these 21 wells are given in Table 7.

The use of the water from wells in Estancia Valley for which information was obtained is given according to the aquifer in Table 8; it is apparent that irrigation is the most important use in this valley.

The suitability of water for irrigation depends in part upon the chemical quality of the water. Use of water high in dissolved solids, or in which the percent sodium is high, is most likely to cause difficulty, but many other factors are involved, such as the nature of the soil and subsoil, method of application of water, and the type of crops grown. Waters containing several thousand parts per million of dissolved solids sometimes are successfully used for irrigation, where irrigation practices permit the application of large volumes of water on well-drained lands. Percent sodium (table 16) is reported in most of the analyses of waters used for irrigation and is the ratio of sodium to the total of the principal dissolved basic constituents (sodium, potassium, calcium, and magnesium), all expressed in equivalents per million, times 100. The percent sodium is important when water is used for irrigation, because

TABLE 6. CHEMICAL ANALYSES OF WATER FROM WELLS IN ESTANCIA VALLEY, TORRANCE AND SOUTHERN SANTA FE COUNTIES, N. MEX.*

(In parts per million)

AQUIFER AND LOCATION	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS	USABILITY†
Quaternary and Tertiary(?) valley fill: Tps. 2 and 3 N. Wells 3.9.3.122 and 3.9.5.424 (valley fill probable aquifer)	1,720-2,080 (2)	44-288 (2)	162-180 (2)	0.9-1.2 (2)	1,960-2,480 (2)	2,570-3,530 (2)	S
T. 4 N., R. 8 E., and Willard	32-110 (2)	14-23 (6)	14-22 (2)	0.4 (1)	160-265 (2)	238-370 (2)	H, D, I, S
T. 4. N., Rs. 9 and 10 E., except Willard	1,400-1,660 (2)	193-1,140 (4)	125-213 (2)	0.8-0.9 (2)	1,220-2,070 (2)	3,110-3,910 (2)	S
T. 5 N., Rs. 7 and 8 E., T. 6 N., R. 8 E., and wells 5.9.6.-311, 5.9.18.400, and 5.9.18.424	14-130 (17)	3-76 (30)	9.5-41 (17)	0.2-1.2 (16)	174-309 (16)	207-419 (16)	H, D, I, S
T. 5 N., R. 10 E.; T. 6 N., Rs. 9 and 10 E.	462-3,220 (9)	72-3,220 (18)	69-483 (9)	0.9-3.0 (8)	725-3,400 (9)	1,160-6,170 (9)	H (undesirable to unusable), I (doubtful to unsuitable), S
Tps. 7 and 8 N., R. 8 E.	22-220 (12)	10-92 (22)	11-41 (12)	0.2-1.4 (14)	178-448 (12)	322-635 (12)	H, D, I, S
Tps. 7 and 8 N., R. 9 E.	57-2,510 (16)	26-980 (20) 4,900 (1)	24-278 (16)	0.4-1.8 (11) 3.6 (1)	292-2,620 (16)	383-5,390 (16)	Satisfactory to unsatisfactory for H, D, I: satisfactory for S
Tps. 9 and 10 N., Rs. 7 and 8 E.	19-244 (14)	20-102 (19) 304 (1)	11-66 (14)	0-0.8 (12)	207-706 (14)	261-970 (14)	H, D (most uses), I, S

TABLE 6. CHEMICAL ANALYSES OF WATER FROM WELLS IN ESTANCIA VALLEY, TORRANCE AND SOUTHERN SANTA FE COUNTIES, N. MEX. (*continued*)

(In parts per million)

AQUIFER AND LOCATION	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCo_3$	DISSOLVED SOLIDS	USABILITY†
Tps. 9 and 10 N., R. 9 E.	111-1,380 (9)	10-436 (10)	17-114 (9)	0.5-2.1 (10)	230-1,620 (9)	354-2,710 (9)	Satisfactory to unsatisfactory for H, D, I: satisfactory for S
Glorieta sandstone member of the San Andres formation (Psgl, 2)	258-2,300 (6)	38-558 (6)	16-350 (5)	0.1-2.0 (4)	226-3,190 (6)	592-5,270 (5)	H and D (usable to unsatisfactory), I, S
Yeso formation:							
East of Mountainair (Py2)	17-26 (3)	7-10 (3)	13-21 (3)	0.2-0.8 (3)	161-182 (3)	220-236 (3)	H, D, I, S
Other areas (Py3, 4, 5)	789-3,230 (7)	20-5,260 (7)	13-1,350 (7)	0.5-1.8 (6) 3.8 (1)	158-8,370 (7)	2,030-12,300 (7)	I (undesirable to unsatisfactory), S
Abo formation (Pal)	11-164 (3)	6-53 (5)	10-32 (3)	0.2-0.6 (3)	200-351 (3)	258-504 (3)	H, D, I, S
Arkosic limestone member of the Madera limestone (Pm):							
Known to be the aquifer	9.1-40 (2)	14-23 (3)	16-21 (2)	1 (1)	184-253 (2)	273-347 (2)	H, D, I, S
Probably the aquifer	26-37 (5)	8-25 (8)	13-31 (5)	0 (4)	267-634 (5)	307-670 (5)	H, D, I, S

* Figures in parentheses represent the number of wells sampled.

† H, drinking; D, other domestic use; I, irrigation; S, stock.

TABLE 7. ANALYSES, AT DIFFERENT TIMES, OF WATER FROM WELLS IN ESTANCIA VALLEY, TORRANCE AND SOUTHERN SANTA FE COUNTIES, N. MEX.

(In parts per million, except as noted)

WELL LOCATION NUMBER*	DEPTH OF WELL (feet)	COLLECTION DATE	SPECIFIC CONDUCTANCE	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS
4.8.13.133	225	8-18-49	629	110	23	22	265	370
		8-31-50	640	—	21	—	—	—
4.9.11.312	20-	7-23-45	4,390	1,400	580	213	1,220	3,110
		3-16-51	4,440	—	592	—	—	—
5.8.15.131	125	9-6-45	379	16	5	12	179	209
		8-16-50	380	—	—	—	—	—
5.8.17.113	148	9-5-46	369	15	4.5	9.5	174	207
		8-29-50	380	—	6	—	—	—
5.8.17.323	135	9-21-44	530	34	41	13	240	288
		8-29-50	619	32	76	16	290	350
5.8.24.311	200	5-13-46	416	29	6	14	190	233
		8-16-50	413	—	9	—	—	—
5.9.6.311	53	1-5-51	553	—	11	—	—	—
		8-7-52	559	—	10	—	—	—
6.8.11.420	75	9-21-44	553	21	11	16	266	313
		7-8-50	541	25	10	—	—	—
6.10.5.300†	—	9-2-48	3,290	1,180	385	138	1,450	2,410
		4-26-50	3,010	948	380	149	1,300	2,130
6.10.7.112	—	7-25-45	2,370	686	302	94	933	1,620
		8-17-50	2,360	—	285	—	—	—
7.8.1.423	103	5-15-46	1,040	220	72	41	448	635
		8-16-50	922	—	74	—	—	—
7.8.9.431‡	297	5-19-48	683	27	10	14	342	417
		8-16-50	728	—	13	—	—	—
7.8.24.431	275	8-11-48	638	—	15	—	—	—
		8-16-50	652	—	29	—	—	—
7.8.34.222	129	8-11-48	537	22	13	11	227	322
		8-16-50	545	—	16	—	—	—
7.8.35.220	—	8-18-50	776	38	92	22	258	420
		3-23-53	599	—	23	—	—	—
8.8.12.212	180	8-11-48	623	25	26	16	296	361
		8-17-50	619	—	32	—	—	—
8.8.24.131	187	5-20-48	582	24	18	20	266	354
		8-17-50	600	—	20	—	—	—
8.8.26.222	20	9-6-46	849	65	38	23	309	513
		8-24-50	800	—	31	—	—	—
10.8.35.411	270	8-11-48	1,350	372	92	50	607	916
		8-30-50	1,360	—	97	—	—	—
10.8.36.111§	309	3-7-48	1,260	349	88	—	518	—
		8-30-50	1,290	—	92	—	—	—
10.9.18.131	192	8-11-48	565	111	13	26	246	354
		8-29-50	834	213	41	38	378	542
10.9.21.431	101	5-15-46	1,430	479	62	54	564	900
		8-31-50	1,720	612	130	71	736	1,210

* Aquifer in valley fill, except as noted.
† Aquifer uncertain.
‡ Aquifer: Madera limestone.
§ Aquifer: Glorieta sandstone member of San Andres formation.

water in which it is more than about 60 may react with the soil, making it less pervious to water and difficult to till. None of the water samples obtained from the main irrigated areas in Torrance County were found to contain as much as 60 percent sodium; however, water east of the main area of irrigation, in the vicinity of the playas, contains more than 60 percent sodium.

MANZANO MOUNTAINS AREA

The most prominent topographic feature in Torrance County is the Manzano Mountains, which form a north-south ridge about 30 miles long and coincide roughly with the western county line for most of that distance. From the crest of the range short, steep-gradient canyons drain westward to the alluvial fans of the Rio Grande valley. On the east side of the range slopes are much gentler than on the west side, and the land surface is cut by rather long, straight shallow valleys. A few low foothills lie to the east of the main part of the Manzano Mountains, but, in general, the mountains area merges gradually with the very gently sloping western part of Estancia Valley. The mountains have an average width of about 5-6 miles. On the south the Manzano Mountains are separated from the Los Pilios Mountains by Abo Canyon. On the north they merge into the lower Manzanita Mountains, which in turn are separated from the Sandia Mountains by Tijeras Canyon. Abo Canyon and its drainage tributaries, and the area of outcrop of the Magdalena group east of the Manzano Mountains (see geologic map, pl 1), are considered part of the Manzano Mountains in this report.

The altitude of the crest of most of the Manzano Mountains south of Capilla Peak is above 9,000 feet. The crest of the northern part of the mountains is between 8,000 and 9,000 feet along most of its length.

GEOLOGY

The highest part of the Manzano Mountains south of Capilla Peak consists largely of Precambrian quartzite, and some schist and granite at the southern end, near Abo Pass. The Sandia formation crops out in a narrow belt on the middle slopes of the mountains south of Capilla Peak, and the Madera limestone crops out on the lower slopes. From Capilla Peak northward the Madera limestone crops out on the crest and the east slope of the Manzano Mountains and is underlain by the Sandia formation, which lies directly upon the Precambrian rocks. The arkosic limestone member of the Madera limestone is exposed over most of the area in which the Madera limestone crops out. The arkosic limestone member ranges from about 500 to 850 feet in thickness in the Manzano Mountains area and consists of alternations of red or brown arkosic sandstone, arkosic limestone, gray limestone, and shale. The variation in the rocks that may be encountered in drilling a well into the arkosic limestone member is illustrated by the sections given on pages 25 and 26.

TABLE 8. USE AND SOURCE OF WATER FROM WELLS IN ESTANCIA VALLEY, TORRANCE AND SOUTHERN SANTA FE COUNTIES, N. MEX.

(Number of wells)

PROBABLE AQUIFER*	QTvf	QTvf or Pa	₽ma	Psg	Psg or Py	Py	Pa	TOTAL
USE								
Irrigation	100	—	10	5	—	3	—	118
Proposed irrigation	16	—	1	—	—	—	—	17
Abandoned or unused irrigation	4	—	—	—	—	—	1	5
Stock	46	—	4	6	1	7	2	66
Abandoned or unused stock	5	—	1	1	—	—	—	7
Domestic	17†	1	2	1	—	—	1	22
Abandoned domestic	2	—	—	—	—	—	—	2
Stock and domestic	22	2	9	2	—	7	9	51
Abandoned stock and domestic	3	—	1	—	—	—	1	5
Abandoned or unused	35	1	1	3	—	1	6	47
Other	3‡	—	—	—	—	4§	—	7
TOTAL	253	4	29	18	1	22	20	347

* Aquifer:
- QTvf — Quaternary and Tertiary(?) valley fill
- ₽ma — Arkosic limestone member of Madera limestone.
- Psg — Glorieta sandstone member of San Andres formation
- Py — Yeso formation
- Pa — Abo formation

† Includes a school well.

‡ Railroad well, municipal well, and industrial well.

§ Includes 3 municipal wells (2 abandoned).

Abo Canyon and its tributaries cut through rocks of the Abo and Yeso formations. The Abo formation, 810 feet thick in Abo Canyon (see p 29), consists of red shale and sandstone and some arkose and conglomerate. The Abo formation crops out over about 35 square miles of the canyon area within the county. The Yeso formation, nearly 700 feet thick in the area, consists largely of red sandstone, gypsum, gray limestone, and some shale. The Yeso formation crops out in about 80 square miles of the canyon area within the county.

PRINCIPAL AQUIFERS

The arkosic limestone member of the Madera limestone is the aquifer yielding water to all the wells for which data were obtained in the Manzano Mountains proper and the area included to the east. As far as is known, no wells in the Manzano Mountains derive their water from the Sandia formation or from Precambrian rocks.

The Abo formation is the aquifer (see pl 2) in most of the northern part of the drainage basin of Abo Canyon, and the Yeso formation is the aquifer in most of the southern part. The well log given below, modified from a log obtained from the Atchison, Topeka & Santa Fe Railway, indicates the character of the rocks penetrated in a well drilled at the town of Abo, in sec. 28, T. 3 N., R. 6 E. The well started in the Yeso formation and was drilled into the Abo formation, but the position of the contact between the two formations is not evident from the log.

LOG OF WELL 3.6.28 IN THE YESO AND ABO FORMATIONS AT THE TOWN OF ABO IN SOUTHWESTERN TORRANCE COUNTY

Material	Thickness (feet)	Depth (feet)
Surface	45	45
Clay, red; nonpumping water level 50 feet; first water at 135, rose to 50	90	135
Sandstone, red; second water at 384, rose to 25	260	395
Clay, red	10	405
Sandstone, red	65	470
Clay, red	50	520
Sandstone, gray	7	527
Clay, red	13	540
Sandstone, red	103	643
Clay, red	168	811
Sandstone, red	129	940
Sandstone, gray	25	965
Sandstone, red; salt water at 990	25	990
Shale, red	70	1,060
Sand, red; salt water at 1,080	20	1,080

RECHARGE

The average annual precipitation at the Rea ranch (altitude 9,200 feet) on the east slope of the Manzano Mountains, near Tajique, was 26.20 inches in the period 1910-1919. The average annual precipitation at Tajique (altitude 7,100 feet) is 19.54 inches. The average annual precipitation on the east slope of the Manzano Mountains is probably between these figures. Although, on the average, approximately two-thirds of the annual precipitation in the Manzano Mountains occurs in the period April-September, it is probable that most of the recharge to the ground-water bodies in the area occurs during the winter and early spring months. This is because the evapotranspiration rate is great in the summer months, and only exceptional rains can be expected to furnish recharge to the ground water at that time of year. The average evaporation rate for the period October-March is about 25 percent of the average annual rate, and the October-March transpiration rate probably is only a fraction of the annual transpiration rate. Thus, because of lower evapotranspiration rate and the lower rate of runoff which results from the slow melting of snow, a larger percentage of the precipitation, in the form of snow melt, probably reaches the groundwater body during October to March than during March to October, even though precipitation is greater in the summer.

During the warmer months of the year, when precipitation is in the form of rainfall, the forest cover on the mountains helps to retard runoff and allows more of the water to sink into the soil. If the precipitation has been heavy, some of the water may run into arroyos and reach Estancia Valley on the east side of the Manzano Mountains. However, most of the flow of the arroyos sinks into the ground or is lost by evaporation before reaching the center of the valley. During periods of unusually heavy rainfall some of the runoff from the Manzano Mountains reaches the salt-lake basins in Estancia Valley, where it remains on the surface until evaporated. At the south end of the Manzano Mountains, excess surface water moves into Abo Canyon and thence out of the county into the Rio Grande valley. There, also, a large part of the precipitation returns to the atmosphere by evapotranspiration, and only a small fraction of it enters the ground-water body.

MOVEMENT AND DISCHARGE

In the high southern part of the Manzano Mountains, in the outcrop area of the Precambrian rocks, ground water moves through openings in the mantle rock and through fractures in the dense underlying rocks. In the northern part of the Manzano Mountains, ground water moves through the crevices and solution channels of the Madera limestone. Such crevices and solution channels in the Madera limestone are visible in caves (which themselves are solution channels) and road cuts in the area where the Madera limestone crops out, and are reported by well drillers to exist in the limestone in the subsurface.

There are numerous intermittent springs and a few permanent springs in the mountains (table 15). These springs occur where relatively impervious beds locally prevent or restrict further downward subsurface movement of the water, and deflect the water to the surface. The portion of this discharge that does not return to the amosphere by evapotranspiration reenters the rocks downslope. Ground water in the mountain areas moves eastward through the Pennsylvanian rocks, and in the Estancia Valley it moves laterally or upward into the valley fill, whence it is discharged artificially by wells or naturally by transpiration and by evaporation from the playa basins. At the south end of the Manzano Mountains, some ground water moves westward out of the county through the channel alluvium in Abo Canyon.

In its movement from the mountains to the valley the ground water passes between impervious beds of varying extent, which confine the water under hydrostatic pressure. Data from wells in the Manzano Mountains area are insufficient to determine the extent of artesian conditions, but some artesian pressure may be expected locally in wells that penetrate the main zone of saturation.

AVAILABILITY

There are numerous springs in the Manzano Mountains area, but most of them do not flow during dry periods. Water wells for which data were obtained in the mountains and adjoining area are as deep as 450 feet (well 10.7.30.321, just north of the Torrance County line). Water levels in this area ranged from 6 feet below the surface, in well 6.5.25.344, to 412 feet below the surface, in well 10.7.30.321. In the Manzano Mountains area most of the dug wells and many of the drilled wells in the Madera limestone obtain water from perched water bodies above the main zone of saturation. Several examples of such dug wells are in sec. 36, T. 7 N., R. 6 E. The quantity of water that can be obtained from the perched bodies usually is not more than 3 or 4 gallons per minute, and some of these wells go dry at times. Water wells that reach the main body of ground water are reported to obtain supplies of water adequate for stock and domestic use. In drilling wells for stock and domestic use in the Manzano Mountains area, it is important to drill below the top of the main ground-water body, the altitude of which is indicated by the contours of the water level on Plate 2.

Wells 6.6.11.334 and 6.6.13.210 were reported to yield at least 20 gpm, the capacity of the small pumps on the wells. Although irrigation wells are not known in the Manzano Mountains area, some irrigation wells near the western edge of Estancia Valley derive most of their water from the arkosic limestone member of the Madera limestone (see p 47). It is possible that a well drilled in the Manzano Mountains area might encounter crevices and solution channels in the arkosic limestone member and might produce a large initial yield. However, depending on the location of the well with respect to sources of recharge, the yield might decline appreciably within a few years.

In the Abo Canyon area, water from wells is commonly somewhat high in sulfate and therefore not desirable for domestic use. Conditions are generally unfavorable for a sufficient supply of ground water for irrigation. A well (see log, p 66) drilled in 1907 for the Atchison, Topeka & Santa Fe Railway, at Abo, N. Mex., was test-pumped at 8 gpm and then abandoned. In this well a water-bearing zone was penetrated at a depth of 135 feet in the Yeso formation, and the water rose to within 50 feet of the surface. At 384 feet another water-bearing horizon was encountered, which was probably in the Abo formation. At this horizon the water rose to within 25 feet of the surface. Salt-water aquifers at 990 and 1,080 feet probably were in the Abo formation.

CHEMICAL QUALITY AND USE

Chemical analyses of water from wells on the east slope of the Manzano Mountains indicate that the ground water is suitable for stock and irrigation use. Although these waters are considered hard, they can be used satisfactorily for ordinary domestic use. In the Abo Canyon area the chemical analyses of water from four wells indicate that the ground water is suitable for stock; although it is generally not desirable for domestic use, it is used for that purpose. The chemical quality of the water from well 3.6.29.243 was better than that of water from the other three wells in the Abo Canyon area, probably indicating that the water from this well had passed through less gypsum of the Yeso formation. Generally, wells that obtain water from the Yeso formation, where the water has moved an appreciable distance through several gypsiferous beds in the formation, yield water undesirable for drinking. The analyses of the water from wells in the Manzano Mountains area are summarized in Table 9.

Water from nearly all wells for which data were obtained in the Manzano Mountains is used for stock or domestic purposes, or both. Well 6.6.11.334 was used for water supply at a sawmill but has since been purchased by the town of Tajique for the community water supply. No irrigation wells are known in the Manzano Mountains area.

PEDERNAL HILLS AND EASTERN UPLANDS

The Pedernal Hills and eastern uplands, an area of mountains, hills, low, rounded ridges, and plateaus, lie in the eastern half of Torrance County and surround Encino and Pinos Wells basins. (See fig 4.) The western limit of the area coincides with the western limits of the outcrop of Precambrian igneous and metamorphic rocks which form Cerrito del Lobo and the Pedernal Hills. Between Cerrito del Lobo and the Pedernal Hills is a strip of land about 12 miles wide underlain by sedimentary rock. This strip of land is a part of Estancia Valley. Cerrito del Lobo and the Pedernal Hills are more resistant to erosion and are consequently higher than the surrounding area. The Pedernal Hills form the principal drainage divide between Estancia Valley and the eastern part of Torrance County. Cerrito del Lobo is about 7 miles from north to south and averages more than 2 miles from east to west, and projects above the gently sloping floor of Estancia Valley as a low dome. The Pedernal Hills range in altitude from about 7,200 feet to about 7,600 feet and are characterized by rather gentle slopes, except in the crest areas, where local relief is moderate. The western and southern margins of the Pedernal Hills grade into the nearly flat surface of Estancia Valley. The Pedernal Hills extend about 30 miles in a north-south direction and are as much as 10 miles wide.

The eastern uplands of Torrance County include the area east of the Pedernal Hills, exclusive of Encino and Pinos Wells basins. A wide

TABLE 9. CHEMICAL ANALYSES OF WATER FROM WELLS IN THE MANZANO MOUNTAINS AREA*

(In parts per million)

LOCATION	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS	USABILITY†
Manzano Mountains	9.7-37 (9)	5-22 (9)	4-24 (9)	0.1-0.4 (8) 3.2 (1)	208-445 (8)	259-514 (9)	H,D (most uses), I, S
Abo Canyon (3)	1,640-2,000	10-26	92-205	0.4-1.2	1,860-2,220	2,440-2,890	D (undesirable but used), S
Well 3.6.29.243, Abo	216	9	34	0.4	420	536	H, D (most uses), I, S

* Figures in parentheses represent the number of samples analyzed.
† H, drinking; D, other domestic uses; I, irrigation; S, stock.

variety of topographic forms is exhibited in the eastern uplands, controlled in part by the type of rock exposed or just beneath the surface. Much of the southeastern part is distinctive for its many solutional depressions. In the east-central and northeastern parts of the uplands, unconsolidated sands and gravels give rise to almost flat or gently rolling surfaces.

Isolated steep-walled mesas and buttes rise above the upland surfaces in many places, and the northern half of the uplands is dissected by Pintada Canyon and its tributaries — steep-sided valleys that have been cut, in some places, several hundred feet into the upland. The higher portions of these valleys, some of which head in the Pedernal Hills, are broad and open.

GEOLOGY

Cerrito del Lobo and the Pedernal Hills consist of Precambrian igneous and metamorphic rocks which are overlapped by the valley fill of Estancia Valley on the west and by Permian beds on the east. Cerrito del Lobo and the Pedernal Hills north of Negra consist of quartzite, in part schistose. Cerrito del Lobo and Pedernal Mountain are white quartzite. South of Pedernal Mountain the quartzite is mostly red, but near Negra it is black. The Pedernal Hills southwest of Negra are made up of quartzite, granite, gneiss, diorite, and other crystalline rocks (Darton, 1928-b, p 283). Rattlesnake Hill consists of black amphibolite, and Cerro del Pino is made up of coarse-grained massive granite, in part gneissic.

In the eastern uplands the Yeso formation, the Glorieta sandstone member of the San Andres formation, the limestone and upper clastic members of the San Andres formation, the Dockum group, and the upland deposits of sand, silt, and gravel crop out. The Ogallala formation, the stream gravels, and the caliche developed in numerous places in most of the formations were not mapped separately, nor have all their exposures been shown on the map.

Along the eastern edge of the Pedernal Hills the Yeso formation thins out against the igneous and metamorphic rocks, but to the east it overlies the Abo formation. The Yeso formation immediately underlies about a third of the area of the eastern uplands. Not all the Yeso formation is exposed in the eastern uplands area of Torrance County, and logs of wells penetrating the entire formation are not available. However, in the Gallinas Mountains the Yeso formation is about 1,000 feet thick, and the log of a well in San Miguel County indicates a thickness of about 600 feet. To the north and east of the outcrop of the Yeso formation are narrower outcrop belts of the Glorieta sandstone member and the limestone member of the San Andres formation. The Dockum group crops out only in the northern and northeastern parts of the eastern uplands. East of the Pedernal Hills the sedimentary rocks dip gently to the east and southeast. Igneous and metamorphic rocks crop out in the eastern uplands in the southeast part of the county east of Varney (Chameleon Hill), northeast of Torrance, and between Duran and Vaughn.

PRINCIPAL AQUIFERS

The principal aquifers of the Pedernal Hills and eastern uplands are the Precambrian rocks, the Abo formation, the Yeso formation, the Glorieta sandstone member of the San Andres formation, and beds of the Dockum group.

The Precambrian igneous and metamorphic rocks are the aquifer in the Pedernal Hills, which cover an area of about 200 square miles, and in about 25 square miles of the eastern uplands. The log (see p 8283) of a well near Negra illustrates the general type of rock that may be encountered and conditions that may be expected in drilling in the Pedernal Hills area.

The Abo formation probably is the principal water-bearing formation over about 35 square miles of the eastern uplands of Torrance County near Clines Corners. The Abo formation, which consists largely of red shale and sandstone, is about 300 feet thick in a well northeast of Clines Corners. In the vicinity of Clines Corners the lower part of the Abo consists of reworked crystalline rock. The Abo does not crop out in eastern Torrance County. The log of a well at Clines Corners, in which the aquifer is arkosic material of the Abo formation, is given below. This well was drilled in 1945 to 1,038 feet; it was deepened in 1950 to 1,301 feet, when the water level in the well was reported to be 899 feet below the surface.

DRILLER'S LOG OF WELL 9.12.16.213, AT CLINES CORNERS

Material	Thickness (feet)	Depth (feet)
Upper elastic member and limestone member of the San Andres formation		
Soil	2	2
Caliche	63	65
Gravel, stream bed	38	103
Sand, yellow, and limestone	72	175
Glorieta sandstone member of the San Andres formation		
Sandstone	42	217
Limestone, gray	14	231
Sandstone	62	293
Sand, yellow, clay and gravel	8	301
Sandstone	33	334
Clay, yellow, sand and gravel	12	346
Sandstone	24	370
Clay, yellow, sand and gravel	25	395
Sandstone	15	410
Sand, yellow, clay and gravel	20	430
Sandstone	37	467
Yeso formation and Abo formation (upper part), undifferentiated		
Conglomerate	20	487
Clay, yellow, sand and gravel	17	504

DRILLER'S LOG OF WELL 9.12.16.213, AT CLINES CORNERS (CONTINUED)

Material	Thickness (feet)	Depth (feet)
Yeso formation and Abo formation (upper part), undifferentiated — *continued*		
Limestone, gray	66	570
Limestone, sandy	15	585
Red beds, mostly clays	40	625
Shales and limes, grays, alternating beds, red beds	275	900
"Gravel"; water, small quantity	14	914
Limestone, gray, interbedded with shales	15	929
Sand, white to gray; water	9	938
Limestone, gray	72	1,010
Sand, white; water	28	1,038
Sand, white	38	1,076
Shale, blue	6	1,082
Lime, white	50	1,132
Sand, red, and rock, red	26	1,158
Lime, white	6	1,164
Sand, white	5	1,169
Sand, red	5	1,174
Shale, sandy, red	6	1,180
Lime, sandy	2	1,182
Rock, red, and shale	10	1,192
Rock, red	10	1,202
Lime, white, hard	6	1,208
Rock, red	7	1,215
Sand, red; water	6	1,221
Abo formation (lower part)		
Granite wash, red	25	1,246
Granite, red, hard	9	1,255
Granite wash, black and gray	10	1,265
Granite, red, hard	13	1,278
Granite wash, black	3	1,281
Granite wash, gray; water	12	1,293
Granite wash, red	8	1,301

The Yeso formation, which crops out over about a third of the eastern uplands, is the principal water-bearing formation over about 650 square miles, or about 90 percent, of the area. Wells near the northeast corner of the county that obtain no water, or insufficient water, in the Dockum group apparently tap the main zone of saturation in the Yeso formation. Near the Chameleon Hills, in wells 1.14.19.310 and 1.14.30.144, water is derived from the beds of reworked Precambrian rocks in the Yeso formation. A Southern Pacific Railroad well at Varney obtains water from the Yeso formation. Its log is given below. This well was completed in 1904 and was test-pumped at 70 gpm.

The Glorieta sandstone member of the San Andres formation is the principal aquifer east of Corona along part of the southern county line and south into Lincoln County (wells 1.13.35.432 and 1S.13.14.143). This member is about 200 feet thick in the eastern uplands.

Little information was obtained for wells deriving water from the Dockum group in Torrance County; the beds of the group are water

LOG OF SOUTHERN PACIFIC RAILROAD WELL (1.13.22.200) AT VARNEY

Material	Thickness (feet)	Depth (feet)
Yeso formation		
Limestone and gypsum	25	25
Shale, red	65	90
Limestone	46	136
Soapstone [probably gypsum], blue	8	144
Shale, red	8	152
Limestone	8	160
Soapstone [probably gypsum], blue	26	186
Limestone	4	190
Soapstone [probably gypsum]	20	210
Shale, red	45	255
Limestone	16	271
Sandstone	13	284
Clay, red	11	295
Shale, red	18	313
Shale, brown	18	331
Shale, red; water level at 357 feet	48	379
Clay, red	20	399
Shale, red	28	427
Gypsum; water at 440 feet, small quantity	24	451
Shale, red	81	532
Sandstone, red	16	548
Sandstone, white; water at 550 feet	55	603
Sandstone, yellow	28	631
Sandstone, gray	42	673
Sandstone, yellow	16	689
Sandstone, gray, and soapstone [probably gypsum]	117	806
Slate and soapstone [probably gypsum]	14	820
Clay, red	3	823
Sandstone, gray	27	850

bearing in the eastern uplands in the northeast corner of the county (wells 9.15.14.134 and 9.15.32.241), near the southeast corner of Santa Fe County (well 10.11.35.122), and north of the Torrance County line, in San Miguel County (well 10.15.34.113). The water tapped by well 10.11.35.122 is perched. Near Derramadero the Dockum group is approximately 300 feet thick.

Recharge, Movement, and Discharge

The average annual precipitation at Pedernal, on the east side of the Pedernal Hills, is 12.75 inches. The average annual precipitation on the Pedernal Hills probably is about 13 inches, as shown on the precipitation map of the 1941 Yearbook of Agriculture (U. S. Dept. Agriculture, 1941, p 1,023), and on the eastern uplands is 12-15 inches. Recharge to the ground-water body of the eastern uplands is infrequent and mainly from the local precipitation; however, the ground-water body in the northern part of the uplands receives recharge also from surface runoff and by underflow from the northern part of the Pedernal

Hills area. The southern part of the uplands receives some underflow from the Pinos Wells basin.

During periods of heavy precipitation, runoff west of the divide of the Pedernal Hills area flows into the Estancia Valley area. Runoff east of the divide flows into Pintada Canyon and Encino and Pinos Wells basins. The runoff into Pintada Canyon that does not evaporate or sink into the ground is lost from the county by surface flow into the Pecos River. Water that seeps into the bed of Pintada Canyon recharges the main zone of saturation in the Yeso formation. The runoff into Encino and Pinos Wells basins either evaporates or enters the ground-water body, the discharge from which is discussed on pages 84 and 87, respectively.

Precipitation and surface runoff in the Pedernal Hills area which is not lost to evapotranspiration sinks into the soil and mantle rock covering the crystalline rocks, and then into crevices in the crystalline rocks to reach the ground-water body. From the crystalline rocks most of the ground water is discharged into the sedimentary rocks of Estancia Valley, Encino basin, Pinos Wells basin, or the eastern uplands. A small part of the water is discharged at springs, where it evaporates or moves over the surface a short distance before reentering the ground. The ground water in the eastern uplands, which occurs mostly in the Yeso formation, moves generally eastward into the adjoining counties.

In the area of outcrop of the limestone member of the San Andres formation in the southeastern part of the county, water from local precipitation percolates from the limestone member into the Glorieta sandstone member and then into the Yeso formation. There is no integrated surface drainage in the area of outcrop of the limestone member, and all runoff discharges into the many sinkholes in the limestone, where it moves underground into adjacent areas.

AVAILABILITY

In the Pedernal Hills and Cerrito del Lobo areas where Precambrian crystalline rocks crop out, there is a wide range in both the depths of wells and the depths to water. Well 8.9.26.332 on Cerrito del Lobo is 53 feet deep, and the depth to water is 34 feet. In the vicinity of Clines Corners well 10.12.29.311, which obtains water from the Abo formation, is 3,600 feet deep, and the depth to water is 800 feet. In 10 wells in the Pedernal Hills the wells range in depth from 108 to 405 feet, and the depth to water ranges from 66 to 360 feet.

In the eastern uplands, wells 9.12.16.213, 9.12.32.430, and 10.12.33.-341, which obtain their water from the Abo formation, range in depth from 960 to 1,301 feet, and the depth to water ranges from 840 to 899 feet. The depths of 53 wells in the eastern uplands, all finished in the Yeso formation, range from 110 to 941 feet, and the depth to water ranges from 51 to 890 feet. Well 9.15.15.420, probably finished in the Yeso formation, is 1,054 feet deep; the depth to water is reported to **be**

922 feet. In general, the areas in which wells are shallowest and the depths to water least in the Yeso formation are close to the Pedernal Hills. Wells of greater depths are nearest to the eastern county line. The depths of 5 wells in the Glorieta sandstone member of the San Andres formation range from 80 to 175 feet, and the depths to water range from 67 to 146 feet. The depths of wells 9.15.14.134 and 9.15.32.241, which are in the Dockum group, are 150 and 360 feet, and the depths to water are 126 and 142 feet, respectively. The depths of wells 10.11.35.- 122 and 10.15.34.113, north of the Torrance County line and finished in beds of the Dockum group, are 10 feet and 185 feet, respectively. The depth to water in well 10.15.34.113 is 137 feet.

CHEMICAL QUALITY AND USE

Chemical analyses of the water from wells in the Pedernal Hills indicate that the water is generally satisfactory for stock, irrigation, and most domestic use. The chemical analyses indicate that in the vicinity of Corona the water is undesirable to unsatisfactory for drinking and most domestic purposes, satisfactory to unsatisfactory for irrigation, and satisfactory for stock. The chemical analyses of water from wells in the eastern uplands in Torrance County show this water to be satisfactory to unsatisfactory for drinking, domestic use, and irrigation, but generally satisfactory for stock. The analyses of water from wells in the Pedernal Hills and eastern uplands are summarized in Table 10.

Of the 86 wells in the Pedernal Hills and eastern uplands for which information was obtained, 61 are used for stock, 12 for domestic and stock water, 8 for domestic water, and 1 for railroad supply; 4 are unused or abandoned.

CHUPADERA MESA AREA

South of Willard an escarpment rises about 500 feet above the floor of Estancia Valley. The top of this escarpment at its northern end is called Mesa Jumanes, but in its entirety the mesa is known as Chupadera Mesa. Chupadera Mesa is about 65 miles in length, north-south. Only the northern portion of this mesa (about 325 square miles) extends into Torrance County, where the mesa is 15-20 miles wide, east-west. According to Bates et al. (1947, p 10), the highest altitude in Gran Quivira quadrangle is 7,250 feet, which is probably the highest altitude on Chupadera Mesa. Chupadera Mesa in Torrance County is typified by a gently rolling to hilly surface. The gently sloping areas contain numerous broad shallow sink holes; the hilly areas are rocky and covered with pinon and juniper. In many places on the mesa abandoned fields give evidence of attempts at dry farming. The northern escarpment of Chupadera Mesa merges eastward into the Gallinas Mountains, which have a maximum altitude of 8,750 feet (pl 5B). The mountains are just west of Corona and cover about 30 square miles. Only their northern tip extends into Torrance County; for convenience this small area

TABLE 10. CHEMICAL ANALYSES OF WATER FROM WELLS IN THE PEDERNAL HILLS AND EASTERN UPLANDS*

(In parts per million)

LOCATION	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS	USABILITY†
Pedernal Hills	34-436 (6)	24-104 (6)	14-56 (6)	0.8-1.2 (3) 1.9-2.6 (3)	172-592 (6)	393-949 (6)	H (satisfactory to undesirable), D, I, S
Well 3.11.5.444 (NE. of Progresso)	400	104	78	1.3	830	1,210	H (poor), D, I, S
Corona vicinity	291-391 (2) 647-3,160 (7)	19-117	31-114 (6) 178-368 (3)	0.2-0.9 (8) 1.8 (1)	472-871 (3) 1,010-2,830 (6)	647-799 (2) 1,140-4,900 (7)	H and D (mostly unsatisfactory), I (good to bad), S
Eastern uplands	33-308 (8) 511-1,120 (7) 1,630-2,920 (5)	5-110 (20)	12-115 (15) 137-380 (5)	0-2.6 (19)	256-815 (11) 1,090-2,820 (9)	417-443 (4) 508-1,020 (5) 1,060-4,180 (11)	H, D, and I (good to unsatisfactory), S
Well 8.14.3.214 (SE. of Palma)	1,420	1,870	474	—	1,980	12,090	No ordinary use

* The figures in parentheses represent the number of samples analyzed.

† H, drinking; D, other domestic use; I, irrigation; S, stock.

is included in the Chupadera Mesa area of this report. The mesa in Torrance County ends on the west in an area dissected by tributaries of Canyon Cueva and Arroyo Seco. However, the area beyond the mesas, in the southwestern corner of the county, is included in the area described in this section, because of hydrologic continuity across the physiographic boundary.

GEOLOGY AND PRINCIPAL AQUIFER

Chupadera Mesa is capped by the limestone member of the San Andres formation. The limestone member is underlain by the Glorieta sandstone member of the San Andres formation, which in Torrance County is exposed in the escarpment on the north and west sides of the mesa. Beneath the Glorieta is the Yeso formation, which is best exposed at the base of the escarpment on the north and west sides of the mesa. Rocks of the Abo formation and the Magdalena group are not exposed around the escarpment of Chupadera Mesa but probably underlie the mesa below the Yeso formation. Darton (1928-b, p 87) states that:

> In general the central and northern parts of Chupadera Mesa form a broad, very shallow syncline in which the beds lie nearly horizontal. This syncline pitches (southward) under the broad valley of the Tularosa basin.

To the west of Chupadera Mesa, in the southwest corner of the county, rocks of the Yeso formation, the Glorieta sandstone member and the limestone member of the San Andres formation, and Tertiary intrusive dikes and sills crop out. In a section measured near the southwest corner of Torrance County, the Yeso formation has a total thickness of 674 feet (see pages 30 and 31). The formation has been divided (Kelley et al., 1946) into four members, which are: (1) the Joyita sandstone member at the top, which consists of sandstone and siltstone and is 62 feet thick; (2) the Callas gypsum member, which consists mostly of gypsum and is 105 feet thick; (3) the Torres member, which consists largely of sandstone, with some gypsum and limestone, and is 402 feet thick; and (4) the Meseta Blanca member at the base, which consists of sandstone and sandy shale and is 105 feet thick. The core of the Gallinas Mountains consists of Precambrian granite and gneiss and is surrounded by Permian sediments and cut by later intrusive rocks.

Data from 30 wells on Chupadera Mesa indicate that the Yeso formation is the aquifer from which the wells on the mesa derive water. The Yeso formation is tapped also by 3 wells in the area west of Chupadera Mesa, in the southwest corner of the county.

RECHARGE, MOVEMENT, AND DISCHARGE

The normal annual precipitation at Gran Quivira, on Chupadera Mesa, is 14.62 inches; 70 percent of the precipitation occurs during the period April-September, when evapotranspiration is greatest. However,

CHEMICAL QUALITY AND USE

Chemical analyses of the water from wells on Chupadera Mesa indicate that it is suitable for stock but is not desirable for domestic use. Although some of the water probably is used domestically, a number of the people who live on the mesa haul water from Mountainair for domestic use. Water from wells in the southwest corner of the county was not analyzed; however, the chemical quality of the water there can be expected to be similar to that from wells on the mesa. The water from well 3.9.33.433 is of better chemical quality than the water analyzed from six other wells on Chupadera Mesa, probably because this well derives water from the upper part of the Yeso formation. The analyses of the water from wells on Chupadera Mesa are summarized in Table 11.

ENCINO BASIN AREA

Encino basin, in the east-central part of Torrance County, is a closed drainage basin having an area of about 240 square miles. The western part of the area draining into the basin includes the eastern part of the Pedernal Hills. Encino, near the center of the basin, is at the north end of an ancient lake similar to the one in Estancia Valley. Near the center of the lake bed is a playa resembling in its origin the playas in Estancia Valley. As in the playas of Estancia Valley, water appears on the surface only after runoff from local rains or snow melt. A separate closed drainage basin, about 45 square miles in area, near the southwest margin of Encino basin is included in the Encino basin area for purposes of discussion. In 1950 about five percent of the population of Torrance County lived in the Encino basin. Communities in this area are Encino, Pedernal, and Negra.

GEOLOGY

The geological formations in the Encino basin area strike in a general north-south direction and dip gently to the east and south. Along the west side of the area Precambrian crystalline rocks crop out. In the northern part of the belt of outcrop, these rocks are quartzite; in the southern part they are largely quartzite but include some schist and igneous rock. East of the crystalline rocks the Yeso formation and the Glorieta sandstone member and the limestone member of the San Andres formation crop out successively in irregular north-south belts. The Yeso formation immediately underlies the surface in more than half the basin.

The playa, about 2 miles south of Encino, is near the center of the ancient lake. The playa is also near the contact of the Yeso formation and the Glorieta sandstone member of the San Andres formation. The lake and dune deposits near Encino are not nearly so extensive, however, as the deposits in Estancia Valley. According to Darton (1928-a), the lake and dune deposits are Quaternary in age. South of the playa, between Encino and Duran, are numerous outcrops of igneous rocks (see

TABLE 11. CHEMICAL ANALYSES OF WATER FROM WELLS ON CHUPADERA MESA*

(In parts per million)

LOCATION	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS	USABILITY†
Chupadera Mesa	1,130-2,030 (6)	9.39 (8)	108-182 (6)	0.2-2.4 (6)	1,320-2,140 (6)	1,700-2,910 (6)	S
Well 3.9.33.433	14	6	14	0.2	172	176	H, D, I, S

* The figures in parentheses represent the number of samples analyzed.
† H, drinking; D, other domestic uses; I, irrigation; S, stock.

pl 1), which probably are sills intruded into the Yeso formation during early Tertiary time.

Principal Aquifers

The principal aquifers in the Encino basin and the smaller basin to the southwest are the Precambrian rocks and the Yeso formation. The Precambrian crystalline rocks are the principal aquifer in about the western third of the area where they crop out, and in the vicinity of Negra, just east of the area of outcrop. The log of an Atchison, Topeka & Santa Fe Railway well about 3 miles north of Negra, given below, indicates the type of rock and the conditions that may be encountered when drilling into the Precambrian rocks in the area.

Log of well 6.13.33.414 about 3 miles north of Negra, N. Mex.

Material	Thickness (feet)	Depth (feet)
Yeso formation		
Soil	5	5
Shale, yellow, stony	19	24
Shale, brown, stony	16	40
Limestone, blue, very hard	2	42
Shale, sandy, brown	34	76
Shale, sandy, light-brown, soft	3	79
Shale, sandy, brown	15	94
Sand rock, brown	16	110
Granite wash from Precambrian rocks		
Granite wash, red, very hard	3	113
Precambrian rocks		
Rock, gray; seamy and shattered at 130 feet	26	139
Rock, light-gray; water level at 152 feet	24	163
Rock, dark-gray, and quartzite; well produced about 25 gpm between 174 and 184 feet	20	183
Schist, micaceous, very hard, seamy; water	2	185
Rock, schistose, reddish-gray, very seamy; well shot with dynamite, causing large cavity between 179 and 205 feet	20	205
Rock, black, very hard, seamy	26	231
Rock, gray, glassy, rather soft	73	304
Quartzite, white, clear	25	329
Stone, sand, schistose, dark-gray	6	335
Schist, micaceous, shaly, light-gray; mud(?), pink; water	14	349
Clay, red	10	359
Quartzite, clear	1	360
Sandstone, brown	6	366
Diorite, schistose, green, soft; at 401 feet, with intake at 359 feet pumping 5 hours at 75-80 gpm lowered the water level from 152 to 299 feet; pumping 72 gpm lowered the water level to 276 feet; pumping 90 gpm lowered the water level to 352 feet	43	409
Quartzite, clear	4	413
Rock, schistose, gray, seamy; water	6	419
Quartzite, brown; 450-454, faulty and seamy	56	475

LOG OF WELL 6.13.33.414 ABOUT 3 MILES NORTH OF NEGRA, N. MEX. (CONTINUED)

Material	Thickness (feet)	Depth (feet)
Precambrian rocks — continued		
Similar to above, only softer; water	24	499
Stone, sand, red, very soft	40	539
Quartzite, clear	5	544
Quartzite, gray, hard; at 558 feet, pumping at 70 gpm lowered the water level to 190 feet, where it held; pumping 100 gpm lowered the water level to 212 feet.	55	599
Quartzite, gray, softer	40	639
Sandstone, schistose, red, gray, and black	5	644
Diorite, schistose, green	5	649
Quartzite, glassy, clear	1	650
Diorite, schistose, green	15	665
Rock, gray and brown, and quartzite; water	15	680
Diorite, schistose, green	10	690
Quartzite, brown	7	697
Granite, red, very hard	3	700

The Yeso formation is the principal aquifer in about the eastern two-thirds of the Encino basin area. The Yeso crops out in the western part of this area and is overlain by the San Andres formation in the eastern part. The log (see p 74) of a well at Varney illustrates the type of sediments that may be encountered, and the conditions that may be expected, when drilling in the region of the Encino basin area in which the Yeso is the water-bearing formation.

Although information was not obtained for any wells deriving water from lake or gravel deposits in the area of the lake beds south of Encino, gravel deposits may be present that contain sufficient water to supply domestic wells and possibly to irrigate small gardens.

RECHARGE, MOVEMENT, AND DISCHARGE

Recharge to the ground-water body in the Encino basin area comes largely from local precipitation and to some extent from inflow of ground water from the Pedernal Hills. After heavy rains some runoff reaches the playa south of Encino, where the water remains until it is evaporated. The average annual precipitation, as determined by the U. S. Weather Bureau at weather stations in or near the Encino basin area, is 12.75 inches at Pedernal, 13.29 inches at Vaughn, 14.16 inches at Duran, and 12.68 inches at Palma. However, the average annual evaporation potential for the Encino basin area is several times the average annual precipitation. Thus it can be expected that only water from exceptionally heavy precipitation will furnish recharge to the ground-water body in this area.

In the western part of the Encino basin area the ground water moves in an easterly direction through fractures in the Precambrian crystalline rocks, and through fractures and solution channels in the Yeso formation, which in the eastern part of Torrance County dips generally to the east. The surface of the playa south of Encino probably is at or near ground-water level, and in the movement of the ground water eastward some of it is discharged to the playa, where it is lost by evaporation. However, most of the natural discharge of the Encino basin area is eastward from the basin through the beds and out of the county into the Pecos River drainage system.

AVAILABILITY

Of the 27 wells in the Encino basin area for which information was obtained, 5 obtain their water principally from the Precambrian rocks, and 5 more probably do. The depths of wells in the Precambrian rocks range from 150 to 700 feet, and the water levels range from 40 to 362 feet below the surface. In 14 wells the Yeso formation is the aquifer, and in 3 wells the Yeso is the probable aquifer. Depths of these wells range from 24 to 640 feet, and water levels range from 18 to 540 feet below the surface.

The largest output reported for any of the wells in the Encino basin area is 110 gpm, as determined in a pumping test of the railroad well (6.13.33.414) about 3 miles north of Negra. This output is inadequate for irrigation on a large scale. The valley-fill deposits near Encino constitute the only aquifer in the Encino basin area that might yield enough water for irrigation. It appears, however, that the area and thickness of the valley fill are too small for it to furnish sufficient water for irrigation. The chances are good for obtaining sufficient water for stock and domestic use from wells drilled into permeable beds almost anywhere in the Encino drainage basin area. (See p12.)

CHEMICAL QUALITY AND USE

The chemical quality of the water from wells in the Encino basin area differs from one aquifer to another. A summary of the chemical analyses of the water from wells in the Encino basin is given in Table 12. Although some of the water from the Yeso formation in the basin can be used for some purposes other than stock, most of it is unsatisfactory for drinking, most domestic uses, and irrigation. Of the 26 wells in the Encino basin area for which information was obtained, 18 wells were used for stock, 5 were domestic and stock wells, 1 was a domestic well, 1 was a railroad and municipal-supply well, and 1 was abandoned.

PINOS WELLS BASIN AREA

Pinos Wells basin covers an area of about 180 square miles in the southeastern part of Torrance County, southwest of Encino basin. Like Estancia Valley and Encino basin, it has no outlet for surface drainage. Excess surface runoff collects in the playas in the northwest part of the basin, which resemble the playas in Estancia Valley and Encino basin.

TABLE 12. CHEMICAL ANALYSES OF WATER FROM WELLS IN ENCINO BASIN*

(In parts per million)

AQUIFER OR PROBABLE AQUIFER	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS	USABILITY†
Precambrian rocks (3)	117- 153	21- 43	21- 25	0.2-2.4	212- 312	368- 425	H, D, I, S
Yeso formation (5)	228-2,630	26-115	34-333	0.9-2.4	294-2,600	594-3,820	S

* The figures in parentheses represent the number of samples analyzed.
† H, drinking; D, other domestic uses; I, irrigation; S, stock.

A region of longitudinal blowouts about a mile in width lies east of the playas, and a smaller region of sand dunes, composed largely of gypsum, lies southeast of the playas. Cerro del Pino to the west, the Gallinas Mountains to the southwest, and small mesas to the east, near Duran, are surrounding highlands which contribute surface runoff to the basin. A group of smaller basins that cover an area of about 65 square miles, west of Pinos Wells basin (see fig 4), is included in Pinos Wells basin for purposes of discussion. In 1950 less than 5 percent of the population of Torrance County lived in the Pinos Wells basin area. The only communities in this area are Cedarvale and Pinos Wells.

GEOLOGY

The surface rock over most of the area of Pinos Wells basin is the Yeso formation. East of Pinos Wells the Yeso formation is covered by about 15 square miles of playa and dune deposits, which are composed largely of gypsum derived from the Yeso formation. According to Darton (1928-a), the playa and dune deposits are of Quaternary age. The origins of the playas in Estancia Valley, Encino basin, and Pinos Wells basin are apparently similar, but the physical features of the playas of the Pinos Wells basin differ somewhat from those of Estancia Valley and Encino basin. Ancient shorelines, the characteristic flatness of ancient lake beds, cliff-like walls around the playas, and laminated lake sediments, which are present in Estancia Valley and Encino basin, have not been found in Pinos Wells basin (Meinzer, 1911, p 83).

PRINCIPAL AQUIFER

Although Meinzer (1911, p 83) mentions some dug stock wells near the playas, which might obtain their water from the playa deposits, the Yeso formation is the only water-bearing formation in the area of Pinos Wells basin for which information was obtained for this report. Only a part of the total thickness of the Yeso formation is exposed in the Pinos Wells basin, and logs of wells that penetrate the entire formation in the basin are not available. However, in the Gallinas Mountains, to the south, the Yeso formation is about 1,000 feet thick. In Abo Canyon, to the west, the thickness is about 700 feet, and the log of a well to the north, in southwestern San Miguel County, indicates that the formation is about 600 feet thick. It is probable, therefore, that in Pinos Wells basin the thickness of the formation is within the range of these figures. The log (see p 74) of a well at Varney illustrates the type of sediments that may be encountered, and the conditions that may be expected, when drilling a well into the Yeso formation in Pinos Wells basin.

RECHARGE, MOVEMENT, AND DISCHARGE

Most of the recharge to the ground-water body of the Pinos Wells basin comes from local precipitation. There is some movement of ground water into the basin, however, from the Gallinas Mountains and from the south end of the Pedernal Hills, including Cerro del Pino. After heavy rains some runoff reaches the playas near Pinos Wells, where the water remains until it is evaporated. The average annual precipitation, as determined by the U. S. Weather Bureau at weather stations near Pinos Wells basin, is 13.29 inches at Vaughn, 14.19 inches at Progresso, 14.16 inches at Duran, 12.75 inches at Pedernal, and 15.09 inches at Corona. The average annual evaporation potential for Pinos Wells basin is several times the average annual precipitation. Therefore, it can be expected that only heavy precipitation will furnish appreciable recharge to the ground-water body in the basin.

Ground water generally moves eastward from the Pedernal Hills and northward from the northern end of the Gallinas Mountains into the Pinos Wells basin. The ground water moves eastward out of the basin into the sedimentary rocks of the eastern uplands. However, a depth to water of 27 feet in well 3.13.33.413, about 1 mile south of one of the smaller playas, indicates that the water table probably is near enough to the surface in the area of the playas for some of the ground water to be discharged by evaporation.

The eastward movement of the ground water from the basin is restricted by metamorphic rocks of low permeability, which crop out about 2 miles northeast of Torrance station, and by igneous rocks, which crop out between the south end of the Encino basin playa and the mesa west of Duran, and between Duran and the county line northeast of Duran along U. S. Highway 54. The surface configuration of the crystalline rocks is not known, so that the total restrictive effect of the rocks cannot be estimated.

AVAILABILITY

The 16 wells for which information was obtained in the area of Pinos Wells basin range in depth from 60 to 525 feet, and the water levels range from 27 to 345 feet below the surface. Little information is available in regard to the yield of the wells. According to reported information, windmill well 2.13.35.344, which is near the edge of the basin and 525 feet deep, and in which the non-pumping water level was 345 feet below the surface, had a weak yield, and the water level dropped to 515 feet below the surface when the well was pumped. However, about a mile south of the playa region, windmill well 3.13.33.413, reported to be 98 feet deep, and in which the water level was measured to be 27 feet below the surface, was reported never to have pumped dry.

In the area of the smaller basins west of Pinos Wells basin, well 2.11.22.313, in August 1949, was equipped with a turbine pump and was reported to yield about 600 gpm. However, a year later the pump had been removed from this well, and the supply of water was reported to be inadequate. The aquifer for this well is limestone of the Yeso formation, which was reported to be of honeycomb texture. Possibly the limestone is permeable, but the local rate of recharge is low, and the well quickly depleted the ground water in storage. The supply of water from stock and domestic wells in the area west of Pinos Wells basin ranged from adequate to inadequate.

The possibilities for irrigation in the Pinos Wells basin appear to be even less favorable than in Encino basin. Even if sufficient quantities of water should be found for irrigation, the chemical quality probably would be unsatisfactory. The water from well samples ranged from undesirable to unsuitable for irrigation.

CHEMICAL QUALITY AND USE

A summary of the chemical analyses of the water from wells in the area of Pinos Wells basin is given in Table 13. Of the 16 wells in the area of Pinos Wells basin for which information was obtained, 8 were used for stock, 7 were for domestic and stock use, and 1 (2.11.22.313) was proposed for irrigation.

TABLE 13. CHEMICAL ANALYSES OF WATER FROM WELLS IN PINOS WELLS BASIN*

(In parts per million)

LOCATION	SULFATE (SO_4)	CHLORIDE (Cl)	MAGNESIUM (Mg)	FLUORIDE (F)	HARDNESS AS $CaCO_3$	DISSOLVED SOLIDS	USABILITY†
Pinos Wells basin (6)	596-2,220	14-245	73-198	0.7-1.3	789-2,120	1,000-3,150	I3, S1
Small basins to the west (4)	256-1,620	13- 51	35-151	0.9-1.3	446-1,880	594-2,450	H2, D2, I2, S1

* The figures in parentheses represent the number of samples analyzed.

† H, drinking; D, other domestic uses; I, irrigation; S, stock. 1, satisfactory; 2, satisfactory to undesirable; 3, undesirable to unsuitable.

Community Supplies

ESTANCIA

Estancia, the county seat of Torrance County, had a population of 916 in 1950. The community water supply is obtained from two wells. One well is 75 feet deep and is equipped with a pump reported to have a capacity of 250 gpm. The other well is equipped with a pump reported to have a capacity of 460 gpm, but its depth is not known. According to the superintendent of the water-supply system, the daily consumption of water in Estancia averages 75,000 gallons in winter and 150,000200,000 gallons in summer. There is one elevated reservoir with a capacity of 50,000 gallons. Thus, either pump is capable of furnishing the average daily demand for the town. The aquifer tapped by the wells is the Tertiary(?) and Quaternary valley fill. Although the water is hard, it can be used for domestic purposes. The mineral content of the water is within the maximum limits prescribed for drinking water by the U. S. Public Health Service. The water supply should be ample for fire protection and sufficient for some time to serve the needs of the town at its present rate of growth. If more water should be needed, additional wells of similar depth nearby should furnish an adequate supply; such wells should be spaced at distances sufficient to avoid excessive mutual interference.

MOUNTAINAIR

Mountainair, with a 1950 population of 1,416, is the largest town in the county. The town water supply in 1952 was furnished by two wells about 600 feet apart. According to the superintendent, the water obtained from these two wells was adequate for the town needs, even though their combined yield of 370 gpm is considerably less than the original combined yield of 960 gpm. Of these two wells, well 4.7.23.312a is 175 feet deep and is pumped at 240 gpm; well 4.7.23.312 is 178 feet in depth and is pumped at 130 gpm. The original static level in the latter well was 115 feet below the surface in 1944, 27 feet above the level measured in July 1951. The pumping level in both wells is about 150 feet below the surface. The pumping levels, the large decline in yield, and the lowering of static levels suggest that the wells are being overpumped and probably interfere excessively with each other, and that the available water stored in the aquifer is limited. Limestone of the Yeso formation is the principal aquifer for these wells.

An additional supply of water for Mountainair is a serious problem. Although more water might be found in the locality of the present wells, the prospect is not encouraging. The quality of the water probably would be satisfactory; the quantity, however, would be uncertain. It would be necessary to find cavities beneath the surface similar to the cavities near the bottom of wells 4.7.23.312 and 4.7.23.312a, and even then there would be the question of the permanence of the supply. In order to obtain a relatively permanent and adequate supply of water for the community of Mountainair without the risk of drilling several dry holes, it might be necessary to locate a well in an aquifer having a higher and a more permanent yield than the Yeso formation. The closest such aquifer is the Tertiary(?) and Quaternary valley fill in the irrigated area southwest or northwest of Willard. Although drilling wells in that location would involve considerable expense for a pipeline, the cost might be less over a period of several years than the total cost of replacing wells deriving water from an aquifer having an inadequate and less permanent yield.

Since the preparation of this report, the town of Mountainair has experienced a severe water shortage, and additional geologic and hydrologic data have been gathered by P. D. Akin and Zane Spiegel, of the New Mexico State Engineer's office. These data are included in a "Memorandum relative to a reconnaissance investigation of a municipal water-supply problem at Mountainair, N. Mex.," June 1955. The memorandum presented information on five possible sources of additional water for Mountainair and suggested that, as a first course of action, a test hole in the SE1/4NWN sec. 26, T. 4 N., R. 7 E., be deepened to a total depth of 350-400 feet.

After this well was deepened to about 450 feet, it yielded approximately 40 gpm, which was deemed inadequate. Subsequently the shortage was relieved temporarily when the town purchased a well in the SWIANWN sec. 24, T. 4 N., R. 7 E. This well is 210 feet deep and yields about 200 gpm (Zane Spiegel, personal communication).

The town uses 150,000-200,000 gallons of water per day. The water-supply system has two reservoirs, an elevated tank having a capacity of 50,000 gallons, and a vertical tank on the surface, with a capacity of 240,000 gallons.

Chemical analyses of the water indicate that the composition of the water from the two principal wells is very similar. (See table 16.) Except for hardness, the water is of satisfactory quality for domestic purposes.

Usually the water derived from the Yeso formation in Torrance County is unsatisfactory for drinking and other domestic use. The water derived from the Yeso formation in the two Mountainair wells for which information is available is satisfactory for a community supply because the water-bearing beds are limestone, and the water, in its movement to the aquifer, has not passed through gypsiferous beds. In this locality gypsum is absent in the part of the Yeso formation between the valley fill above and the limestone beds which are the aquifer.

MORIARTY AND BUFORD

The population in 1950 of Precinct 8 in Torrance County was 655, and most of this number lived in Moriarty and Buford. These two communities are within the irrigated part of Estancia Valley. Neither community has a public water supply; the people are served by individually owned wells which derive water from the valley fill. The individual wells adequately meet the needs of the people at the present time. Should Moriarty and Buford feel the need of installing a community-supply system, sufficient water can be obtained in the valley fill from a depth of about 50-200 feet. The chemical quality of the water is satisfactory for drinking, and, although the water is hard, it can be used for most domestic purposes.

WILLARD

Willard (population 296 in 1950) has no public water-supply system. The inhabitants obtain water from individually owned wells which are dug or drilled. The wells in the town are equipped with buckets, windmills, or pressure pumps. Information for wells in or near Willard indicates that water sufficient for the needs of the community and of a desirable chemical quality can be obtained from the valley fill within a depth of 150 or 160 feet. The water is of satisfactory quality for drinking and, although hard, can be used for most domestic purposes. However, east from Willard and toward the playas, the water from wells rapidly becomes unsatisfactory in quality for drinking or most domestic use.

CORONA

Corona is in Lincoln County, half a mile south of the Torrance County line. Ground-water conditions in the vicinity of Corona were studied in connection with the investigation of Torrance County. Corona, with a population of 530 in 1950, has a community water-distribution system which has obtained water from the supply system of the Southern Pacific Railroad, whose source is the Bonito Reservoir in the Sierra Blanca, east of Carrizozo, in Lincoln County. The railroad has sold this reservoir to the city of Alamogordo, and a pipeline from the reservoir to Alamogordo is under construction.

A study was made in the vicinity of Corona to determine the possibility of obtaining a local supply of ground water for the town. Wells were visited within a radius of 5-8 miles of Corona, and samples of water were taken from most of these wells for chemical analysis. The water from none of the wells, for which the Yeso formation was the principal aquifer, was desirable, and the water from most of the wells was unsatisfactory for drinking or general domestic use. All the water is very hard, and the sulfate content is too high for the water to be satisfactory for drinking. It is unlikely that water in sufficient quantity, and of a satisfactory quality, can be expected from the Yeso formation in this area. It is possible that water of a satisfactory quality might be obtained from the Abo formation, which is nearly a thousand feet below the surface, but the Abo may not furnish adequate quantities. It is likely that it would be necessary to look several miles to the south from Corona in order to obtain sufficient ground water of a satisfactory quality to supply the needs of the town.

ENCINO

Encino (population 408 in 1950) has a community water-distribution system to which water is piped from wells of the Atchison, Topeka & Santa Fe Railway, about 3 miles north of Negra. Five wells have been drilled at this location. The latest one drilled, which was completed in 1930 and obtained its water from Precambrian crystalline rocks, was tested at about 100 gpm (see log, p 82-83). This quantity by itself should be sufficient to supply the needs of the railroad and the town of Encino. Chemical analyses of water at Negra made by railroad personnel indicate that the water is satisfactory for drinking.

TORREON

The population of Torreon was not determined, but the population in 1950 of Precinct 2 in Torrance County was 519, and most of this number lived in Torreon. Torreon has a water-supply system and obtains its water from a spring and windmill well adjacent to the spring. The water supplied by both the spring and the windmill well comes from the Madera limestone. The system has two storage tanks having a total capacity of 11,000 gallons. According to the New Mexico Department of Public Health, the water supply in 1950 was ample for the needs of the town. The quality of the water is satisfactory for drinking, and even though the water is hard, it can be used for most domestic purposes. There are several windmill wells near the town. If additional water should be needed for the local supply, it probably could be obtained in the Madera limestone within a depth of 200 feet.

TAJIQUE

The population of Tajique was not determined, but the population in 1950 of Precinct 1 in Torrance County was 290, and most of this number lived in Tajique. Tajique is supplied with water from two wells. According to the superintendent of the water system, the two wells together supply only 1,000 gallons a day to the town, a quantity insufficient to meet the demands. Each of these wells was drilled in 1948, in cooperation with the New Mexico Department of Public Health, to a depth of 200 feet in the Madera limestone. The yield of one was reported to be 41/2 gpm and of the other 3 gpm at the time of drilling.

Well 6.6.11.334, at a former sawmill camp just east of the northeast edge of town, was reported to yield a much greater quantity of water than the town wells. This well, which was equipped with a pump jack and a 1-horsepower electric motor, is 180 feet *deep*. The water commission of Tajique purchased this well for use as part of the community supply, but as of 1952 it was not being so used. Well 6.6.13.210, about 2 miles east of Tajique, also is reported to have a higher yield than the town wells. This well is about 240 feet deep and equipped with a pump jack and a 1/2-horsepower electric motor. The comparative depth and surface altitude of wells 6.6.13.210 and 6.6.11.334 and the Tajique wells indicate that the latter probably were not drilled deep enough to penetrate the same water-bearing bed in the Madera limestone tapped by the wells of higher yield.

CHILILI

Chilili, although in Bernalillo County, is surrounded partly by Torrance County and consequently was included in the investigation of Torrance County. The population of Chilili was not determined, but the population in 1950 of Precinct 34 in Bernalillo County was 264, and most of this number lived in Chilili. The town at the present time has no municipal water-supply system. Two windmill wells in the town obtain their water from the Madera limestone. One of these wells, reported to be 86 feet deep and to furnish an adequate supply of water, is used by several people in the town. The water from this well is of satisfactory chemical quality for drinking and, although it is hard, it can be used for most domestic purposes. If additional water is desired, it probably can be obtained from the Madera limestone by drilling another well. It should be kept in mind that if insufficient water is obtained at one horizon, the possibility still exists for obtaining more water by drilling to a deeper bed in the Madera limestone.

DURAN

The population of Duran was not determined, but the population in 1950 of Precinct 10 in Torrance County was 221, and most of this number lived in Duran. At present the community obtains its water from the water line of the Southern Pacific Railroad, the same source as that for Corona.

A field study was made near Duran to determine the possibility of obtaining a local supply of ground water (Smith, 1953). The groundwater problem in the area is one of both inadequate quantity and poor chemical quality. The water from most of the existing wells is derived from the Yeso formation, which in this area is known to yield sufficient water to supply only windmills or small pumps. The quality of the water from the Yeso formation in the area is unsatisfactory for a community supply.

A well nearly 2 miles southeast of Duran in sec. 28, T. 3 N., R. 15 E., about 150 feet deep, was reported to pump about 200 gpm in a test. The chemical quality of the water is satisfactory for drinking and domestic use. This water is derived from a perched zone in the Glorieta sandstone member of the San Andres formation, or possibly from a limestone unit in the upper part of the Yeso formation. The water in the zone must be derived from precipitation within the local area, and the quantity of water in storage in the perched zone undoubtedly is not large. Nevertheless, on the basis of data obtained during a 70-hour pumping test made in November 1955, there appears to be an adequate quantity of water in storage to supply the needs of Duran at its present rate of consumption.

PUNTA DE AGUA

The population of Punta de Agua was not determined, but the population in 1950 of Precinct 5 in Torrance County was 215, and most of this number lived in Punta de Agua. Punta de Agua has no community water-supply system, but it is understood that the community recognizes the need for one. In the early part of 1951 a well was drilled in the town, with the cooperation of the New Mexico State Department of Public Health, to obtain water for a community supply. This well was drilled 400 feet deep into the Abo formation. The yield of the well was reported to be less than 2 gpm, a quantity inadequate for the needs of the town. Another well was drilled under the same arrangement about half a mile west of town to a depth of 102 feet into the Abo formation. The yield of this well was reported to be one-half gpm. Although it is recognized that an additional well might not yield a sufficient quantity of water, the present supply probably could be supplemented by drilling another well. Such a well should be drilled at least to the depth of the well in town, 400 feet. Chemical analyses of water from dug wells near Punta de Agua show that the shallow water is satisfactory for drinking and domestic use; probably the deeper water also is satisfactory, at least as far down as 400 feet.

TORRANCE AND VARNEY

The railroad stations of Torrance and Varney are furnished water from the water-supply system of the Southern Pacific Railroad, which supplies Corona and Duran also. Sufficient water for Torrance and Varney probably can be obtained from wells drilled into the Yeso formation, but chemical analyses of water from wells in the area indicate that the water probably would be unsatisfactory for drinking and for most domestic use.

NEGRA

The railroad station of Negra, which is supplied by water from the Atchison, Topeka & Santa Fe Railway well (6.13.33.414), about 3 miles north of Negra, has more than a sufficient quantity of water of a suitable chemical quality for its needs. The five wells in this well field obtain water from Precambrian crystalline rocks.

OTHER COMMUNITY SUPPLIES

Other communities in Torrance County are supplied with water from individually owned sources. In most places the inhabitants get water from dug or drilled wells which are equipped with a bucket or a windmill.

The small community of McIntosh is in the irrigated area of Estancia Valley, and sufficient water of a quality satisfactory for drinking and domestic use is available from the valley fill.

The ground water in the vicinity of the community of Manzano, in the foothills of the Manzano Mountains, also is of satisfactory quality for drinking and domestic use, but individual wells may yield only a small quantity of water. However, a quantity of water sufficient to serve the needs of a community system probably could be obtained from several wells of small capacity.

The quality of water at Pedernal is satisfactory for drinking and domestic use. Windmills pump a quantity sufficient for the needs of the town, and additional water probably can be obtained from more wells.

Gran Quivira, Cedarvale, Progresso, and Pinos Wells are all small communities where sufficient quantities of water can be obtained from individually owned windmill wells to serve the needs, but the chemical quality of the water is unsatisfactory for drinking and domestic use.

At Abo, water of satisfactory chemical quality was obtained from a shallow well; however, the yield was not dependable for a public supply. As the quality of the ground water at Abo is generally unsatisfactory for domestic use, it would be necessary to go some distance to find a dependable supply of satisfactory quality for the community.

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TABLE 14.

RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA

EXPLANATION OF COLUMN HEADINGS

WELL LOCATION NUMBER: See p. 8 for explanation. Some wells not visited.

YEAR COMPLETED: Parentheses indicate year reported is approximate.

TYPE OF WELL: All wells were drilled, unless otherwise indicated in remarks column.

ALTITUDE OF SURFACE: Determined with aneroid barometer and from topographic maps, in feet above mean sea level.

WATER LEVEL: Measured depth to water given to nearest 0.1 foot. Other levels reported, parentheses indicating uncertainty.

DEPTH OF WELL: "M" means measured depth, which may be equal to or less than original depth. All other figures are reported, parentheses indicating uncertainty.

USE: A, abandoned; D, domestic; I, irrigation; Ind, industrial; M, municipal; P, proposed; RR, railroad; S, stock; Sc, school; U, unused.

TYPE OF LIFT: B, bucket; H, hand pump; N, not equipped; P, pump jack; T, turbine; W, windmill.

REMARKS: gpm, gallons per minute; rept., reported; meas., measured.

See tables that follow:

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
1.11.11.110	Ralph A. Lee	Owner	1929	-	298	-	302	-	S	Yeso fm.	W	Main aquifer at 300 ft. Adequate and permanent.
1.11.14.140	C. E. Vickrey	Father of owner	1918	6,430	281.2	8/3/50	312	6	S	Ls. in Yeso fm.	W	Main aquifer at 306 ft. Inadequate but permanent. Drawdown 25 ft in 20 min a. ½ gpm.
1.11.14.344	do.	-	1943.	-	280	-	445	6	D, S	Yeso fm.	W	Main aquifer at 306 ft. Adequate and permanent. See analysis, Table 16.
1.11.17.422	Ralph A. Lee	Roy Jeter	1945	-	200	-	256	5	S	do.	W	Main aquifer at 245 ft. Inadequate. Drawdown 52 ft. in one hour at 4 gpm. Good taste.
1.12.20.312	Roy Jeter	do.	(1948)	-	258.8	7/18/50	400	8	D, S	do.	W	Windmill cut off to measure water level. See analysis, Table 16.
1.13.10.111	Fred Large	-	-	-	220.0	7/18/50	300	6	D, S	do.	W	Pumping when water level measured. Adequate.
1.13.21.200	Harry Ryberg	-	1950	-	270.6	7/19/50	322	7	S	do.	W	Main aquifer at 270 ft. Adequate.
1.13.22.200	Southern Pacific	Lane	1904	-	357	-	850	10	RR	do.	-	-
1.13.34.211	Sheffield	Colbough	(1934)	-	282.7	4/6/51	500	10	S	do.	W	Main aquifer at 285 ft. Inadequate. See analysis, Table 16.
1.13.35.432	Argenbright	-	-	6,480	146.0	do.	175	-	S	Glorieta ss. member of San Andres fm.	W	Adequate and permanent. See analysis, Table 16.
1.14.11.120	-	-	-	-	(300)	-	611	6	S	Yeso fm.	-	Main aquifer at 610 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
1.14.15.420	Noble Snodgrass	-	1942	-	200	-	227	-	-	Probably Glorieta ss. member of San Andres fm.	-	Main aquifer at 200 ft.
1.14.17.210	do.	-	1949	-	210	-	439	-	-	Probably Yeso fm.	-	-
1.14.19.310	John Bernard	-	-	6,790	72	-	75	-	-	Yeso fm.	W	Dry in dry weather. Good taste.
1.14.27.240	Noble Snodgrass	Henry Cimes	1905	6,480	174.6	7/25/50	463	6	U	do.	-	Poor taste.
1.14.28.410	do.	-	(1910)	-	199.9	7/27/50	230M	-	SA	Probably Yeso fm.	-	Unsuitable for domestic use.
1.14.29.410	do.	-	1950	-	265	-	327	6	-	Yeso fm.	-	-
1.14.30.144	J. L. Rogers	Owner	1949	6,685	316	-	324	-	S	do.	W	Main aquifer at 322 ft. Adequate and permanent. Drawdown 6 ft in one hour at 4 gpm. Good taste.
1.15.3.432	Hindi Brothers	-	(1946)	-	Dry	-	(700)	-	S	do.	N	Main aquifer at 700 ft. Went dry in 1948.
1.15.5.111	do.	-	(1916)	-	500	-	550	-	S	do.	W	Adequate. Poor taste.
1.16.7.410	do.	-	(1940)	-	630	-	650	6	S	do.	W	Adequate and permanent. See analysis, Table 16.
1.16.7.410a	do.	-	1948	-	630	-	650	6	S	do.	W	Adequate and permanent.
1.16.19.311	do.	Turner	(1930)	-	630	-	640	6	S	do.	W	Main aquifer at 640 ft. Adequate and permanent.
2.5.3.310	C. Pohl	R. Marshall	(old)	5,855	44.0	8/29/49	50	-	D	Abo fm.	W	Dug. Sulfate taste.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com- pleted	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measure- ment	Depth of well (feet)	Diam- eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
2.5.4.223	J. J. Contreras	Owner	(1930)	-	29.8	8/11/50	55	-	DA	Abo fm.	N	Dug. Main aquifer at 55 ft. Adequate and permanent.
2.5.10.332	R. B. Laing	-	-	5,930	31.9	11/17/49	-	-	S	do.	W	-
2.6.9.233	R. L. Chilton	-	(1915)	-	7.7	8/11/50	26	-	S	Yeso fm.	W	Dug. Adequate and permanent. See analysis, Table 16.
2.6.23.244	E. V. Cain	-	(1918)	6,585	-	-	290	-	S	do.	W	Adequate and permanent.
2.7.14.433	J. H. Cumiford	Brown; Phipps	1927	-	487.0	8/8/50	530	-	D, S	do.	W	Could not get good water-level measurements. Main aquifer at 514 ft. Inadequate but permanent. See analysis, Table 16.
2.7.17.424	Belle Chisum	Colter	(1932)	-	(500)	-	707	6	D, S	do.	W	Main aquifer just below 500 ft. Inadequate. See analysis, Table 16.
2.8.11.310	A. D. Braswell	-	-	-	500	-	(900)	-	-	do.	W	Inadequate.
2.8.15.442	Minnie Gooch	-	-	-	493.3	2/9/51	600	-	S	do.	W	Inadequate. See analysis, Table 16.
2.9.18.333	Will Goar	K. A. Huey	1933	-	420	-	500	5	S	do.	P	Main aquifer at 497 ft; water rose 80 ft in well (rept.). Adequate and permanent. See analysis, Table 16.
2.10.10.111	Sam Brown	-	(1930)	-	136.9	1/19/51	270	-	S	do.	W	Inadequate but permanent. See analysis, Table 16.
2.11.20.140	L. H. Hobbs	-	-	-	116	-	(150)	-	D, S	do.	W	Adequate and permanent. Drawdown 30 ft.
2.11.21.312	do.	-	-	-	57	-	60	-	S	do.	W	Adequate and permanent. See analysis, Table 16.
2.11.22.313	do.	-	1948	-	143	-	200	-	PI	do.	N	Main aquifer at 150 ft probably in cavity or fractures. Inadequate. 600 gpm, rept.
2.11.25.221	E. H. McCloud	-	-	6,350	156.8	8/3/50	200M	-	D, S	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
2.12.6.122	-	-	-	-	99.7	7/20/50	122M	-	D, S	Yeso fm.	W	Pumping when water level measured. See analysis, Table 16.
2.12.19.444	George Davis	-	(1915)	-	211.8	7/19/50	235M	-	D, S	do.	W	Pumping intermittently when water level measured. Adequate and permanent. See analysis, Table 16.
2.12.24.423	-	-	-	-	122.5	do.	135M	-	S	do.	W	See analysis, Table 16.
2.13.27.111	Emma L. Winniford	-	-	6,290	207.5	do.	220	6	S	do.	W	Pumped before water level measured. See analysis, Table 16.
2.13.35.344	Fred Large	-	-	-	345	-	525	-	S	do.	W	Inadequate. See analysis, Table 16.
2.14.14.411	Alex Hindi	Jess Ridell	1942	-	650	-	710	5	S	do.	W	Main aquifer at 710 ft. Well pumps sand. Adequate and permanent.
2.14.24.313	Noble Snodgrass	-	1942	-	465	-	710	-	S	do.	W	Main aquifer at 710 ft. Adequate and permanent.
2.15.6.112	Alex Hindi	-	(1912)	-	320	-	372	-	S	do.	W	Adequate and permanent. See analysis, Table 16.
2.15.7.144	do.	Rudolfo Abalaco	(1926)	-	380	-	(400)	-	S	do.	W	Main aquifer at 400 ft. Adequate and permanent.
2.15.8.312	do.	Turner	(1935)	-	350	-	402	6	S	do.	W	Main aquifer at 400 ft. Adequate and permanent. Unsuitable for drinking. See analysis, Table 16.
2.15.10.141	do.	Turner	(1930)	6,200	348.0	6/26/53	700	-	S	do.	W	Main aquifer at 700 ft. Adequate and permanent.
2.15.13.124	do.	"Butch" Smith	(1930)	-	(640)	-	648	-	S	do.	W	Main aquifer at 648 ft. Adequate and permanent.
2.15.24.212	do.	-	(1914)		600	-	630	-	D, S	do.	W	Adequate and permanent. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com-pleted	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diam-eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measure-ment						
2.15.34.411	Alex Hindi	Critten	1950	-	590	-	600	6	S	Yeso fm.	W	Main aquifer at 600 ft. Adequate and permanent. Drawdown 10 ft in 30 min.
3.6.1.222	Cibola National Forest	-	(1910)	-	234	-	270	6	D	do.	W	Adequate and permanent. 6 gpm rept. on test April 1943.
3.6.4.112	Ernest Corzine	-	(1918)	6,580	139.2	1/25/50	300	-	D, S	do.	W	Adequate and permanent.
3.6.10.122	Howard Griffin	-	(1920)	6,495	206.6	1/25/50	250	-	D, S	do.	W	-
3.6.19.311	-	-	-	-	71.4	8/10/50	96M	6	S	Probably Yeso fm.	W	-
3.6.23.112	-	-	-	-	27.6	do.	-	-	S	Yeso fm.	W	Dug.
3.6.28	Santa Fe Railway	-	(1905)	-	25	-	1,080	13	A	Probably Abo fm.	-	Tested at 8 gpm.
3.6.29.243	Valentin Serna	-	1940	-	43.5	8/11/50	50	-	S	Yeso fm.	W	Dug. Main aquifer at 45 ft. Inadequate and non-permanent. See analysis, Table 16.
3.6.34.431	-	-	-	-	11.3	8/10/50	22M	-	SA	Quaternary al.	W	Dug. See analysis, Table 16.
3.7.3.434	Irving (?)	-	-	6,530	262.6	8/7/50	288M	8	A	Yeso fm.	-	-
3.7.20.114	-	-	-	6,430	147.9	8/10/50	155M	-	S	do.	W	Windmill cut off to measure water level. See analysis Table 16.
3.7.26.113	Hodges	-	-	6,655	-	-	400+	-	S	do.	W	Adequate and permanent. Unsuitable for human consumption.
3.8.1.113	-	-	-	6,260	208.7	8/3/50	220M	7	S	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
3.8.16.222	Mrs. J. L. Hodgin	-	-	6,425	184.2	8/1/50	210M	-	D, S	Yeso fm.	W	Adequate and permanent. See analysis, Table 16.
3.9.3.122	Jack Dean	-	-	-	37.0	8/3/50	90+M	-	S	Probably Tertiary (?) and Quaternary valley fill	W	Adequate and permanent. Not used for domestic purposes. See analysis, Table 16.
3.9.5.424	-	-	-	-	20.0	8/3/50	35M	5	S	do.	W	See analysis, Table 16.
3.9.33.433	Sam Brown	-	-	-	300	-	311	-	S	Probably Yeso fm.	W	Adequate and permanent. See analysis, Table 16.
3.10.15.342	-	-	-	-	15.5	1/12/51	-	-	S	Tertiary (?) and Quaternary valley fill	W	Dug.
3.10.22.121	-	-	-	-	26.9	do.	-	-	S	do.	W	Dug. See analysis, Table 16.
3.11.5.444	Harvey J. Austin	Clarence Vick	1916	-	200	-	212+	-	D, S	Precambrian granite	W	Adequate and permanent. See analysis, Table 16.
3.11.30.320	Austin	-	1949	-	64.0	8/18/49	-	-	PI	Tertiary (?) and Quaternary valley fill	-	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
3.12.9.231	Lee Campbell	Roy Jeter	1945	-	204.2	7/21/50	253	-	D, S	Weathered Precambrian granite	W	Main aquifer at 225 ft. Driller hit granite about 80 ft. Permanent. $\frac{1}{4}$ gpm rept. after 4 hrs. pumping. See analysis, Table 16.
3.13.33.413	Juan Garcia	-	(1941)	-	26.9	7/20/50	98	-	S	Yeso fm.	W	Pumped before water level measured. Permanent. See analysis, Table 16.
3.14.17.132	Valencia	-	-	-	128.5	9/20/50	150M	-	S	do.	W	See analysis, Table 16.
3.14.35.212	Estolano Chavez	-	-	6,410	204.3	9/19/50	300+M	8	D, S	do.	W	Permanent. See analysis, Table 16.
3.15.20.311	Alex Hindi	Jess Ridell	1947	6,280	168.5	6/9/53	220	8	S	do.	W	-
3.15.22.333	M. Sanchez	Rudolfo Abalaco	(1917)	6,210	187.7	6/8/53	-	-	S	do.	W	See analysis, Table 16.
3.15.28.441	Alex Hindi	-	(1900)	6,210	122.1	9/7/50	140	-	S	Probably Glorieta ss. member of San Andres fm.	W	Adequate and permanent. See analysis, Table 16.
3.15.28.441a	do.	-	(1900)	-	130	-	140	-	S	do.	W	Adequate and permanent. See analysis, Table 16.
3.15.28.441b	do.	C. L. Bowen	1952	6,210	124.8	6/9/53	148M	22	U	do.	N	-
3.15.29.310	do.	Barnett	(1930)	6,250	172.4	do.	307M	6	S	Yeso fm.	W	Adequate.
3.16.31.440	do.	"Butch" Smith	(1938)	-	600	-	650	5	S	do.	W	Main aquifer at 650 ft. Permanent.
4.5.12.444	Troy Phipps	-	-	7,235	78.9	1/19/50	140M	5	D, S	Abo fm.	W	Adequate and permanent.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
4.5.15.422	Wester	-	-	-	104+	-	-	-	D	Abo fm.	H	-
4.5.36.444	-	-	-	-	55.1	1/25/50	96M	5	S	do.	W	-
4.6.2.424	Tony Tabet	Ray Brown	(1947)	6,535	67.1	9/5/50	300	16	IA	do.	N	Measured depth 200 ft. Main aquifer at 76 ft. Inadequate.
4.6.3.444	-	-	-	-	5.3	11/16/49	10M	-	D, S	do.	W	Dug. See analysis, Table 16.
4.6.4.211	-	-	-	6,710	17.9	do.	24M	-	D	do.	B	do.
4.6.7.444	Bob Akin	-	-	-	80	-	86	-	D, S	do.	W	Adequate and permanent.
4.6.9.331	Pedro Mirabel	Phipps	(1925)	6,960	43.0	1/19/50	65	6	D, S	do.	W	Inadequate and nonpermanent.
4.6.14.442	-	-	-	-	95.8	do.	110M	5	S	do.	W	-
4.6.19.222	George Kayser	-	-	-	249.0	11/9/49	(300)	-	D, S	do.	W	Could not get good water-level measurements. Pumps dry in 45 min.
4.6.26.242	Barney Mitchell	-	-	6,675	242.3	do.	(340)	-	D, S	do.	W	See analysis, Table 16.
4.6.27.121	-	-	-	6,800	135.2	1/24/50	196M	5	D, S	do.	W	-
4.7.3.143	-	-	-	6,370	97.0	5/25/50	108M	-	A	do.	W	-
4.7.8.132	-	-	-	6,450	72.5	1/19/50	100M	7	A	do.	W	-
4.7.11.344	Mrs. Melton	-	-	6,370	104.5	6/14/50	(160)	-	D, S	do.	W	Adequate and permanent. See analysis, Table 16.
4.7.17.100	do.	-	(1919)	-	64.0	11/16/49	70M	-	D, S	Probably Abo fm.	W	Could not get good water-level measurements.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
4.7.20.112	-	-	-	6,495	114.1	1/19/50	150M	-	AD, S	Probably Abo fm.	W	-
4.7.22	John Auferoth	-	-	6,400	141.2	10/26/44	165	-	D, S	Yeso fm.	W	-
4.7.23.312	Mountainair	Layne-Texas	1944	6,355	132.7	7/27/51	178	-	M	Ls. in Yeso fm.	T	Drawdown about 17 ft at 133 gpm. See analysis, Table 16.
4.7.23.312a	do.	do.	do.	-	-	-	175	-	M	do.	T	240 gpm, rept. See analysis, Table 16.
4.7.24.444	Roy Whitehead	-	-	6,335	137.0	6/15/50	182M	-	D, S	Yeso fm.	W	Water-level measurements would not check. Adequate and permanent.
4.7.27	John Auferoth	K. A. Huey	(1930)	6,390	144.5	10/26/44	165	5	D, S	do.	W	Adequate and permanent.
4.7.27.434	J. P. Farmer	-	-	6,430	165.6	6/15/50	198	6	D, S	do.	P	Cavity reported at bottom. Adequate and permanent.
4.7.31	Dawson	-	-	6, 550	265	-	285	-	-	do.	W	Drawdown to 285 ft in 8-hr test at 12 gpm.
4.7.32.331	Mountainair No. 4	K. A. Huey	-	6,545	264.0	10/26/44	308	-	UM	do.	W	Permanent.
4.7.32.332	Mountainair No. 2	do.	-	6,545	(300)	-	586	-	UM	Probably Yeso fm.	P	-
4.7.32.414	Mrs. Margaret E. Elliott	-	(1930)	6,490	193.0	6/15/50	250M	-	D, S	Yeso fm.	W	Adequate and permanent. See analysis, Table 16.
4.8.1.144	J. M. Harper	-	1938	6,130	55.3	7/9/41	58	-	D	Tertiary (?) and Quaternary valley fill	B	Dug.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
4.8.2.121	-	-	-	6,160	93.8	6/15/50	115M	-	A	Tertiary (?) and Quaternary valley fill	W	-
4.8.9.343	-	-	-	6,275	154.0	do.	180M	-	A	Probably Tertiary (?) and Quaternary valley fill	H	-
4.8.11.233	R. B. Slease	-	1950	-	81.5	5/19/50	-	-	U	do.	N	-
4.8.11.433	do.	J. J. Merrifield	1949	-	83.2	2/8/50	180	16	PI	Tertiary (?) and Quaternary valley fill	N	Drilled 20 ft into solid rock.
4.8.12.233	do.	do.	-	-	61.0	5/2/51	-	16	PI	do.	N	Cavity rept. at bottom.
4.8.12.330	do.	-	-	-	67.9	2/8/50	-	6	A	do.	W	-
4.8.12.333	do.	J. J. Merrifield	1949	-	71.2	do.	272	16	PI	do.	N	Drilled through 60 ft solid rock. Cavity rept. at bottom. Drawdown 20 ft in 142 hr.
4.8.13.133	C. O. Hagan	George Glimes	1949	6,140	79.6	5/4/49	225	16	I	do.	T	Main aquifer at 105 ft. 980 gpm, meas. See analysis, Table 16.
4.8.13.233	do.	J. J. Merrifield	1949	6,130	71.1	2/8/50	216	16	I	do.	T	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
4.8.13.333	R. B. Slease	J. J. Merrifield	1949	-	79.8	2/8/50	230	16	I	Tertiary (?) and Quaternary valley fill	T	800 gpm, meas.
4.8.13.412	do.	do.	1949	6,120	65.7	do.	242	16	I	do.	T	See analysis, Table 16.
4.8.14.140	do.	do.	1949	-	94.4	do.	200	16	U	do.	N	Well filled May 1950. 200 gpm, rept.
4.8.14.233	do.	-	1950	-	92.0	5/19/50	-	16	PI	do.	N	-
4.8.14.433	do.	J. J. Merrifield	1949	-	93.9	2/8/50	211M	16	PI	do.	N	-
4.8.18.122	A. B. Blake	-	-	6,290	118.0	6/14/50	200	-	D, S	Probably Tertiary (?) and Quaternary valley fill	W	Adequate and permanent. See analysis, Table 16.
4.8.24.133	R. B. Slease	George Glimes	1949	-	84.5	5/4/49	230	20	I	Tertiary (?) and Quaternary valley fill	T	Main aquifer at 200 ft. 1,200 gpm, meas. Drawdown 23 ft on test. See analysis, Table 16.
4.8.24.222	Maurice Ottoson	Roy Custer	1940	6,120	57.2	1/7/41	157	6	D	do.	W	-
4.9.5.344	do.	-	-	-	31.3	9/4/46	-	6	A	do.	W	-
4.9.6.400	Roland Benson	-	1940	-	36.8	2/13/41	41	-	A	do.	W	Bored. Main aquifer at 36 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
4.9.6.444	Red Ball Camp	-	-	-	36.7	2/20/41	-	-	A	Tertiary (?) and Quaternary valley fill	H	-
4.9.7.441	Maurice Ottoson	-	-	6,110	54.1	7/9/41	-	6	A	do.	W	-
4.9.8.100	Inland Utilities no. 1	-	-	-	32	-	148	12	Ind	do.	—	1,000 gpm, rept. Drawdown 35 ft on test.
4.9.8.144	Santa Fe Railway	-	-	6,100	32.3	2/13/41	235	10	RR	do.	T	Drawdown 30 ft.
4.9.10.133	Loyd Brandenburg	-	-	6,080	19.2	2/20/41	-	6	S	do.	W	-
4.9.11.112	do.	Hendrickson and Smith	1950	6,040	0.2	3/2/51	7M	6	U	do.	N	Bored. Equipped with water stage recorder for 1½ years. See analysis, Table 16.
4.9.11.312	do.	-	-	-	Flowing	7/23/45	20-	-	S	do.	N	Dug. See analysis, Table 16.
4.9.16.131	-	-	-	-	24.0	1/19/51	33M	5	S	do.	W	See analysis, Table 16.
4.9.19.440	Hammerstock	George Glimes	1948	-	43.5	6/22/49	130	16	PI	do.	N	Main aquifer at 50 ft.
4.9.22.122	Jack Dean	-	-	-	5.2	8/3/50	100M	6	A	do.	W	-
4.10.2.143	W. W. and A. D. Formwalt	-	-	-	92.4	8/1/50	100M	-	S	do.	W	See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
4.11.22.132	F. J. Austin	Tom Stump	-	-	220	-	300	-	S	Precambrian metamorphic rocks	W	See analysis, Table 16.
4.12.22.234	W. W. Mitchell	-	1935	-	230.4	7/21/50	280+	14	D, S	do.	W	Adequate and permanent. See analysis, Table 16.
4.13.12.114	Buck Harvey	-	(1941)	-	160	-	(180)	-	S	Yeso fm.	W	Adequate and permanent. Good taste.
4.13.22.220	do.	-	(1914)	-	120	-	(200)	-	S	do.	W	Adequate and permanent. See analysis, Table 16.
4.13.29.244	-	-	-	-	204.3	9/20/50	280M	18	S	do.	W	-
4.14.9.422	-	-	-	-	25.8	9/21/50	125M	6	S	Probably Yeso fm.	W	-
4.14.19.412	A. Wayne Price	-	-	-	140.2	do.	240M	-	S	Yeso fm.	W	Windmill cut off to measure water level. See analysis, Table 16.
4.14.27.442	-	-	-	-	257.8	9/19/50	300M	-	A	do.	W	-
4.15.11.413	Claude Collins	-	-	6,190	400	-	550	-	S	do.	W	Adequate and permanent. Sulfate taste.
5.5.23.433	McKinley	-	-	7,355	59.9	11/17/49	140	5	D	Madera ls.	P	Measured depth: 107 ft. See analysis, Table 16.
5.5.35.312	Cibola National Forest	-	-	7,435	6.4	11/16/49	52M	5	A	Probably Tertiary (?) and Quaternary valley fill	N	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.5.36.411	Dick Candelaria	L. A. Anderson	1947	7,135	78.2	11/9/49	170	6	D,S	Abo fm.	W	Measured depth 142 ft. Adequate and permanent.
5.6.3.141	Juanita Moorehead	-	1945	6,680	59.0	5/26/50	69	-	D,S	Tertiary (?) and Quaternary valley fill.	W	Measured depth 68 ft. Adequate and permanent.
5.6.6.221	Delfin Davalo	L. A. Anderson	1942	6,950	108.5	11/18/49	173	6	D,S	Madera ls.	W	Deepened 1948. Adequate.
5.6.7.122	L. A. Anderson	do.	-	7,055	203.4	11/17/49	245	6	D,S	do.	W,P	Adequate and permanent.
5.6.10.344	McClellan	Lane and Reese	(1946)	6,700	111.3	11/29/49	229	6	U	Tertiary (?) and Quaternary valley fill	N	Measured depth 146 ft.
5.6.10.344a	do.	-	(1920)	6,700	130	-	150	-	D	do.	W	See analysis, Table 16.
5.6.20.313	-	-	-	6,810	19.1	11/17/49	19.2M	-	U	do.	B	Dug. Almost dry.
5.6.24.224	G. G. Imboden	-	1919	6,440	95.0	5/25/50	183M	7	D	Tertiary (?) and Quaternary valley fill or Abo fm.	W	Inadequate.
5.6.25.311	-	-	-	6,465	99.5	6/8/50	-	-	D,S	do.	W	Windmill cut off to measure.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.6.27.124	Anastacio Candelaria	-	-	6,605	74.9	11/17/49	80	-	D, S	Probably Tertiary (?) and Quaternary valley fill	W	Dug. Adequate and permanent.
5.7.6.331	M. W. Alexander	-	(1923)	6,515	133.9	6/8/50	150	6	D, S	Tertiary (?) and Quaternary valley fill or Abo fm.	P	Measured depth 140 ft.
5.7.9.122	-	-	-	6,405	169.6	do.	186M	-	A	Probably Tertiary (?) and Quaternary valley fill	W	-
5.7.11.411	O. H. Brown	Ray Brown	-	6,245	86.4	9/14/47	120	16	I	Tertiary (?) and Quaternary valley fill	T	400 gpm, rept.
5.7.15.212	Ewing School	-	-	6,305	117.9	2/21/41	-	-	Sc	do.	W	Public school well. See analysis, Table 16.
5.7.27.244	Jacobo Chavez	Ray Brown	(1950)	6,250	47.5	5/25/50	100M	8	D, S	do.	W	Adequate.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.7.29.433	-	-	-	6,345	38.3	5/25/50	180M	8	A	Tertiary (?) and Quaternary valley fill or Abo fm.	W	-
5.7.31	Mountainair no. 1	Layne-Texas	1944	-	26	-	108	-	U	Abo fm.	N	Municipal test well.
5.7.31.200	Mountainair	do.	1944	-	23	-	104	-	U	do.	N	do.
5.7.32	-	Earl T. Hoard	1938	-	23	-	82	-	U	do.	N	Municipal test well. 80 gpm, rept. Drawdown about 58 ft in over 24 hr.
5.7.36.333	Lee Elliott	Fincher	1950	6,285	71.3	5/25/50	150	13	S	do.	W	Measured depth 150 ft. Main aquifer at 73 ft.
5.7.36.334	Do.	-	1933	6,280	96	-	110	-	A	do.	W	Equipment removed and hole plugged, Sept. 1950. See analysis, Table 16.
5.8.2.333	J. B. Chamberlain	Ed Cowley	1931	6,135	Flowing	2/13/41	150	8	S	Tertiary (?) and Quaternary valley fill	N	About 50 gpm rept. See analysis, Table 16.
5.8.4.343	F. C. Bowden	-	-	6,185	30.9	9/9/41	-	8	S	do.	W	-
5.8.5.131	Glen Gustin	Pat Homan	1949	6,220	63.4	5/4/49	150	12	I	do.	T	-
5.8.5.311	do.	Glen Gustin	1948	6,215	64.0	5/18/48	256	16	I	do.	T	Pumping level about 140 ft. 380 gpm meas.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.8.5.344	McMath	W. M. Hibner	1947	6,200	51.1	2/18/47	200	18	I	Tertiary (?) and Quaternary valley fill	T	910 gpm, meas. See analysis, Table 16.
5.8.6.431	W. M. Hibner	W. M. Hibner	1946	6,235	84.3	5/18/48	212	18	I	do.	T	Main aquifer at 126 ft. 630 gpm, meas. Drawdown 34 ft.
5.8.7.431	John Ingle	Ray Brown	1946	6,230	70.6	5/14/46	201	16	I	do.	T	680 gpm, meas.
5.8.8.331	Madison Davis	do.	1946	6,215	54.2	2/18/47	200	18	I	do.	T	710 gpm, meas.
5.8.8.341	Guy Edwards	J. C. Richards	1950	6,210	59	-	200	-	I	do.	T	See analysis, Table 16.
5.8.8.424	Arling T. Austin	Lane	1947	6,185	62.0	3/23/48	204	20	I	do.	T	1,360 gpm, meas. Drawdown 17 ft. See analysis, Table 16.
5.8.9.423	F. C. Bowden	Ray Brown	1946	6,185	53.1	9/5/46	150	9	D, S	do.	W, P	-
5.8.10.331	Charles Rattan	do.	1946	-	18.9	do.	176	16	I	do.	T	800 gpm, rept.
5.8.10.331a	do.	do.	1947	-	22.6	9/14/47	158	18	I	do.	T	-
5.8.10.333	do.	do.	1946	-	18.4	5/14/46	132	16	I	do.	T	800 to 900 gpm, rept.
5.8.11.122	Floyd Bailey	Bill Brown	1950	-	12.8	3/1/50	240	16	U	do.	N	500 to 600 gpm, rept.
5.8.11.212	do.	-	1950	-	11.1	do.	171	6	U	do.	N	400 gpm, rept.
5.8.11.221	J. B. Chamberlain	Henry Sawyer	(1910)	6,120	11.3	2/13/41	18	-	A	do.	W	Dug.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com- pleted	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measure- ment	Depth of well (feet)	Diam- eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.8.11.221a	J. B. Chamberlain	-	-	-	11.6	2/15/49	23	8	S	Tertiary (?) and Quater- nary val- ley fill	W	-
5.8.12.111	do.	Ed Cowley	1931	6,120	17.1	2/13/41	212	6	A	do.	H	Main aquifer at 200 ft.
5.8.15.113	D. S. Bailey	Ray Brown	1946	6,160	17.9	2/18/47	153	18	I	do.	T	940 gpm, meas.
5.8.15.131	Joe Begley	do.	1945	-	13.7	5/8/45	125	16	I	do.	T	Main aquifer at 115 ft. 500 gpm, rept. Drawdown 27 ft at 300 gpm. See analysis, Table 16.
5.8.15.131a	do.	-	1946	-	18.3	5/14/46	70	8	D	do.	—	See analysis, Table 16.
5.8.15.311	Charles Rattan	-	1946	-	21.0	do.	151	16	I	do.	T	-
5.8.15.313	do.	Pat Homan	1945	-	20.6	2/20/46	225	16	I	do.	T	Main aquifer at 70 ft. 750 gpm, rept. Drawdown 77 ft.
5.8.16.111	Arling T. Austin	Lane	1947	6,205	58.1	9/14/47	204	20	I	do.	T	1,090 gpm, meas. Drawdown 31 ft.
5.8.16.211	Ben Mullen	Lane	1947	6,190	49.1	9/14/47	185	20	I	do.	T	1,215 gpm, meas.
5.8.16.231	Ace Giles	Ray Brown	1947	6,180	44	-	162	18	I	do.	T	Main aquifer at 56 ft. 2,200 gpm, rept.
5.8.16.421	Joe Begley	do.	1948	6,170	28.4	5/19/48	150	16	I	do.	T	1,110 gpm, meas.
5.8.17.113	Madison Davis	do.	1945	-	43.3	5/8/45	148	16	I	do.	T	Main aquifer at 95 ft. 975 gpm, meas. See analysis, Table 16.
5.8.17.212	Virgil Garland	do.	1947	-	56.7	9/14/47	201	18	I	do.	T	Main aquifer at 82 ft. 1,070 gpm, meas.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
5.8.17.241	Ray Brown	-	-	6,195	43.1	7/10/41	-	-	U	Tertiary (?) and Quaternary valley fill	—	-
5.8.17.311	do.	-	1925	6,195	27.4	1/7/41	127	24	I	do.	T	1,200 gpm, rept.
5.8.17.311a	do.	-	-	-	30.1	5/27/47	-	-	I	do.	T	2,380 gpm, meas.
5.8.17.323	do.	Ray Brown	1936	6,190	29.8	1/7/41	135	-	I	do.	T	Main aquifer at 32 ft. 500 gpm, rept. See analysis, Table 16.
5.8.17.334	do.	-	-	6,185	13.6	2/19/41	-	-	D	do.	H	Dug.
5.8.18.224	S. W. Hodgson	Pugh	1906	6,215	42.9	7/10/41	60	6	D	do.	H	-
5.8.18.233	do.	-	1946	-	39.2	5/14/46	153	16	I	do.	T	-
5.8.18.312	Willard Hodgson	Ray Brown	-	-	38.6	2/18/47	159	18	I	do.	T	1,100 gpm, meas. See analysis, Table 16.
5.8.18.313	do.	do.	1947	6,200	32.2	do.	64	6	D	do.	B	-
5.8.18.421	F. H. Ayers	do.	1946	6,195	27.6	5/14/46	146	16	I	do.	T	890 gpm, meas.
5.8.21.111	R. B. Ford	do.	1945	-	27.6	2/20/46	169	16	I	do.	T	400 gpm, rept. Drawdown 30 ft.
5.8.24.311	B. E. Wallace	do.	1946	6,115	21.9	do.	200	16	I	do.	T	Main aquifer at 30 ft. 300 gpm, rept. See analysis, Table 16.
5.8.25.212	Homer Arnn	-	-	6,120	24.6	7/9/41	27M	-	DA	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.8.25.222a	Homer Arnn	-	(1912)	6,115	26.3	2/13/41	300	-	IA	Tertiary (?) and Quaternary valley fill	N	Dug and drilled.
5.8.25.222b	Homer Arnn (1946)	-	-	-	28.2	do.	-	-	D, S	do.	W	Dug.
5.8.27.122	-	-	-	6,150	21.7	6/15/50	25M	-	DA,S	do.	W	See analysis, Table 16.
5.8.28.122	-	-	-	6,160	18.5	2/9/50	-	5	S	do.	W	-
5.8.30.121	-	-	-	6,195	29.7	2/19/41	-	-	DA	do.	W	Dug. See analysis, Table 16.
5.8.32.333	Frank Meder	-	-	6,230	71.4	do.	-	-	D, S	do.	W	-
5.8.36.341	Mrs. Iva Deane Moe	-	-	6,110	46.6	2/13/41	300	12	S	do.	W	See analysis, Table 16.
5.9.6.311	Homer Berkshire	-	-	-	21.9	1/12/51	53M	6	S	Do.	W	do.
5.9.8.413	F. C. Bowden	Nat Kellogg	-	-	61	-	206	16	I	do.	T	Main aquifer at 110 ft. 700 gpm, rept. Drawdown 16 ft.
5.9.29.111	-	-	-	-	22.2	12/15/49	-	5	S	do.	W	-
5.9.31.331	G. L. McBeth	-	-	6,110	34.7	2/13/41	210	24	I	do.	T	Main aquifer at 35 ft.
5.9.32.211	Loyd Brandenburg	-	-	6,090	19.6	4/26/50	50M	6	D, S	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
5.10.13.443	-	-	-	6,175	96.0	7/28/50	125M	-	S	Tertiary (?) and Quaternary valley fill	W	Pumping when measured. See analysis, Table 16.
5.10.27.444	-	-	-	6,105	40.8	2/20/41	-	6	S	do.	W	-
5.10.31.133	-	-	-	6,100	24.0	do.	25+M	-	SA	do.	W	Dug.
5.11.12.211	Burnett Harvey	-	-	-	105.0	12/22/50	180M	6	S	Precambrian metamorphic rocks	W	Adequate and permanent. See analysis, Table 16.
5.12.23.333	John Harris	Bailey	(1923)	-	170.0	1/5/51	250	-	D	Probably Precambrian metamorphic rocks	W	Could not get good water-level measurement. Adequate and permanent.
5.13.17.243	Ted McLaughlin	-	(1912)	-	53.7	7/19/50	298	-	D, S	Precambrian metamorphic rocks	W	Adequate and permanent.
5.13.17.300	do.	-	1907	-	40	-	150	-	S	do.	W	Do.
5.13.21.100	Buck Harvey	-	(1930)	-	160	-	194	-	S	Probably Precambrian metamorphic rocks	W	Do.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
5.13.22.240	Buck Harvey	-	(1915)	-	160	-	(200)	-	S	Probably Precambrian metamorphic rocks	—	Adequate and permanent.
5.13.28.133	do.	-	(1915)	6,320	160	-	184	-	D, S	do.	W	Adequate and permanent. See analysis, Table 16.
5.14.1.111	Potter	-	-	-	178.1	7/21/50	300+	-	S	Yeso fm.	W	Adequate and permanent. Sulfate taste.
5.14.4.433	do.	Ferguson	1949	-	540	-	640	-	S	do.	W	-
5.14.9.240	do.	-	-	-	43	-	-	-	S	Probably Yeso fm.	W	Adequate and permanent.
5.14.23.422	A. R. Cecil	-	(1920)	6,110	18.3	9/26/50	24	-	S	do.	W	Dug. 20 gpm, rept.
6.5.25.344	-	-	-	7,280	6.1	12/7/49	8M	-	D	Madera ls.	B	Dug.
6.6.2.122	Diego Barela	-	-	6,793	256.5	12/8/49	316	6	D, S	do.	W	Relation of water level to land surface not known.
6.6.4.210	Martinez Sanchez	-	-	7,110	23.2	do.	-	-	D	do.	B	Dug. Relation of water level to land surface not known.
6.6.11.334	-	-	-	6,690	59.9	3/9/51	(180M)	5	IndA	do.	P	Abandoned sawmill.
6.6.13.210	Cecil D'Spain	Ed Kelly	(1930)	6,555	175.1	12/9/49	240	8	D, S	do.	P,W	Main aquifer at 238 ft. Adequate and permanent.
6.6.14.111	Tajique town	Lane	1948	6,655	59.4	12/7/49	200	-	M	do.	P	Relation of water level to land surface not known. First water at about 30 ft sealed off. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
6.6.15.224	George Formwalt	-	-	6,690	37.2	12/7/49	39M	-	D	Madera ls.	B	Dug.
6.6.22.431	-	-	-	6,730	85.7	do.	-	5	S	do.	W	Relation of water level to land surface not known. See analysis, Table 16.
6.6.29.344	Francisco Sanchez	-	1914	6,985	150	-	176	8	D, S	do.	W	Adequate and permanent.
6.6.30.433	Pat Lujan	L. A. Anderson	1949	7,075	98.5	12/7/49	200	5	D, S	do.	W	Do.
6.6.32.220	Francisco Sanchez	-	(1936)	6,985	162.8	do.	-	-	S	do.	W	-
6.7.7.244	Johnnie Stephens	-	1917	6,515	143.4	12/9/49	150	8	D, S	do.	W	-
6.7.9.424	-	-	-	-	64.0	6/9/50	72M	6	DA,S	Tertiary (?) and Quaternary valley fill	W	-
6.7.11.222	-	-	-	-	138.6	12/15/49	-	-	S	do.	W	-
6.7.15.433	Ralph G. Smith	-	(1916)	6,345	154.9	6/9/50	170	10	D, S	Probably Madera ls.	P,W	Adequate and permanent. See analysis, Table 16.
6.7.25.133	Charles Clark	Ray Brown	1947	6,250	73.2	3/23/48	(300)	14	I	Tertiary (?) and Quaternary valley fill	—	Main aquifer at 85 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com-pleted	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diam-eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measure-ment						
6.7.26.400	Roy Reynolds	-	1948	6,280	116	-	375	-	I	Tertiary (?) and Quater-nary val-ley fill	—	Main aquifer at 132 ft. 200 gpm. Drawdown 34 ft.
6.7.27.343	-	-	-	6,340	131.8	6/8/50	145M	-	S	do.	W	-
6.7.28.200	Claude Brown	Charlie Flood	1948	6,380	172	-	272	9	I	Probably Madera ls.	T	350 gpm, rept. Drawdown 11 ft.
6.7.29.343	Melcor Lujan	Fry	1947	6,460	147.1	6/8/50	200	6	D, S	do.	W	-
6.7.35.411	Jan Dellinger	-	1948	6,260	58.0	5/4/49	-	-	I	Tertiary (?) and Quater-nary val-ley fill	—	-
6.8.1.111	Pat Homan	Pat Homan	-	-	22.3	5/19/48	(450)	18	I	do.	—	See analysis, Table 16.
6.8.1.244	J. H. Wiggins	-	-	6,100	21.5	9/9/41	-	-	S	do.	W	Dug.
6.8.2.111	Ellison Timmons	-	-	-	16.1	3/24/48	-	14	UI	do.	—	-
6.8.2.333	-	-	-	6,140	13.1	2/16/41	-	-	A	do.	—	Dug.
6.8.3.221	Ellison Timmons	Ray Brown	1940	6,160	26.3	2/14/41	195	18	U	do.	—	Main aquifer at 80 ft. 150 gpm, rept.
6.8.8.424	-	-	-	6,220	75.4	7/23/41	-	6	A	do.	N	-
6.8.9.112	Johnson	Cunningham	1948	6,230	91.5	5/19/48	268	16	I	do.	T	1,100 gpm, estimated. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
6.8.10.433	Allen Ayers	Leo Koger	1951	-	-	-	200	16	PI	Tertiary (?) and Quaternary valley fill	—	-
6.8.11.420	Estancia town	Nat Kellogg	(1936)	-	7	-	75	10	M	do.	T	Main aquifer at 40 ft. 250 gpm, rept. See analysis, Table 16.
6.8.11.433	Pablo Lucero	-	-	6,130	6.1	3/10/41	-	-	-	do.	—	Dug.
6.8.12.133	Aurileo Brito	-	-	6,120	21.1	2/21/41	21+	-	D	do.	B	do.
6.8.15.444	Estancia Cemetery	-	-	6,155	31.0	2/13/41	-	-	-	do.	W	Cemetery.
6.8.16.222	McGee estate	-	-	6,190	59.5	2/21/41	-	-	D,S	do.	W	-
6.8.24.111	Aurileo Brito	-	-	6,125	8.6	2/13/41	-	-	D,S	do.	W	Dug. See analysis, Table 16.
6.8.27.134	R. M. Spruill	Nat Kellogg	-	6,165	20.6	7/10/41	100	6	S	do.	W	-
6.8.27.331	Allen Ayers	Ray Brown	1949	6,170	30	-	244	18	I	do.	—	Main aquifer at 115 ft. See analysis, Table 16.
6.8.30.434	J. W. Langley	-	-	6,200	39.7	2/21/41	60	-	D,S	do.	W	Dug and drilled.
6.8.32.113	Roy Waggoner	Ray Brown	1949	6,180	40	-	275	-	I	do.	T	600 gpm, rept. See analysis, Table 16.
6.8.32.212	O. R. Ethridge	W. M. Hibner	1946	6,170	23.2	2/18/47	209	18	I	do.	T	Main aquifer at 140 ft. 630 gpm, meas. Drawdown 70 ft. See analysis, Table 16.
6.8.32.400	do.	do.	1947	6,185	65	-	243	20	I	do.	T	Main aquifer at 120 ft. Drawdown 30 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
6.8.34.311	J. B. Chamberlain	Ray Brown	1946	6,165	16.5	9/5/46	150	14	I	Tertiary (?) and Quaternary valley fill	T	650 gpm, meas.
6.9.9.222	-	-	-	6,080	6.2	2/20/41	-	8	S	do.	W	See analysis, Table 16.
6.9.11.211	H. E. Means	Ray Brown	-	-	5.1	5/4/49	148	18	I	do.	—	1,260 gpm, meas. See analysis, Table 16.
6.9.28.333	-	-	-	-	14.8	1/19/51	26M	6	S	do.	W	Windmill cut off to measure. See analysis, Table 16.
6.9.33.333	-	-	-	-	17.2	12/15/49	-	8	S	do.	W	See analysis, Table 16.
6.10.5.312	Milton Berkshire	-	1948	-	11.0	2/16/49	186	16	I	Probably Tertiary (?) and Quaternary valley fill	T	-
6.10.7.112	-	-	-	6,080	5.7	2/16/49	-	6	S	Tertiary (?) and Quaternary valley fill	W	See analysis, Table 16.
6.10.8.112	J. M. Milbourne and son	Pat Homan	1948	-	7.9	9/2/48	169	16	I	do.	T	Main aquifer at 142 ft. 1,500 gpm, rept. Drawdown 22 ft. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com-pleted	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measure-ment	Depth of well (feet)	Diam-eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
6.10.12.433	-	-	-	-	36.3	7/28/50	70M	8	S	Probably Tertiary (?) and Quater-nary val-ley fill	W	-
6.10.15.143	Milton Berkshire	-	-	6,075	17.0	7/27/50	35M	7	S	Tertiary (?) and Quater-nary val-ley fill	W	-
6.10.25.344	C. A. Blackwell	-	1936	6,130	42.7	7/12/41	63	7	S	do.	W	-
6.10.27.400	Dean ranch	-	-	-	25	-	50-	-	-	do.	—	See analysis, Table 16.
6.10.27.444	Fred Lick	-	-	6,085	20.8	2/20/41	40M	6	S	do.	W	-
6.10.32.222	Jones Land and Cattle Co.	-	1949	-	13.0	7/27/50	95M	5	S	do.	W	See analysis, Table 16.
6.11.10.212	-	-	-	6,255	102.9	7/28/50	-	-	S	Probably Tertiary (?) and Quater-nary val-ley fill	W	Windmill cut off to measure. Estimated nonpumping level 90 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com-pleted	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measure-ment	Depth of well (feet)	Diam-eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
6.11.19.234	Jones Land and Cattle Co.	-	-	-	31.0	7/28/50	56M	6	S	Tertiary (?) and Quaternary valley fill	W	See analysis, Table 16.
6.11½.24.222	A. Wayne Price	Ferguson	-	6,310	80.8	7/12/50	108M	-	S	Precambrian metamorphic rocks	W	Adequate and permanent.
6.12.2.110	do.	do.	-	-	(350)	-	538	-	S	do.	W	Do.
6.12.15.244	Harold C. Pric.	do.	-	-	360	-	405	-	S	do.	W	Do.
6.12.18.411	do.	-	-	-	66	-	140	-	S	do.	W	See analysis, Table 16.
6.13.1.111	Bigbee	-	(1900)	-	175	-	220	-	S	Yeso fm.	W	-
6.13.17.124	do.	"Dub" Jones	(1940)	-	362	-	377	-	S	Probably Precambrian quartzite	W	Permanent.
6.13.30.320	Ted McLaughlin	W. L. Cruse	-	-	190	-	260	-	D, S	Precambrian metamorphic rocks	W	Main aquifer at 235 ft. Adequate and permanent.
6.13.33.414	Santa Fe Railway	O. V. Poe	1930	-	153	-	701	-	RR	do.	T	Drawdown 60 ft at 110 gpm.
6.14.17.110	-	-	-	6,310	177.8	7/20/50	325M	6	S	Yeso fm.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
6.14.29.413	Potter	Ferguson	1948	-	540	-	646	-	S	Yeso fm.	W	Adequate and permanent. Sulfate taste. Unfit for most stock.
6.14.30.411	-	do.	1952	-	99.4	7/5/52	245M	-	U	do.	N	-
6.15.25.210	Theo Berlier	Ranker	1947	-	890	-	941	-	S	do.	W	Adequate and permanent.
7.6.26.411	-	-	(1938)	6,900	54.0	12/8/49	-	-	S	Madera ls.	W	See analysis, Table 16.
7.6.27.341	Glover	Leo and Henry Irving	-	-	148.7	12/8/49	168	6	D	do.	W	Adequate.
7.6.36.111	Placido Chavez	-	(1940)	6,800	25.5	do.	60	-	D, S	do.	H, W	Do.
7.6.36.122	-	-	-	6,720	47.3	do.	70M	-	D, S	do.	W	-
7.6.36.213	Lorenzo Barela	-	-	6,700	39.0	12/9/49	50	-	D, S	do.	W	Dug. Dry in very dry periods.
7.6.36.214	Filomeno Barela	-	1931	6,700	44.5	do.	112	-	D, S	do.	W	Adequate.
7.7.4.313	Charley Lucero	-	-	6,645	160.3	11/7/49	-	-	D, S	do.	W	-
7.7.10.422	-	-	-	6,460	103.2	5/12/50	110M	-	S	do.	W	See analysis, Table 16.
7.7.12.342	DeHart estate	B. F. Strotman	1936	6,355	45.4	2/15/41	65	-	-	do.	W	Do.
7.7.12.444	C. R. Roland	do.	-	6,350	46.5	do.	1,359	7	U	do.	—	CO_2 test well. Main aquifer at 64 ft.
7.7.17.444	O. H. Tinnin	-	-	6,600	224.0	2/3/50	262	-	D, S	do.	P	Adequate.
7.7.19.111	-	-	-	6,745	60.5	12/9/49	-	5	A	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
7.7.23.112	-	-	-	6,455	119.9	5/11/50	145M	-	S	Madera ls.	W	See analysis, Table 16.
7.7.29.343	Bob Garland	-	(1930)	6,575	236.6	2/3/50	245M	5	D, S	do.	W	Adequate and permanent. See analysis, Table 16.
7.7.34.144	-	-	-	6,380	66.7	5/11/50	93M	5	S	do.	W	-
7.8.1.231	Myrtle A. Homan estate	Jack Lamb	1933	6,140	27.2	7/11/41	56	8	S	Tertiary (?) and Quaternary valley fill	W	-
7.8.1.423	Floyd Stump	Floyd Stump	1941	6,150	24.8	2/15/41	103	10	I	do.	T	Main aquifer at 45 ft. Drawdown 54 ft in 2 hr at 150 gpm. See analysis, Table 16.
7.8.3.140	Wayne Laws	-	-	6,225	54.3	9/16/47	-	18	I	do.	T	Main aquifer at 60 ft.
7.8.3.300	Neal Jenson	Ed Cowley	1921	6,190	5.3	5/28/47	84	18	I	do.	T	1,340 gpm, meas.
7.8.3.300a	do.	Charlie Blount	1948	-	11.1	10/26/48	130	20	I	do.	T	Main aquifer at 82 ft. 1,400 gpm, rept.
7.8.3.433	Antelope Springs Co.	R. E. Farley	1922	-	15.5	9/1/50	-	12	I	do.	T	Drawdown 4 ft at 1,250 gpm.
7.8.3.433a	do.	Charlie Blount	1947	-	22	-	94	20	I	do.	T	Main aquifer at 86 ft. Cavern at bottom. Drawdown 4 ft at 1,500 gpm. See analysis, Table 16.
7.8.3.434	H. W. Rice	-	-	6,175	Flowing	-	-	-	S	do.	—	-
7.8.4.211	Ensminger	J. C. Richards	1950	6,255	(135)	-	224	-	I	Probably Madera ls.	T	Main aquifer at 178 ft. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
7.8.6.224	J. H. Hunt	-	-	6,320	80.0	2/23/50	90	7	D, S	Tertiary (?) and Quaternary valley fill	W	Measured depth 97 ft. Nonpermanent.
7.8.7.121	C. T. Norman	W. M. Hibner	1947	6,350	75.2	5/28/47	200	12	—	Madera ls.	—	-
7.8.8.311	Knox and Barron	Knox and Thomas	-	6,320	109.2	5/19/48	348	16	—	do.	—	-
7.8.9.112	Wayne Laws	-	-	6,220	12.4	5/3/49	13.4M	-	Pl	Probably Madera ls.	N	-
7.8.9.431	Knox and Barron	Knox	1948	6,255	44.7	8/10/48	297	16	—	do.	T	Main aquifer at 272 ft. 850 gpm, rept. 59°F. See analysis, Table 16.
7.8.9.444	-	-	-	6,255	62.5	2/15/41	65M	6	U	Probably Tertiary (?) and Quaternary valley fill	N	-
7.8.10.221	H. W. Rice	-	-	6,195	17.7	3/11/41	-	-	-	Tertiary (?) and Quaternary valley fill	B, W	-
7.8.10.244	-	-	-	6,190	18.6	7/11/41	-	-	-	do.	P	Dug.
7.8.11.132	Antelope Springs Co.	Nat Kellogg	1942	-	9.2	5/28/47	250	18	I	do.	T	Deepened 1947. Drawdown 100 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
7.8.12.433	W. A. Deatherege	W. A. Deatherege	1938	6,135	23.5	2/21/41	30	-	D	Tertiary (?) and Quaternary valley fill	—	-
7.8.12.433a	Arthur Schmidt	Crawford	1947	-	22.2	9/16/47	103	12	PI	do.	T	Drawdown 20 ft at 75 gpm, rept.
7.8.16.142	J. Thomas	-	1946	6,255	63.7	9/6/46	231	16	I	Probably Madera ls.	T	1,500 gpm, meas. See analysis, Table 16.
7.8.16.422	B. F. Strotman	-	-	6,230	45.6	2/15/41	100	8	D, S	Tertiary (?) and Quaternary valley fill	W	-
7.8.19.422	Bruce Grimes	-	1948	6,320	131.1	2/16/49	400	12	PI(A)	Probably Tertiary (?) and Quaternary valley fill	N	Filled in 1951.
7.8.20.240	J. B. Burns	-	-	6,265	86.7	3/24/48	-	-	I	Tertiary (?) and Quaternary valley fill	N	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
7.8.20.334	Marion Gates	Pat Homan	1948	6,305	110.2	3/24/48	202	16	I	Probably Tertiary (?) and Quaternary valley fill	T	1,100 gpm, rept.
7.8.23.311	Paul McCall	Nat Kellogg	(1930)	6,190	18.3	2/14/41	75	12	I	Tertiary (?) and Quaternary valley fill	T	Main aquifer at 15 ft. 800 gpm, rept.
7.8.23.324	Oller L. Austin	-	1924	6,165	2.5	do.	161	12	U	do.	N	Filled in 1951.
7.8.23.334	James P. Morgan	-	-	6,175	6.5	do.	(30)	6	D, S	do.	W	Inadequate.
7.8.24.431	R. T. Floyd	-	1947	-	21.8	5/28/47	(275)	12	I	do.	T	240 gpm, meas. See analysis, Table 16.
7.8.24.433	do.	-	-	6,125	25.2	2/14/41	27M	-	—	do.	—	See analysis, Table 16.
7.8.25.411	do.	Floyd Stump	(1938)	6,110	23.5	do.	237	-	U	do.	N	Main aquifer at 25 ft.
7.8.26.121	Mrs. T. M. McCloskey	-	-	-	4.0	2/4/43	-	-	—	do.	N	Dug. 600 gpm, meas. See analysis, Table 16.
7.8.26.121a	Cole Strong	Pat Homan	1947	-	Flowing	11/26/47	315M	16	I	do.	T	See analysis, Table 16.
7.8.26.141	Richter	Ray Brown	1945	-	8.9	5/8/45	100	18	PI	do.	—	Main aquifer at 75 ft.
7.8.27.221	F. C. Pace	-	-	6,185	19.8	2/14/41	-	6	DA,S	do.	N	Equipped with recorder.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
7.8.27.434	Lilburn Homan	Ray Brown	1946	6,175	26.1	9/6/46	240	18	—	Tertiary (?) and Quaternary valley fill	—	-
7.8.31.333	Arnold Vareen	-	-	6,320	116.8	5/9/50	131M	-	S	do.	W	-
7.8.33.123	B. A. Kincheloe	-	1936	6,230	32.4	2/14/41	80	-	U	do.	—	-
7.8.33.424	E. C. Hayes estate	-	-	6,205	53.3	do.	-	-	—	do.	B	Dug.
7.8.34.222	Lilburn Homan	Ray Brown	1947	6,160	18.5	5/29/47	129	18	I	do.	T	Drawdown 12 ft in 2 hr at 1,400 gpm. 58°F. See analysis, Table 16.
7.8.35.111	Homer Voss	Floyd Stump	1940	6,145	19.0	2/11/41	100	12	U	do.	N	Main aquifer at 83 ft.
7.8.35.131	Bob McNeil	Westerman and Schrock	1947	-	(20)	-	255	16	IA	do.	—	Main aquifer at 50 ft. 300 gpm.
7.8.35.332	Homer Voss	-	-	6,150	16.1	2/14/41	20	-	A	do.	N	-
7.8.36.343	-	-	-	6,115	24.5	do.	-	12	—	do.	N	-
7.9.5.211	-	-	-	6,130	19.3	3/11/41	-	-	U	do.	N	Dug.
7.9.10.333	Mrs. Minnie Farnsworth	Arthur Willis	1939	6,120	15.8	do.	38	-	S	do.	H	Main aquifer at 19 ft.
7.9.17.221	-	-	-	-	16.8	11/9/50	-	-	I	do.	T	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
7.9.18.211	Forest and August Shultz	Lane and Homan	1950	-	19	-	400	12	PI	Tertiary (?) and Quaternary valley fill	—	-
7.9.27.111	H. E. Means	Fincher	1950	-	18.8	4/26/50	120	12	A	do.	T	Water supply for oil test well. Main aquifer at 107 ft. See analysis, Table 16.
7.9.30.412	W. L. Davidson	Nat Kellogg	-	-	11.3	3/24/48	540	-	I	do.	T	600 gpm, rept.
7.9.31.222	-	-	-	6,100	8.0	8/30/50	18M	7	S	do.	W	Drawdown 1 ft in 30 min. See analysis, Table 16.
7.9.32.211	Mary Brown	Pat Homan	-	-	8	-	212	16	I	do.	—	See analysis, Table 16.
7.10.2.133	-	-	-	-	147.4	7/6/50	165M	-	S	Glorieta ss. member of San Andres fm.	W	-
7.10.18.431	Herman, Harold, and A. Wayne Price	-	(1948)	-	27	-	288	18	I	Probably ls. in Yeso fm.	T	Main aquifer at 275 ft. 3,000 gpm, rept. See analysis, Table 16.
7.10.19.112	Benefield no. 5	H. M. Marlow	1950	-	34.1	7/6/50	280	-	I	do.	—	Upper 140 ft cased off. 2,250 gpm, rept. See analysis, Table 16.
7.10.23.141	Milton and Homer Berkshire	-	-	6,230	144.5	do.	165M	-	S	Glorieta ss. member of San Andres fm.	W	See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
7.10.30.411	-	-	-	6,090	23.7	7/6/50	-	-	I	Probably ls. in Yeso fm.	T	See analysis, Table 16.
7.10.35.111	Milton and Homer Berkshire	-	-	-	62.0	do.	173M	-	S	Glorieta ss. member of San Andres fm.	W	Do.
7.11.9.120	Hosea Stockton	-	(1932)	-	(315)	-	343	-	D, S	Yeso fm.	W	Main aquifer at bottom. Adequate and permanent. Sulfate taste.
7.11.14.213	Roy Dean (?)	-	-	-	(200)	-	200	-	S	Probably Yeso fm.	W	Adequate. See analysis, Table 16.
7.11.26.212	do.	-	-	-	113.2	7/26/50	175M	-	S	do.	W	Windmill cut off to measure.
7.11.31.214	Roy Dean	-	-	-	99.9	do.	105M	6	S	Glorieta ss. member of San Andres fm.	W	-
7.11.34.311	do.	-	-	-	93.0	do.	200M	6	S	Yeso fm.	W	Pumping intermittently when water level measured. See analysis, Table 16.
7.12.19.300	Milton Henson	-	1916	-	285	-	-	-	S	Precambrian metamorphic rocks	W	Inadequate but permanent. See analysis, Table 16.
7.12.30.200	Milton Henson	-	1930	6,540	320.0	7/11/50	(375)	6	D, S	do.	W	Pumping when water level measured. Main aquifer at 140 ft. Permanent. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com- pleted	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measure- ment	Depth of well (feet)	Diam- eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
7.13.13.330	Bigbee	Ura Morgan	-	-	280	-	300+M	-	S	Yeso fm.	W	Permanent.
7.13.23.133	do.	-	-	6,280	185	-	225	-	D, S	do.	W	See analysis, Table 16.
7.13.30.430	J. T. Prather	Ferguson	-	-	475	-	500	-	D, S	do.	W	Adequate and permanent.
7.13.33.124	Bigbee	Keene	(1923)	-	290	-	(400)	-	D, S	do.	W	-
7.13.34.230	do.	Deepened by Critten	-	-	240	-	300+	-	S	do.	W	Permanent.
7.14.6.243	do.	-	-	6,450	492	-	(600)	-	S	do.	W	20 gpm, rept. Sulfate taste.
7.14.18.144	do.	Simmons	-	-	300	-	458	-	U	do.	—	Inadequate. Sulfate taste.
7.14.27.442	do.	-	-	-	160	-	200-	-	S	do.	—	See analysis, Table 16.
7.14.28.144	do.	-	-	6,140	200-	-	(250)	-	S	do.	—	-
8.6.12.444	T. J. Loyd	-	-	7,170	22.2	12/16/49	40	24	U	Madera ls.	N	Dug.
8.6.12.444a	do.	-	1934	7,170	40	-	160	8	D, S	do.	W	Pumps dry in 2 hr.
8.6.15.221	Aragon	John Gibbs	-	7,320	26.4	1/17/50	57	-	D	do.	W	Adequate.
8.6.22.110	A. R. White	-	-	7,420	28.0	1/20/50	29M	-	D	do.	B	Dug.
8.6.36.313	Mrs. P. O. Garcomelli	Allan Milligan	-	7,250	25.7	12/15/49	65	5	D	do.	H	-
8.7.2.443	-	-	-	6,540	93.6	do.	(106M)	-	D, S	do.	W	-
8.7.8.341	Justo Tapia	-	(1945)	6,940	128.2	1/18/50	195	5	D, S	do.	W	Pumping when measured. Adequate.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
8.7.9.142	-	-	-	6,800	75.2	1/18/50	140M	-	DA, S	Madera ls.	W	-
8.7.22.320	Frank Gutierrez	-	1929	6,640	46.5	12/16/49	150	-	D, S	do.	W	Adequate and permanent.
8.7.23.144	Augustine	-	-	6,560	76.6	do.	(100M)	-	D, S	do.	W	Adequate.
8.7.27.433	-	-	-	6,710	153.6	do.	200M	-	DA	do.	N	-
8.7.29.322	E. A. Dow	Pat Homan	1948	6,790	41.7	do.	86	6	D, S	do.	W	Adequate. See analysis, Table 16.
8.7.35.344	Homer Voss	-	(1932)	6,515	126.9	5/12/50	(150)	-	D, S	do.	P, W	Permanent.
8.8.1.434	Bennie Moore	-	1948	-	28.5	5/(?)/48	200	16	I	Tertiary (?) and Quaternary valley fill	T	Main aquifer at 179 ft. 2,300 gpm, rept. See analysis, Table 16.
8.8.10.111	W. H. Woodman	Pat Homan	1947	-	108.1	3/25/48	425	16	I	do.	T	Main aquifer at 135 ft. 750 gpm, rept. See analysis, Table 16.
8.8.10.244	Dennis Willie	Jack Lamb	1928	6,240	69.2	7/12/41	112	6	D, S	do.	W	-
8.8.12.212	Lawrence Groff	John E. Smith	1948	-	29.3	5/20/48	180	20	I	do.	T	Main aquifer at 150 ft. 1,080 gpm, meas. 58°F. See analysis, Table 16.
8.8.13.311	B. M. Maxwell No. 2	Pat Homan	1947	-	21.9	3/25/48	200	16	I	do.	T	Main aquifer at 20 ft. 1,700 gpm, meas. See analysis, Table 16.
8.8.13.324	B. M. Maxwell no. 1	do.	1947	-	49.6	9/16/47	200	10	I	do.	T	Main aquifer at 54 ft. 900 gpm, rept. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
8.8.15.343	Ed W. Davis	-	1933	6,270	97.0	2/23/40	102	-	D, S	Tertiary (?) and Quaternary valley fill	W	Dug.
8.8.17.433	-	-	-	6,355	130.7	2/24/50	150M	-	S	Madera ls.	W	See analysis, Table 16.
8.8.19.112	-	-	-	6,490	140.2	do.	214M	-	DA,S	do.	W	-
8.8.24.131	Noah Buck and Cunningham	-	-	-	10.6	3/25/48	187	16	—	Tertiary (?) and Quaternary valley fill	—	1,100 gpm, rept. See analysis, Table 16.
8.8.26.222	-	-	-	6,190	7.6	7/12/41	20M	-	S	do.	W	See analysis, Table 16.
8.8.28.311	Cecil Thomas	Virgil White	1950	6,310	144.4	6/19/52	213	16	I	Madera ls.	T	Drawdown 10 ft in 10 hr at 650 gpm.
8.8.28.311a	do.	John E. Smith	1950	-	140.1	5/3/51	160	16	I	do.	T	Pumping when water level measured. 800 gpm, meas. 58°F.
8.8.28.440	do.	-	-	6,265	95.6	do.	115	8	US	Probably Madera ls.	N	-
8.8.29.144	-	-	-	6,340	121.2	2/23/50	129M	-	S	Madera ls.	W	-
8.8.33.111	Cecil Thomas	-	1950	6,290	135	5/(?)/52	200	12	I	do.	T	800 gpm, meas. 58°F.
8.8.34.111	Sowel	-	-	6,255	79.6	2/23/50	(190)	14	PI	Probably Madera ls.	N	Measured depth 113 ft. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
8.8.35.322	A. C. Hibner	Melvin Hibner	1947	6,240	50.1	5/28/47	228	16	I	Probably Madera ls.	T	Drawdown 44 ft in 30 min at 900 gpm.
8.9.6.431	Bartlett	J. F. Smith	1950	-	41.2	3/9/50	275	16	I	Tertiary (?) and Quaternary valley fill	T	1,100 gpm, rept.
8.9.7.211	do.	do.	-	-	41.5	3/1/50	300	16	I	do.	T	See analysis, Table 16.
8.9.8.111	-	-	-	6,175	25.7	3/11/41	-	-	U	do.	N	Dug.
8.9.16.242	-	-	-	-	16.4	7/7/50	(30M)	-	S	do.	W	-
8.9.19.133	Stewart Miller	J. Floyd Smith	1949	-	-	-	340	16	I	do.	—	See analysis, Table 16.
8.9.26.332	-	-	-	-	34.1	7/7/50	53M	6	S	Weathered Precambrian metamorphic rocks	W	-
8.9.29.111	Mrs. Harry Bigger	-	-	6,140	20.9	3/11/41	100	-	D, S	Tertiary (?) and Quaternary valley fill	W	Dug and drilled.
8.9.29.111a	do.	-	-	-	21.7	6/18/41	75	-	SA	do.	W	Dug.
8.9.29.122	Ted Klusman	Bedford Mills	-	-	23.4	8/22/50	38M	80	D	do.	W	Dug. Adequate and permanent. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
8.9.30.111	G. I. King	Pat Homan	1948	-	20.1	3/24/48	200	16	I	Tertiary (?) and Quaternary valley fill	T	1,400 gpm, rept.
8.9.30.122	Jim Fulton	Virgil White	1950	-	24	-	231	16	I	do.	T	Main aquifer at 183 ft. 700 gpm, rept. See analysis, Table 16.
8.9.30.322	McGregor no. 2	John E. Smith	1950	-	26	-	285	-	PI	do.	—	500 gpm, rept.
8.9.35.333	-	-	-	-	15.8	8/22/50	30M	6	S	do.	W	See analysis, Table 16.
8.10.14.111	-	-	-	-	257.1	7/7/50	275M	-	S	Yeso fm.	W	Do.
8.10.17.133	-	-	-	6,250	184.7	do.	250M	-	S	Probably Glorieta ss. member of San Andres fm.	W	Windmill cut off to measure. See analysis, Table 16.
8.10.32.341	Bobby Parks	-	-	6,185	148.4	do.	(180)	-	D, S	Glorieta ss. member of San Andres fm.	W	Measured depth 166 ft. Windmill cut off to measure. See analysis, Table 16.
8.10.32.341a	do.	-	1946	6,185	134.5	do.	180	-	U	do.	N	Measured depth 259 ft.
8.10.36.241	-	-	-	-	188.1	7/6/50	300+M	6	S	Yeso fm.	W	See analysis, Table 16.
8.11.21.124	Buck Harvey	-	-	-	338	-	585	-	D, S	do.	W	Do.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
8.11.26.412	Buck Harvey	-	1949	-	438	-	458M	-	S	Probably Yeso fm.	W	-
8.11.30.222	do.	-	-	-	184.5	7/25/50	313	5	S	Yeso fm.	W	Pumped before water level measured.
8.12.15.411	Charlie Waller	-	-	-	580	-	(645)	8	S	Probably Yeso fm.	W	See analysis, Table 16.
8.12.26.332	do.	-	-	-	609	-	770	-	S	do.	W	See analysis, Table 16.
8.13.8.332	do.	-	(1925)	-	585	-	670	-	D, S	Yeso fm.	W	Permanent. See analysis, Table 16.
8.13.22.130	do.	-	-	-	550	-	600	-	S	do.	W	See analysis, Table 16.
8.14.3.214	Bigbee	Umbarger no. 1	1949	6,585	480	-	2,800	-	S	Probably Yeso fm.	W	Oil test well. See analysis, Table 16.
8.14.12.220	do.	Jess Ridell	(1945)	-	400-	-	932	5	S	do.	W	Adequate and permanent.
8.14.17.414	do.	do.	(1945)	6,390	500-	-	916	-	S	do.	W	Adequate. Sulfate taste.
8.15.14.310	do.	Critten	-	-	940	-	1,001	-	S	do.	P	Sulfate taste.
9.6.9.224	Justo Martinez	-	(1935)	7,150	28.9	2/1/50	45	-	D	Madera ls.	B	Dug. Permanent.
9.6.21.230	A. S. Anaya	Virgil Garland	(1947)	7,500	177.0	1/23/50	296	8	D, S	do.	W	Could not get good water-level measurements. Permanent.
9.6.23.222	-	-	-	7,181	154.2	do.	270M	8	DA,S	do.	W	-
9.6.25.334	Paul McComb	-	(1920)	7,120	10.9	1/17/50	(30)	-	D, S	do.	W	Dug. Adequate.
9.6.34.142	Manuel Gutierrez	-	(1900)	7,195	43.2	do.	53M	-	D, S	do.	B,W	Dug. Permanent.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
9.7.2.342	Vigil brothers	-	1913	6,490	125.6	5/3/50	172	6	D, S	Madera ls.	P, W	Permanent.
9.7.7.333	G. B. Loyd	-	(1930)	6,920	(375)	-	418	18	D, S	do.	W	Do.
9.7.15.113	Muller	-	(1916)	6,600	47.1	5/3/50	48	-	D	Probably Tertiary (?) and Quaternary valley fill	B	Dug.
9.7.16.443	Martinez	-	(1900)	6,660	9.0	do.	15	-	D	Tertiary (?) and Quaternary valley fill	B	Dug. Permanent.
9.7.24.113	C. W. (Bill) Dunn	-	-	-	140	-	200	-	D, S	Madera ls.	W	Deepened 1946.
9.7.35.113	-	-	-	-	71.6	5/3/50	88M	-	A	do.	W	-
9.7.36.414	Charlie Dean	-	-	6,420	102.6	2/3/50	132	-	D, S	do.	P, W	Deepened 1937.
9.8.2.112	Valley Irrigation Co.	-	-	-	59.9	5/20/48	-	-	I	Tertiary (?) and Quaternary valley fill	T	1,900 gpm, meas.
9.8.2.242	do.	-	-	-	56.7	9/15/47	550	13	—	do.	—	-
9.8.3	do.	Dennisson	1947	-	96	-	367	13	—	do.	—	Main aquifer at 254 ft.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
9.8.3.312	Valley Irrigation Co.	-	-	-	72.4	5/20/48	-	-	I	Tertiary (?) and Quaternary valley fill	T	See analysis, Table 16.
9.8.7.244	Charlie Shook	-	(1925)	-	83.8	5/12/50	(100)	-	D, S	Madera ls.	W	Main aquifer at 63 ft. Permanent.
9.8.9.200	Chester Timmons	Dick Lamb	1948	-	80	-	146	16	I	Tertiary (?) and Quaternary valley fill	—	Drawdown 50 ft at 1,000 gpm.
9.8.9.443	Charles John	Sigenthaler	(1907)	6,285	96.4	2/22/50	190	-	D, S	do.	W	Deepened. Permanent.
9.8.10.210	G. L. Evans	-	-	-	60	-	420	16	I	do.	T	Drawdown 60 ft at 1,000 gpm.
9.8.11.233	Manuel Lujan	-	1947	-	56.8	5/20/48	(320)	-	I	do.	T	-
9.8.14.311	Benefield no. 4	H. M. Marlow	1950	-	58.9	4/13/50	475	-	I	do.	T	See analysis, Table 16.
9.8.20.133	Hornsby	-	1912	6,340	91.1	1/23/50	125	-	D, S	do.	P,W	Permanent.
9.8.21.121	Dr. I. B. Ballenger	Pat Homan	-	6,250	72	-	480	12	I	Probably Tertiary (?) and Quaternary valley fill	T	250 gpm, rept. See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
9.8.24.300	Anraya Filandro	Dan Pino	-	-	44.9	8/22/50	115	8	D	Tertiary (?) and Quaternary valley fill	—	See analysis, Table 16.
9.8.24.330	Valley Irrigation Co.	Dennisson	1947	-	40.5	3/25/48	185	16	-	do.	—	-
9.8.25.111	-	-	-	6,180	10.1	7/12/41	-	-	S	do.	B	Dug.
9.8.26.121	-	-	-	6,205	21.3	7/24/41	-	-	S	do.	W	-
9.8.26.430	Will Price	Lane and Homan	1950	-	-	-	303	16	PI	do.	—	-
9.8.26.433	Everitt Shockey	W. D. Cunningham	1948	-	46.0	8/11/48	198	16	I	do.	T	Main aquifer 138 ft. Drawdown 28 ft at 1,000 gpm.
9.8.28.244	-	-	-	6,250	78.9	2/23/50	100+M	6	AS	do.	W	-
9.8.29.311	Charles Snowden	C. L. Blunt	1948	6,360	82.6	do.	350	-	I	Probably Tertiary (?) and Quaternary valley fill	T	Drawdown 60 ft.
9.8.34.210	John E. Smith	John E. Smith	-	-	60	-	520	12	I	Tertiary (?) and Quaternary valley fill	—	Drawdown 80 ft at 700 gpm.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year com- pleted	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diam- eter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measure- ment						
[illegible].8.34.330	P. W. Flowers	-	1948	-	30	-	350	16	I	Tertiary (?) and Quarter- nary val- ley fill	—	Drawdown 80 ft at 1,000 gpm.
[illegible].8.35.211	W. M. Hughes	Jack and Dick Lamb	1947	-	43	-	194	10	I	do.	T	400 gpm, rept. See analysis, Table 16.
[illegible].9.11.341	Bill Ehret	Jack Lamb	1951	-	39.3	11/19/52	260	16	I	Glorieta ss. mem- ber of San Andres fm.	T	Drawdown 10 ft at 800 gpm.
[illegible].9.12.111	W. R. Abrahams	-	(1908)	6,225	43.1	7/4/50	46M	-	D	do.	W	-
[illegible].9.15.133	Hitchin' Post	Dan Pino	1946	-	25	-	(65)	-	D	Tertiary (?) and Quater- nary val- ley fill	W	Permanent. See analysis, Table 16.
[illegible].9.16.233	-	-	-	-	21.4	7/3/50	75M	-	S	do.	W	See analysis, Table 16.
[illegible].9.32.131	G. L. Dean	McCabe and Miller	-	6,175	6.9	2/20/41	74	12	-	do.	W	Main aquifer at 16 ft. See analysis, Table 16.
[illegible].9.32.131a	do.	-	-	-	7.4	10/1/43	72	10	D	do.	W	-
[illegible].9.32.311	Paul Davis	-	1947	-	15.7	5/20/48	(450)	-	—	do.	—	-
[illegible].9.33.131	-	-	-	-	12.8	7/7/50	62M	-	S	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
9.10.13.233	Tony Gomez	Jack Lamb	1948	6,560	366	-	384	6	S	Yeso fm.	W	Adequate and permanent.
9.10.16.311	-	-	-	6,315	127.8	7/4/50	150M	-	S	Yeso fm. or Glorieta ss. member of San Andres fm.	W	-
9.10.18.233	Bill Ehret	Jack Lamb	-	-	208	-	358	-	-	Yeso fm.	P	Tourist court supply. Main aquifer near bottom. Water rose to 208 ft. Adequate. See analysis, Table 16.
9.10.18.411	do.	do.	-	-	250	-	400	-	-	do.	P	Trading post and cafe. Main aquifer near bottom. Water rose to 250 ft. Adequate. See analysis, Table 16.
9.10.23.342	-	-	-	-	83.1	7/5/50	130M	-	S	Probably Yeso fm.	W	See analysis, Table 16.
9.10.28.424	Hagerman	-	-	-	480	-	(563)	-	-	Yeso fm.	P,W	-
9.10.30.311	John Williams	-	-	6,290	108.0	7/4/50	125M	-	S	Probably Tertiary (?) and Quaternary valley fill	W	See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
9.10.33.313	Dick Lamb	Jack Lamb	(1940)	-	123.0	7/4/50	150	-	D,S	Probably Glorieta ss. member of San Andres fm.	W	Pumping when measured. Permanent.
9.11.6.311	Army Training Camp	Layne-Texas	1950	6,660	462	-	516	-	—	Yeso fm.	—	Army post. See analysis, Table 16.
9.11.7.134	Don Chavez	-	-	6,540	346.4	6/13/50	394	8	S	do.	W	Adequate.
9.11.15.224	Hagerman	-	-	-	560	-	(563)	-	D,S	do.	P,W	Adequate and permanent.
9.12.16.213	S. L. Smith	Ferguson and Leonard	1945	-	899	3/(?)/50	1,301	-	D	Abo fm.	P	Deepened March 1950 from 1,038 to 1,301 ft by Frank Leonard with upper water cased off. Main aquifer at 1,281 ft. See analysis, Table 16.
9.12.32.430	Charlie Waller	H. R. Davis	1950	-	840	-	960	7	S	do.	W	Adequate. See analysis, Table 16.
9.13.16.220	Alva Halderman	-	1948	-	51.0	7/13/50	110	8	S	Yeso fm.	W	See analysis, Table 16.
9.14.27.331	Belvins McKenzie	-	-	-	(450)	-	600+	-	S	do.	W	Do.
9.15.14.134	do.	-	(1934)	-	126.2	7/12/50	150	-	D,S	Dockum group	W	Measured depth 135 ft. See analysis, Table 16.
9.15.15.420	do.	-	1945	-	922	1954	1,054	-	S	Probably Yeso fm.	P	15 gpm, rept.
9.15.19.113	do.	-	-	-	500+	-	800	-	S	do.	W	

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
9.15.20.110	Roy Cline	Ferguson	1954	-	(900+)	-	975	-	D	Probably Yeso fm.	P	Rept. extremely hard; unfit for drinking, cooking, or washing.
9.15.32.241	Blevins McKenzie	-	-	-	66.7	7/11/50	80	-	S	Dockum group	W	See analysis, Table 16.
10.6.26.114	Jake McFall	Kenny and Winthrop Nugent	-	7,060	142.5	3/15/50	360	-	S	Madera ls.	P	-
10.7.11.111	-	-	1942	6,530	148.4	4/27/50	203	-	A	Probably Tertiary (?) and Quaternary valley fill	W	-
10.7.12.434	Mrs. Cecil Blackwell	Lum Gardner	1920	6,450	227.2	do.	267	-	D, S	Tertiary (?) and Quaternary valley fill	W	Permanent.
10.7.15.333	Hughes	-	(1920)	6,565	182+	-	280	4	D, S	Probably Madera ls.	P	Do.
10.7.16.412	-	-	-	6,540	216.2	5/4/50	250M	6	DA, S	Madera ls.	W	-
10.7.23.212	Mosley	-	-	6,480	138.3	8/25/48	200	12	I	Probably Madera ls.	T	See analysis, Table 16.
10.7.23.234	Ray Bassett	Cunningham	1948	6,470	143.1	do.	206	16	I	do.	T	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
10.7.24.433	W. L. Williams	-	1931	6,450	127	-	148M	-	D	Tertiary (?) and Quaternary valley fill	P	See analysis, Table 16.
10.7.25.122	do.	-	(1919)	6,450	131.0	4/25/50	143	-	SA	do.	N	-
10.7.25.211	do.	J. Floyd Smith	1947	6,455	123	-	324	16	I	do.	T	Main aquifer at 145 ft. Drawdown 90 ft at 400 gpm. See analysis, Table 16.
10.7.27.331	Rideout	(State Highway Dept.)	(1934)	6,660	345.8	4/28/50	385	-	D	Madera ls.	P	Permanent.
10.7.30.321	Paul Northam	Turner	(1941)	6,770	412.4	3/15/50	450M	5	S	do.	W	Do.
10.7.35.231	J. D. Hill	-	-	6,545	220.1	2/24/50	274	5	S	do.	W	Pumped before water-level measured.
10.8.3.333	-	-	-	-	167.7	2/21/50	180M	-	A	Tertiary (?) and Quaternary valley fill	W	-
10.8.11.331	Ruben Cavasos	-	1908	-	120.9	2/22/50	150	6	A	do.	W	-
10.8.13.133	W. R. Irby	-	1948	-	88.8	do.	518	-	I	do.	T	1,040 gpm, meas.
10.8.17.424	Kenneth Martin	-	-	-	135.5	2/17/49	(150)	6	SA	do.	W	-
10.8.20.233	Martin	Jack and Dick Lamb	1950	-	158.1	3/15/50	400	16	—	do.	N	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
10.8.20.444	Alice M. Martin	Dick Lamb	1930	-	130.0	2/21/50	200	-	D, S	Tertiary (?) and Quaternary valley fill	P,W	Permanent. See analysis, Table 16.
10.8.23.144	H. E. Irwin	-	-	-	64	-	503	12	I	do.	—	Drawdown 46 ft at 1,000 gpm. See analysis, Table 16.
10.8.25.311	Floyd Irvin	Lloyd Smith	1948	-	73.6	5/20/48	238	16	I	Probably Tertiary (?) and Quaternary valley fill	T	See analysis, Table 16.
10.8.31.421	Les Bassett	Virgil White	1950	-	93.1	5/16/50	251	12	I	Probably Madera ls.	T	Do.
10.8.34.210	L. G. Elliott	F. G. Smith	-	-	83	-	312	16	I	Tertiary (?) and Quaternary valley fill	—	Drawdown 36 ft at 800 gpm.
10.8.34.220	do.	-	-	-	65	-	340	16	I	do.	—	Drawdown 55 ft at 800 gpm.
10.8.34.413	Lloyd Smith	-	-	-	78.6	8/11/48	-	12	I	do.	T	-
10.8.35.211	Valley Irrigation Company	-	-	-	52.0	do.	165	16	I	Glorieta ss. member of San Andres fm.	T	Aquifer probably in cavity or fractures. 3,040 gpm, meas.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
10.8.35.312	Valley Irrigation Company	-	-	-	65.2	5/20/48	-	-	I	Probably Tertiary (?) and Quaternary valley fill	T	-
10.8.35.331	do.	-	-	-	65.1	do.	-	-	I	do.	T	1,230 gpm, meas. See analysis, Table 16.
10.8.35.411	do.	-	-	-	62.9	do.	270	16	I	do.	T	See analysis, Table 16.
10.8.36.111	do.	J. Floyd Smith	1947	-	34.9	9/15/47	309	13	I	Glorieta ss. member of San Andres fm.	T	Main aquifer at 80 ft probably in cavity or fractures. Drawdown 7 ft in 3 hrs at 1,380 gpm. See analysis, Table 16.
10.9.5.111	Bill King	M. C. Ossley	1934	-	20.5	8/11/48	695	16	I	Tertiary (?) and Quaternary valley fill	T	1,200 gpm, rept. See analysis, Table 16.
10.9.5.220	C. L. Blunt	C. L. Blunt	-	-	80	-	316	14	I	do.	—	Drawdown 55 ft at 1,000 gpm.
10.9.8.110	M. A. Rowell	do.	-	-	65	-	203	16	I	do.	T	-
10.9.18.131	W. E. Dollahon	Cunningham	1948	-	69.5	2/17/50	192	18	I	do.	T	Main aquifer at 136 ft. Drawdown 20 ft in 6 hrs at 2,000 gpm. See analysis, Table 16.
10.9.20.342	Civil Aeronautics Administration	Pat Homan	1946	6,225	40	-	135	-	D	do.	P	Main aquifer at 130 ft. Adequate and permanent.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
10.9.20.44a	J. F. Laird	Dick Lamb	1949	-	30	-	60	6	D	Tertiary (?) and Quaternary valley fill	W	Main aquifer at 30 ft. Adequate and permanent. See analysis, Table 16.
10.9.21.321	Everitt Shockey	J. L. Mathieson	1947	-	-	-	300	10	I	do.	—	Main aquifer at 259 ft. Drawdown 30 ft at 800 gpm. See analysis, Table 16.
10.9.21.431	do.	do.	1943	6,210	27.1	5/15/46	101	7	D,S	do.	P	Main aquifer at 42 ft. See analysis, Table 16.
10.9.24.333	C. F. O'Neal	-	(1918)	-	70.0	7/3/50	80	-	S	Probably Glorieta ss. member of San Andres fm.	W	Measured depth 75 ft. Permanent.
10.9.29.130	Glen Terry	Virgil White	1949	-	55.1	2/18/49	200	14	I	do.	T	Drawdown 3.5 ft at 1,030 gpm. See analysis, Table 16.
10.9.30.144	King brothers	Dennisson	1950	-	-	-	400	-	U	Glorieta ss. member of San Andres fm.	—	Main aquifer at 83 ft.
10.9.30.233	do.	do.	1950	-	100.2	4/13/50	125M	-	U	do.	N	Main aquifer at 112 ft.
10.9.31.121	-	-	-	-	65.4	2/9/51	232M	-	I	do.	T	-
10.9.32.313	-	-	-	-	61.5	5/23/50	63M	6	SA	do.	W	-

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level		Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
					Below land surface (feet)	Date of measurement						
10.9.34.311	Bowman	-	-	-	23.2	7/3/50	-	-	S	Tertiary (?) and Quaternary valley fill	W	Dug. See analysis, Table 16.
10.10.32.333	-	-	-	-	139.5	7/4/50	158M	-	D,S	Glorieta ss. member of San Andres fm.	W	See analysis, Table 16.
10.11.35.122	Chavez	-	-	-	-	-	10	-	D	Dockum group	W	Dug.
10.12.29.311	Hagerman (?)	-	(1949)	-	800	-	3,600	-	-	Probably Abo fm.	N	Location from oral description. Oil test well.
10.12.33.341	Hagerman	-	-	-	880	-	1,290	-	-	Abo ss.	P,W	Permanent.
10.14.29.221	Frank Ortiz y Davis	-	1944	-	400	-	650	-	D,S	Yeso fm.	W	Adequate and permanent. See analysis, Table 16.
10.15.26.334	W. A. Thompson	-	-	6,150	12.1	7/12/50	30	-	D,S	do.	W	Dug. Measured depth 32 ft. See analysis, Table 16.
10.15.34.113	do.	-	(1936)	-	136.8	do.	185	6	S	Dockum group	W	Permanent.
11.9.19.122	Ferguson	Dennisson	1950	-	117.1	2/8/50	440	18	PI	Tertiary (?) and Quaternary valley fill	N	-
1S.8.1.433	James Wells	-	-	-	650	-	670	-	S	do.	P	See analysis, Table 16.

TABLE 14. RECORDS OF SELECTED WELLS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

Well location number	Owner or name	Driller	Year completed	Altitude of land surface (feet)	Water level: Below land surface (feet)	Water level: Date of measurement	Depth of well (feet)	Diameter of well (inches)	Use	Principal aquifer	Type of lift	Remarks
1S.8.7.332	-	-	(1928)	-	480	-	500	-	-	Tertiary (?) and Quaternary valley fill	W	Adequate and permanent.
1S.9.4.	"Capt." John Smith	-	-	-	600	-	(630)	-	-	Yeso fm.	—	-
1S.9.5.	-	-	-	-	650	-	708	-	-	do.	W	-
1S.9.7.144	James Wells	-	-	-	618	-	650	-	-	do.	W	-
1S.9.9.132	Frank Wells	-	-	-	657	-	832	-	-	do.	W	-
1S.12.12.314	J. M. Melton	George Perry	-	6,780	438.2	3/21/50	650	-	S	do.	W,P	Main aquifer at 630 ft. Adequate. See analysis, Table 16.
1S.12.13.400	Buchanan	Fincher	-	6,770	442.7	4/6/51	460+M	-	D	do.	W	See analysis, Table 16.
1S.13.5.213	Cane	do.	1947	6,735	(345)	-	357	-	D,S	do.	W,P	Main aquifer at 350 ft. See analysis, Table 16.
1S.13.9.411	Penix	-	-	6,665	220(?)	-	546	-	S	do.	W	Main aquifer at 300 ft. 3/4 gpm. See analysis, Table 16.
1S.13.10.400	do.	-	-	-	360	-	516	-	S	do.	W	Main aquifer at 396 ft. 1½ gpm.
1S.13.14.143	Earl Binyon	-	-	-	-	-	160	-	D,S	Glorieta ss. member of San Andres fm.	W,P	Well caved in to 140 ft. Adequate and permanent. See analysis, Table 16.
1S.13.20.100	Hester	George Perry	(1945)	6,645	364.5	4/5/51	400	6	S	Yeso fm.	W	Main aquifer at 390 ft. Adequate and permanent. See analysis, Table 16.

TABLE 15. RECORDS OF SELECTED SPRINGS IN TORRANCE COUNTY, N. MEX.

Explanation of column headings

Location number: See p. 8 for explanation.

Yield: E after figure indicates estimated yield; R indicates reported yield; others measured.

Use: A, abandoned (has been used); CG, campground; D, domestic; PS, public supply; S, stock; U, unused (never used, or no evidence of use at time of visit).

Location number	Owner	Name	Topographic situation	Kind of rock and geologic unit	Improvements	Yield		Use of water
						Gpm	Date	
4.6.29.444	-	-	Arroyo floor	Sandstone; Abo formation	Rock enclosed; water piped to tank	1 E	1/24/50	A
5.5.10.313	Cibola National Forest	New Canyon Spring	Base of mountain	Alluvium and talus	Rock enclosed; water piped to campground	6	11/8/49	CG
6.5.2.124	do.	Big Spring	Valley floor	Limestone; Madera limestone	-	1 E	11/18/49	CG
6.5.2.134	do.	-	do.	do.	-	1 E	do.	CG
6.5.24.224	do.	-	Arroyo bank	do.	-	2	12/7/49	D, S
6.5.36.221	do.	-	Arroyo floor	do.	Rock enclosed	1 E	do.	D, S
6.6.27.100	Town of Torreon	Torreon Spring	do.	do.	Water pumped to reservoirs	-	-	PS
6.8.11.340[a]	Town of Estancia	Estancia Spring	Valley flat	Tertiary(?) and Quaternary valley fill	Rock and concrete enclosed; curbed with rock and concrete	2 E	6/20/52	S
7.5.35.231	Cibola National Forest	Fourth of July Spring(upper)	Base of mountain	Limestone; Madera limestone	Water piped to campground	1	11/18/49	CG
7.5.35.422	do.	Fourth of July Spring(lower)	Small valley	do.	-	1 E	11/18/49	U
7.6.29.120	Riley ranch	Riley Ranch Spring	Arroyo floor	do.	Rock and concrete enclosed	Dry	12/8/48	D, S

TABLE 15. RECORDS OF SELECTED SPRINGS IN TORRANCE COUNTY, N. MEX. (continued).

Location number	Owner	Name	Topographic situation	Kind of rock and geologic unit	Improvements	Yield		Use of water
						Gpm	Date	
7.8.23.410	Antelope Spring Co.	Antelope Spring	Hillside	Tertiary(?) and Quaternary valley fill	Spring house	20 E	9/1/50	D, S
7.12.11.322[a]	Marvin Hensen	-	Mountain side	Precambrian metamorphic rocks	Deepened and concrete enclosed; hand lift pump	-	-	D, S
7.15.2.100	Bigbee ranch	-	-	Dockum group	-	½ R	7/12/50	S

[a] Chemical analysis in Table 16.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
					AQUIFER: PRECAMBRIAN ROCKS									
3.11.5.444	3/15/51	1,750	31	204	78	98	560	400	104	1.3	20	1,210	830	20
3.12.9.231	7/20/50	822	25	101	32	35	314	154	24	2.6	0.4	529	384	17
4.11.22.132	3/16/51	1,380	22	145	56	82	194	436	104	2.1	6.1	949	592	23
4.12.22.234	7/21/50	1,090	27	130	40	53	164	362	60	1.9	5.0	760	489	19
5.11.12.211	12/29/50	767	-	-	-	-	235	-	34	-	-	-	-	-
5.12.27.230	7/18/50	659	19	87	23	16	152	153	43	.2	1.7	418	312	10
5.13.14.311[a]	7/(?)/50	906	17	62	34	92	233	228	42	2.4	1.6	594	294	41
5.13.28.133[a]	7/19/50	669	16	48	25	63	207	146	22	2.4	0.2	425	223	38
5.13.30.111[a]	7/18/50	593	18	50	21	46	188	117	21	1.8	0.5	368	212	32
6.12.18.411	7/13/50	826	22	101	18	49	198	185	49	1.1	8.0	531	326	25
7.12.19.300	7/11/50	646	24	46	14	81	332	34	26	1.2	2.9	393	172	51
7.12.30.200	7/11/50	800	25	66	25	80	419	48	30	.8	4.5	485	268	39
					AQUIFER: MADERA LIMESTONE									
5.5.23.433	8/11/50	458	13	52	19	24	288	16	5	0.4	0	271	208	20
6.6.14.111[b]	2/16/51	676	11	11	4	160	423	22	8	3.2	0.5	428	44	89

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
						AQUIFER: MADERA LIMESTONE								
6.6.14.111[b]	7/22/52	666	-	-	-	-	385	-	14	-	-	-	50	-
6.6.22.431	8/11/50	569	13	98	12	10	330	25	10	0.2	5.9	337	294	7
6.7.15.433[a]	1/12/51	485	-	-	-	-	284	-	8	-	-	-	-	-
7.6.26.411	2/16/51	648	-	-	-	-	383	-	12	-	-	-	-	-
7.7.10.422	5/12/50	431	19	68	9.8	8.3	218	21	11	-	15	259	210	8
7.7.12.342	8/15/50	861	20	152	16	15	483	37	22	0.1	14	514	445	7
7.7.23.112	9/15/50	776	18	102	24	33	476	14	14	0.2	0.3	440	353	17
7.7.29.343	9/15/50	603	16	103	10	13	328	30	15	0.1	5.2	354	298	8
7.8.4.211[a]	8/16/50	783	-	-	-	-	471	-	16	-	-	-	-	-
7.8.9.431[a]	5/19/48	683	21	114	14	21	418	27	10	0	3.8	417	342	-
Do.	8/16/50	728	-	-	-	-	436	-	13	-	-	-	-	-
7.8.16.142[a,c]	5/19/48	683	17	120	13	13	408	28	10	0	4.4	406	353	-
8.7.29.322	2/16/51	651	16	109	12	17	353	30	15	0.1	19	392	322	10
8.8.17.433	8/30/50	586	17	39	21	60	281	40	23	1.0	8.0	347	184	41
8.8.18.433	8/22/50	561	-	-	-	-	274	-	23	-	-	-	-	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued)

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: MADERA LIMESTONE														
8.8.33.200[a]	7/19/50	543	18	79	17	4.8	242	37	24	-	8.1	307	267	4
8.8.34.111[a]	8/17/50	585	-	-	-	-	307	-	25	-	-	-	-	-
10.7.23.212[a]	8/29/50	939	19	166	23	7.4	572	26	16	0	8.1	548	508	3
10.7.27.340	7/19/50	482	18	75	16	3.0	281	9.1	14	-	0.2	273	253	3
10.8.31.421[a]	9/1/50	1,110	18	203	31	9.4	732	26	17	0	4.4	670	634	3
AQUIFER: ABO FORMATION														
4.6.3.444	8/11/50	418	23	64	10	13	228	20	13	0.2	2.6	258	200	12
4.6.4.211	8/11/50	475	19	77	13	6.7	286	11	6	0.2	5.9	280	246	6
4.6.26.242	3/2/51	419	-	-	-	-	235	-	13	-	-	-	-	-
4.7.11.344	3/2/51	405	-	-	-	-	245	-	10	-	-	-	-	-
5.7.36.334	8/16/50	792	28	88	32	29	188	164	53	0.6	16	504	351	15
9.12.16.213	7/11/50	2,000	29	304	108	50	149	1,120	13	1.8	0.2	1,700	1,200	8
9.12.32.430	7/17/50	1,180	9.3	132	25	95	91	511	21	1.1	0.6	840	432	32
Do.	5/26/51	1,320	24	173	66	46	176	606	16	1.9	0.5	1,020	703	12
AQUIFER: YESO FORMATION														
1.8.4.222	8/2/50	2,170	7.8	336	150	12	110	1,320	11	0.6	0.2	1,890	1,460	2

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: YESO FORMATION														
1.10.11.412	1/26/51	2,940	27	562	174	11	497	1,630	23	1.7	0.2	2,670	2,140	1
1.11.14.344	8/3/50	2,360	19	516	82	11	196	1,410	13	1.0	0	2,150	1,620	1
1.12.20.312	7/18/50	2,650	22	538	142	11	164	1,700	14	0.7	0.1	2,510	1,930	1
1.13.34.211	3/17/50	3,590	13	544	168	235	57	2,360	39	0.1	0.4	3,390	2,050	20
1.16.7.410	12/18/50	1,220	-	-	-	-	143	-	27	-	-	-	-	-
2.6.9.233	8/(-)/50	2,840	26	586	136	26	186	1,790	25	0.5	30	2,710	2,020	3
2.7.14.433	8/8/50	2,010	11	310	134	13	195	1,130	9	0.8	1.1	1,700	1,320	2
2.7.17.424	8/8/50	3,040	11	556	182	51	128	2,030	16	2.4	0. 2	2,910	2,140	5
2.8.15.442	2/9/51	2,960	-	-	-	-	225	-	12	-	-	-	-	-
2.9.18.333	2/23/51	3,280	-	-	-	-	164	-	39	-	-	-	-	-
2.10.10.111	1/19/51	3,140	17	560	219	36	207	2,100	12	1.2	0.2	3,050	2,300	3
2.11.21.312	8/3/50	1,500	27	258	65	8.3	151	751	14	1.3	0.8	1,200	911	2
2.12.6.122	7/20/50	895	22	121	35	17	162	256	51	1.2	11	594	446	8
2.12.19.444	7/19/50	2,650	27	506	151	12	232	1,620	21	0.9	0.3	2,450	1,880	1
2.12.24.423	7/19/50	1,310	22	196	73	5.8	118	596	39	1.3	12	1,000	789	2

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: YESO FORMATION														
2.13.27.111	7/19/50	2,830	27	594	138	6.9	87	1,890	16	1.0	0.9	2,720	2,050	1
2.13.35.344	7/18/50	3,300	14	546	181	132	60	2,220	22	0.8	0.1	3,150	2,110	12
2.15.6.112	6/9/53	3,020	-	-	-	-	108	-	72	-	-	-	-	-
2.15.8.312	6/9/53	2,930	-	-	-	-	114	-	67	-	-	-	-	-
2.15.24.212	9/7/50	1,770	17	334	63	21	120	929	44	0.8	9.8	1,480	1,090	4
3.6.29.243	8/(-)/50	795	21	112	34	15	260	216	9.0	0.4	0.4	536	420	7
3.7.20.114	8/10/50	3,020	18	550	205	12	142	2,000	26	1.2	4.9	2,890	2,220	1
3.8.16.222	8/1/50	2,750	10	548	154	2.3	121	1,800	21	1.4	0.2	2,600	2,000	0
3.9.33.433[a]	2/23/51	335	16	46	14	2.1	184	14	6	0.2	2.8	176	172	3
3.13.33.413	7/20/50	2,970	21	484	198	55	279	1,750	61	1.0	1.6	2,710	2,020	6
3.14.17.132	9/20/50	3,390	14	558	178	125	85	1,900	245	0.7	1.1	3,060	2,120	11
3.14.35.212	9/19/50	2,720	14	522	148	18	120	1,700	56	0.8	0.6	2,520	1,910	2
3.15.20.311[a]	6/9/53	2,930	-	-	-	-	134	-	153	-	-	-	-	-
3.15.22.333	6/9/53	2,870	-	-	-	-	104	-	56	-	-	-	-	-
3.15.26.111	6/9/53	2,070	-	-	-	-	110	-	106	-	-	-	-	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: YESO FORMATION														
4.7.23.312[d]	12/15/44	371	16	42	15	16	192	26	10	0.4	2.3	222	166	-
4.7.23.312a	7/27/51	368	24	43	13	14	192	17	10	0.2	3.7	220	161	16
4.7.32.414	3/2/51	383	27	38	21	14	213	22	7	0.8	1.7	236	182	14
4.13.22.220	9/20/50	3,140	21	594	170	41	123	1,910	110	1.6	27	2,940	2,180	4
4.14.19.412	9/21/50	4,040	13	492	333	180	103	2,630	115	1.1	0.7	3,820	2,600	13
5.14.18.222	3/16/51	1,240	22	134	63	28	184	436	26	0.9	13	814	594	9
5.14.32.300	7/24/45	3,410	-	542	230	85	100	2,210	69	1.2	0.2	3,190	2,300	-
7.10.18.431[a]	8/30/50	5,800	-	-	-	-	644	-	910	-	-	-	-	-
7.10.19.112[a e]	4/12/50[f]	19,600	-	1,140	1,610	-	242	-	6,300	-	-	-	9,460	-
Do.[g]	4/26/50	17,400	14	1,130	1,350	1,220	283	3,230	5,260	-	-	12,300	8,370	24
Do.[h]	4/26/50	6,640	20	728	385	390	334	2,130	1,240	1.5	5.3	5,060	3,400	20
7.10.19.411[a]	4/12/50[f]	6,920	-	685	358	534	451	2,190	1,200	-	-	5,190	3,180	27
7.10.30.411[a]	4/12/50[f]	4,880	-	490	260	310	287	1,620	740	-	-	3,560	2,290	23
Do.	8/31/50	4,820	-	-	-	-	286	-	735	-	-	-	-	-
7.11.14.213[a]	7/25/50	827	18	79	32	58	309	114	49	2.8	9.4	514	328	28

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: YESO FORMATION														
7.11.34.311	7/26/50	2,460	22	332	147	93	337	1,180	89	1.8	1.0	2,030	1,430	12
7.13.23.133	7/14/50	682	23	60	26	46	201	138	34	-	1.3	427	256	28
7.14.27.442	7/14/50	2,990	16	512	190	56	209	1,900	20	1.2	0.1	2,800	2,060	6
8.10.14.111	7/7/50	3,050	18	532	174	82	171	1,970	20	1.0	1.0	2,880	2,040	8
8.10.36.241	7/6/50	4,410	10	504	380	209	95	2,920	110	0.5	0.4	4,180	2,820	14
8.11.21.124	7/25/50	2,720	24	510	137	51	203	1,630	54	2.6	0.1	2,510	1,840	6
8.12.15.411[a]	7/17/50	861	23	78	45	46	133	308	31	2.2	0.4	600	380	21
Do.	5/26/51	799	25	86	37	34	204	229	19	2.4	0.9	533	366	17
8.12.26.332[a]	5/26/51	955	26	100	40	54	193	302	36	2.6	0.1	656	714	22
8.13.8.332	7/14/50	1,730	22	272	102	15	151	955	8	1.0	0.1	1,450	1,100	3
Do.	5/26/51	1,740	-	-	-	-	156	-	10	-	-	-	-	-
8.13.22.130	5/26/51	1,470	27	180	64	80	177	656	37	2.3	0.2	1,130	712	20
8.14.3.214[ai]	5/31/49	15,400	-	14	474	4,160	6,420	1,420	1,870	-	1.6	12,090	1,980	82
9.10.18.233	9/27/50	3,350	20	42	13	708	439	789	365	0.6	0.6	2,150	158	91
9.10.18.411	12/15/50	3,450	21	90	39	664	315	956	400	3.8	0.9	2,330	385	79

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
					AQUIFER: YESO FORMATION									
9.10.23.342[a]	7/5/50	1,210	20	137	59	26	199	232	59	0.4	189	820	584	9
9.11.6.311	7/5/50	726	22	88	28	31	166	211	12	0.7	33	508	334	17
9.13.16.220	7/13/50	808	16	128	38	<10	293	212	6	0.4	1.3	546	476	0
9.14.27.331	7/11/50	2,130	23	322	115	64	278	1,100	28	1.0	0.3	1,790	1,280	10
10.14.29.221	7/13/50	1,590	22	197	85	66	173	795	9	0.4	1.3	1,260	841	15
1S.8.1.433	8/2/50	2,270	21	340	171	13	278	1,250	34	0.2	3.6	1,970	1,550	2
1S.12.13.400	3/17/50	1,460	16	237	68	17	151	663	61	0.5	8.5	1,140	871	4
1S.13.5.213	3/17/50	1,620	16	290	70	16	380	647	42	0.3	2.7	1,270	1,010	3
1S.13.9.411	3/16/50	3,780	13	540	241	205	185	2,470	42	0.9	0.7	3,600	2,340	16
1S.13.20.100	3/17/50	961	12	138	31	29	203	291	45	0.2	0.4	647	472	12
Do.	4/5/51	960	-	-	-	-	-	-	66	-	-	-	-	-
					AQUIFER: GLORIETA SANDSTONE MEMBER OF THE SAN ANDRES FORMATION									
1.13.35.432	3/17/50	1,390	22	236	55	11	180	565	66	0.3	11	1,060	815	3
3.15.28.441[a]	9/7/50	809	2.9	128	12	8.3	233	100	54	0	20	440	369	5

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
			AQUIFER: GLORIETA SANDSTONE MEMBER OF THE SAN ANDRES FORMATION											
3.15.28.441[a]	6/8/53	777	-	-	-	-	255	-	50	-	-	-	-	-
3.15.28.441a[a]	9/7/50	1,130	-	-	-	-	368	-	115	-	-	-	-	-
Do.	6/8/53	949	-	-	-	-	259	-	72	-	-	-	-	-
7.10.23.141	9/26/50	1,910	29	330	58	50	126	865	100	1.6	28	1,520	1,060	9
7.10.35.111	7/14/50	6,040	41	702	350	586	1,990	2,300	310	0.1	2.0	5,270	3,190	29
8.10.17.133[a]	7/7/50	968	24	115	56	13	154	375	12	-	16	687	518	5
8.10.32.341	7/7/50	891	17	64	16	105	132	258	38	-	29	592	226	50
9.9.12.111	8/24/50	3,040	22	286	73	330	146	1,020	385	1.8	1.7	2,190	1,010	41
10.8.36.111	3/7/48	1,260	-	-	-	89	274	349	88	-	-	-	518	27
Do.	8/30/50	1,290	-	-	-	-	264	-	92	-	-	-	-	-
10.9.29.130[a]	8/31/50	1,530	-	-	-	-	234	-	122	-	-	-	-	-
10.10.32.333	3/2/51	3,630	26	312	71	432	184	1,020	558	2.0	5.0	2,520	1,070	-
15.13.14.143	3/22/50	1,130	20	168	49	12	182	391	55	0.2	14	799	620	4
			AQUIFER: DOCKUM GROUP											
9.15.14.134[a]	7/12/50	709	24	104	29	13	415	33	5	0	31	443	378	7

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number[*]	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids[†]	Hardness as $CaCO_3$	Percent sodium
AQUIFER: DOCKUM GROUP														
9.15.32.241	7/11/50	661	22	86	17	32	260	91	22	0.1	19	417	284	20
10.15.26.334[a]	7/12/50	1,100	20	114	48	67	307	308	36	0.4	5.2	750	482	23
AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL														
3.9.3.122[a]	8/3/50	2,780	24	520	162	13	159	1,720	44	0.9	7.5	2,570	1,960	1
3.9.5.424[a]	8/3/50	3,950	19	698	180	122	128	2,080	288	1.2	83	3,530	2,480	10
3.10.22.121	1/26/51	2,490	-	-	-	-	178	-	104	-	-	-	-	-
4.8.1.144	12/31/50	740	-	-	-	-	278	-	20	-	-	-	-	-
4.8.13.133	8/18/49	629	-	70	22	32	227	110	23	-	1.1	370	265	21
Do.	8/31/50	640	-	-	-	-	225	-	21	-	-	-	-	-
4.8.13.412	8/17/50	743	-	-	-	-	210	-	18	-	-	-	-	-
4.8.18.122[a]	8/16/50	370	25	41	14	20	178	32	14	0.4	3.3	238	160	21
4.8.24.133	8/31/50	690	-	-	-	-	208	-	20	-	-	-	-	-
4.9.6.400	10/25/50	597	-	-	-	-	250	-	15	-	-	-	-	-
4.9.11.112	8/17/50	5,280	-	-	-	-	65	-	450	-	-	-	-	-
Do.	3/13/51	8,630	-	-	-	-	379	-	1.140	-	-	-	-	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
4.9.11.112	4/4/51	8,270	-	-	-	-	-	-	1,040	-	-	-	-	-
Do.	5/30/51	8,540	-	-	-	-	371	-	1,070	-	-	-	-	-
Do.	6/29/51	8,510	-	-	-	-	-	-	1,070	-	-	-	-	-
4.9.11.312	7/23/45	4,390	-	137	213	612	328	1,400	580	0.8	1.7	3,110	1,220	-
Do.	3/16/51	4,440	-	-	-	-	340	-	592	-	-	-	-	-
4.9.16.131	1/19/51	3,280	-	-	-	-	316	-	193	-	-	-	-	-
4.10.2.143	8/1/50	5,050	24	642	125	505	570	1,660	685	0.9	7.1	3,910	2,070	35
5.6.10.344[a]	3/2/51	634	11	5.0	1.7	152	382	19	8	2.0	0.4	387	20	94
5.7.15.212	8/16/50	435	20	72	14	1.8	259	19	5	0.2	1.9	262	237	2
5.8.2.333	8/30/50	414	22	71	12	0	240	19	5	0.6	1.8	249	226	0
5.8.5.344	8/15/50	499	24	77	13	14	279	30	10	0.4	1.9	307	246	11
5.8.8.341	8/16/50	348	-	-	-	-	206	-	4	-	-	-	-	-
5.8.8.424	8/16/50	351	-	-	-	-	207	-	3	-	-	-	-	-
5.8.13.	4/(-)/51	629	-	-	-	-	385	-	6	-	-	-	-	-
5.8.15.131	9/6/45	379	-	52	12	13	223	16	5	0.4	0.5	209	179	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
5.8.15.131	8/16/50	380	-	-	-	-	222	-	-	-	-	-	-	-
5.8.15.131[a]	8/16/50	378	-	-	-	-	220	-	-	-	-	-	-	-
5.8.17.113	9/5/46	369	-	54	9.5	14	220	15	4.5	0.4	1.2	207	174	-
Do.	8/29/50	380	-	-	-	-	215	-	6	-	-	-	-	-
5.8.17.323	9/21/44	530	-	75	13	15	217	34	41	0.2	2.7	288	240	-
Do.	8/29/50	619	20	90	16	10	205	32	76	0	4.8	350	290	7
5.8.18.312	8/29/50	368	-	-	-	-	215	-	6	-	-	-	-	-
5.8.18.341	2/(-)/51	294	-	-	14	-	161	14	9	-	0.1	-	-	-
5.8.19.111	2/10/51	410	-	-	-	-	215	-	14	-	-	-	-	-
5.8.24.311	5/13/46	416	-	53	14	17	228	29	6	0.4	1.3	233	190	-
Do.	8/16/50	413	-	-	-	-	207	-	9	-	-	-	-	-
5.8.25.110	4/(-)/51	594	-	-	-	-	273	-	15	-	-	-	-	-
5.8.27.122	8/16/50	500	19	65	17	23	280	31	12	0.8	0.2	306	232	17
5.8.30.121	8/16/50	616	21	83	18	25	269	59	35	0.2	3.2	377	281	16
5.8.36.341	9/20/44	557	-	36	22	49	250	58	12	1.1	2.1	303	180	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL														
5.9.6.311	1/5/51	553	-	-	-	-	297	-	11	-	-	-	-	-
Do.	8/7/52	559	-	-	-	-	297	-	10	-	-	-	-	-
5.9.18.400	4/26/50	660	22	53	41	31	359	130	12	1.2	1.1	419	300	18
5.9.18.424	4/26/50	650	21	58	40	24	260	121	13	1.2	1.4	408	309	15
5.10.13.443	7/28/50	4,210	20	626	152	249	92	1,820	524	2.3	16	3,450	2,190	20
5.10.28.400	7/23/45	7,250	-	565	483	745	262	3,220	1,020	3.0	2.3	6,170	3,400	-
6.8.1.111	8/22/50	625	-	-	-	-	371	-	13	-	-	-	-	-
6.8.9.112	8/22/50	553	21	97	12	8.0	334	20	8	0.2	3.0	334	292	6
6.8.11.420	9/21/44	553	-	80	16	20	329	21	11	0.3	2.7	313	266	-
Do.	7/18/50	541	-	-	-	-	311	25	10	-	-	-	-	-
6.8.13.200	1/15/51	464	-	-	-	-	270	-	10	-	-	-	-	-
6.8.15.	2/(-)/51[k]	403	-	-	-	-	226	-	9	-	-	-	-	-
6.8.24.111	8/17/50	525	-	-	-	-	302	-	10	-	-	-	-	-
6.8.27.331	8/15/50	451	22	68	14	7.6	246	31	5	0.2	2.7	272	227	7
6.8.32.113	8/15/50	465	22	76	10	11	266	19	6	0.2	8.7	284	230	9

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
6.8.32.212	8/29/50	500	-	-	-	-	265	-	9	-	-	-	-	-
6.9.1.300	4/26/50	2,640	24	228	107	226	252	780	336	1.1	5.4	1,830	1,010	33
6.9.2.400	8/(-)/50	3,060	-	-	-	-	-	-	420	-	-	-	-	-
6.9.9.222	8/17/50	2,260	-	-	-	-	368	-	300	-	-	-	-	-
Do.	3/9/51	2,190	-	-	-	-	-	-	286	-	-	-	-	-
Do.	4/4/51	2,280	-	-	-	-	-	-	302	-	-	-	-	-
Do.	6/29/51	2,420	-	-	-	-	-	-	325	-	-	-	-	-
6.9.11.	4/12/50[f]	1,800	-	177	69	122	295	462	190	-	-	1,160	725	27
6.9.11.211	8/30/50	2,300	-	-	-	-	265	-	285	-	-	-	-	-
6.9.12.	2/(-)/51[k]	9,450	-	-	-	-	322	-	1,440	-	-	-	-	-
6.9.28.333	1/19/51	4,380	-	-	-	-	903	-	244	-	-	-	-	-
6.9.33.333	3/9/51	1,980	-	-	-	-	-	-	79	-	-	-	-	-
Do.	4/4/51	2,010	-	-	-	-	-	-	81	-	-	-	-	-
Do.	6/29/51	1,900	-	-	-	-	-	-	86	-	-	-	-	-
Do.	8/7/52	1,840	-	-	-	-	518	-	72	-	-	-	-	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
6.10.5.300a	9/2/48	3,290	-	352	138	238	222	1,180	385	1.4	8.2	2,410	1,450	-
Do.	4/26/50	3,010	22	274	149	215	284	948	380	1.2	5.0	2,130	1,300	26
6.10.7.112	7/25/45	2,370	-	219	94	194	256	686	302	0.9	2.7	1,620	933	-
Do.	8/17/50	2,360	-	-	-	-	260	-	285	-	-	-	-	-
6.10.8.	4/26/50	2,680	22	248	126	189	276	818	328	1.4	4.6	1,870	1,140	27
6.10.8.112	8/17/50	2,660	-	-	-	-	272	-	335	-	-	-	-	-
6.10.27.400	7/25/45	3,500	-	300	195	260	266	1,200	455	2.0	1.0	2,540	1,550	-
6.10.32.200	7/25/45	4,070	-	360	246	311	330	1,520	515	2.1	0.9	3,210	1,910	-
6.10.32.222	7/27/50	4,020	20	366	251	283	335	1,500	508	2.3	1.4	3,100	1,940	24
6.11.19.234	7/28/50	4,060	-	-	-	-	223	-	386	-	-	-	-	-
7.8.1.423	5/15/46	1,040	-	112	41	51	273	220	72	0.7	3.5	635	448	-
Do.	8/16/50	922	-	-	-	-	266	-	74	-	-	-	-	-
7.8.3.433a	9/1/50	703	20	110	15	22	384	40	18	0.2	3.3	418	336	13
7.8.12.200	7/11/50	602	-	-	-	-	-	-	18	-	-	-	-	-
7.8.12.431	9/11/50	633	-	-	-	-	307	-	25	-	-	-	-	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL														
7.8.13.211	8/30/50	709	24	84	26	32	326	57	40	0.4	3.0	427	316	18
7.8.20.342[a]	8/16/50	834	22	131	21	26	504	25	16	0.1	9.5	499	414	12
7.8.24.431	8/11/48	638	-	-	-	-	352	-	15	-	-	-	-	-
Do.	8/16/50	652	-	-	-	-	333	-	29	-	-	-	-	-
7.8.24.433	8/16/50	783	25	32	24	115	326	74	50	0.8	14	496	178	58
7.8.26.121	8/16/50	667	-	-	-	-	405	-	10	-	-	-	-	-
7.8.26.121a	11/28/47	654	11	90	20	31	406	24	10	0.2	2.1	388	306	-
7.8.29.414	11/10/50	513	-	-	-	-	286	-	11	-	-	-	-	-
7.8.34.222	8/11/48	537	24	73	11	29	300	22	13	0.6	1.2	322	227	-
Do.	8/16/50	545	-	-	-	-	304	-	16	-	-	-	-	-
7.8.35.220	8/18/50	776	30	67	22	51	239	38	92	1.2	0.4	420	258	30
Do.	3/23/53	599	-	-	-	-	268	-	23	-	-	-	-	-
7.9.3.300	6/1/50	3,090	28	294	134	211	186	1,040	358	-	3.2	2,160	1,280	26
7.9.20.	8/(-)/50	732	24	39	48	48	292	101	36	1.2	-	441	295	26
7.9.23.300	6/1/50	21,700	-	-	-	-	-	-	4,900	-	-	-	-	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
7.9.27.111	4/26/50	1,800	27	189	76	106	254	523	180	0.7	6.1	1,230	784	23
7.9.30.210	4/12/50[f]	696	-	48	42	40	346	57	26	-	-	383	292	23
7.9.30.220	7/20/50	1,010	-	-	-	-	-	-	32	-	-	-	-	-
7.9.31.222	8/30/50	2,490	21	185	180	151	338	907	174	1.8	74	1,860	1,200	21
7.9.32.211	4/26/50	1,370	22	94	87	93	343	440	36	1.3	0.3	943	592	25
Do.	8/30/50	1,280	-	-	-	-	348	-	35	-	-	-	-	-
8.8.1.434	8/17/50	667	-	-	-	-	343	-	32	-	-	-	-	-
8.8.10.111	8/27/50	547	21	78	11	25	252	42	22	0.2	14	337	240	18
8.8.11.400	10/16/50	510	-	-	-	-	219	-	31	-	-	-	-	-
8.8.12.212	8/11/48	623	24	92	16	15	320	25	26	0.2	5.1	361	296	-
Do.	8/17/50	619	-	-	-	-	304	-	32	-	-	-	-	-
8.8.13.113	8/17/50	560	-	-	-	-	271	-	31	0.6	-	-	-	-
8.8.13.311	8/17/50	591	-	-	-	-	304	-	28	0.6	-	-	-	-
8.8.13.324	8/17/50	557	25	66	19	27	284	25	27	1.4	1.7	332	242	20
8.8.24.131[l]	5/20/48	582	27	74	20	26	326	24	18	0.6	4.3	354	266	-

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
8.8.24.131[1]	8/17/50	600	-	-	-	-	332	-	20	-	-	-	-	-
8.8.25.	4/3/51	519	-	-	-	-	275	-	18	-	-	-	-	-
8.8.26.222	9/6/46	849	-	86	23	79	427	65	38	0.56	11	513	309	-
Do.	8/24/50	800	-	-	-	-	421	-	31	-	-	-	-	-
8.9.6.400	8/19/50	1,180	27	126	43	69	313	231	99	0.6	3.0	753	492	23
8.9.7.211	8/19/50	989	29	105	38	56	336	158	68	0.4	3.0	623	418	23
Do.	8/22/50	981	26	105	32	65	332	156	68	0.4	3.3	620	394	26
8.9.18.110	5/15/51	567	-	-	-	-	270	-	29	-	4.7	-	-	-
8.9.18.320	5/15/51	1,800	26	178	62	138	252	511	183	-	4.0	1,230	699	30
8.9.18.333	8/22/50	535	-	-	-	-	268	-	27	1.0	-	-	-	-
Do.	5/15/51	546	-	-	-	-	272	-	25	-	3.4	-	-	-
8.9.19.133	8/21/50	754	25	92	24	34	274	98	50	0.7	2.9	462	328	18
8.9.29.122	8/21/50	834	25	97	28	40	279	116	64	0.6	3.5	511	357	20
8.9.30.122	m	1,370	-	142	45	90	273	323	124	-	-	858	540	27
Do.	8/21/50	692	27	78	24	35	282	72	42	1.0	3.0	421	293	21

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
9.8.21.121[a]	9/1/50	871	26	135	30	4.1	437	55	29	0.4	15	510	460	2
9.8.21.221	8/17/50	1,170	25	140	31	68	304	174	68	0.4	120	776	477	24
9.8.24	10/2/51	1,930	-	-	-	-	246	-	304	-	-	-	-	-
9.8.24.200	9/1/50	1,090	29	149	50	10	198	310	79	0.8	2.6	728	578	4
9.8.24.300	8/22/50	1,010	26	136	42	16	206	242	86	0.8	2.3	652	512	6
9.8.27.433	9/1/50	809	-	-	-	-	452	-	22	-	-	-	-	-
9.8.35.211	8/17/50	821	-	-	-	-	353	-	40	-	-	-	-	-
9.9.15.133	7/3/50	3,640	17	366	90	391	159	1,330	436	1.2	1.3	2,710	1,280	40
9.9.16.233	7/3/50	3,160	19	326	75	320	177	1,080	385	1.6	1.6	2,300	1,120	38
9.9.31.222	8/30/50	1,880	25	196	103	69	249	595	164	1.1	4.7	1,280	912	14
9.9.32.131	9/19/44	3,670	-	460	114	80	218	1,380	120	2.1	0.2	2,260	1,620	-
9.10.30.311[a]	7/4/50	1,290	25	146	53	42	136	282	174	2.2	21	812	582	14
10.7.24.433	8/29/50	512	16	80	13	7.4	230	30	26	0.4	15	301	253	6
10.7.25.211	8/29/50	642	14	107	17	2.1	306	40	31	0.6	5.3	368	337	1
10.8.20.444	8/31/50	431	18	65	11	5.1	165	19	20	0.8	41	261	207	5

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
8.9.32.130	4/12/50[f]	1,390	-	87	73	108	309	347	97	-	-	864	517	31
8.9.32.310	4/12/50[f]	1,520	-	148	54	106	237	400	150	-	-	975	592	28
8.9.34.330	4/26/50	3,500	23	304	132	335	204	1,160	460	1.4	3.4	2,520	1,300	36
8.9.34.440	8/21/50	6,430	-	-	-	-	336	-	895	-	-	-	-	-
8.9.35.333	8/22/50	6,800	21	590	278	779	282	2,510	980	3.6	90	5,390	2,620	39
9.8.3.312	8/29/50	1,160	29	154	40	49	370	244	66	0.4	3.5	768	548	16
9.8.12.113	8/17/50	1,330	36	174	66	28	243	402	102	0.5	3.5	932	706	8
9.8.12.300	7/8/50	1,140	-	156	-	-	236	-	84	-	-	-	-	-
9.8.13.[n]	7/25/50	1,170	29	166	53	7.4	227	329	83	-	2.8	782	632	2
9.8.13.200	7/20/50	1,070	-	-	-	-	-	-	79	-	-	-	-	-
Do.	7/28/50	1,040	-	-	-	-	-	-	73	-	-	-	-	-
9.8.14	9/(-)/50	1,080	23	152	41	26	288	255	70	0.4	3.2	713	548	9
9.8.14.100	8/17/50	981	23	132	34	29	213	240	73	-	6.4	642	470	12
9.8.14.200	9/15/50	997	28	138	40	18	264	230	62	0.6	3.2	650	509	7
9.8.14.311	9/5/50	1,410	25	197	48	58	366	366	93	0.3	3.0	970	689	16

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
				AQUIFER: TERTIARY(?) AND QUATERNARY VALLEY FILL										
10.8.23.144	8/31/50	614	20	78	25	17	280	67	23	0	4.2	372	298	11
10.8.25.311[a]	8/29/50	1,390	-	-	-	-	262	-	101	-	-	-	-	-
10.8.35.331[a]	8/11/48	1,410	-	-	-	-	304	-	96	-	-	-	-	-
10.8.35.411[a]	8/11/48	1,350	26	161	50	69	290	372	92	0.6	2.5	916	607	20
Do.	8/30/50	1,360	-	-	-	-	284	-	97	-	-	-	-	-
10.9.5.111	8/11/48	572	25	64	17	32	162	135	10	1.1	11	375	230	23
10 9.18.131	8/11/48	565	23	56	26	24	194	111	13	0.5	4.6	354	246	17
Do.	8/29/50	834	22	89	38	34	204	213	41	0.6	3.9	542	378	16
10.9.20.444[a]	8/21/50	1,570	20	194	61	13	144	409	152	0.5	5.0	926	735	4
10.9.21.321	8/31/50	1,890	-	-	-	-	182	-	194	-	-	-	-	-
10.9.21.431	5/15/46	1,430	-	137	54	77	164	479	62	1.3	8.9	900	564	-
Do.	8/31/50	1,720	22	178	71	106	160	612	130	1.7	14	1,210	736	24
10.9.34.311	7/7/50	2,550	21	276	108	158	205	854	290	0.6	11	1,820	1,130	23
				AQUIFER: QUATERNARY ALLUVIUM										
3.6.34.431	8/10/50	2,530	21	592	92	8.6	125	1,640	10	0.4	14	2,440	1,860	1

See footnotes at end of table.

TABLE 16. CHEMICAL ANALYSES OF WATER FROM WELLS AND SPRINGS IN TORRANCE COUNTY, N. MEX., AND ADJACENT AREA (continued).

(Analyses by U. S. Geological Survey; chemical constituents in parts per million)

Well location number*	Date of collection	Specific conductance (micromhos at 25°C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids†	Hardness as $CaCO_3$	Percent sodium
					AQUIFER: QUATERNARY ALLUVIUM									
6.8.11.340[o]	8/17/50	484	25	68	18	11	280	20	10	0.2	3.0	293	244	9
7.12.11.322[p]	7/12/50	250	9.9	41	8.1	<10	114	24	8	-	2.5	150	136	0

FOOTNOTES

* Well numbers correspond to numbers in Table 14.

† Sum of determined constituents with bicarbonate included as carbonate.

a Aquifer uncertain

b Iron (Fe) = 0.34 ppm

c pH = 7.6

d Iron (Fe) = 0.16 ppm

e Sample taken at 38-foot depth.

f Date received.

g Sample taken at 125-foot depth after well cased off between surface and 90 feet.

h Sample taken at 155- to 200-foot depth after well cased off from surface to 140 feet.

i pH = 8.3

j Iron (Fe) = 0.03 ppm; pH = 7.8

k Probable date.

l pH = 7.3

m Received 4/12/50; probably taken from a relatively shallow aquifer before well was completed.

n Lot 24; block number not given.

o Aquifer is Tertiary and Quaternary valley fill

p Aquifer is Precambrian rock

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Numbers in *italics indicate* figures and plates; **boldface** indicates main references.