GROUND-WATER RESOURCES OF THE EL PASO AREA, TEXAS PROGRESS REPORT NO. 6

Bу

R. A. Scalapino

With

Section on Quality of Water

By Burdge Irelan

PREPARED IN CO-OPERATION BETWEEN THE CITY OF EL PASO. The texas state board of water engineers, and the geological survey, united states department of the interior

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GROUND-WATER RESOURCES OF THE EL PASO AREA, TEXAS PROGRESS REPORT NO. 6

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INTRODUCTION

Location and extent of area

El Paso, which according to recent estimates has a population of 135,000, is in the extreme western part of Texas on the Rio Grande just below the Franklin Mountains and the Sierra del Paso del Norte in Mexico; it has been known since Spanish times as "The Pass of the North." Ciudad Juarez, which according to the Rand McNally Commercial Atlas of 1940 had a population of 48,676, is across the river from El Paso.

The area and the ground-water reservoirs in it have been described in detail by Sayre and Livingston 1/ and the review of the extent of the area, the ground-water reservoirs, and the early history of development of ground water is summarized largely from their report.

For about 50 miles along the west side of the Franklin and Organ Mountains the Rio Grande flows south-southeast through a broad, flat-bottomed valley known as the Mesilla Valley, locally called the Upper Valley. Near the southern end of the Franklin Mountains, the river turns abruptly southeastward and passes through the El Paso Valley, locally referred to as the Lower Valley. The El Paso Valley, which is about 6 to 8 miles in width and 225 to 350 feet in depth, is carved diagonally across the Hueco bolson. The bolson is a broad, gently tilted plain bounded on the east by the Hueco and Finlay Mountains, on the south by part of the Sierra Madre Oriental of Mexico, on the west by the Franklin Mountains, and on the north by the Tularosa Basin. The bolson surface rises abruptly from the Rio Grande valley floor, giving the appearance of a broad elevated table land, and for this reason it is locally referred to as the Mesa. This report deals primarily with the ground-water reservoir beneath the Hueco bolson and the El Paso or Lower Valley.

Previous reports

An intensive study of the ground-water resources of the El Paso area was begun in 1935 by the Geological Survey, United States Department of the Interior, in cooperation with the City of El Paso and the Texas State Board of Water Engineers. The first report on the results of that investigation was released to the City of El Paso in 1937. A detailed report of the study was released in March 1941; it was later published by the U. S. Geological Survey as Water-Supply Paper 919.

Since August 1936, personnel from the water department of the City of El Paso have made measurements of water levels in wells monthly, collected water samples for chemical analysis from selected wells at regular intervals, and obtained records of the monthly pumpage from city, Army, and industrial wells in the El Paso area, including Juarez, Mexico. The data obtained have

^{1/} Sayre, A. N., and Livingston, P.P., Ground-water resources of the El Paso area, Texas: U. S. Geol. Survey Water-Supply Paper 919, 1945.

been given careful study from time to time by several members of the Geological Survey. Eight memoranda and progress reports based on these data have been released since 1937 and the measurements of water levels have been published annually in water supply papers of the U. S. Geological Survey.

Purpose of this report

The present progress report discusses the amount of water pumped, the fluctuations in water levels, and the removal of water from storage during the 13-year period 1936-48. It discusses the salt-water encroachment in certain areas and the resultant effect on the quality of water. The report also discusses the experimental work carried on in cooperation with the City of El Paso to determine the feasibility of artificially recharging the valley or artesian area of the reservoir with surface water from the Rio Grande.

GROUND-WATER RESERVOIRS

The principal water-bearing beds in the El Paso area are the unconsolidated bolson deposits that partially fill the deep structural trough between the Franklin and Hueco Mountains, the younger outwash deposits that form a mantle over the older bolson deposits, and river alluvium that has been deposited in the valley. The unconsolidated deposits consist of alternating beds of clay, sand, and gravel; the individual beds range in thickness from a fraction of an inch to nearly a hundred feet. Although many wells have been drilled in this area and drillers' logs of the material penetrated have been compiled and studied, it is difficult, and in places impossible, to correlate beds from one well to another; therefore, these unconsolidated deposits will be considered as a unit in this report.

Mesa area

Sands can be found in the bolson deposits that yield water of good quality nearly everywhere on the Mesa except in the northeastern part. The yield of wells and the depth to water vary widely from place to place. Near the east side of the Mesa the water level ranges from 300 to 400 feet below the land surface; on the west side near Fort Bliss it is 200 feet; and near the New Mexico-Texas boundary it is about 300 feet. The difference in the depth to water is caused in part by the bolson surface rising toward the east and in part by the water table dipping toward the southeast. In general, the water in the Mesa area does not rise appreciably above the level at which it is encountered-that is, it occurs unconfined or under water-table conditions.

El Paso Valley (artesian) area

Water occurs in the sands and gravels beneath the El Paso Valley at depths ranging from 10 feet to at least 1,276 feet below the land surface; however, not all this water is potable. The water in deep wells in the valley is under artesian pressure and rises in the wells to an elevation comparable to that of the water table in the wells on the Mesa. Water drawn from wells between the depths of about 300 to 800 feet below the surface in the immediate vicinity of El Paso and possibly for a short distance downstream from El Paso generally is of satisfactory quality for public and industrial supplies. In the valley downstream from El Paso most wells are relatively shallow and the water, with the exception of the public supply at Fabens, is in general more or less highly mineralized. A well drilled at Clint to a depth of 1,100 feet is reported to have encountered only briny water.

Shallow water-bearing beds

Shallow water-bearing beds in the Lower Valley contain moderately to highly mineralized water and are apparently more or less completely separated by impervious beds from the deeper aquifer, which contain water of good quality. These shallow water-bearing beds occur at about the same level as or slightly above the upper fresh-water-bearing beds of the Mesa, and under certain conditions this highly mineralized water moves from the shallow beds in the valley into the beds beneath the Mesa. This condition poses a constant threat to the fresh-water-bearing beds in the area.

DEVELOPMENT OF GROUND WATER

History of development and use of ground water

According to Water-Supply Paper 919 (pp. 5-6) the first well to furnish water to the City of El Paso was known as the Watts well, which was dug about 1892 in the El Paso Valley a few hundred feet from the Rio Grande. It yielded a large amount of water but the water was of unsatisfactory quality for human consumption. During the time that water was supplied chiefly from this well, drinking water was shipped to El Paso from Deming, New Mexico. The Watts well supplied the City until 1904. In 1904 the International Water Company bought the water-works and started drilling wells on the Mesa north of Fort Bliss. In 1910 the City acquired the property of the water company and continued to drill wells on the Mesa. The Mesa wells were operated from a central plant by air lift. Owing to the low efficiency and high cost of operating this plant. city officials decided to explore the deep water sands below the Mesa nearer the city. In December 1917, construction was begun on City well (well 50) in the Montana well field (see fig. 4). Pumpage was gradually shifted from the Mesa well field to the Montana well field and wells in the downtown area of El Paso, and in 1926 pumping from the Mesa well field was discontinued. In 1934 an increase in the chloride content of the water from the Montana well field became noticeable and a large part of the pumpage was shifted to the Mesa well field, where new deep wells had been drilled and equipped with deep-well turbine pumps powered with electric motors.

With few exceptions there was a steady increase in total pumpage from deep wells from 1906 to 1943 when the City of El Paso placed in operation its plant for treating surface water. The total average daily pumpage from all deep wells in the El Paso area, including Juarez, Mexico, from 1906 through 1948 is shown graphically in Figure 1.A.

The City of El Paso is the principal user of ground water from deep wells in the El Paso area. Records show that the City used approximately 44 percent of the total amount of water pumped from deep wells during the years 1943 to 1948, inclusive; industries in the area used about 26 percent; the City of Juarez, Mexico, used about 18 percent; and the United States Army at Fort Bliss used about 12 percent.

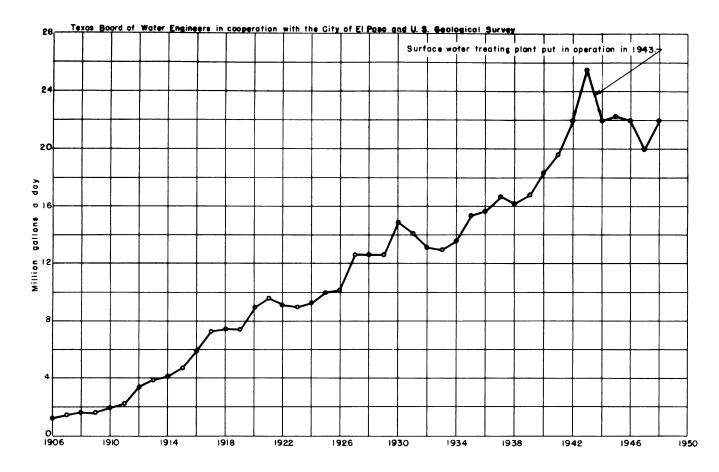


Figure I,A.-Graph showing average daily pumpage from all deep wells in the El Paso area, Texas, from 1906 to 1948, inclusive.

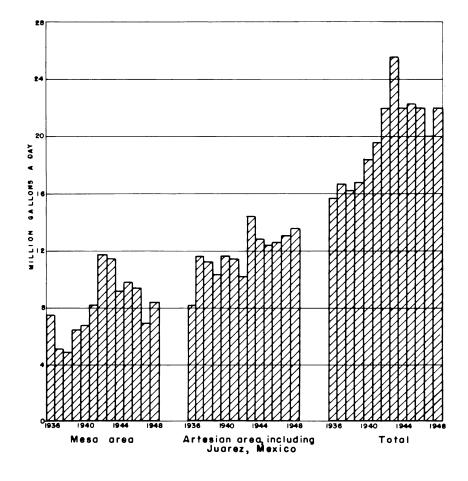


Figure I, B.- Estimated average daily pumpage from deep wells in the El Paso area from 1936 to 1948, inclusive.

In the Mesa area the average daily pumpage by years from 1936 through 1940 was 6,200,000 gallons a day; from 1941 through 1943, 10,500,000 gallons a day; and from 1944 through 1948, 8,700,000 gallons a day.

In the valley artesian area including Juarez, Mexico, the average daily pumpage by years from 1936 through 1940 was 10,600,000 gallons a day; from 1941 through 1943, 11,900,000 gallons a day; and from 1944 through 1948, 12,900,000 gallons a day. Increasing demands for water by the local industries in the valley artesian area has kept the total pumpage at or near the same rate as in 1942, although the City has lightened the draft on the ground-water reservoir by the use of surface water.

Figure 1,B shows that the rate of pumpage from the Mesa area has declined whereas the rate of pumpage from the artesian area has increased. The average pumpage on the Mesa during the period 1944-48 was 1.8 million gallons a day less than it was during the period from 1941 through 1943. In the valley or artesian area the average rate of pumping during the period 1944 through 1948 was 1,000,000 gallons a day greater than that in the period 1941 through 1943.

The following table shows the estimated average pumpage from deep wells in the El Paso area from 1936 to 1948, inclusive, in gallons a day.

Year	Artesian area, including Juarez and Montana field	Mesa area	Total
1936	8,200,000	7,500,000	15,700,000
1937	11,600,000	5,100,000	16,700,000
1938	11,300,000	4,900,000	16,200,000
1939	10,300,000	6,500,000	16,800,000
1940	11,600,000	6,800,000	18,400,000
1941	11,400,000	8,200,000	19,600,000
1942	10,200,000	11,800,000	22,000,000
1943	14,100,000	11,500,000	25,600,000
1944	12,800,000	9,200,000	22,000,000
1945	12,400,000	9,900,000	22, 300, 000
1946	12,600,000	9,400,000	22,000,000
1947	13,100,000	6,900,000	20,000,000
1948	13,600,000	8,400,000	22,000,000

Table 1. Estimated average daily pumpage from deep wells in the El Paso area from 1936 to 1948, inclusive, in gallons a day

<u>Pumpage from shallow ground water</u>. The shallow ground water in the valley, as previously mentioned, is too highly mineralized to be used without treatment where water of good quality is required. However, for refrigeration, air conditioning, and other uses it is a convenient source of cool water. No attempt has been made to locate all the shallow wells and only rough estimates have been made of the total volume of water pumped, but it seems likely that the total pumpage is $\frac{1}{2}$ is a rather large. A large electrical plant, an oil and a copper refinery, several office buildings, and others use shallow ground water, largely untreated. If The City of El Paso is now pumping some

shallow ground water and treating it in the new Rio Grande treatment plant, to help reduce the draft on the deeper aquifers. It is estimated that the average over-all withdrawal from the shallow wells amounts to more than 3,000,000 gallons a day but probably less than 6,000,000 gallons a day.

FLUCTUATIONS OF WATER LEVELS

Mesa area

Monthly measurements of water levels in selected wells have been made since December 1935. Owing to variations in seasonal pumpage, it has been found that measurements made in January of each year are the most reliable for purposes of showing annual changes of water levels. The contour map (fig. 2) has been prepared to show the change in water levels on the Mesa from January 1936 to January 1949. This map shows that in the 13-year period the water level has fallen a maximum of 16 feet in the Mesa well field and 15 feet in the Fort Bliss well field. It also shows that the compound cone of depression created by these two centers of pumping has spread about 12 miles to the north and perhaps 9 miles or more to the east. Control for the contours in the eastern part is largely estimated. The boundary formed by the Franklin Mountains, which halts the migration of the depression to the west, probably causes the cone to spread farther to the north than to the east.

The changes in water levels in seven observation wells located at distances of 1 to 12 miles from the center of pumping are shown graphically in figure 3. In general, the rate of decline has been almost constant since 1936. The approximate locations of these and all other observation wells used in this report are shown on the sketch map, figure 4.

Valley area, including Montana well field

The water levels in the deep artesian wells in the valley respond quickly to changes in the rate of pumping from a well itself or from other wells in the area, and they fluctuate over a rather wide range. This is illustrated by the graphs in figure 5 showing changes in artesian pressures in three observation wells. Although these graphs show variations in water levels of as much as 23 feet during one season, the artesian pressure in none of the wells has shown a sustained downward trend since the first available records.

Table 2 below shows numbers and owners of observations wells shown in table 3 and figure 4.

Well No.	Owner	Well No.	Owner
8	El Paso Electric Co., well 4	62A	El Paso Water Control and Improvement
9	El Paso Electric Co. well		District No 1, well 2
10	El Paso drainage well	64	U. S. Geological Survey test hole 1
12	City of Juarez, well 1	65	City; of El Paso Municipal Airport well 1
13	City of Juarez, well 2	67	Texas and New Orleans Railway
18	City of Juarez, well 3	67B	Texas and New Orleans Railway
19	El Paso Milling Company	68	Texas and New Orleans Railway
21	El Paso City well 10	72	Fort Bliss well 2
25	El Paso Ice and Refrigeration Co.	75	Fort Bliss well 5
28	Acme Laundry Co.	75B	El Paso City well 15
29A	Consumers Ice Co., well 2	7 5 D	El Paso City test well 12
30A	El Paso City well 14	76	U. S. Geological Survey test hole 2
3.2 A	El Paso City well 17	77	El Paso City well 11
39	Price Dairy	77B	El Paso City well 15
42	El Paso City well 9	78C	El Paso City well 4 (test well)
44	Harry Mitchell Brewing Co.	78	El Paso City well 11
48A	El Paso City well 28	79	El Paso City well 8
48B	El Paso test well 33	82A	El Paso City well 20
49	El Paso City well 4	112	El Paso City well 32 (Old Mesa well field
50	El Paso City well 1	128B	El Paso City well 21
51	El Paso City well 2	128C	El Paso City test well 23
52	El Paso City well 3	130	G. L. Cook
52A	El Paso Water Control and Improvement	136	U. S. Geological Survey test hole 3
	District No. 1, well 1	138	U. S. Army reservation
53	Loretta College	139A	El Paso City test well 29
55	Texas Company Refinery	140	Southern Pacific Lines
59	Nichols Copper Co. (Phelps-Dodge)	143A	El Paso City test well 30
59A	Nichols Copper Co. (Phelps-Dodge)		

Table 2. Observation wells in the El Paso area, Texas

The following table gives the altitude of the water levels or artesian pressure in feet, above sea level in observation wells in the El Paso area during the period 1944-48.

Table 3.	Water	levels	in	the	E1	Paso	area,	Texas.	in	feet	above	sea	level	l
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1945

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Well	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	No▼.	Dec。
8	3,693.27	3,691.62		3,692.63		3,691.82	3,691.82	3,692.12	3,692.22	3,693.81		
9	3,694.73	3,691.62		3,693.61		3,690.17	3,690.42		3,692.58			
10	3,693.87	3,691.80		3,693.00	3,691.67	3,689.99	3,690.37	3,690.12	3,691.81		3,693.25	
12	a/3,634.21				. /3,628.05	<u>a</u> /3,628.32						
18	a/3,659.30				a/3,650.59	a/3,650.96						
19 "	3,688.47					3,688.05			3,694.44			
21	3,684.41	3,683.44		3,682.81	3,681.88	3,682.03	3,681.89	3,681.86	3,682.95	3,684.67	3,684.45	3,683.37
22A	3,691.74			3,691.68		3,691.52						
28	3,681.89								3,676.71			
29A	3,665.59	3,657.29		3,661.12	3,655.07	3,654.02	3,653.27	3,655.36	3,654.87	3,665.19	3,675.49	3,659.74
30A	3,665.09	a/3,640.77			a/3,639.10		<u>a</u> /3,637.34	a/3,640.18		3,675.27	3,676.35	
32A	3,666.16	a/3,636.16		a/3.638.12	a/3,633.05	a/3,634.09	a/3,632.28	a/3,634.73		3,675.56	3,675.66	
39	3,666.37							3,658.02				
	a/3,620.52	a/3,625.37	3,669.73	a/3.623.95	a/3.625.31	a/3.625.94	a/3.623.64	a/3,621.16	a/3,621.35	3,674.04	3,675.90	
42A	3,688.77			3,688.89		3,688.95			_ .			
44	3,663.57											
48A	3,671.51	3,669.85	3,674.44	3,672.74	3,664.39	3.662.00	<u>a</u> /3,623.83	3,665.31		3,675.68	3,678.03	3,673.23
48B	3,674.51	3,673.12	3,676.15	3,675.42	3,670.78	3,669.13	3,668.20	3,669.99	3,669.88	3,676.68	3,678.11	3,674.92
49	3,669.86	3,668.35	3,672,51		a/3,600.41	a/3,599.91	a/3,599.16	3,660.93	3,659.75	3,675.57	3,675.57	3,671.67
50	3,674.42	3,673.76	3,676.13	3,675.28	3,657.29	3,657.95	3,657.12	3,666.04	3,665.27	3,675.48	3,677.02	3,673.28
51	3,669.95	3,668.76	3,672.17	3,671.21	3,652.37	3,652.12	3,651.54	3,659.07	3,659.85	3,671.43	3,674.67	3,671.42
52	3,669.69	3,668.55	3,671.51		a/3,629.32			a/3,633.83	-,	3,671.06	3,674.10	3,670.67
53	3,668.90	3,667.53	3,670.67	3,669.17	3,656.55	3,655.60	3,655.48		3,659.49	3,660.13	3,673.16	
55	3,667.54	3,668.60	3,670.09	3,671.17	3,666.46	3,663.99	3,663.20	3,664.75				
59	3,665.07	3,000.00	3,010:07	0,012021	.,	3,660.65						
59A	3,669.05					3,665.57						
	3,676.96	3,677.49	3,677.08	3,677.31	3,676.88	3,676.82	3,676.62	3,676.54	3,676.49	3,675.98	3,676.32	
64 67B	3,668.05	3,665.27	3,011.00	0,011001	3,666.52	3,657.35		3,659.13	•••••			
	3,660.47	3,653,48	3,662.44		3,643.49	3,640.56		3,636.91				
72 75B		3,664.81	3,664.71	3,664.40	3,663.10	3,662.65	3,662.46	3,663.23	3,662.10	3,663.18	3,663.10	3,663.56
	3,662.36	3,004.01	3,665.99	3,004.40	3,003.20	5,002.00	0,002140	0,000120	0,002020		.,	
75D		2 674 19	3,674.38	3,673.75	3,672.89	3,672.42	3,672.26	3,672.32	3,672.07	3,673.83	3,674.07	3,674.44
76	3,674.33	3,674.12		3,658.40	3,652.62	3,650.49		3,650.11	3,649.83	3,658.29	3,659.76	3,660.22
77	3,658.85	3,660.56	3,660.45	3,673.91	3,673.60	3,673.49	3,673.30	3,673.15	3,673.00	0,000.27	3,672.90	3,673.09
78C	3,673.96	3,673.76	3,673.89	3,661.18	3,013.00	3,013.49	3,013,34	3,013.15	3,010.00		0,012090	0,010.07
79	3,658.53	3,661.62	1		- /2 642 55	- /2 609 74	- /3 609 74					
82A	3,667.79	a/3,605.49	a/3,606.89	a/3,607.38	<u>=</u> /3,003.33	<u>*/3,602.74</u>	4/3,002.14			3,656.15	3,657.62	3,658.33
112	3,661.21	3,663.25	3,663.52	3,663.26	2 (4) 18	2 601 04	3,680.90	3,680.79	3,680.68	3,680.59	3,680.48	0,000000
128C	3,681.49	3,681.37	3,681.40	3,681.33	3,681.18	3,681.04	3,000.90	3,000.09				a/3,635.60
128B	A / 3,636.07	<u>a/3,634.53</u>	▲ /3,634.59	a /3,635.83	a/3,034.84	<u>4/</u> 3, 4 4, 22	44 (12,034)	<u>•</u> /3,634.40	=/3,034.40	-/ 3, 033.42	-/ 3, 03 3. 13	=/3,033.00
130	3,682.12	3,679.99	3,681.96	3,680.57			2 (2 607 84	2 607 17	3 607 17	3,696.98	
136	3,697.41	3,697.42	3,697.57	3,697.61				3,697.20	3,697.17	3,697.17	3,070,78	
139A	3,709.07			3,709.24		3,709.02						
143A	3,723.36			3,723.37		3,723.28						

4/ Pumping.

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Table 3. Water levels in the El Paso area, Texas, in feet above sea level -- Continued

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$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Well Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
3,682.553,691.123,691.053,689.533,682.733,667.893,667.893,667.833,667.833,667.843,667.843,677.1763,677.122 <th< td=""><td>8</td><td></td><td></td><td></td><td></td><td></td><td></td><td>3,688.33</td><td></td><td></td><td></td><td></td></th<>	8							3,688.33				
3,656.61 3,662.12 3,682.18 3,662.28 3,662.28 3,662.48 3,682.43 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,682.41 3,662.41 3,661.41 3,661.41 3,661.41 3,661.41 3,661.41 3,661.41 3,661.41 3,661.42 3,611.22 3,671.12 3,671.12 3,671.22 <td< td=""><td>10 3,693.84</td><td>3,682.55</td><td></td><td></td><td>3,691.12</td><td>3,691.05</td><td>3,689.93</td><td></td><td></td><td></td><td>3,690.40</td><td></td></td<>	10 3,693.84	3,682.55			3,691.12	3,691.05	3,689.93				3,690.40	
3,656.61 3,662.57 3,682.51 3,661.48 3,661.76 3,651.05 3,661.76 3,671.160 3,657.16 3,671.65 3,671.65 3,661.48 3,661.75 3,671.65 3,671.126 3,651.122 3,671.22	19 3,688.28						3,688.53					
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	30Aa/3,636.33	a/3,636.67			3,641.48	3,660.46		3,662.73		3,671.72		
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	Jen.	reb.	Mar.	Apr.	May	June	July	Aug.	Şept.	Oct.	Nov.	Dec.
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	1.690.08											
	1.682.71		3,682.68	3,682.60		3,682.36		3,682.22	3,682.42			
ŝ	1,658.60	3,657.13		3,667.74		3,666.32						
e/3		a/3.640.86	3,670.49			3,664.51		3,670.13	3,671.69			3.676.22
		a/3,636.43		a/3,642.44				3,670.60	3,672.22			3,675.60
	a/3, 626.32	a/3,625.97		3,670.66				3,669.36	3,670.85			3,676.58
١	3.671.41	3,669.49	3,674.62			3,667.32	3,664.38	3,668.75	3,671.69			3,667.76
468 3	3.674.11	3.672.42	3,675.38	3,675~19		3,671.38	3,670.58	3,673.21	3,673.73			3,677.63
	1.671.01	3,668.16	3,672.46									3,674.59
•	1,675.38	3,673.93	3,676.28			3,669.58	3,666.29	3,665.48	3,667.66			3 , 677 - 88
•••	3,670.52	3,668.63	3,672.18									
	1,670.78	3,668.39										
ŝ	3,670.35	3,667.85	3,671.27			3,663.50		3,660.83	3,665.38			3,674.28
	3,669.59					3,660.82						
"	3,664.52											
	3,677.20	3,677.18	3,676.93	3,676.86		3,675.88	3,675.72	3,675.65	3,676.38			3,676.28 1
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76 3	3,674.14	3,674.03	3,673.82	3,673.93		3,672.26	3,671.88	3,671.78	3,671.45			3,674.49
	3.662.04	3,661.28	3,662.18	3,658.72		3,658.00	3,655.25	3,655.17	3,654.81			3,664.84
7.8C 3	3.671.67	3,671.79	3,671.56			3,671.48	3,671.33	3,671.44	3,671.28			3,670.36
	3.663.03	3.662.74	3,663.56			3,657.53						3,664.44
128B a/3	3.635.25	a/3.633.89				a/3,632.34						3,632,34
	3.678.36	3.679.22	3,679.07	3,679.10		3,678.88	3,678.70	3,678.66	3,678.51			3,679.11
	3,696.68	3,696.61	3,696.46	3,696.52		3,696.45	3,696.24	3,696.25	3,696,11			3,696.28
139A 3	3,708.51					3,788.39						
	3. 722. 91					3.723.26						

A/ Pumping.

Table 3. Water levels in the El Paso area, Texas, in feet above sea level - Continued

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3,680.	44							3, 673. 03	3,683.95
1 1 2 6	79 a/3,607.57		3,665.12	3,664.46	3,666.43	3,671.64	3,676.35	3,677.29	3,677.60
0°7 - 7 - 0 - 7							3,671.59		3,672.98
3, 673.	81		3,658.45		3,659.48	3,664.26	3,671.00		3,675.65
3,668.	35		3,660.20						
			3,675.78	3,675.58	3, 675, 66	3,675.29	3,675.46	3,676.51	3,675.55
									3,657.28
3,663.32	32	3,660.17	3,659.36	3,658.97	3,658.97	3,656.18	3,660.60	3,662.36	3,664.13
			3 671 80	3 671 17	3 671 13	3 670 99	3 679 36	3 673 05	3,600.31 3,674 10
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			3,696,03	3,695.93	3,695.98	3,695.75	3,695.67	3,695.58	3,695.86
			3,708.34						

<u>a</u>/ Pumping.

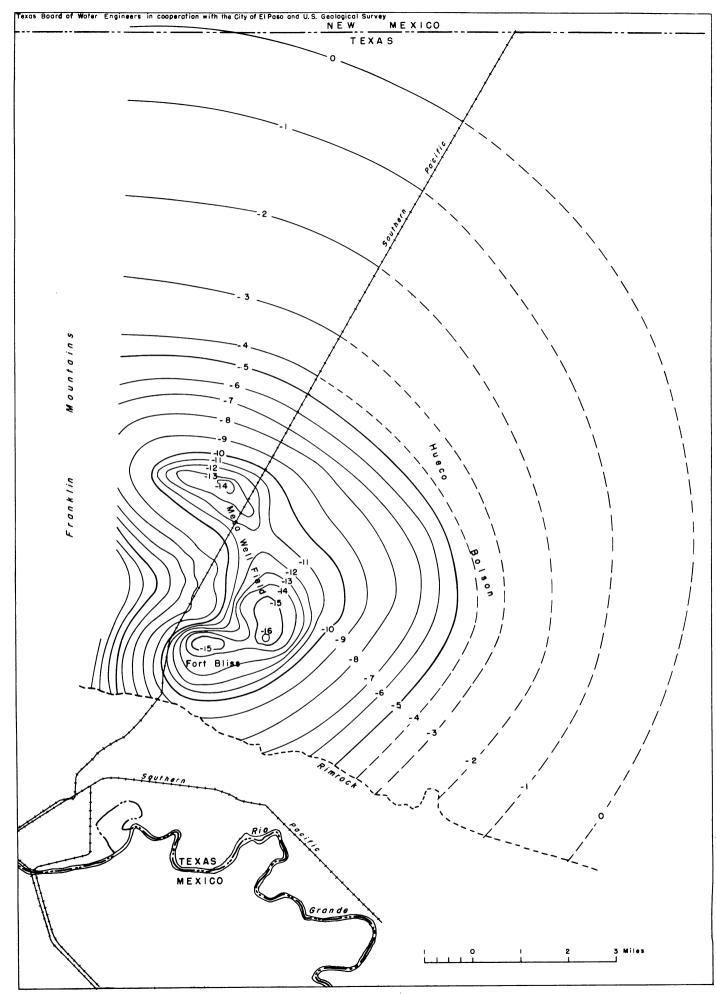


Figure 2.-Map of the El Paso area showing decline (-) of the water table on the Mesa northeast of El Paso from January 1936 to January 1949.

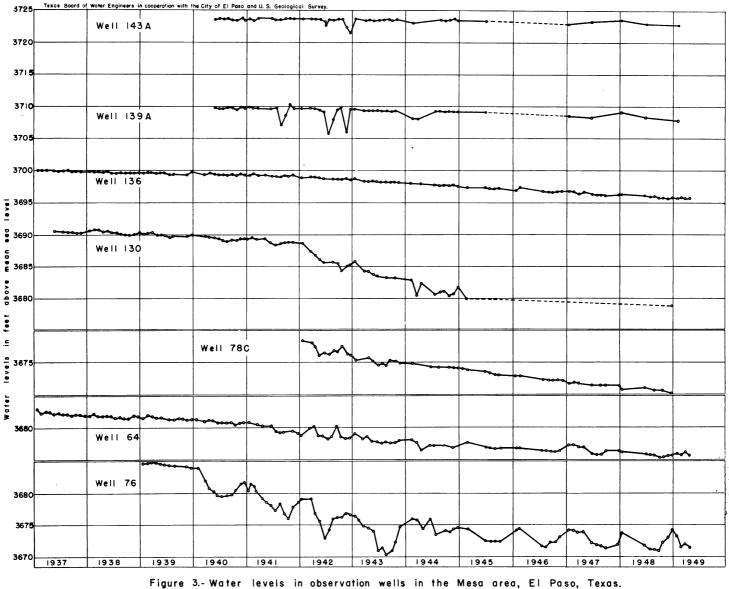
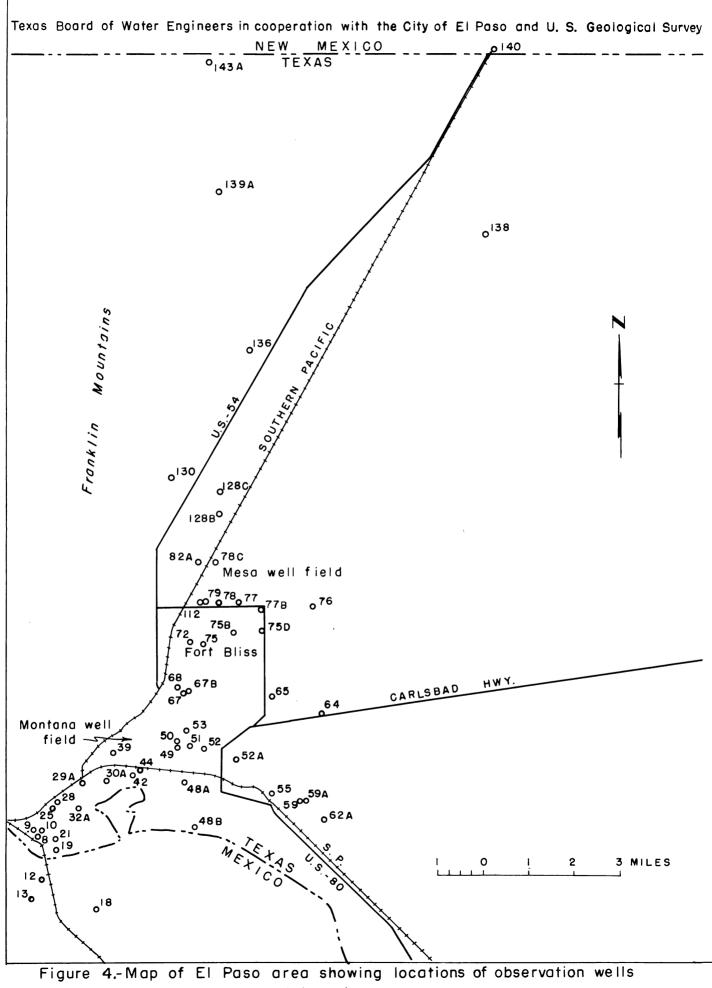
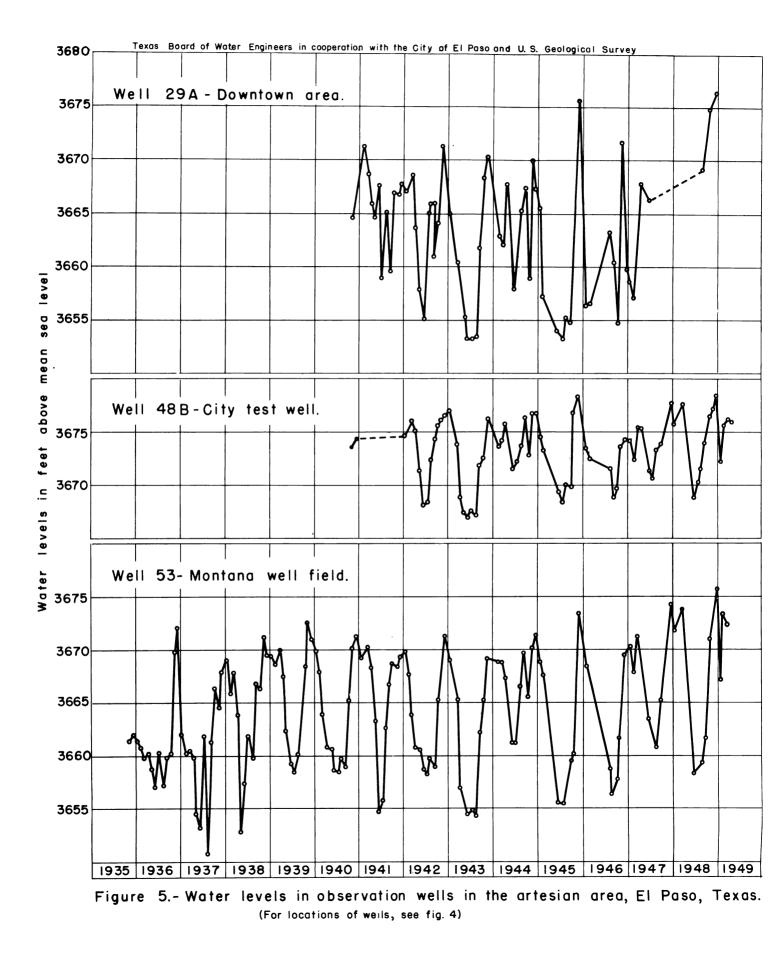


Figure 3.- Water levels in observation wells in the Mesa area, El Paso, Texas (For locations of wells, see fig. 4)

mic-1949



used in this report.



REMOVAL OF WATER FROM STORAGE ON THE MESA

In the progress reports of 1944 and 1945, water-table conditions were assumed to exist throughout the Mesa north of the rimrock, and computations based on the records of water-level measurements showed the volume of material unwatered on the Mesa to be 206,000 acre-feet from 1936 to 1943 and 100,000 acre-feet during the 2-year period 1943-44. Using the same method, it is estimated that the volume of material unwatered during the years from 1945 to 1949 was 118,000 acre-feet and during the entire 13-year period 1936 to 1949 was 424,000 acre-feet.

In previous reports the figure of 17½ percent has been used as the specific yield, and it has been computed that the amount of water removed from storage was about 4,600,000 gallons a day from 1936 to 1943, and about 8,000,000 gallons a day during 1943 and 1944. Using the same figure, it has been computed that 4,600,000 gallons a day was removed from storage from 1945 to 1949; and about 5,100,000 gallons a day for the entire period from 1936 to 1949.

The pumpage of ground water in the El Paso area for the 13-year period from 1936 to 1949 averaged about 20,100,000 gallons a day. Of this amount it is computed that about 5,100,000 gallons a day was removed from storage on the Mesa. Therefore, the difference between these figures indicates that an average of about 15,000,000 gallons a day was obtained from recharge or lateral movement of water toward the well fields from beyond the Mesa; study of the available data indicates that most of this water came from recharge on the Mesa.

ARTIFICIAL RECHARGE

Experimental studies

The availability of excess surface water from the Rio Grande during the winter, when the demand on the output of the treatment plant is low, suggested to Mr. E. J. Umbenhauer, Superintendent of the El Paso Department of Water and Sewage, the possibility of storing some of this water in the artesian area for removal at a later date. The practice would have the added advantage of increasing the head in the fresh-water sands and helping to prevent, to some extent, the encroachment of salt water into these sands. In 1947 the U. S. Geological Survey was requested to make an investigation to determine the feasibility of this plan, and considerable field work and study have been done by R. W. Sundstrom and the writer.

In February 1948 the Geological Survey, in cooperation with the City of El Paso and the Texas State Board of Water Engineers, began field work to obtain the data necessary for computing the effects of recharge and comparing these computations with the observed effects. Water was injected into well 49 (City well 4) at the rate of 1,060 gallons a minute for 15 days, and the effect on the water level in well 50 (City well 1) was recorded by an automatic water-stage recorder.

In connection with the recharge investigation, a pumping test was made in the Montana well field to determine the effect of pumping on the artesian pressure. In this test, well 49 (City well 4) were pumped continuously at the rate of 1,360 gallons a minute for 48 hours and the resulting drawdowns were observed in well 50 (City well 1), 1,000 feet from well 49; well 53 (Loretta College), 3,200 feet from well 49; well 52 (City well 3), 3,450 feet from well 49;

and well 48 (City well 18), 4,000 feet from well 49. From the results of this test, the coefficients of transmissibility and storage for the water-bearing materials were computed mathematically by means of the Theis nonequilibrium formula. The coefficient of transmissibility may be expressed as the number of gallons of water that will move in 1 day through a vertical strip of the aquifer 1 foot wide and having the height of the aquifer, when the hydraulic gradient is unity. The coefficient of storage, under artesian conditions, may be expressed as the volume of water, measured in cubic feet, released from storage in each column of the aquifer having a base 1 foot square and a height equal to the thickness of the aquifer, when the artesian head is lowered 1 foot.

The coefficients of storage and transmissibility obtained from this test are listed in the table below.

Well No.	Coefficient of transmissibility	Coefficient of storage
49	Pumped well	
50	124,,400	0.00271
53	139,600	· 00117
52	82 · 400	· 00063
48a	129 , 100	00138

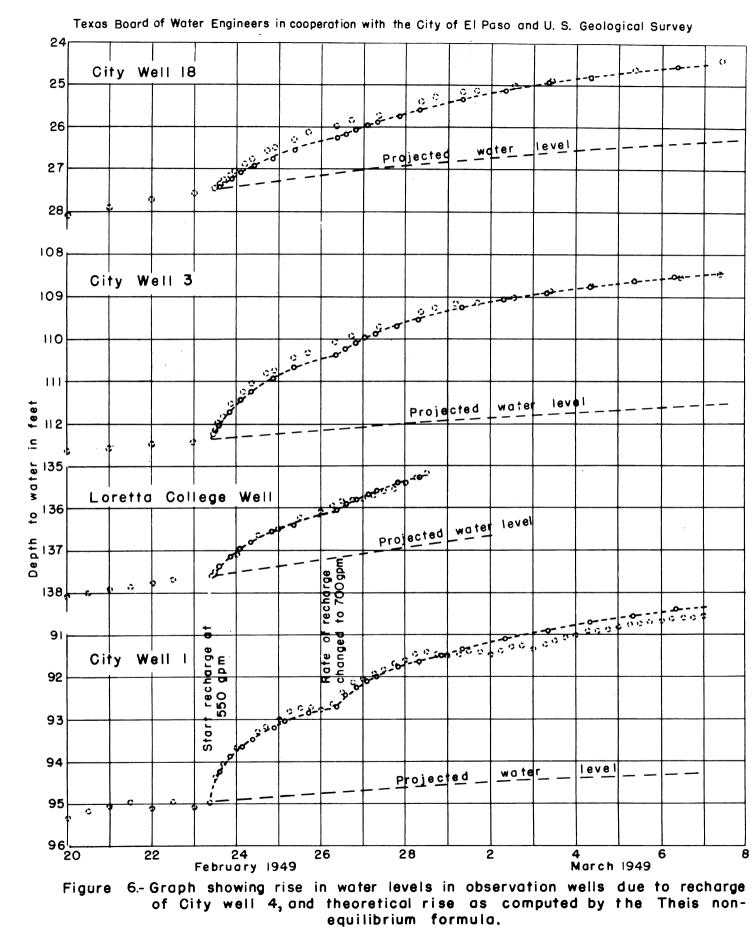
Table 4. Coefficients of transmissibility and storage obtained in pumping test on well 49 (City well 4)

Using the data above, the theoretical rise in the artesian pressure in well 50 (City well 1) resulting from the artificial recharge at 1,060 gallons a minute was computed and found to follow very closely the observed rise in pressure recorded by the automatic water-stage recorder. Water was again injected into well 49 (City well 4) at a constant rate of 550 gallons a minute for 3 days and then increased to 700 gallons a minute for 9 days. The rise in water levels was recorded on automatic water-stage recorders in wells 50 and 53 and measured with a steel tape at frequent " intervals in wells 52 and 48a. By using the coefficients of transmissibility and storage obtained from the pumping tests, by means of the Theis nonequilibrium formula, the theoretical rise in artesian pressures was computed. The observed and computed theoretical rises in pressure caused by artificial recharge agree closely. (See fig. 6).

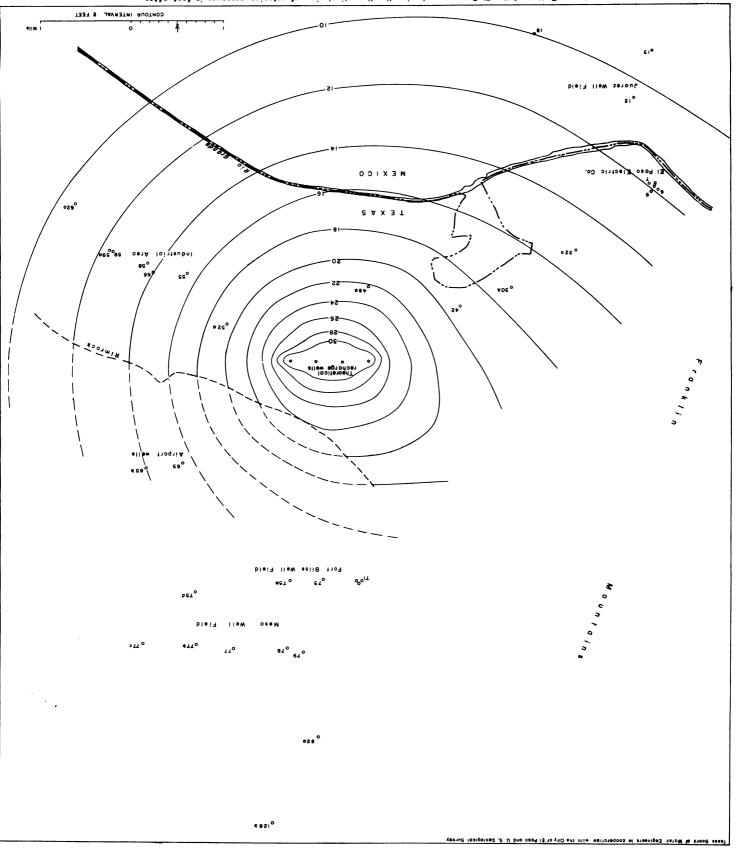
Theoretical effect of recharge

Owing to the close correlation between the computed and observed rises in pressure, calculation of the theoretical effect of recharging the Montana well field at a higher rate than that used during the experiment seems justified. For the purpose of computation, four wells spaced at intervals of 1,500 feet were assumed to be located in the Montana well field, each well to be recharged at the rate of 1,000 gallons a minute for 90 days. The pressure cone developed by this hypothetical recharge field has been computed, using averages of the coefficients of transmissibility and storage obtained in the pumping test and taking into consideration the boundary formed by the Franklin Mountains on the west. The results of this study are shown in figure 7. The contour showing a rise of 10 feet reaches a distance of about 4 miles south and east from the center of recharge, and it was computed that a rise in artesian pressure of 1 foot would occur at a distance of about 11 miles south and east from the center of recharge.

The boundary between artesian and ground-water conditions has not been definitely established, but for purposes of computation it was assumed to be near the rimrock of the Mesa. The rise in water levels in wells on the Mesa where water-table conditions prevail would not be nearly so great



o Observed water level



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nor would the cone spread so far, owing to the fact that the water-bearing beds have a specific yield of about 17½ percent (0.175) as compared to an average storage coefficient of 0.0015 in the artesian area. The exact boundary between the two areas has not been established; therefore, the spread of the pressure cone has been computed only for the area assumed to be under artesian pressure.

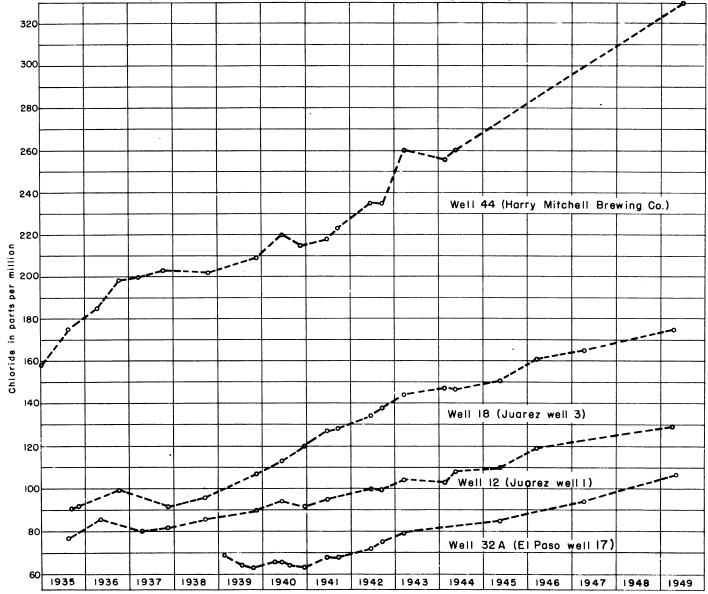
It is apparent from study of the data that recharge at the rate of 4,000 gallons a minute for 90 days would raise the artesian pressure in most of the deep wells in the artesian area from 10 to 35 feet. (See fig. 7). It must be remembered that the rise is largely a result of the transmission of pressure and does not represent the position of water introduced by recharge. The position of the recharge water has not been computed, but at the end of 90 days the recharge water the would not have moved more than a few hundred feet from the recharge wells, and most of the water could be recovered if pumping in the immediate vicinity of the recharge wells were started immediately after injection stops. Pumping from industrial wells near the Montana well field would lower the artesian pressure built up by recharge, but it would not withdraw any appreciable quantity of the water used in recharge.

A discussion in a following section of this report points out that salt-water encroachment into the fresh-water beds is taking place in some parts of the artesian area. Where such encroachment is taking place, the increase in artesian pressure due to artificial recharge would be beneficial in retarding or halting the advance of salt water into the aquifer. Further benefits of artificial recharge in the Montana well field area could be expected in the Mesa area, where the rate of movement of ground water from the Mesa toward the artesian area would be retarded owing to the increase of pressure in the artesian area. Also, the yield of the wells in the valley area, where many of the city and industrial wells are located, would increase at comparable pumping levels and the cost per gallon of pumping from the wells would decrease.

SALT-WATER ENCROACHMENT

In the artesian area, where wells penetrate beds containing highly mineralized water before reaching fresh-water beds, there is always danger of the mineralized water moving into the fresh water, either through holes in the well casings or by penetration through or around the barrier separating the two aquifers. Since 1935 the mineral content in the water from some of the wells in the El Paso area has increased steadily. As examples, the increase in chloride in 10 wells is shown graphically in figures 8, 9, and 10.

Although the total increase in mineral content has not become alarming at any of the City wells, there is a definite upward trend that should be given careful consideration in future development of the ground-water supply of the area. Further lowering of water levels or the artesian pressure probably would accelerate the rate of encroachment.



Texas Board of Water Engineers in cooperation with the City of El Paso and U.S. Geological Survey

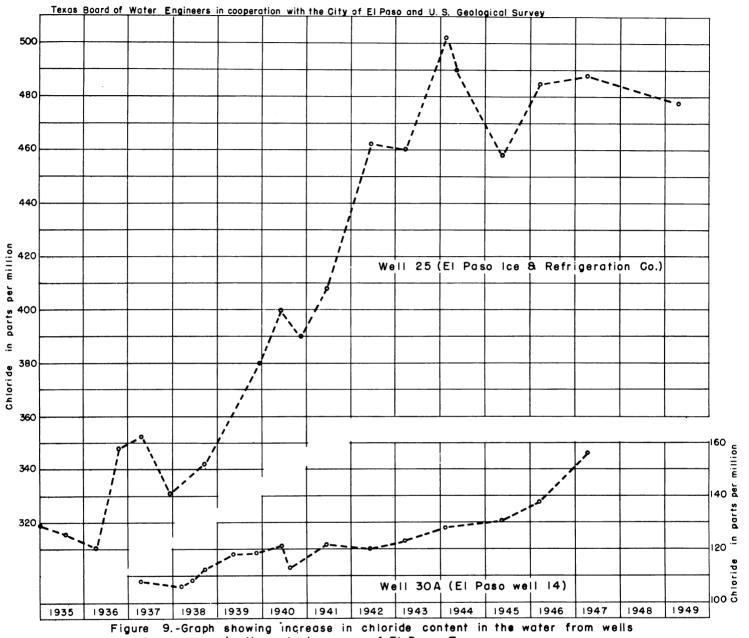
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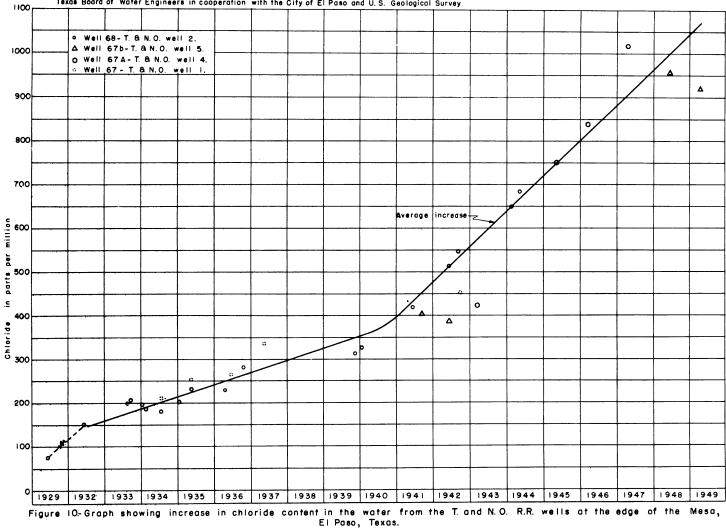
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Figure 8. - Graph showing increase in chloride content in the water from wells in the artesian area of El Paso, Texas and Juarez, Mexico.

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in the artesian area of El Paso, Texas.



Texas Board of Water Engineers in cooperation with the City of El Paso and U.S. Geological Survey

m/c-1949

The following table shows the chloride in parts per million in water from eight observation wells in the artesian area at the time of the first analysis and last analysis and the percentage increase in chloride of the last analysis over the first

		FIRST	ANALYSIS	LAST A	VALYSIS	
Well	Owner	Date	Chloride (ppm)	Date	Chloride (ppm)	Percentage increase
12	Juarez well 1	8-22-35	77	4-22-49	129	68
18	Juarez well 3	9-23-35	91	4-22-49	175	92
25	El Paso Ice and Refrigeration Co.	8-23-35	316	4-22-49	478	52
30A	El Paso well 14	4-20-37	108	4-26-47	178	65
32A	El Paso well 17	2- 4-39	69	4-22-49	107	55
44	Mitchell Brewery	1- 5-35	158	5- 8-44	260	65
67 a 67B	and T. & N. O. well at $\frac{1}{2}$ edge of the Mesa	10-25-31	38	4-21-49	920	2,400

Table 5. Chloride in water from eight observation wells in the El Paso area, Texas

1/ Companion wells.

QUALITY OF WATER

By Burdge Irelan

Analyses of water from 24 supply wells, arranged chronologically, are given in the tables on pages 19-21. Most of the analyses were made in the laboratory of the City of El Paso or in the Geological Survey laboratories in Washington or Austin. A few of the analyses were made in commercial or industrial laboratories. Information as to the source of a small number of analyses is missing. When known, the sources of the analyses are given.

As has been previously pointed out in Water-Supply Paper 919, few generalizations can be made regarding the quality of the ground water in the El Paso area. The tables indicate that most of the wells yield water that varies somewhat in chemical composition. These variations are probably due to changes in pumping and mutual interference of the wells. Wells that produce water from more than one zone may show some changes in composition due to changes in the proportions of the water produced from the different zones.

In order to determine whether significant changes are occurring in the character of water being produced from any area or from a particular well, it is helpful to know the limitations and precision of the analyses themselves. The collected analyses come from a number of sources and in many cases the methods of analysis used are not known. Where changes shown in the tables are small, they may be due to differences in analytical procedures and techniques. Changes of only a few parts per million or a few percent in any constituent should not be regarded as important unless supported by changes in other constituents. Not all the constituents tabulated can be assumed to have been determined with equal precision. The determinations of chloride are probably the most nearly correct, followed by the bicarbonate and sulfate determinations, whereas the dissolved solids and hardness determinations are the least accurate.

The tabulated dissolved solids may be either the residue left on evaporation or the sum of the constituents found by analysis, bicarbonate being recalculated as carbonate. The sum may or may not include the silica, as the silica determination has been omitted by many analysts. The residue on evaporation may also include some water of crystalization. A variation of 10 percent in the dissolved solids reported should not, therefore, be regarded as significant.

Formerly many of the hardness determinations were made by the soap method. Where calcium and magnesium are reported, the hardness is customarily calculated. The soap-method and calculated values for hardness do not ordinarily agree exactly. The soap value is the least reproducible and is increasingly unreliable for hardness values above 100.

In some of the analyses sodium was determined and separate calculated values are given for potassium. Usually, however, sodium was calculated by difference from the reacting values of the for other constituents, and the value includes potassium. As the error in calculating sodium is the sum of the errors of the individual determinations, small changes in the sodium tabulations are not significant.

The bicarbonate value is usually precise unless accompanied by changes in calcium that may indicate precipitation of calcium carbonate. Most of the sulfate values are good, but some sulfate determinations may have been made by turbidity methods and may be as much as 25 percent in error. Where sulfate exceeds 100 parts per million, turbidity methods are seldom used and the higher values for sulfate are dependable.

Chloride is easily determined and the amounts reported are usually reliable. Consequently changes in chloride in the table indicate accurately changes in the water quality. Nitrate is usually low and is mainly useful in accurately calculating the sum of dissolved solids and the sodium. Nitrate above 10 parts per million is more apt to be in error than lower amounts.

Wells 12 and 18 in Juarez and well 25 in El Paso show a gradual increase in the dissolved solids without significant changes in the proportions of the various constituents. These changes may indicate contamination of the main water-bearing beds. Other wells in the downtown area show smaller changes of the same nature. The effect of the recent artificial recharge of well 49 (City well 4) with treated surface water is plainly shown by the increased sulfate and decreased chloride in the analysis for April 22, 1949.

The tabulated analyses clearly show that changes are occurring in the chemical characteristics of water from wells in the El Paso area. A continued program of chemical analyses is necessary to observe future changes and to determine the remedial measures that may be needed to protect the available water supplies.

SUMMARY

Pumpage from the bolson deposits, the principal fresh-water-bearing aquifers of the El Paso area, increased from 1,200,000 gallons a day in 1906 to 15,700,000 gallons a day in 1936, and to a peak of 25,600,000 gallons a day in 1943. In 1944 the City of El Paso placed its Rio Grande treatment plant in operation. Since that time the city has been using treated surface water from the Rio Grande and treated ground water from shallow wells in the downtown area of El Paso to reduce the total pumpage of ground water from deep wells to an average of 21,700,000 gallons a day during the period from 1944 to 1948, inclusive. During recent years less water has been pumped from wells on the Mesa, and thus the center of pumping from all wells in the El Paso area in 1948 was farther south, toward the valley of the Rio Grande, than it was prior to 1944.

Each year since 1936 the withdrawal of ground water from storage on the Mesa, has exceeded the amount of water contributed from recharge. As a result, the water levels in wells on the Mesa have declined persistently since 1936. From the amount of decline in water levels on the Mesa, it has been computed that about 425,000 acre-feet of material has been unwatered, which indicates that on the average about 5,000,000 gallons of water a day has been removed from storage on the Mesa from 1936 to 1949. Subtracting the amount of water removed from storage from the total pumpage indicates that an average of about 15,000,000 gallons a day was obtained from recharge on the Mesa or from other sources. A study of the data at hand indicates that most of this water came from recharge on the Mesa.

It has been pointed out in this and previous reports that there is danger of salt-water rencroachment into the fresh-water aquifer, both in the artesian area in the valley and in parts of the Mesa. Graphs of the chloride content of the water from 10 wells are shown in the report. These graphs clearly indicate that, during the period of observation since 1935, the mineral content of the wrter from these wells has increased steadily. The continuation of the steady rise in mineral content of the water poses a threat to the future usefulness of at least a part of the ground-water reservoir that is now yielding good potable water.

The results of experimental tests in artificial recharge indicate that it may be practicable to inject surface water into the ground-water reservoir for the purpose of storing water for later use. Such recharge would also be advantageous in maintaining the water table and artesian pressure at higher levels, which in turn would halt or retard the rate of ingress of salt water into the fresh-water sands.

Careful observation and study should be continued in the El Paso area. More observation wells for both water-level observation and the collection of water samples for chemical analyses are needed northeast and east of the Mesa well field.

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June 12, 1940 550 - 93 16 80 204 156 94 June 3, 1941 532 - 95 15 74 1941 155 95 June 3, 1942 547 - 95 15 74 194 155 95 June 3, 1942 547 - 94 15 74 200 161 100 June 7, 15, 1944 566 - - 104 16 77 206 165 99 May 22, 1945 671 - - 103 18 77 201 183 110 May 22, 1945 660 - - 110 19 77 201 183 119 May 22, 1945 660 - - 110 19 77 201 183 110 May 22, 1945 660 - - 112 19 77 201 183 110 May 22, 1945 660 - - 122 225 144 91 M		Nov.			552	• •	•	92	15	11	192	154	60	•	•	2.92	1	
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June 17, 1941 532 - 95 15 74 198 155 95 Sept. 15, 1942 547 - - 95 15 76 200 161 100 Sept. 11, 1944 566 - - 103 16 77 206 165 104 May 29, 1944 580 - - 103 16 77 201 170 103 May 29, 1944 580 - - 110 19 77 206 165 104 May 27, 1946 660 - - 110 19 77 204 170 103 Mar. 22, 1946 660 - - 110 19 77 204 179 110 Mar. 22, 1945 671 - - 110 19 77 204 179 110 Mar. 22, 1945 660 - - 112 19 77 204 179 108 Mar. 22, 1949 72 210 18 77 204 170 108 77 204 170 109 Mar. 22, 1949 620 22 12 12		Dec .		-	532	3	,	95	16	72	204	156	92	0	°	303	-	
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May 9, 1944 580 - - 103 18 77 202 172 108 May 22, 1945 671 - - 110 19 77 202 172 108 110 Mar. 22; 1945 660 - - 114 19 77 206 112 193 109 109 100 117 210 118 119 77 210 113 119 77 206 213 129 129 129 120 129 129 129 129 129 129 129 129 129 129 129 129 129 129 129 129 129 120 127 113 Sept. 25, 1936 620 - - 110 18 133 134 Unve 12, 1940 647 - - 112 133 256 165		Feb.			566	0	0	104	16	74	201	170	103	e	ŝ	326	П	
May 22, 1945 671 - - 110 19 72 204 179 110 Mar. 27, 1946 660 - - 114 19 77 210 183 119 Mar. 27, 1946 660 - - 122 229 81 206 212 129 Sept.23, 1935 562 12 - 112 19 77 216 183 119 Sept.23, 1935 562 12 - 112 19 77 214 92 Nov. 25 1936 526 12 - 112 18 73 254 142 92 Nov. 15, 1939 660 - - 124 210 133 134 Mov. 15, 1939 660 - 124 206 142 92 June 17 1941 713 23 254 184 127		May		-	580	0		103	18	11	202	172	108	0	2°5	331	1	
Mar. 27, 1946 660 - - 114 19 77 210 183 119 Apr. 22, 1949 720 25 - 122 22 81 206 212 129 Sept.23, 1935 562 - - 112 9,2 81 206 212 129 Dec. 22, 1935 562 - - 112 9,2 82 259 148 92 Dec. 22, 1935 526 12 - 112 9,2 82 256 148 92 Nov. 15, 1936 650 - - 112 19 73 256 148 92 Nov. 15, 1930 660 - - 112 19 73 256 140 107 June 12, 1940 677 - - 124 20 262 177 113 June 12, 1940 677 - - 124 20 57 141 120 June 12, 1940 677 - - 124 23 76		May		-	671	٥	0	110	19	72	204	179	110	0	4 ° .	3.52	-1	
Apr. 22, 1949 720 25 - 122 22 81 206 212 129 Sept. 23, 1935 562 - - 108 17 71 257 148 91 Dec. 22, 1935 562 - - 108 17 71 257 148 91 Dec. 22, 1935 528 - - 110 18 73 255 148 92 Nov. 2, 1936 520 - - 110 18 73 255 140 92 Nov. 15, 1939 660 - - 112 19 73 255 147 92 June 17, 1941 770 25 - 112 19 73 256 167 107 June 17, 1941 770 25 - 124 23 75 279 191 127 June 17, 1941 713 - - 134 23 75 279 191 127 June 17, 1941 713 - - 144 <td< td=""><td></td><td>Mar.</td><td></td><td>~</td><td>660</td><td>0</td><td>0</td><td>114</td><td>19</td><td>77</td><td>210</td><td>183</td><td>119</td><td>0</td><td>°2</td><td>362</td><td>-</td><td></td></td<>		Mar.		~	660	0	0	114	19	77	210	183	119	0	°2	362	-	
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1943 775 - - 153 24 89 295 218 144 1944 794 - - 166 25 80 297 230 147 1944 792 - - 152 27 91 296 227 147 1945 955 - - 170 29 74 304 233 151 1946 -828* - - 170 29 74 304 233 151 1946 -828* - - 171 29 78 243 161 1947 - - 171 29 78 206 243 161 1947 - - - 167 306 243 161 1949 98 26 - 167 307 276 175		Sept	.15,	-	741	•	0	146	24	84	286	208	138	0	6	463	Ч	
1944 794 - - 166 25 80 297 230 147 1944 792 - - 152 27 91 296 227 147 1945 955 - - 170 29 74 304 233 151 1946 - - 170 29 74 304 233 151 1946 - - 171 29 78 286 243 161 1947 - - - 171 29 78 286 243 161 1947 - - - 167 33 161 165 165 1949 984 26 - 167 33 107 307 276 175		Mar.	26,	-	775	8	0	153	24	89	295	218	144	0	1.5	480	l	
1944 792 - 152 27 91 296 227 147 1945 955 - - 170 29 74 304 233 151 1946 - - - 171 29 74 304 233 151 1946 - - - 171 29 78 304 233 151 1947 - - - 171 29 78 206 243 161 1947 - - - - - - 165 165 1949 984 26 - 167 33 107 307 276 175		Feb.	11,	-	194	0	•	166	25	80	297	230	147	ð	°2	518	1	
1945 955 - 170 29 74 304 233 151 1946 4 528 - 171 29 78 286 243 161 1947 - 306 - 165 1949 984 26 - 167 33 107 307 276 175		May	°	-	792	0	0	152	. 27	91	296	227	147	0	2.0	490	1	
1946		Ma y	22 °	-	955	O	0	170	29	14	304	233	151	0	•	544	I	
1947 306 306 307		Mar.	. 27,	-	-828-	0	8	171	29	78	286	243	161	e	þ	346	1	
。22。1949 984 26 。 167 33 107 307 276		Apr.	, 26,	-	0	0	0	9		0	306	.1	165	0	8	0	I	
		Apr.		94	984	26	0	167		107	307	276	175	0	°	552	7	

Table 6. Analyses of water from wells in the El Paso area, Texas (Results are in parts per million)

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Well	Owner	Depth of well (ft.)	collection	Dissolved solids			cium		Sodium and potassium (Na + K)	Bicar- bonate (HCO ₃)	fate	ride	Fluor- ide (F)	Ni- trate (NO ₃)	Total hardness as CaCO 3	Source o analysis <u>a</u> /
25 E	1 Paso, Texas	509	Jan. 7, 1935		-	•	-	-	-	173	112	319	-	-	234	1
(El Paso Ice &		Aug. 23, 1935	-	-	-	-	-	-	164	-	316	-	-	165	1
	Refrigeration		Apr. 22, 1936	796	-	-	49	16	230	170	107	310	-	0.0	188	1
	Co. well 4)		Oct. 28, 1936	842	•	-	56	17	240	170	97	348	•	- 0	210	1
			Apr. 19, 1937	904	31	0.06	57	17	247	169	105	352	-	.10	212	1
			Nov. 2, 1987	-	-	-	56	17	-	174	104	331	-	• 0	210	1
			Sept.28, 1938	898	31	-	56	17	244	176	109	342	-	.0	210	1
			Nov. 14, 1939	904	•	-	-	-	222	170	110	380	-	- 0	308	1
			June 11, 1940	951		-	68	21	262	172	115	400	-	. 0	256	1
			Nov. 29, 1940	937	-	-	66	21	259	178	113	390	-	. 0	251	1
			June 17, 1941	937	-	-	55	22	268	144	113	408	. 0	. 0	228	1
			Sept.19, 1941	935	-	-	64	21	260	168	112	395	-	.0	246	1
			June 2, 1942	1,059	-	-	80	24	286	170	123	462	-	. 0	298	1
			Sept.15, 1942	1,053	•	-	77	24	286	165	126	458	-	1.0	290	1
			Mar. 26, 1943	1,066	-	-	82	24	286	177	127	460	-	. 0	303	1
			Feb. 12, 1944	1,140	-	-	94	27	295	166	136	502	-	1.5	346	1
			May 8, 1944	1,110	-	-	85	30	289	161	136	490	-	. 0	336	1
			May 23, 1945	1,060	-	•	89	27	270	164	134	458	-	. 2	333	1
			Mar. 25, 1946	1,130	-		97	29	285	183	140	485	-	1.0	361	1
			Apr. 28, 1947		•	-	-	•	-	176	-	488	-	-	-	1
			Apr. 22, 1949	1,150	34	-	92	32	280	170	151	478	-	- 2	361	1
	l Paso, Texas (City well 14)	703	Åpr. 20, 1937	450	26	0.12	23	8.6	126	172	69	108		. O	93	1
	(010) #811 14)	105	Mar. 11, 1938	465	26	6.4	27	17	108	179	69	106	-	-	137	2
			June 24, 1938	446	18	5.8	34	8.9	115	176	69	108	-	-	118	2
			Sept. 24, 1938	423	29	. 02	22	7.5		171	63	112	-	.15	86	1
			May 1, 1939	471	17	· V2	32	4.6	148	168	112	118	-		99	2
				425	-	-	3Z	4.0	148	172	66	118	-	.0	76	1
			Nov. 16, 1939		-	•	-	-				121	•			1
			June 10, 1940	435	31	-	17	~ ^	138	176 170	68	113		. 0	86	1
			Aug. 28, 1940	473	31	-	24	6.2	141 135	161	73 68	122	0.3	- .25	68	2
			June 16, 1941	443	-	•		8.1		170	73				94 100	1
			Sept.18, 1941	467		-	24	9.7 10	141 143	178	77	136 140	-	~ O	111	2
			Sept.18, 1941	399	38 35	-	28 25	9.0		175		140	-	.25 -	100	2
			Mar. 13, 1942	504 438	33	-	22	9.0 8.5		172	61	120	-	.0	90	1
			June 2, 1942			-					69		-			1 2
			June 2, 1942	475	42	-	28	12	153	182	95	145	-	-	120	4
			Sept. 15, 1942	454	-	-	23	7.7	141	193	67	118	-		89	1
			Mar. 23, 1943	445	-	-	26	8.1	133	173	69	.123	-	- 5	98	1
			Feb. 11, 1944	450	-	-	26	8.0		170	69	128	-	- 2	98	1
			May 22, 1945	499	-	-	27	8.6		170	70	131	-	.0	103	1
			Mar. 25, 1946	519	-	-	25	8.7	152	192	71	139	-	.0	98	1
			Apr. 26, 1947	-	-	-	-	-	-	178	-	156	-	-	74	1

Table 6. Analyses of water from wells in the El Paso area, Texas -- Continued

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Well	Owner	Depth of well (ft.)	Date of collection	Dissolved solids			cium		Sodium and potassium (Na + K)	bonate	fate	ride	Fluor- ide (F)	Ni- trate (NO ₃)	Total hardness as CaCO ₃	Source of analysis a/
32A	El Paso, Texas			10.6			• •				(0					
	(City well 17)	750	Feb. 4, 1939	426	17 15	4.3 .1	34 518	14 6	74	88	62	69 64	•	-	143 71	2 2
			July 11, 1939 Oct. 28, 1939	377 382	20	• 1	31	9.1	133 102	172 174	124 92	63	-	-	115	2
			Apr. 16, 1940	364	25	2.4	30	9.1	92	172	77	66	-	-	113	2
			June 10, 1940	323		2	37	11	71	178	50	66	-	۰0	138	ī
			Aug. 28, 1940	394	2 2		35	11	89	177	87	641		-	133	2
			Dec. 5, 1940	397	31	•	35	11	86	179	81	63	-	. 0	133	1
			June 16, 1941	397	26	-	36	11	89	178	81	68	. 6	. 0	135	1
			Sept.18, 1941	407	45	-	37	9.0		190	86	80	•	. 0	129	2
			Sept.18, 1941	374	-	0	35	12	89	183	80	-	•	• 0	137	1
			Feb. 6, 1942	410	36	-	43	12	97	193	86		•	ь	166	2
			June 2, 1942	386	~ .		36	11	94	188	80			~	135	1
			June 2, 1942	413	\$1	-	42	14	93	187	94	80 75	6	~	163	2
			Sept. 15, 1942 Mar. 24, 1943	387 401	-	-	36 40	11 12	94 93	182 186	81 85		•	• 0 • 0	135 150	1
			May 22, 1945	457	•		43	12	94	184	87	85		• ¥	157	1
			Apr. 26, 1947	-				•	-	188		94		9	148	î
			Apr. 22, 1949	552	•	9	67	20	88	197	123	107	•	8	249	1
42	El Paso, Texas (City well 9)	802	Sept. 1, 1933 Mar. 30, 1935	538 528	16 14	0	25 31	5 ° 2 7 ° 4		191 298	66 61	147 138	- -	•	84 109	4
			Aug. 19, 1935	-	•	•	•	0	-	172	0	138	•	•	72	1
			Sept. 16, 1935	490	-	-	21	8.0		183	76			. 0	85	1
			Mar. 17, 1937	611	31		30	10	184	174	78			· 05	116	1
			June 13, 1938	507	25	1.8	22	6.0		181	84		•	•	132	2
			Sept. 24, 1938	516	35		20	8.1	156	186	83			- 0	83	1
			May 1, 1939	531 501	23	1.6	30 22	4-0 8-0		183 1 8 8	117 90		-	. 6	112	2 1
			June 10, 1940 Aug. 29, 1940	515	28		23	8.2		183	\$5		-	• U	88 92	2
			Nov. 28, 1940	484			20	· 7.7		186	89		-	. 0	82	1
			June 16, 1941	489			23	6.9		176	74		0.9	ů	86	ĩ
			Sept.18, 1941	518	40		26	9.0		195	80		-	Ĵ	102	2
			Feb. 6, 1942	\$15	40	-	25	10	162	197	85				104	2
			June 2 1942	471			20	7.4	152	184	66	135		. 0	80	1
			June 2, 1942	521	44	ø	25	12	172	193	105	156	•	-	112	2
			Mar. 23, 1943	491	•		25	7.7		186	76		-	. 5	94	1
			Feb. 11, 1944	486		0	22	7.0		185	75		8	- 2	84	1
			May 8, 1944	486		-	20	6.7		188	76		-	1.0	78	1
			May 22, 1945	52 6	•	•	23	7.3		181	76		-	• 8	\$8	1
			Mar. 25, 1946	544	-	-	22	7.0	168	205	77		-		84	1
			Apr. 97, 1949	524	32	a	19	7.1	76	181	11	139	9	e 🌒	76	1

Table 6. Analyses of water from wells in the El Paso area, Texas -- Continued

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14 E1 Pase, Teas. 14 E1 Pase, Teas. 15 100: 10, 100 16: 20, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 10, 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 16: 100 100 <t< th=""><th>We 1 1</th><th></th><th>Depth of well (ft.)</th><th></th><th>Date of collection</th><th>Dissolved solids</th><th>Silica (SiO₂)</th><th>Iron Cal- (Fe) cium (Ca)</th><th>l-Magae um sium a) (Mg)</th><th>- Sodium and potassium (Na + K)</th><th>Bicar- bonate (HCO₃)</th><th>Sul- fate (S04)</th><th>Chlo- ride (Cl)</th><th>Fluor- ide (F)</th><th>Ni- trate (NO₃)</th><th>Total hardness as CaCO3</th><th>Source analysi a/</th></t<>	We 1 1		Depth of well (ft.)		Date of collection	Dissolved solids	Silica (SiO ₂)	Iron Cal- (Fe) cium (Ca)	l-Magae um sium a) (Mg)	- Sodium and potassium (Na + K)	Bicar- bonate (HCO ₃)	Sul- fate (S04)	Chlo- ride (Cl)	Fluor- ide (F)	Ni- trate (NO ₃)	Total hardness as CaCO3	Source analysi a/
Prevery vel (1) 33, 41, 5, 1935 - - - - 1 - - 1 - 1 - 1 - 1 - 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-	El Paso, Texas (Mitchell'															
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Table 6. Analyses of water from wells in the El Paso area, Texas -- Continued

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Source of analysis a/			ㅋㅋㅋㅋㅋㅋㅋ のㅋㅋ # ㅋㅋㅋ 않ㅋㅋㅋ
Total hardness as CaCO ₃	181 181 182 186 198 198 198 198 198 198 198 198 198 198	144 128 128 128 128 133 135 135 135 135 135 135	117 103 99 96 105 106 130 106 130 106 126 106
Ni- trate (NO ₃)	81811 1 1 1 1 6118 	₩ ₩ ₩ ₩ 10.1 × • • • • • • • • • • • • • • • • • •	ເຊຍາວາດ ເຊຍ
Fluor- ide (F)	• • • • • • • • • • • • • • • • • • •	0 3 8 7 3 6 8 8 8 8 8 8 8 8 8	, , , , , , , , , , , , , , , , , , ,
Chlo- ride (Cl)	152 152 152 152 152 152 152 152 152 152	206 212 213 213 213 213 213 213 213 213 213	234600 2346000 2346000 2346000 2346000 2346000 23460000 23460000 2346000000000000000000000000000000000000
Sul- fate (SO ₄)	72 66 66 66 66 66 73 72 72 72 72 72 72 72 72 72 72 72 72 72	80 81 77 77 76 77 76 77 77	80 80 101 101 105 105 105 105 105 105 105 10
Bicar. bonate (HCO ₃)	162 162 162 162 165 165 165 165 165 165 165 165 165 165	156 156 157 158 158 156 156 156 156 156 156 156 156 156 156	99999999999999999999999999999999999999
Sodium and potassium (Na + K)	120 128 128 128 128 128 128 128 128 128 128	5 172 178 176 176 176 176 188 188 181 182	135 141 141 141 140 140 144 131 137 131 135 131 135 131 135 131
Magne- sium (Mg)	511355116 95 511356 95 511356 95 51136 9 51136 9 51136 9 51136 9 51136 9 51136 1 51136 1 51136 1 51136 1 51136 1 5115 1 515 1 5115 1 515 1 515 1 5	·	9.9 9.4 10.2 12.3 9.9 9.9 9.9 13.9 12.1 12.1 12.1 12.1 12.1 12.1 12.1 12
om Cal- e) cium (Ca)		900 619 400 8 98 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	00000000000000000000000000000000000000
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ssolved Si solids (S	6499 6499 672 672 672 6844 723 7691 780 7666 723 7693 7693 7693 780 780 780 780 780 780 780 780 780 780	581 581 586 557 557 556 559 642 540 540 643 540 540 540 540 540 543 533 540 540 540 540 540 540 540 540 540 540	4 4 6 6 7 8 4 8 7 8 4 8 7 8 4 8 6 6 9 8 9 8 9 8 9 8 9 8 9 8 9 8 9 8 9
f Di on	1936 1936 1937 1937 1937 1938 1938 1948 1948 1948 1948 1948 1948 1948	1935 1935 1935 1945 1944 1944 1945 1945 1945 1945 194	1935 1935 1935 1935 1937 1937 1946 1946 1944 1944 1944 1944 1944 1944
Date of collectio	June 29, May 65, Aux 66, June 26, June 25, June 10, June 10, June 29, June 29, June 23, June 22, June	Ја п. Ја п. Ачб. 28 , Ачб. 28 , 15 , 17 , 26 , 26 , 27 , 26 , 27 , 27 , 26 , 27 , 27 , 27 , 26 , 27 , 27 , 27 , 27 , 	Jan. 7, Mar. 13, Oct. 28, Oct. 28, Sept. 29, Nov. 16, June 12, June 12, June 3, June 3, Mar. 25, Mar. 25, Mar. 25,
Depth of well (ft.)	6 8 8	69 4	5
Отлег	El Paso, Texas (City well 3)	El Paso, Texas (Texas Cost well)	El Paso, Texas (Airport well)
Ve I I	52	55	65A

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We 1 1	Owner	Depth of well (ft.)	Date of collection	Dissolved solids	Silica (SiO ₂)		cium	Magne- sium (Mg)	Sodium and potassium (Na + K)	bonate	fate	ride	Fluor- ide (F)	Ni- trate (NO ₃)	Total hardness as CaCO ₃	Source of analysis <u>a</u> /
67	El Paso, Texas															
	(T & N O well 8)	869	Oct. 25, 1921	309	24	-	32	11	66	225	27	38		-	125	-
			June 12, 1929	434	- 32	•	55 90	24 40	62 54	223 201	37 49	102 200	•	8.9 8.7	236 389	3 3
			Aug. 22, 1933 Jan. 12, 1934	578 576	41	-	83	40	58	201	38	200	-	8.9	372	3
			Feb. 19, 1934	589	35	-	88	29	76	186	53	204		8.9	339	3
			July 25, 1934	585	22	-	87	43	60	202	50	212		8.7	394	3
			May 27, 1935	666	35		96	48	68	198	53	255		8.7	437	3
			June 4, 1936	702	36		102	49	75	217	53	268	•	11	456	3
			May 6, 1937	-	-	-	107	47	90 🛸	228	56	288	•	5.5	460	1
			June 17, 1941	875	-	•	136	67	91	178	68	420	0.3	4.0	615	1
			Sept.16, 1942	911	Ð	a	143	63	105	178	55	452	6	5.0	616	1
57A	El Paso, Texas															_
	(T & N O well 4)	860	Mart 26, 1943	890	60	•	144	71	83	196	64	425		6.3	651	1
			May 23, 1945	1,400	-	•	240	124	95	180	95	755	•	5.4	1,110	1
			Mar. 26, 1946	1,520			260	139	95	167 174	99 -	840 1,020	0	4.0	1,220 1,350	1 1
			Apr. 28, 1947		• 	*	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					1,020			1,550	*
67B	El Paso, Texas		Se-6 10 1041	805		0	136	57	80	150	51	402		5.2	574	1
	(T & N O well 5)	860	Sept.18, 1941 June 2, 1942	799	0		125	53	96	166	50	388		5.6	530	1
			June 9, 1942	1,750	35		293	130	148	154	102	958	-	4.3	1,270	i
			Apr. 21, 1949	1,700	33		280	123	154	160	103	920	•	5.9	1,200	ī
i8 E	81 Paso, Texas															
-	(T & N O well 2)	864	1922 (?)	330	36	•	34	14	43	174	32	42	-	a	142	2
			June 12, 1929	384	•	۵	55	19	52	211	40	76	•	5.8	215	3
			July 11, 1932	479	26	•	65	26	71	192	43	153	•	6.2	272	3
			Aug. 22, 1933	566	24	-	76	41	66	182	47	209	•	8.7	358	3
			Jan. 12, 1934	606	35		82	33 31	56 57	180 172	25 46	198 188	•	8.9 8.9	340 337	3 3
			Feb. 19, 1934	522 514	21		84 75	31	63	178	44	180	a e	8.7	315	3
			July 25, 1934 Jan. 5, 1935	514	21	-		-		199	48	202	-	-	218	1
			May 27, 1935	612	33	-	88	36	75	182	44	232	-	8.7	368	î
			Apr. 23, 1936	580	-	-	88	39	73	194	48	230	-	6.3	380	ī
			Oct. 28, 1936	651	-	•	100	49	72	188	48	282		7.3	451	ī
			Nov. 16, 1939	737	-	-	108	55	71	182	55	312	•	3.2	496	1
			June 11, 1940	764	-		124	64	66	200	72	335	a	4.4	572	1
			Nov. 29, 1940	743	-		112	\$5	86	200	58	328	-	5.6	506	1
			June 2, 1942	1,042	-	•	161	86	100	197	76	515	-	7.5	756	1
		,	Sept.15, 1942	1,086	-	-	167	91	103	192	77	548	•	5.0	791	1
			Teb. 17, 1944	1,240	-	•	208	109	90	181	85	650	•	12	967	1
			May <u>9,</u> 1944	1,279	-	•	196	111	111	148	91	685	•	5.5	946	1

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Table 6. Analyses of water from wells in the El Paso area, Texas -- Continued

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Table 6. Analyses of water from wells in the El Paso area, Texas -- Continued

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	of of well (ft.)	Uate of collection	s of ction	Dissolved solids	Şilica (SiO ₂)	Iron (Fe)	cium cium (Ca)	Magne- sium (Mg)	Sodium and potassium (Na + K)	Bicar - bonate (HCO ₃)	Swl- fate (SO ₄)	Chlo- ride (Cl)	Fluor - ide (F)	Ni- trate (NO ₃)	Total S hardness a as CaCO3	Source of analysis
El Paso, Texas (Fort Bliss well	5) 770	, a b			23		32	10	\$	173	15	40			121	•
	;	Jan.		20	1	1	•	•	3	183	40	38		•	147	. –
			-		ı	٠	32	13	53	178	39	4	•	5.0	133	
			-		ı	•	34	13	49	178	36	39	•	7.0	138	
			17, 1937	7 297	32	0.03	33	12	56	178	36	40	•	7.5	132	-
			-	80	31	•	33	14	57	186	45	43	•	5.3	140	٦
			-		·	•	•	•	55	•	38	42	•	4.7	129	-
		June	10,		•	•	35	13	52	184	35	45	0	5°2	141	-
			17,		•	5	37	13	54	184	40	46	0.8	5°2	148	1
		Sept.]	19, 194		0	0	30	13	60	186	34	46	0	6 ° 8	128	1
		Seyt.	19, 194		48	0	37	14	68	200	55	54	0	0	149	5
		June	3, 194		0	8	35	13	54	188	39	42	0	6.6	141	1
		Sept.]			0	9	35	13	53	182	42	43	đ	4 . 5	141	I
					0	•	41	13	54	203	37	45	•	5.5	156	1
		May			0	6	36	13	59	195	42	45	•	6°0	144	1
			_		ı	•	4	1	50	185	40	48	•	6.1	158	l
					8	0	9	15	57	201	36	57	0	3°5	162	-
			13, 1946		31	°.	39	14	57	190	41	52	* 6	6.5	155	I
			-		0	0	9	,	0	188	0	46	9	0	118	1
					34	•	34	15	55	188	39	84	9	6.0	146	1
		Apr.			8	•	38	14	55	183	41	50	8	7.5	152	I
			-		32	0	34	13	59	182	41	49	8	6°6	138	I
75D El Paso, Texas																
(City well 19)	;	Feb.	6, 194	4	50	•	27	9		211	97	7 6	e	0	105	~
•				4	54		20	14		212	94	94	0	8	133	6
					49	•	29	13		214	115	88	0	,	126	
					0		3.6	12		205	00	86	0	6.0	134	۱
		Kav			C	a	28	10		208	93	86	c	2.2	111	. –
					0	0	27	9.8		203	62	1	0		102	
			25. 1946		0	0	26	8.6	137	224	92	85	0	4.7	106	(
					40	•	24	\$°6		206	06	87	9	4.9		
					40	•	24			199	103	83	ð	2.9	100	

Well Owner Depth Date of Dissolved Silica Iron Cal-Magne- Sodium and Bicar- Sul-Chlo- Fluor-Ni-Total Source of solids (SiO₉) (Fe) cium sium potassium bonate fate ride ide trate hardness analysis of collection (Na + K) (HCO₃) (SO₄) (Ca) (Mg) (NO₂) as CaCO₂ (Cl) (F) well <u>a</u>/ (ft.) 77 B El Paso. Texas (City well 15) May 23, 1938 • 2.5 Nov. 16, 1939 . . . Apr. 8, 1940 . June 10, 1940 . • ~ . Aug. 29, 1940 1.1 2.5 June 16, 1941 Feb. 6, 1942 ...**I.**. • 4.5 June 3, 1942 v • May 30, 1942 ь. 3.0 Sept.16, 1942 • -0 • • 4.0 Mar. 25, 1943 • Feb. 15, 1944 ø 9.8 • 3.8 • 4.0 May 28, 1944 • ~ 4.1 May 22, 1945 p • Mar. 25, 1946 . . o 3.8 Ł • Apr. 26, 1947 3.8 June 7, 1948 a o 4.4 Apr. 22, 1949 -• El Paso, Texas 4.5 (City well 11) Sept.11, 1935 • Apr. 22, 1936 ~ ~ .13 6.7 June 25, 1937 June 3, 1938 0.04 5.2 June 11, 1940 . June 16, 1941 0.9 6.8 • . 7.5 Sept, 19, 1941 -• Apr. 28, 1947 • • • 8.3 Apr. 21, 1949 El Paso, Texas (City well 8) Jan. 5, 1935 • 6.7 Sept.16, 1935 • Apr. 22, 1936 -.... 8.8 Oct. 28, 1936 • Apr. 25, 1937 . 9.4 8.3 ---Oct. 29, 1937 Mer. 11, 1938 8.0 • 6.0 July 9, 1938 • . 1.5 Sept.23, 1938 May 1, 1939 1.5 ø May 8, 1940 • 9.4 June 10, 1940 • • Aug. 29, 1948 -7.0 Nov. 28, 1944 . .7 7.8 June 16, 1941 . • 9.0 Sept.19, 1141 Sept. 19, 1941 - 354 . • 9.2 . . June 3, 1942 June 3, 1942 4.5 • Sept. 16, 1942 Mar. 25, 1943 7.0 . • May 22, 1945 42.3 9.6 June 7, 1948 Apr. 21, 1949

Table 6. Analyses of water from wells in the El Paso area, Texas -- Continued

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	Table	.9	Analyses o	of water	from wells	s in the	EI	Paso area,	а, Техаз	:	Continued						
Well	Очпет	Depth of well (ft.)	Date of collection	e of ction	Dissolved solids	Silica (SiO ₂)	Ir on (Fe)	Cal- W cium s (Ca) (Magne- sium (Mg)	Sodium and potassium (Na + K)	Bicar- bonate (HC\$3)	Sul- fate (S0 ₄)	Chlo-	Fluor~ ide (F)	Ni- trate (NO ₃)	Total hardness as CaCO ₃	Source of analysis
82A	El Paso, Texas (City well 20)	.	Feb. Mar. 1 Jume Jume Sept.1 Feb. 2 Feb. 2 Apr. 2 Jume Apr. 2 Apr. 2	8, 1942 11, 1942 3, 1942 17, 1942 15, 1944 8, 1944 22, 1944 22, 1944 22, 1945 21, 1949 21, 1949	223 223 223 223 223 223 223 223 223 223	60% 60% 60%	0.01	സ്നയന്നുന്ന 4 4 നാരമസമാരം4 9 4 4	112 123 134 13 13	44 44 94 94 94 94 94 94 94 94 94 94 94 9	202 184 181 181 181 184 177 188 188 188	40400000000000000000000000000000000000	0 0 8 8 6 0 4 7 0 0 2 7 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	80 1 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	6 8 6 8 10 6 5 7 2 7 2 7 2 7 2 7 2	1144 1555 1344 1389 1389 1389 1382 1382 1382 1382 1382 1382 1382 1382	8-8
e 37	<pre> El Paso Natural Gas Co. (Mesa) </pre>	9 9 90	JAPT - 2 JAPT -	7 1935 323 1935 323 1935 228 1936 229 1937 229 1937 25 1940 17, 1941 17, 1941 17, 1944 25, 1944 25, 1944 25, 1944 25, 1944 25, 1944 25, 1944 25, 1944 25, 1944 26, 1947 26, 1947 27, 1947 26, 1947 27, 1947 26, 1947 27, 19	000 0000000000000000000000000000000000	••••••••••••••••••••••••••••••••••••••		44° 6444° 4444444° 6440° 5 01 311460123333 01	18 18 18 18 19 19 19 10 10 10 10 10 10 10 10 10 10 10 10 10	129 1339 146 146 146 146 146 146 146 146 146 146	2001 2001 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2004 2005 2005	120 106 112 112 112 112 112 112 112 112 112 11	22 22 22 22 22 22 22 22 22 22	• • • • • • • • • • • • • • • • • • •	ຸ 4 , , , , , , , , , , , , , , , , , ,	74 46 46 46 46 46 46 46 46 46 4	

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Analyses of water from wells in the El Paso area, Texas -- Continued Table 6.

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	Омлег	Depth of well (ft.)	Date of collection	of tion	Dissolved solids	Silica Iron (SiO ₂) (Fe)	Iron (Fe)	Cal- cium (Ca)	Magne- sium (Mg)	Sodium and Bicar-Sul- potassium bonate fate (Na ⁺ K) (HCO ₃)(SO ₄	Bicar- bonate (HCO ₃)	Sul- fate (S0 ₄)	Chlo- ride (Cl)	Fluor- ide (F)	Ni- trate (NO ₃)	Total hardness as CaCO ₃	Source of analysis a/
128B	El Paso, Texas																
	(City well 21)	:	Feb.	_		42	•	37	12	80	222	60	50	•	•	142	2
				-		50	•	42	15	64	211	60	49	•	•	167	0
						•	•	39	13	56	204	46	38	•	5.0	151	1
				25, 1943	3 299	•	•	42	13	53	203	46	39	•	5.8	158	٦
						•	•	43	14	51	201	47	39	•	8.4	165	I
				•••		•	•1	40	13	59	206	47	42	•	5.5	154	Ţ
				-		•	•	43	14	55	201	55	42	•	5.1	165	1
				•••		•	•	42	14	54	210	36	47	٠	3.8	162	1
				-		•	•	•	•	•	204	•	48	•	•		T
						39	۱	42	15	63	210	52	52	•	5.4	166	-
				•••		37	•	43	14	60	198	55	50	•	6.0	160	I

Source of analyses. ٦

(1) U. S. Geological Survey.

(2) City of El Paso.(3) Southern Pacific Laboratories.

(4) El Paso Testing Laboratories.
 (5) Bureau of Ladustrial Chemistry, The University of Texas.

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Following are listed the water supply papers of the Geological Survey that contain records of water levels in wells in the El Paso area, Texas:

Water-Supply Paper	Year
817	1934
817	1935
817	1936
840	1937
845	1938
886	1939
909	1940
939	1941
947	1942
989	1943
1019	1944
1026	1945