Pumping Test on Brine Wells of Emro Corporation near Carlsbad, New Mexico

By C. V. Theis and R. E. Hale

Geological Survey

Introduction

It has long been known that a heavy saline brine occurs at shallow depths in certain locations south of Carlsbad. The brine in sections 25 and 26, T. 25 S., R. 26 E., has been shown to contain about 50 gms. per liter of metallic magnesium in the sulphate form as well as sodium sulphate and other useful minerals. Exploration of this source of Mg. had been carried on by the Emro Corporation for some time when a 7-day pumping test was recommended by the Defense Plant Corporation.

Officials of the Emro Corporation contacted Mr. Hale of the Geological Survey just before the test, but some of his suggestions, particularly that the two wells be pumped separately and that provision be made for measuring the water levels in all the adjoining wells, were not carried out. ~~Mr. Theis was advised of the test when it was about to be concluded and arrived just after pumping was shut down.~~ Nevertheless, much significant information was gathered by ~~Mr.~~ Mr. Hale during the course of the test.

Location of Wells

The accompanying diagram gives the location of the wells in the neighborhood of the pumping test. The numbers on the map, assigned by Mr. Utz of the Emro Corporation, are used throughout this report for the purpose of simplicity, but the proper legal descriptions are also

recorded below the diagram. Wells No. 1 and No. 2 were pumped almost continuously for seven days. Automatic water-stage recorders were placed on wells 3, 6, and 7, during the pumping, and on the pumped wells after they were shut down. No provision could be made for measuring No. 4, a flowing well, and the static level in No. 5, the other flowing well, could not be measured before pumping began.

Character of Material

The driller's log in general show only a succession of gypsum beds above the brine. The brine appears to occur also in gypsum altho in some cases a siltstone is reported. The rocks below the brine are also gypsum in part although in some of the deeper holes anhydrite is reported to preponderate. Water used for stock is struck in the upper part of some of the holes, in gypsum. Sample logs made by R. H. King of the Geological Survey of the Perdue-Guitar No. 2 and the F. A. Forehand No. 2 (Nos. 7 and 4, respectively, of the diagram), wells record gypsum predominating throughout the holes, with subordinate dolomite and clay, with anhydrite appearing in the lower part of No.7 about 40 feet below the brine.

It appears from the information available that the brine occurs in no separate and distinctive beds, that there is no definite and distinct cap rock bed (although the brine is under considerable pressure), and that the brine lies near the bottom of the gypsum zone but not directly upon the unaltered anhydrite below.

Nature of Pumping Test

Pumping began on Well 1 at 9:35 a.m., January 29, 1912 and ended at 9:35 a.m., February 5. The pump cylinder in well 1 was placed at a

depth of 156 feet and after a few hours the pump began to suck air. During the test, the pumping rate was necessarily continually reduced so that the brine level stood throughout at about 156 feet depth. Pumping began on No. 2 well at 3:03 p.m., January 29, and was continued without significant interruption until 3:21 p.m., February 5.

During the course of the test the pumping crews measured the pumping rate each hour by filling a 55-gallon barrel. Measurements of the density of the brine at No. 2 were made every six hours and a sample of the water taken. About the same procedure was followed at No. 1. A record of the time the pump was shut down was also made. These data are incorporated in a sworn report of the pumpers submitted to the Defense Plant Corporation.

Mr. Hale of the Geological Survey collected samples as follows:

Etz No. 1	Etz No. 2
About 10:30 a.m. Jan. 29	About 3:25 p.m. Jan. 29
2:11 p.m. Feb. 4	2:45 p.m. Feb. 4
9:15 a.m. Feb. 5	3:30 p.m. Feb. 5.

Mr. Hale made measurements of density daily throughout the test, except on January 30 and 31, when no hydrometer was available.

During the pumping automatic water stage recorders were placed on wells 3, 6, and 7 and measurements of brine levels were made in well 5. Well No. 4, a capped, flowing well, could not be measured because the salt precipitated from the brine and solidified below the cap. Wells 3 and 6 were not much affected by the pumping but the water levels in wells 5 and 7 lowered several feet. The automatic water level recorder on well 7 showed fluctuations of water level at all the periods for which the operators recorded shut downs and by the absence of anomalous fluctuations at other times showed that there were no unrecorded shut downs when the pumping rate was significantly changed in No. 2.

After pumping ceased, automatic recorders were installed on wells 1 and 2, as soon as possible, to measure the recovery rate. A recording barograph was maintained near Well 3 after February 3, in order to correlate fluctuations of water level with barometric pressure.

Results of Test

The data concerning pumping rates and water levels are given in the appendix.

Briefly, Well No. 2 was pumped rather constantly at the rate of 55 gallons a minute for seven days, pumping being only interrupted for repairs to the pump totalling in several periods about six hours. During this time a little over half a million gallons of brine was pumped. The density of the brine remained constant, at 1.354 to 1.358 (higher reading at end of test) and the temperature remained at 66.5° F. The depth to water in the well before pumping was 10.58 feet and fell to 46.85 feet when pumping 55 gallons a minute, a drawdown of about 36 feet. Wells No. 6 and 3 were not affected by the pumping. The water level in well 7 lowered about six feet during the pumping and by its small rises after shut downs in No. 2 well showed that its aquifer was continuous with that of No. 2. The water level in well No. 5 lowered by the end of the test about three feet below its position on the second day of pumping. No measurements could be made at earlier times. Its action indicated that its aquifer is connected to that of either No. 2 or No.1, and most probably to the former.

Well No. 1 pumped steadily for the seven days except for two periods totalling five hours. The location of the cylinder and tubing was at a depth of about 156 feet and after a few hours the well was

pumped at its maximum rate for that setting of the pump. It pumped about 22 gallons a minute during the early part of the test period but only about 12 gallons during the latter part. Apparently none of the other wells was affected by its pumping. The depth to water in No. 1 was 85.28 feet before pumping began, so that the drawdown was about 70 feet. The density of the brine remained constant at 1.360 during the test.

Two days after No. 1 was shut down the depth to water in it was about 42 feet lower than before pumping and about 42 hours after shutting down No. 2 the depth to water was about 10 feet below its original static level.

Interpretation of Data

The data with regard to the pumping test are not as yet complete and much more information will be needed before the reserves of brine can be estimated. The wells are still recovering slowly and it is not known as yet if there will be any significant decrease of head due to the pumping. The early record of recovery seems to indicate that there might be some permanent lowering but inasmuch as little is known about the ~~slope~~ shape and size of the aquifer the early record can not be relied upon. ~~Further information will be forwarded as the information becomes available.~~ The permanent effect of the pumping upon water levels is obviously of prime importance.

The effect of the pumping upon wells 7 and 5 and lack of much effect on 6 and 3 indicates that the brine occurs in discontinuous pockets. This is also indicated by the fact that dry holes were drilled in NW¼SE¼ Sec. 24, and SE¼NW¼ Sec. 25, the latter between brine wells 2 and 5 on one side and 3 and 4 on the other.

In line with this evidence of the pockety character of the brine is the chemical character of the pick-up in this section of the Pecos River. Red Bluff Draw on which the brine wells are located, enters the Pecos River between the Pierce Canyon and Red Bluff gaging stations. Periodic samples of the water collected between October 1, 1938, and September 30, 1940, show that the river in this section picked up an average of 4.1 pounds of magnesium per minute, which, if all were contributed by this brine, would correspond to a discharge of only 12 or 13 gallons a minute. Moreover, the increase in magnesium content of the stream as compared with the increase in flow of the stream in this area represent a water only slightly higher in magnesium content than the water in the Pecos in the section and much less in magnesium content than the water added to the Pecos in the stretch at Malaga Bend, immediately above the Pierce Canyon station. It seems evident that only a negligible quantity of the brine, if any, discharges into the Pecos River and that the brine in Red Bluff Draw lies in a series of traps.

Further Work

In connection with the test just finished, levels will be run on the wells involved to determine the elevation of water-level in each well to ascertain whether or not the brine is moving and if so in what direction. Samples will be taken of the shallow water in the draw to determine if there is evidence of any of the heavy brine mixing with the overlying fresher water. Samples will also be taken of the efflorescence of salt in low places in the draw to ascertain if it resembles a precipitate from the brine.

In order to prove the extent of the brine much additional information must be gathered. Planning of additional work should probably be postponed until the information is complete on the first test. It seems probable, however, that besides the obvious necessity of prospecting for further localities by drilling, some cores should be obtained, if possible, to determine the porosity of the brine bearing zone and that additional pumping tests should be made, perhaps of shorter duration, during which the possibility that the overlying fresher water may also be involved in the circulation should also be investigated.

In this connection it should be held in mind that only a comparatively small quantity of brine is required. It is understood that the prospective plant will require only about 100 gallons of brine a minute. This would represent a use of only about 600 acre-feet of brine in five years. It seems quite probably that such a quantity is available, although the exploration so far has not proved it.

Depth to Water in Pumped and Neighboring Wells during Emro Pumping Test, January 29--February 5, 1942

Time	Pumping Rate * Gallons a Minute: Etz No.1	Etz No.2	Depth to Water below Measuring Point (Feet): Etz No.1	Etz No.2	Etz No.3	Etz No.5	Etz No.6	Etz No.7	Time
1/27/42									
2:36 p			85.28						
3:50 p				10.58					
3:52p-4:19p		1/							
1/28/42									1/28/42
Approx. 11 am-									
2:30 p	Approx. 25								
3:39 p							8.75		3:39 p
3:49 p								25.53	3:49 p
1/29/42									1/29/42
9:20 a			98.67						
9:32 a			98.61						
9:35 a	2/								
10:53 a							8.85		10:53 a
10:55 a	27.5--21.3						4/8.64		10:55 a
11:12 a							5/8.68		11:12 a
11:30 a								25.60	11:30 a
11:38 a								4/ 25.05	11:38 a
11:39 a								5/	11:39 a
12:25 p				10.83					
12:27 p		2/							
12:30 p		2/							
1:43 p		2/	156±						
1:52 p		2/							
3:03 p		2/57					8.83	25.35	3:03 p
3:58 p	21.3				1.58			25.35	3:58 p

Time	Pumping Rate * Gallons a Minute: Etz No.1	Pumping Rate * Gallons a Minute: Etz No.2	Depth to Water Below Measuring Point (Feet): Etz No.1	Etz No.2	Etz No.3	Etz No.5	Etz No.6	Etz No.7	Time
1/30/42			156±						1/30/42
Midnight 29-30	21.3--27.7						9.01	25.69	Midnight
11:00 a	2/	57							
11:35 a		2/					9.08	26.10	11:35 a
12:00 n	0						9.07	26.11	12:00 n
12:05 p									
12:45 p		55		39.40			9.05	26.13	12:45 p
1:30 p	2/								
1:37 p						3.50	9.05	26.16	1:37 p
2:45	27.7--20.5			42.10			9.05	26.22	2:45 p
3:09 p					1.63			26.23	3:09 p
5:30 p									
6:30 p	15.0								
Midnight							9.13	26.83±	Midnight
1/31/42									1/31/42
9:01 a	15.0--13.6				5/1.67		9.11	27.22	9:01 a
10:13 a		56		40.48	1.68		9.10	27.25	10:13 a
12:00 n		2/			1.66		9.06	27.38	12:00 n
1:45 p		2			1.63		9.02	27.41	1:45 p
Midnight		56			1.62		9.05	27.71	Midnight
2/1/42									2/1/42
9:25 a ~~9:45~~ a	13.0	2/			1.65		9.08	27.85	~~9:45~~ a 9'
11:30 a		2/			1.64		9.05	27.84	11:30 a
12:00 n					1.63		9.04	27.83	12:00 n
12:35 p		27.4		35.98	1.63		9.02	27.82	12:35 p
1:44 p					1.61	4.775	8.98	27.79	1:44 p
1:45 p		2/							
3:50 p		2/							
4:15 p		44							
5:15 p		55							
Midnight					1.55		9.00	28.07	Midnight
2/2/42									2/2/42
12:00 n					1.57		9.11	28.87	
1:10 p	13.0--11.0	55--57		46.85	1.56		9.09	28.90	1:10 p.
1:47 p					1.56	4.695	9.08	28.92	1:47 p
Midnight					1.57		9.15	29.62	Midnight

Time	Pumping Rate * Gallons a minute: Etz No. 1	Etz No. 2	Depth to Water below Measuring Point (Feet): Etz No. 1	Etz No.2	Etz No.3	Etz No.5	Etz No.6	Etz No.7	Time
2/3/42	↑		156±						2/3/42
Aprox 7:30 a	11.5	3/							
8:30 a.m	↓	2/ 57							
6:00 a.m	3/								
9:00 a.m	2/ 13.4								
12:00 n.					1.54		9.06	29.88	12:00 n
2:40 p				44.61	1.52		9.02	29.89	2:40
3:04 p					1.51	5.34	9.02	29.89	3:04
Midnight					1.54		9.10	30.31	Midnight
2/4/42	↑								2/4/42
Noon					1.54		9.09		Noon
2:40 p	12.0—15.8			41.97	1.52		9.06		2:40
5:05 p	↓				1.51	5.89	9.06		5:05
Midnight	↓	↑			1.52		9.08		Midnight
2/5/42	↑								2/5/42
9:35 a	3/ 15.89 —13.3								
Noon		52			1.48		9.10		Noon
3:15 p				44.63	1.46		9.08	31.39	3:15
3:21 p		2/ ↓							
7:41 p					1.50	6.465	9.17	31.62	7:41 p
Midnight									

1/ Bailed a total of 825 gallons from No. 2
2/ Pumping started
3/ Pumping stopped
4/ Fresh water added to well to keep reservoir float from coming in brine. Water level rose as a consequence.
5/ Automatic water stage recorder installed.

* From Drillers record. The following measurements of pumping rate were made by Mr. Hale:

		No. 1		No. 2	
Jan. 29	10:00 a.m	27.5		3:24 p.m.	57
	12:58 p.m.	21.5			
30	10:00 a.m.	22.7		2:52 p.m.	55
	3:34 p.m.	17.4			

Measurements of pumping rate by Mr. Hale (Continued)

Jan. 31	10:50 a.m.	11.2	10:15 a.m.	55
Feb. 1	10:30 a.m.	11.5	11:48 a.m.	28.6
			12:35 p.m.	23.6
			1:10 p.m.	55.0
Feb. 2			2:40 p.m.	49.5
Feb. 3			2:45 a.m.	36.6
Feb. 4	2:11 p.m.	14.8	2:58 a.m.	47
Feb. 5	9:15 a.m.	8.6		

Depth to Water, in feet, below Measuring Point, in Wells of Emro Corporation during early part of Recovery period After Pumping Wells No. 1 and No. 2 from January 29 to February 5, 1942

Time	Ets No. 1 Depth to Water	Time	Ets No. 2 Depth to Water	Ets No. 3 Depth to Water	Ets No. 5 Depth to Water	Ets No. 6 Depth to Water	Ets No. 7 Depth to Water
Static Level before pumping	85.78		10.58	1.58	?	8.85	25.53
2/5/42		2/5/42					
9:35 a.m	1/	3:21 p	1/	1.46		9.08	31.39
10:18 p	150.00	3:25 p	30.42	1.46		9.08	31.40
1:19 p	149.76	3:29 p	27.83	1.46		9.08	31.41
1:40 p	149.52	3:34 p	26.47	1.46		9.08	31.42
1:50p	149.30	3:37 p	25.82	1.46		9.08	31.42
1:01 p	149.30	3:40 p	25.25	1.46		9.09	31.43
1:15 p	148.74	3:35 p	24.47	1.46		9.09	31.43
1:30 p	148.41	3.51 p	23.70	1.46		9.09	31.44
1:45 p	148.09	3:58 p	23.94	1.46		9.09	31.44
2:00 p	147.75	4:04 p	22.39	1.45		9.09	31.45
2:15 p	147.42	4:11 p	31.20	1.45		9.09	31.45
2:46 p	146.79	4:20 p	31.30	1.45		9.09	31.46
3:42 p	145.74	4:30 p	30.76	1.45		9.10	31.46
4:37 p	144.71	4:30-- 6:30	2/				
5:30 p	142.78	6:00 p	28.38	1.46		9.14	31.55
6.08 p	142.84	6:10 p	28.13	1.47		9.15	31.56
7:24 p	142.03	6:20 p	27.88	1.47		9.16	31.57
8:19 p	141.39	6:33 p	27.70	1.47		9.16	31.58
9:15 p	140.62	6:44 p	27.60	1.48		9.16	31.59
10:10p	139.97	7:39 p	26.93	1.49		9.16	31.63
11:06p	139.35	7:41 p		1.49	6.465	9.17	31.63
		8:35 p	26.48	1.50		9.19	31.68
		9:30 p	26.10	1.52		9.20	31.74
		10:30p	25.75	1.53		9.21	31.78
		11:30p	25.43	1.54		9.21	31.84
2/6/42		2/6/42					
12:01	138.77	12:15a	25.17	1.55		9.21	31.88
12:57a	138.14	1:10 a	24.91	1.55		9.21	3/
1:52 a	137.70	2:05 a	24.69	1.56		9.22	
11:40a	137.83	3:00 a	24.47	1.56		9.22	
11:54a	132.79	3:55 a	24.29	1.57		9.23	
12:49p	132.45	4:50 a	24.12	1.58		9.23	
1:45 p	132.12	5:45 a	23.98	1.58		9.24	
2:40 p	131.80	6:40 a	23.84	1.59		9.25	
3:35 p	131.54	7:35 a	23.70	1.60		9.26	
4:31 ~~4:13~~ p	131.29	8:30 a	23.58	1.61		9.28	
		8:46 a			6.97	9.28	
5:26 p	131.05	9:05 a	23.48	1.62		9.27	

Time	Str No. 1 Depth to Water	Time	Str No. 2 Depth to Water	Str No. 3 Depth to Water	Str No. 5 Depth to Water	Str No. 6 Depth to Water	Str No. 7 Depth to Water
2/6/42		2/6/42					
6:21 p	130.79	9:13 a	23.45	1.62		9.26	
7:16 p	130.59	10:03 a	23.30	1.63		9.25	31.10
8:12 p	130.39	10:40 a	23.19	1.62		9.23	31.10
9:07 p	130.17	11:04 a	23.12 ±	1.62		9.22	31.10
10:02p	129.96	12:00 N	22.96 ±	1.62		9.20	31.08
		12:07 p			6.95	9.20	31.08
10:58	129.78	12:55 p	22.84 ±	1.61		9.17	31.06
11:53 p	129.60	1:50 p	22.61 ±	160		9.13	31.04
		2:47 p	22.50 ±	1.59		9.12	31.02
		3:42 p	22.39	1.59		9.11	31.01
		4:37 p	22.28	1.59		9.11	31.01
		5:32 p	22.20	1.59		9.11	31.01
		6:27 p	22.10	1.59		9.12	31.01
		7:22 p	22.02	1.59		9.12	31.01
		8:17 p	21.93	1.59		9.12	31.01
		9:14 p	21.85	1.59		9.12	31.01
		10:09 p	21.76	1.59		9.12	31.00
		11:04 p	21.66	1.58		9.11	31.00
		11:59 p	21.58	1.58		9.10	31.88
2/7/42		2/7/42					
12:48 a	129.40	12:54 a	21.49	1.58		9.09	31.87
1:44 a	129.24	1:49 a	21.41	1.58		9.08	31.86
2:39 a	129.10	2:45 a	21.35	1.56		9.07	31.84
3:34 a	128.89	3:41 a	21.30	1.56		9.06	31.81
4:29 a	128.71	4:36 a	21.25	1.55		9.06	31.80
5:25 a	128.57	5:32 a	21.19	1.55		9.08	31.80
6:20 a	128.42	6:27 a	21.13	1.55		9.07	31.90
7:15 a	128.31	7:22 a	21.07	1.55		9.08	31.90
		8:05 a			7.11	9.08	31.90
8:11 a	128.18	8:18 a	21.02	1.55		9.08	31.90
9:06 a	128.06	8:15 a	21.01	1.55		9.08	31.90
10:09 a	127.96	8:24 a	20.99	1.55		9.07/8	31.90
4/		10:45a		1.54	7.07	9.06	31.88
		12:00 N	20.68	1.52		8.02	31.84
		6:00 p	20.23	1.46		8.49	31.49
		12:00 M	19.88	1.42		8.49	31.41
		2/8/42					
		6:00 a	19.60	1.41		9.00	31.56
		12:00 N	19.27	1.39		9.00	31.50
		6:00 p	19.07	1.38		9.04	31.43
		12:00 M	19.00	1.47		9.14	31.48
2/9/42		2/9/42					
		6:00 a	18.91	1.53 ±		9.21	31.57
		12:00 N	18.70	1.55 ±		9.18	31.57
		5:07 p			7.13	9.12	31.48
5:08 p	124.68	5:13 p	18.555				

1/ Pumping stopped. 2/ Removed sucker rods and 4-inch tubing
3/ No record; counter-weight on recorder hung.
4/ No record; recorder clock stopped.

5 Ed 100

Location of brine wells
St Emro Corp. near Carlsbad
sheet 2 of 2.

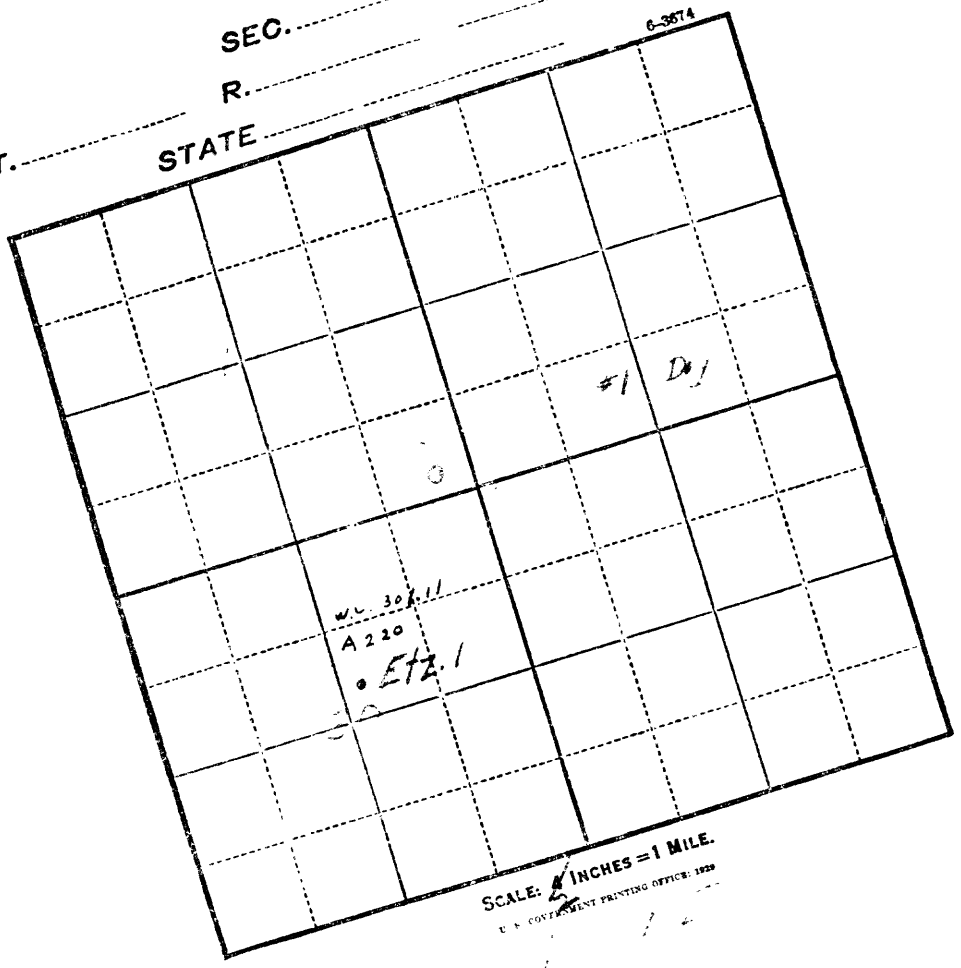
4—590a

SEC. ..... MER.

R. .....

T. ..... STATE .....

6-3674



SCALE: 4 INCHES = 1 MILE.

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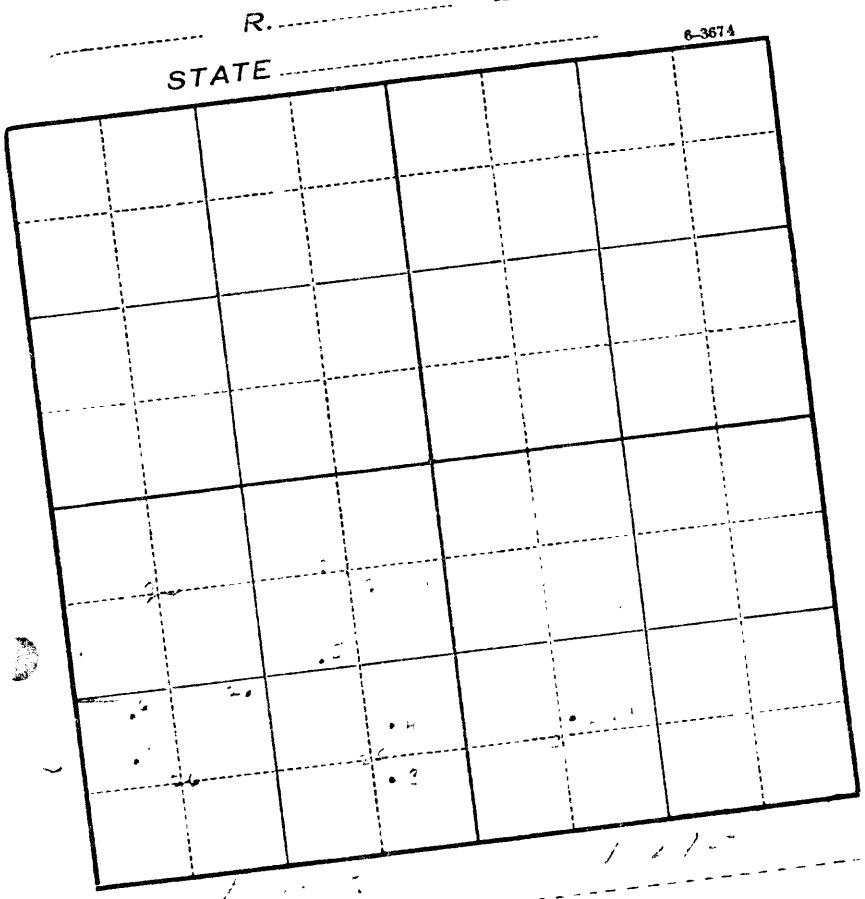
5 Ed 40

SEC. ..... MER. .....

R. ....

STATE .....

6-3674



5 Ed 100

Location of brine wells of Emro Corp near Carlsbad. Sheet 1 of 2

4—590a

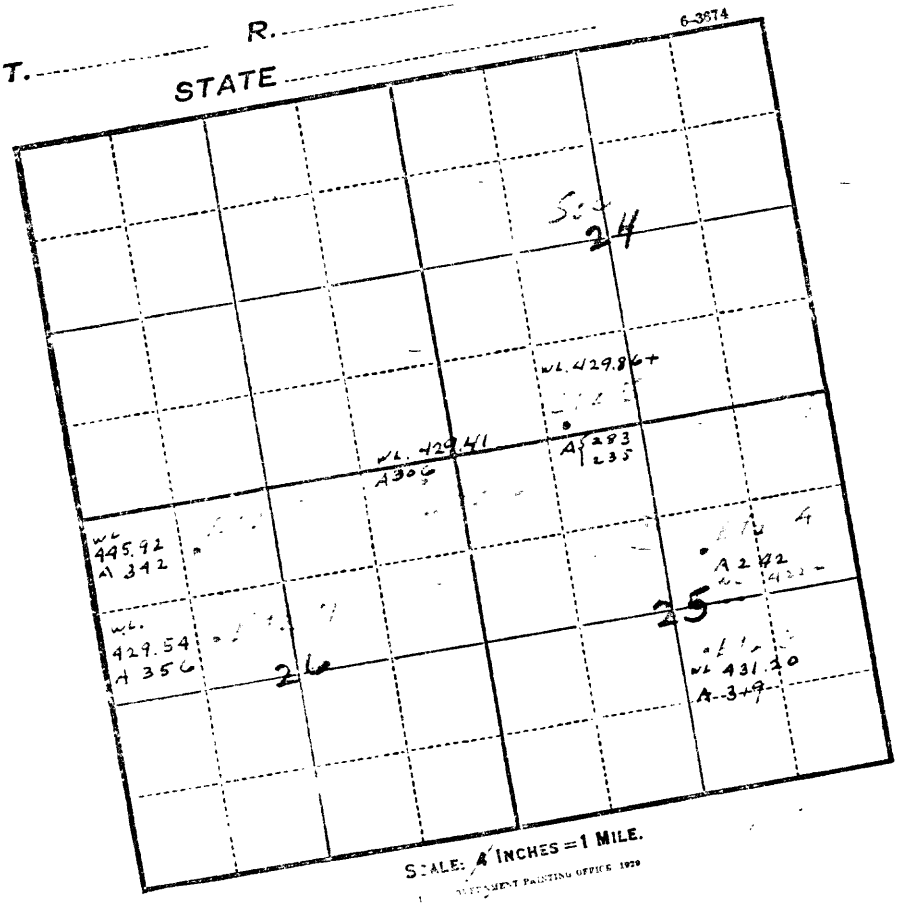
SEC. ..... MER.

R. .....

T. .....

STATE .....

6-3674



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