AQUIFER DESIGNATION FOR UIC:
PROTOTYPE STUDY IN SOUTHEASTERN NEW MEXICO

Submitted to:

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December 17, 1979

Santa Fe, NM 87501

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AQUIFER DESIGNATION FOR UIC:

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INTRODUCTION

The New Mexico Oil Conservation Division (OCD), in conjunction with Lee Wilson and Associates, has performed a prototype study to implement the aquifer designation regulations which are proposed as part of the Federal Underground Injection Control program. Designation criteria require protection of aquifers which are currently used for drinking water or which have a total dissolved solids (TDS) content of less than 10,000 mg/l. However, aquifers may be exempted from designation if they are or will be used for mineral, oil or geothermal energy production, or if they cannot provide drinking water for reason of economics, technology or gross contamination.

In New Mexico, state regulations already require that ground water with a TDS less than 10,000 mg/l be protected against virtually all types of pollutant discharge. UIC goes beyond the State programs by requiring explicit identification and mapping of the areas to be protected. However, aquifers protected under State regulations could be exempted from protection under UIC in areas of mineral, oil or geothermal energy production. Because the concept of designation or exemption is new, and standardized procedures are not available, the process of aquifer evaluation is potentially difficult, complex, and time-consuming; it may be expensive in terms of the commitment of resources for data gathering and interpretation. A prototype study is needed to develop procedures and evaluate the complexity and expense of the aquifer-designation process. The prototype reported here involved all steps in the process except for those related to a formal public hearing.

The project described here involved the mapping of aquifers in a 144-square-mile area near Artesia, in Eddy County (Figure 1). Characteristics of the area include the following:

1. Both artesian water and oil are produced from the same geologic unit, the San Andres Formation of Permian age. This situation is characteristic of much of southeastern New Mexico and implies that boundary-setting in aquifer designation must be precise.

2. Injection into the San Andres is practiced both for secondary recovery and brine disposal; thus the

potential for contamination is significant and the role of UIC designations as a protective tool becomes important.

3. Considerable information on the area has already been compiled by agencies or private companies (for example, water-level maps). Additional data can be readily obtained (for example, porosity values can be read from modern geophysical logs).

METHODS AND DATA

Geologic, hydrologic, and energy-resource data for the study area were gathered from published reports and the files of federal, state and local agencies concerned with water or energy resources. Information on salinity and porosity was developed in part from geophysical logs produced from new, deep gas wells which penetrated the Grayburg-San Andres interval. The Dual Laterlog and Compensated Neutron Log were utilized to determine resistivity of formation fluids and formation porosity. With proper borehole corrections, these logs provide an accurate assessment of fluid salinity. However, data are generally available only for deeper formations, since wells are required to be cased through formations known to contain potable water. The data were compiled into four tables (Tables

1 to 4), which include geohydrologic information, records of water wells, and records of oil, gas and injection wells (including geophysical data wells), and lithologic descriptions. The tables were then interpreted to produce maps basic to the aquifer designation process (see Figures 2 through 9); the maps present structural contours, potentiometric surfaces, the location of shallow oil and gas pools, and the location of information wells.

The maps and tables were used to develop Figure 10, a cross-section of the study area. This cross-section portrays most of the information needed to make aquifer designations. The section shows the location of fresh water, oil and gas pools, geologic boundaries, potentiometric surfaces of shallow and artesian aquifers, and representative wells. Figure 10 is used as the base for the various designation options considered in the Results section.

The geology of the study area (see Figures 2, 3 and 4) reflects its position as a backwater depositional zone in the Permian Reef complex of New Mexico and Texas. Dolomites predominate, with limestone increasing southeastward toward the reef, and redbeds and evaporites increasing north and west onto the shelf. In general, the Permian units dip toward the southeast and thicken in the same direction.

The principal aquifer and hydrocarbon-producing zones both occur within the San Andres Formation, which lies between the Grayburg Formation of the Artesia Group, and the Glorieta Sandstone. This formation is therefore the critical interval for UIC protection. Two separate porosity horizons are situated within the San Andres. The upper horizon is a high-porosity (20 per cent) interval which contains an artesian aquifer and some isolated hydrocarbon development. The artesian quifer underlies most of the area. The Aquifer includes much of the Grayburg as well as and the upper, porous zone of the San Andres. The water contains less than 3000 mg/l dissolved solids, except in the southeastern part of the map area where oil is produced from the lower Grayburg.

The lower horizon corresponds to the Slaughter dolomite zone, where locally developed porosity contains oil and gas, and total dissolved solids exceed 10,000 mg/l. A zone of low porosity apparently acts as a confining horizon, or permeability barrier, which separates the aquifer from the Slaughter zone and the oil pools.

Data on geohydrology and water quality in the area (see Tables 2 and 3, Figures 5, 6, 7) indicate that although fresh water is found to the base of the San Andres in some locations, there is no water production below the artesian aquifer. (However, fresh water is found beneath the San Andres in the Roswell Basin outside the study area; see Gross et al., 1978).

In most locations, fresh water is not found in wells which penetrate below the artesian aquifer. However, resistivity data indicate that fresh water may extend to the base of the San Andres in some locations (Arrow A, Figure 10). In all such cases, geophysical logs indicate that the fresh water occurs in rocks with low porosity (averaging less than 7 percent), suggesting that the water is interstitial. No fresh-water yield is obtained from any well which penetrates below the artesian aquifer. Water in the Glorieta exceeds 10,000 mg/l in all geophysical data wells.

In units east of the Pecos River, water contains more dissolved solids than in corresponding units west of the river. Most fresh-water production comes from the Yates Formation, with dissolved solids values which can be as low as 1,000 mg/l, but are generally above 4,000 mg/l.

A shallow aquifer extends from the western portion of the prototype area to the Pecos River (Figures 4 and 5). The aquifer includes the valley alluvial fill and upper portion of the Seven Rivers Formation. Little information is available for the lower Seven Rivers and Queen Formation, below the shallow aquifer, since they serve only as a minor source of water within the basin.

Shallow hydrocarbon development occurs primarily in the eastward-dipping Slaughter zone within the San Andres Formation (see Table 3; Figures 8 and 10). Six million barrels of oil have been pumped from over 400 wells in 10 pools which occur in the prototype area. Production has depleted to non-profitable levels in most wells and underground injection is applied for enhanced recovery in the Atoka San Andres, Atoka Grayburg, and Red Lake pools (Figure 8). Salt-water disposal is active in two wells.

Subtle changes of strike and dip and effective porosity development within the Permian units control regional pinchouts of hydrocarbon production, and separate many pools produced within similar horizons. Absence of vertical permeability development within the San Andres protects the artesian aquifer against oil migration from lower depths. Hence, contamination of the artesian aquifer by the underlying oil pool is unlikely. Local porosity along the Artesia Vacuum Arch within the Grayburg creates some oil production from facies above the Slaughter zone. Here, absence of vertical permeability development also protects the artesian aquifer. This trend continues east across the Pecos River in zones separated by permeability barriers. Most of these shallow pools have been depleted to production rates of less than one barrel per day per well.

Several points developed in the Methods section affect the four aquifer designation alternatives considered below. A considerable amount of fresh water which must be protected against contamination by underground injection is available in the study area. The shallow aquifers do not affect the designation process since they are underlain by the deeper artesian aquifer. Thus designation of the deeper aquifer will also protect the shallow aquifers. While oil production takes place as high as the top of the Grayburg, and fresh water is found to the base of the San Andres, no fresh-water production occurs below the artesian aquifer. There is a geologic basis in a large part of the study area for distinguishing between the upper porous horizon containing water and the lower porous horizon containing oil and gas.

RESULTS

Four alternatives were considered in the prototype study; three reflect a principle of designation (or exemption) contained in the UIC regulations, and the fourth is a combination containing the best overall approach.

Alternative 1. The entire stratigraphic interval to the base of the San Andres could be designated as an aquifer requiring UIC protection, with exemption for areas in which hydrocarbon production occurs.

Alternative 2. The interval could be designated as an aquifer only where total dissolved solids are less than 10,000 mg/l.

Alternative 3. The interval could be designated as an aquifer only where production of fresh water is likely to be economically or technically feasible.

Alternative 4. A combination of options 2 and 3 could be used. This alternative is the one recommended for the prototype area.

Each alternative must be judged in terms of: a) its effectiveness in protecting drinking water; and b) its administrative efficiency. Figures 11-15 display the various aquifer designations which would result from each alternative.

Alternative 1; Full Designation with Exemptions for Hydrocarbon Production

If the lower limit of the aquifer were designated as the base of the San Andres (see Figure 11), all known fresh water in the study area would be protected since TDS exceeds 10,000 mg/l throughout deeper horizons. Upper and lateral boundaries of active oil pools would then be used to exempt areas of hydrocarbon production. The heavy dashed line in Figure 11 illustrates how such a boundary would appear in cross-section.

This approach promises good protection of drinking water. The available evidence indicates that hydrocarbon production occurs within localized porosity zones (potential injection zones) which are unconnected to the artesian aquifer; further, fresh water has not been found beneath any oil pool. Therefore, wastes injected into areas exempted from designation would not be expected to commingle with fresh water in the protected aquifers. However, the approach would face severe administrative problems. Boundaries must be redrawn each time an oil pool is extended or a new pool developed, requiring a lengthy and expensive public review and hearing process on each boundary change. Further, determination of the exact location of pools (especially the upper limit) is quite time-consuming.

Alternative 2: Use of TDS Boundary

Use of a line to define the lower limit of water containing less than 10,000 mg/l solids would, by UIC definition, provide protection to all potential drinking water (see Figure 12). The major drawback to using this method throughout the study area is that there are no water-quality analyses available from the lower part of the San Andres, nor from many higher units east of the Pecos River. Instead, the determination that fresh water occurs to the base of the San Andres Formation involves the use of resistivity data from deep geophysical data wells. There are relatively few geophysical data wells; hence the boundary can only be approximate and the depth to which UIC protection should extend is uncertain. East of the river the line is drawn across the top of oil pools because elsewhere in the area TDS values in and beneath beneath pools are always greater than 10,000 mg/l. Administration of a designation based on approximate boundaries and uncertain depths would be difficult. In addition, evaluations of resistivity data from geophysical data wells is time-consuming and hence expensive. The approach may be the only one feasible in much of New Mexico, but in the prototype area a better procedure is available (see below).

Alternative 3: Boundary Based on Porosity

The fresh water which lies between the base of the artesian aquifer and the base of the San Andres appears to be interstitial, trapped in pore spaces with little or no permeability. It is doubtful that usable quantities of water could be obtained by wells which tap this horizon. Therefore, the base of the artesian aquifer itself could be used as a UIC boundary in the study area since it effectively limits the depth at which fresh water resources are available (see Figure 13). The boundary is readily drawn based on the extensive well records available in the area. In practice it is preferable to place the base of the protected zone 100 feet below the aquifer to provide a margin of safety. This would be consistent with existing state regulations, which require casing of all oil wells from the land surface to a depth 100 feet below the artesian aquifer.

The historic use of this criteria in State regulations indicates that administrative difficulties would be minimal. Moreover, data are adequate to present the boundary in map form (Figure 14). However, the artesian aquifer does not extend east of the Pecos River; a different approach is needed to provide aquifer protection in that part of the study area.

Alternative 4: Combination of Designation Techniques

To provide protection for fresh-water in the artesian basin as well as protection for those scattered sources outside the basin boundaries, a combination of designation techniques is necessary. A boundary placed 100 feet below the base of the artesian aquifer is feasible in the map area west of the Pecos River (Alternative 3). However, east of the river where the artesian aquifer does not occur, designation of boundaries would require careful scrutiny of well records and available geological data to determine zones productive of fresh water (using the procedures described in Alternative 2). The boundary drawn east of the river in Figure 14 is extrapolated from elsewhere in the area, and would need to be fixed in more detail if a UIC application were to occur east of the Pecos. This combination of options provides the best strategy for designating all potential sources of fresh water in the prototype area.

Figure 15 is a cross-section which identifies the boundary of the designated aquifer drawn according to Alternative 4. While this approach would require different types of administration in different parts of the prototype area, it also provides the most comprehensive protection. The administrative burden would not be significantly greater than that required for each individual technique above.

SUMMARY AND CONCLUSIONS

The prototype study has determined that boundaries can be set and aquifers identified under the UIC program. In the study area, existing state regulations can be used in coordination with UIC goals to carry out aquifer designations for the area west of the Pecos River. Designation of aquifers east of the Pecos requires use of geophysical data and available well records to determine appropriate boundaries based on total dissolved solids concentrations. This experiment provides many insights on the procedures to be used for UIC aquifer evaluations.

Geophysical data from oil and gas wells will be an important source of information, since they reveal conditions in deeper aquifers, which, while not currently use for drinking water, should be protected under UIC. The TDS boundary method (Alternative 2) will be very useful in those areas which lack the geologically defined aquifer limit which occurs in the study area. The TDS method is likely to be used in much of New Mexico; however, the boundaries set will be less reliable than those established on a geologic basis, unless salinity is geologically controlled. A major administrative concern is that the procedures used in designating aquifers not change every time new data become available. This concern makes the exemptions of aquifers for hydrocarbon production an undesirable alternative.

The prototype study cost approximately $100 per square mile. This provides a basis for budget estimates for other mapping elsewhere in New Mexico. Less cost and time will be involved in mapping the remainder of the Roswell basin as a result of the experience and techniques developed in the prototype area. Costs elsewhere in the state will vary depending upon data availability and the complexity of geologic and hydrologic conditions. Since most of the state will have little or no data available from deep wells, costs will be lower (and results less reliable) than in the prototype area.

The estimated cost of aquifer designation in New Mexico, based on $100 per square mile, would be $12,166,000. Even if costs eventually approach $10/square mile, a considerable expense will be incurred by the UIC program. Where feasible, existing administrative procedures, such as New Mexico's state regulations, would reduce UIC costs considerably.

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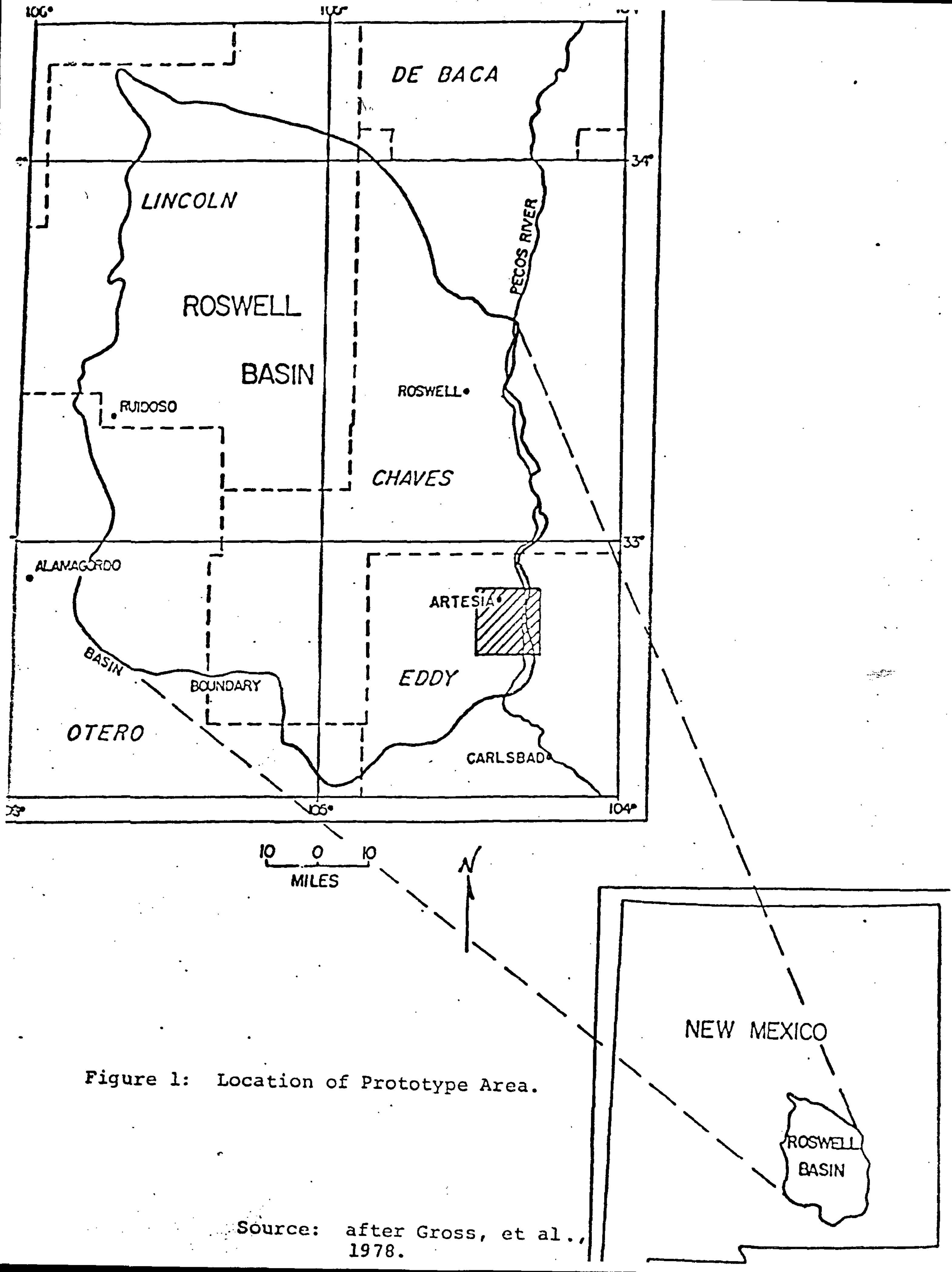


Figure 1: Location of Prototype Area.

Source: after Gross, et al., 1978.

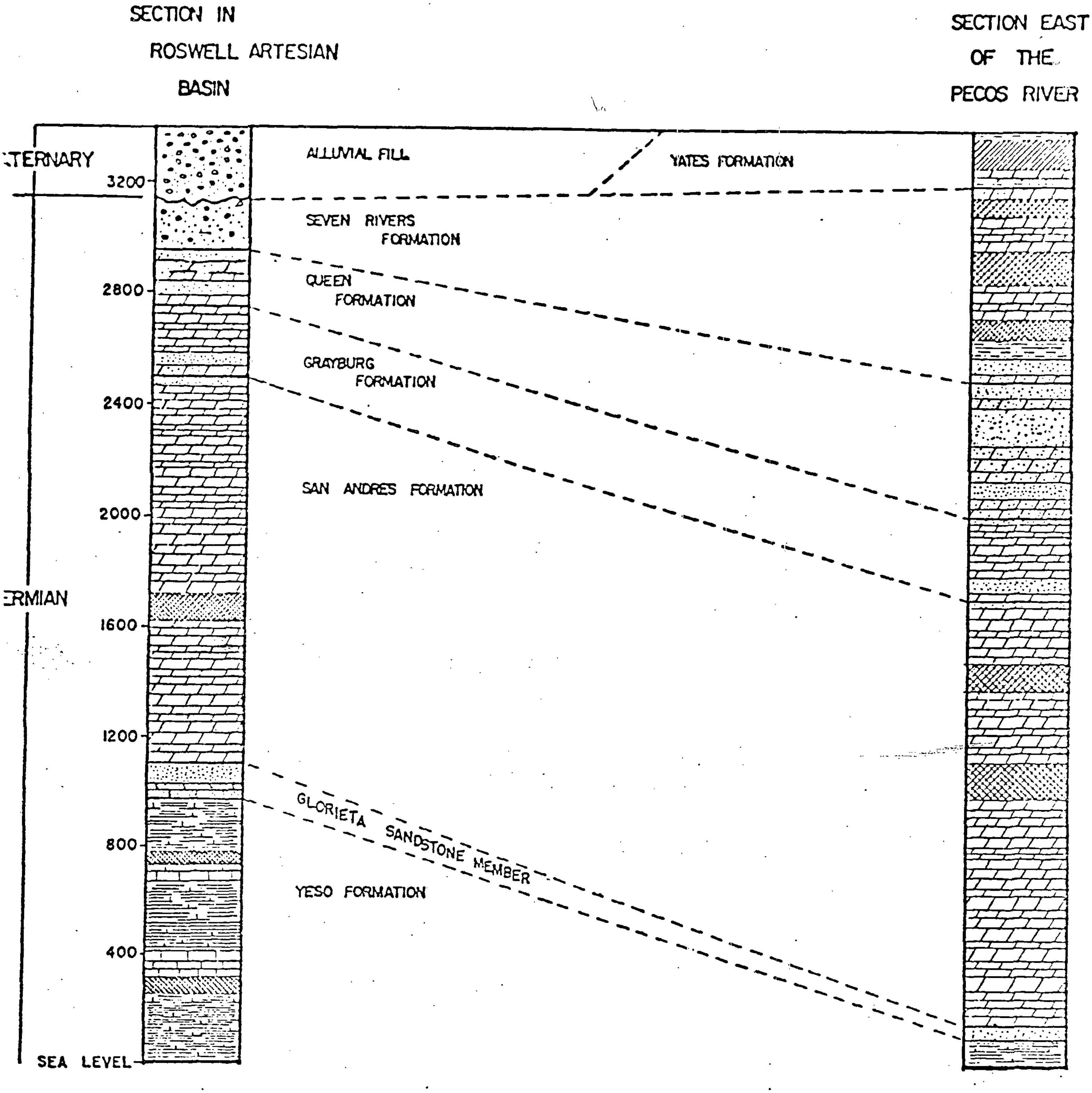


Figure 2: GENERALIZED STRATIGRAPHIC COLUMN ARTESIA AREA

Source: M. Holland, 1979.

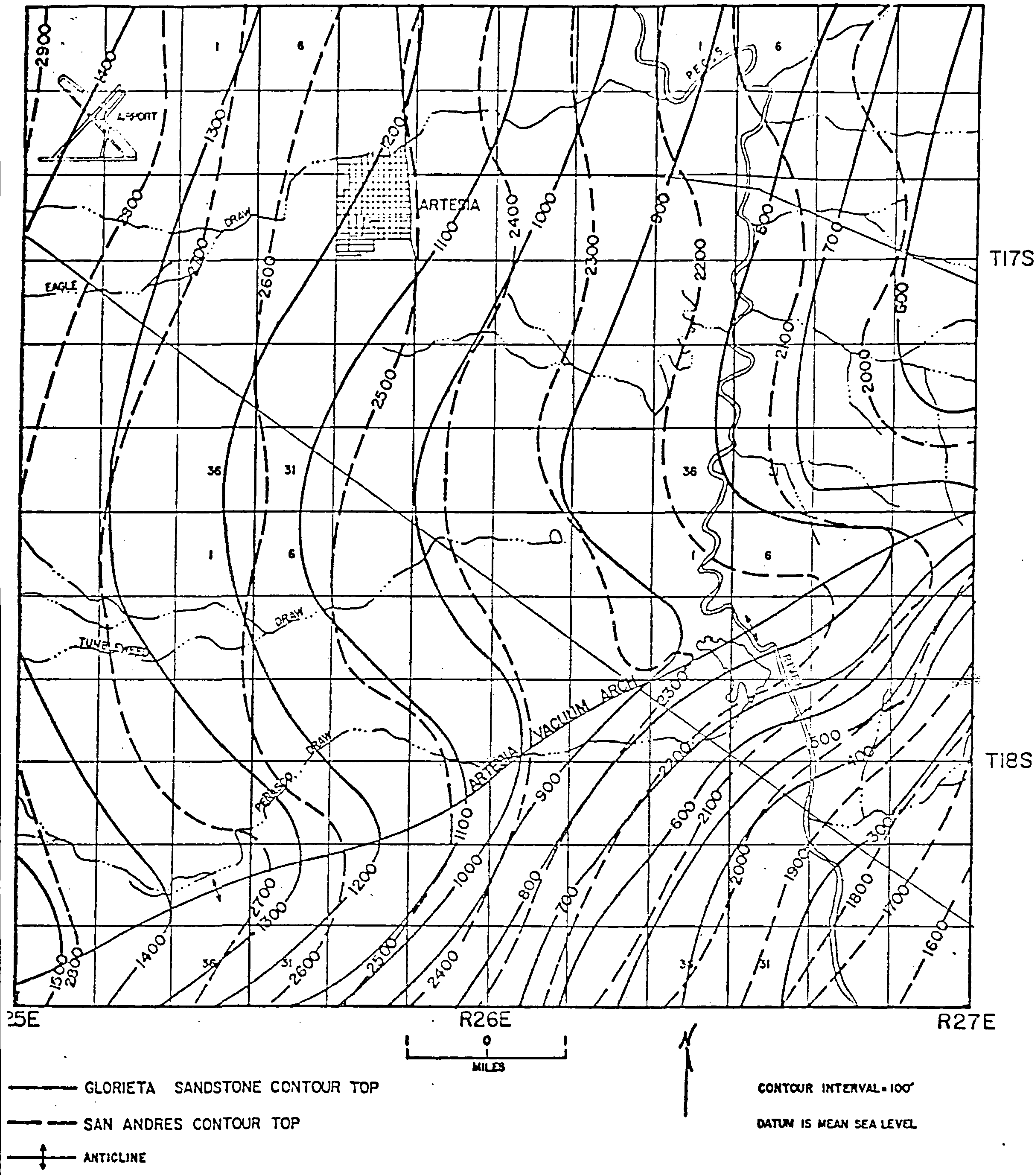
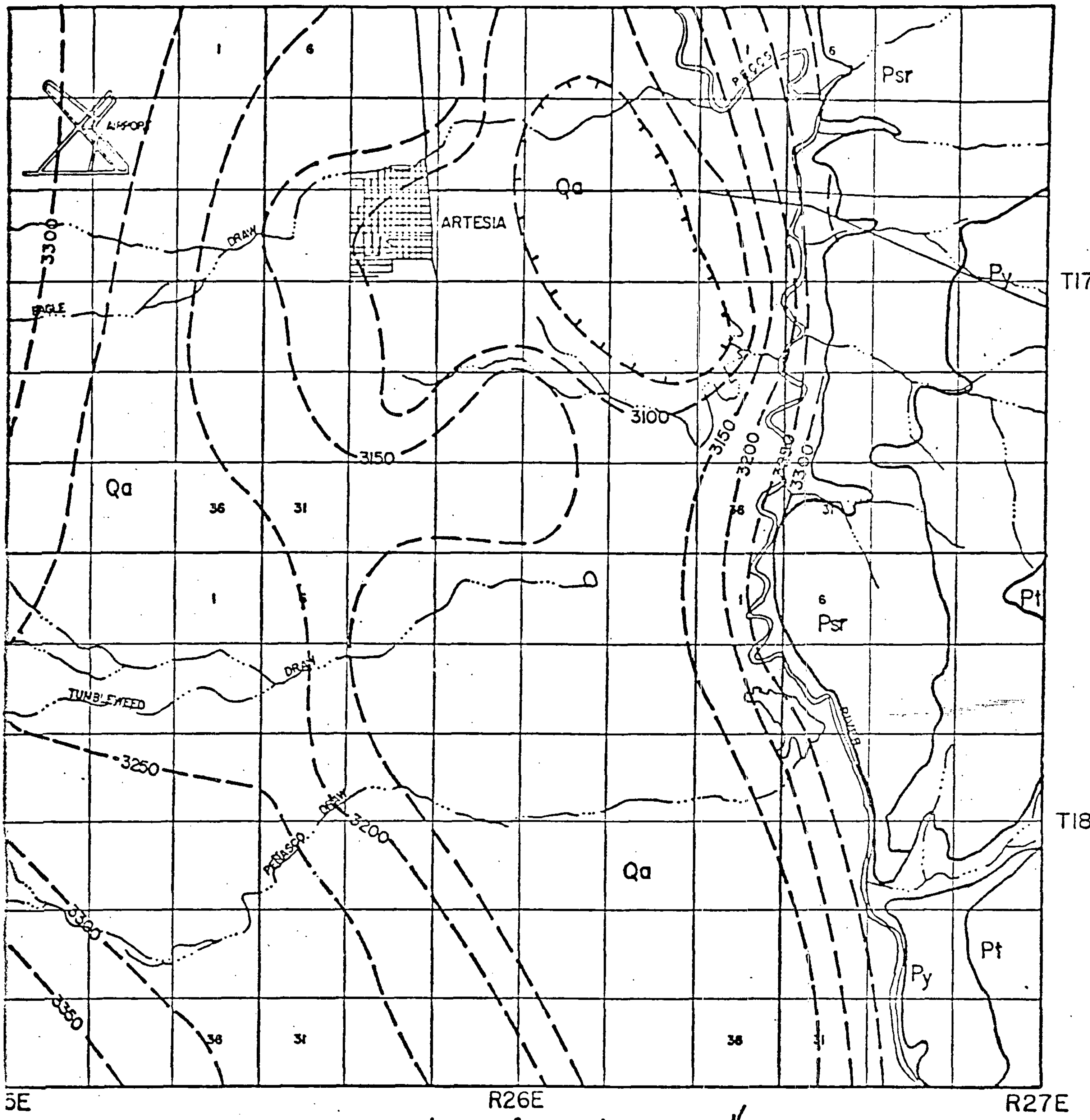


Figure 3: Structure Contour on San Andres Formation and Underlying Glorieta Sandstone Member.

Source: Modified after Maddox, 1969 by M. Stahl and M. Holland, 1979.



—— SURFACE GEOLOGIC CONTACT

— — CONTOUR ON THE BASE OF THE VALLEY FILL

Qa - QUATERNARY ALLUVIUM
Pt - TANSILL FORMATION
Py - YATES FORMATION
Psr - SEVEN RIVERS FORMATION

CONTOUR INTERVAL=50'
DATUM IS MEAN SEA LEVEL

Figure 4: Surface Geology.
Source: Modified after Kelley, 1971 and Lyford, 1973 by M. Stahl.

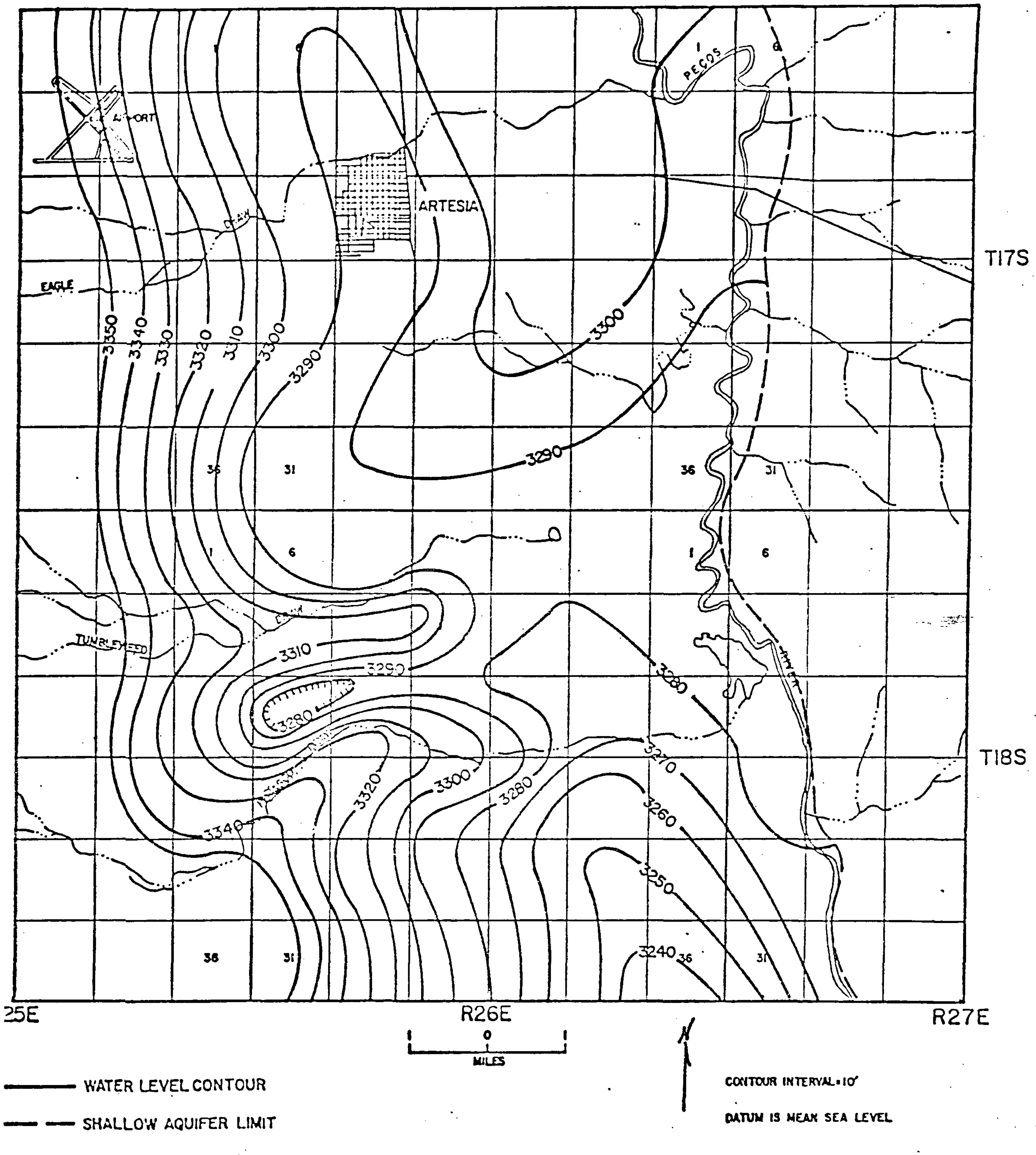


Figure 5: Potentiometric Surface of Shallow Aquifer.

Source: after E. Welder, 1977.

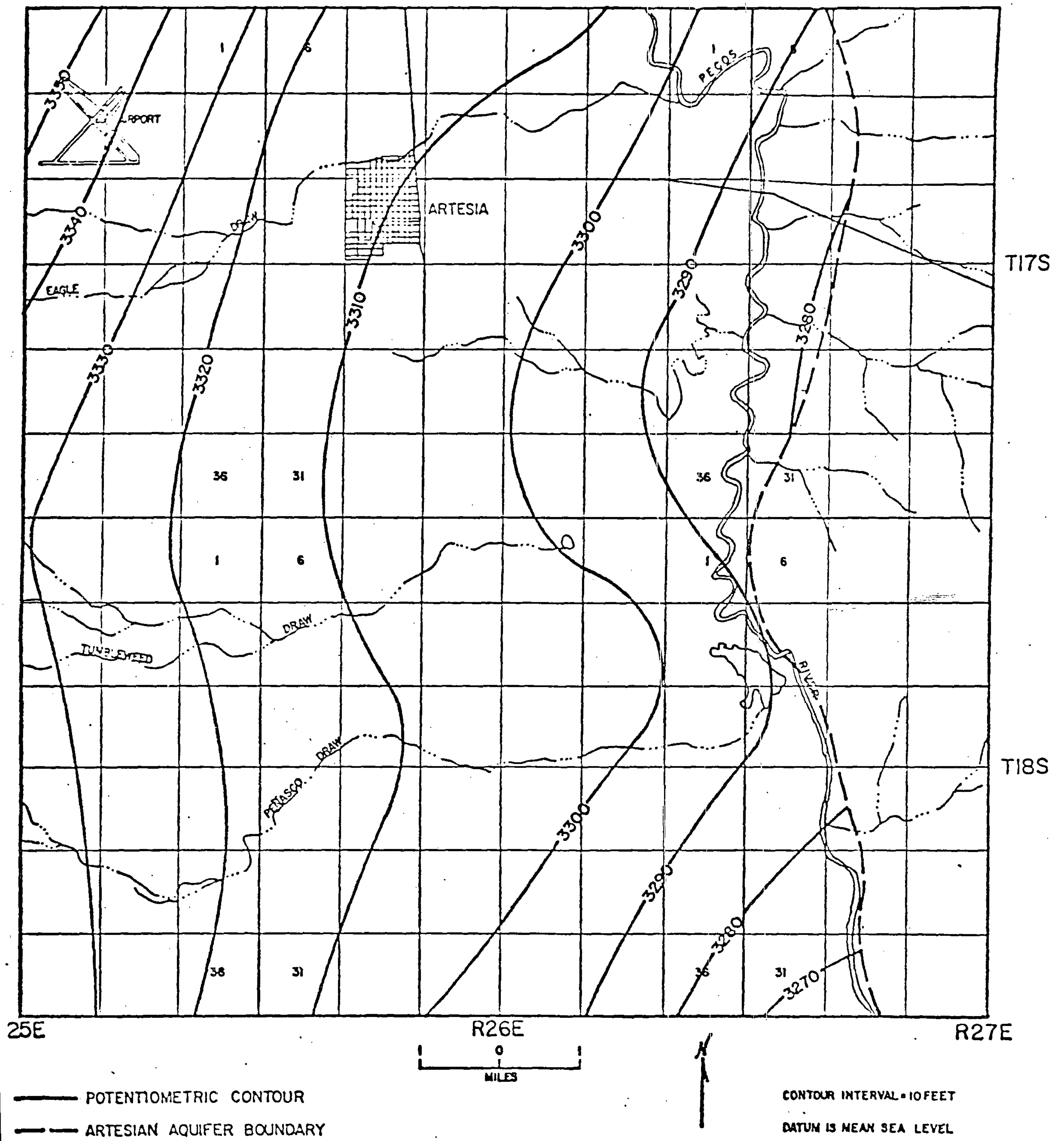


Figure 6: Potentiometric Surface of Artesian Aquifer.

Source: after E. Welder, 1977

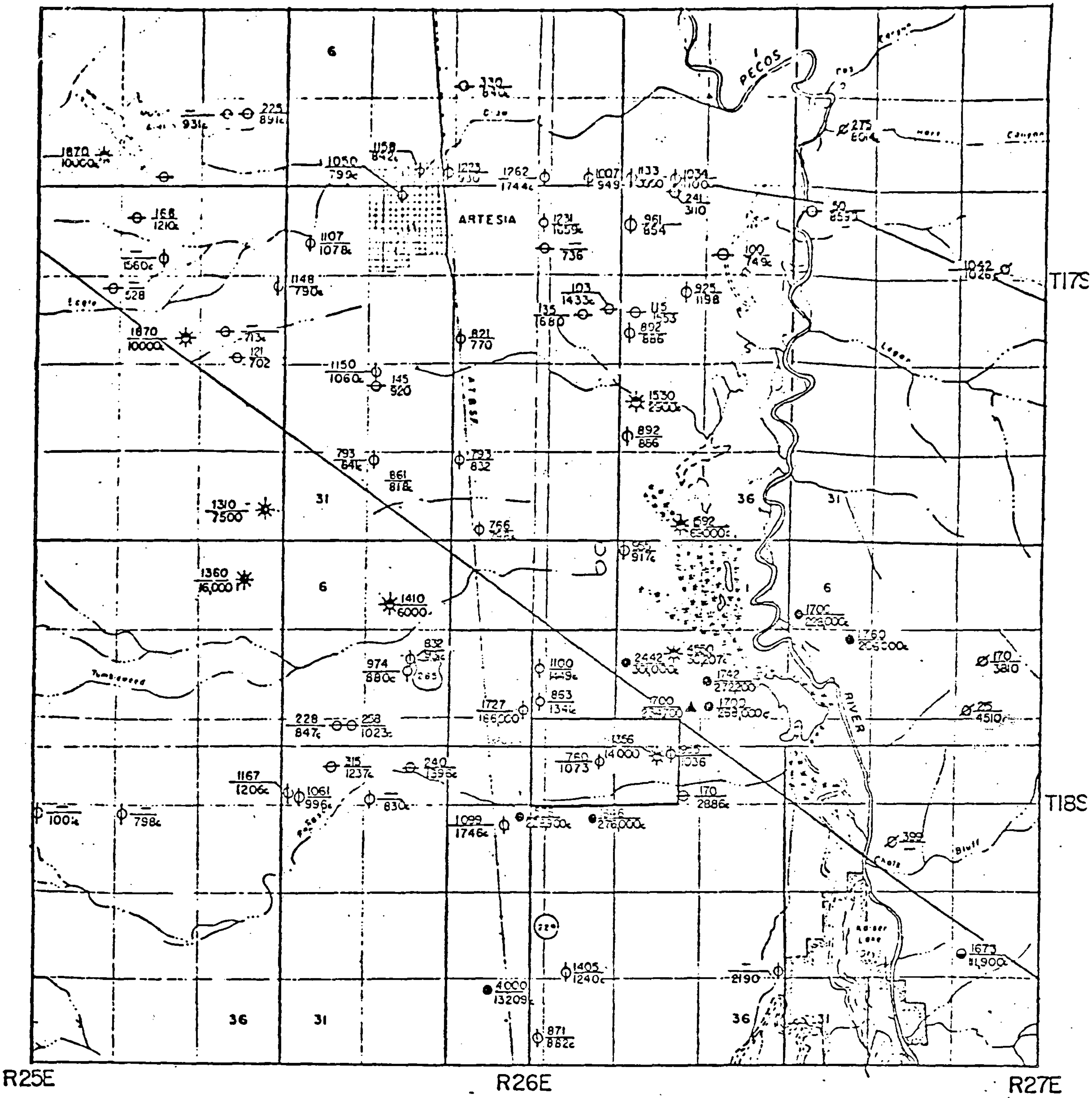


Figure 7: WATER QUALITY WELL PLOT

1 0 1
MILES

O DEPTH OF ANALYSIS (FEET BELOW SURFACE) / TOTAL DISSOLVED SOLIDS IN PPM (c INDICATES CALCULATED FROM CHLORIDES)

- WATER WELL—SHALLOW AQUIFER
- WATER WELL—ARTESIAN AQUIFER
- WATER WELL—ARTESIA GROUP
- OIL WELL—SHOW OF WATER
- OIL WELL
- GEOPHYSICAL DATA WELL—DEEP GAS
- PENNSYLVANIAN GAS WELL

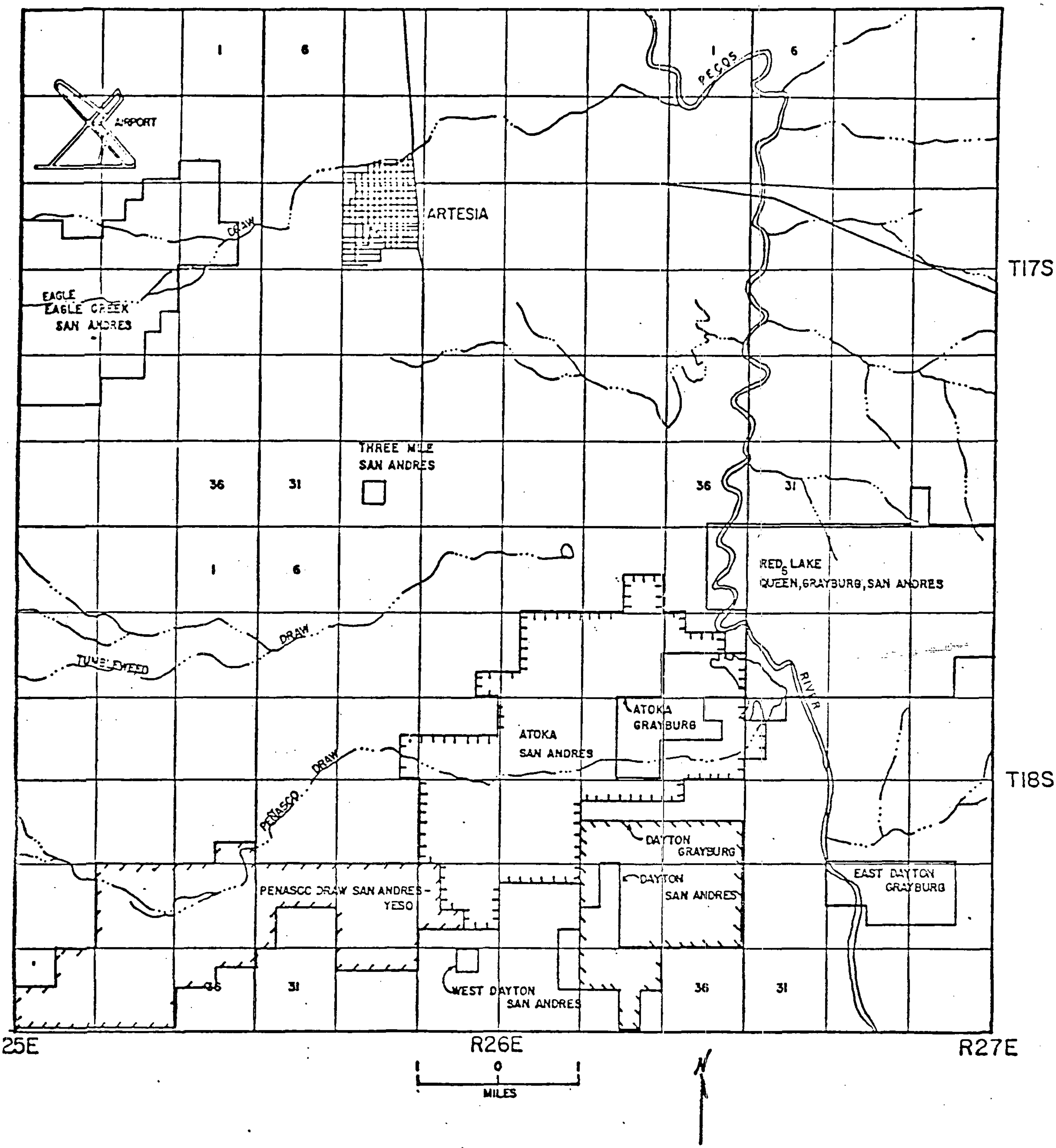


Figure 8: Location of Shallow Oil and Gas Pools.

Source: M. Holland, 197!

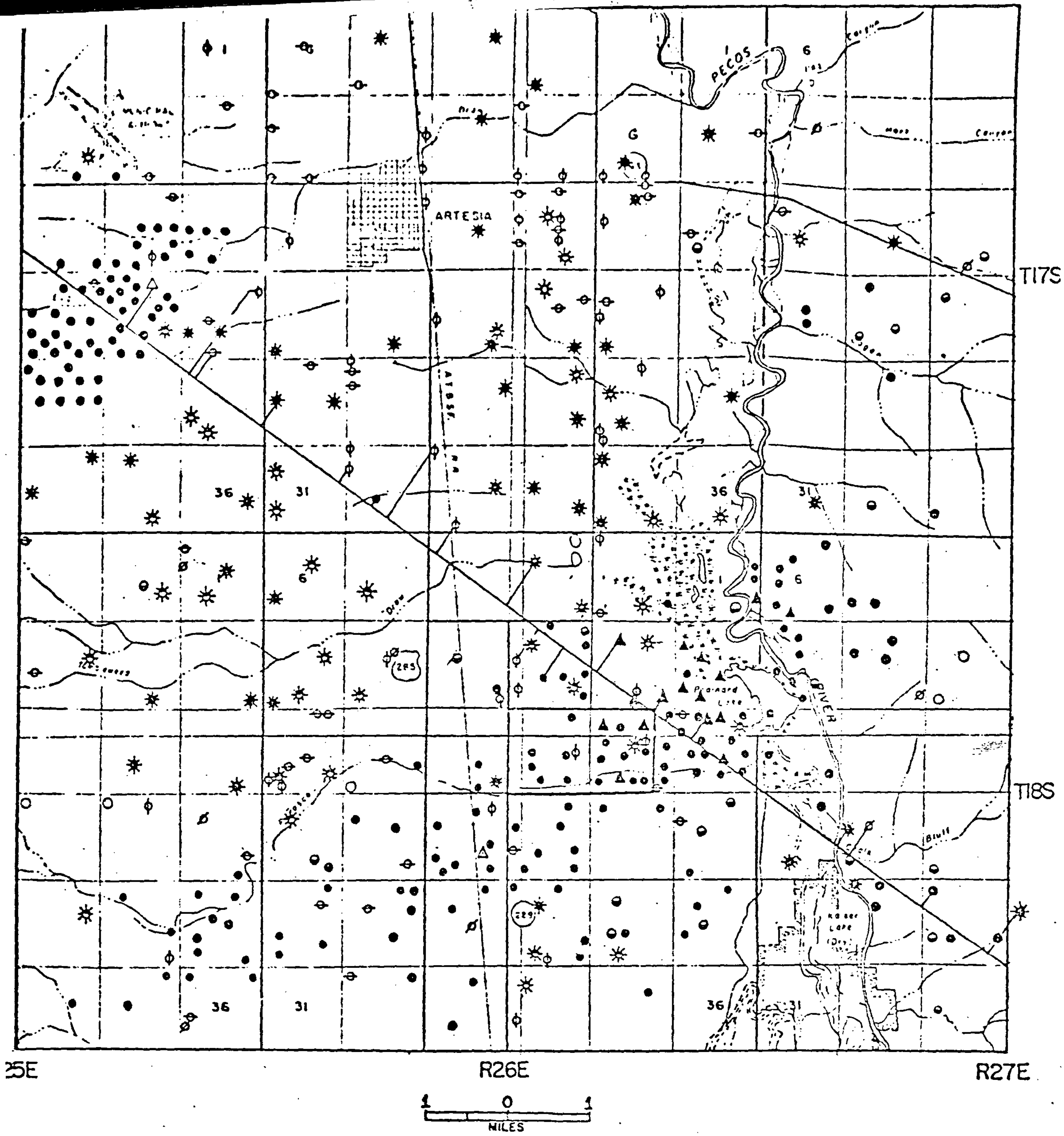


Figure 9: REPRESENTATIVE INFORMATION WELLS (OIL, GAS, WATER, INJECTION)

- WATER WELL–SHALLOW AQUIFER
- WATER WELL–ARTESIAN AQUIFER
- WATER WELL–UPPER ARTESIA GROUP
- OIL WELL
- OIL WELL–SHOW OF WATER
- PENNSYLVANIAN GAS WELL
- GAS WELL–GEOPHYSICAL DATA
- GAS WELL–SHOW OF WATER
- INJECTION WELL
- SALT WATER DISPOSAL

NOTE: ALL WELLS IN AREA NOT DEPICTED
SOME WELLS WERE DRY HOLES BUT ARE DATA SOURCE
SOME WELLS NOW PLUGGED AND ABANDONED

Source: M. Holland, 1979.

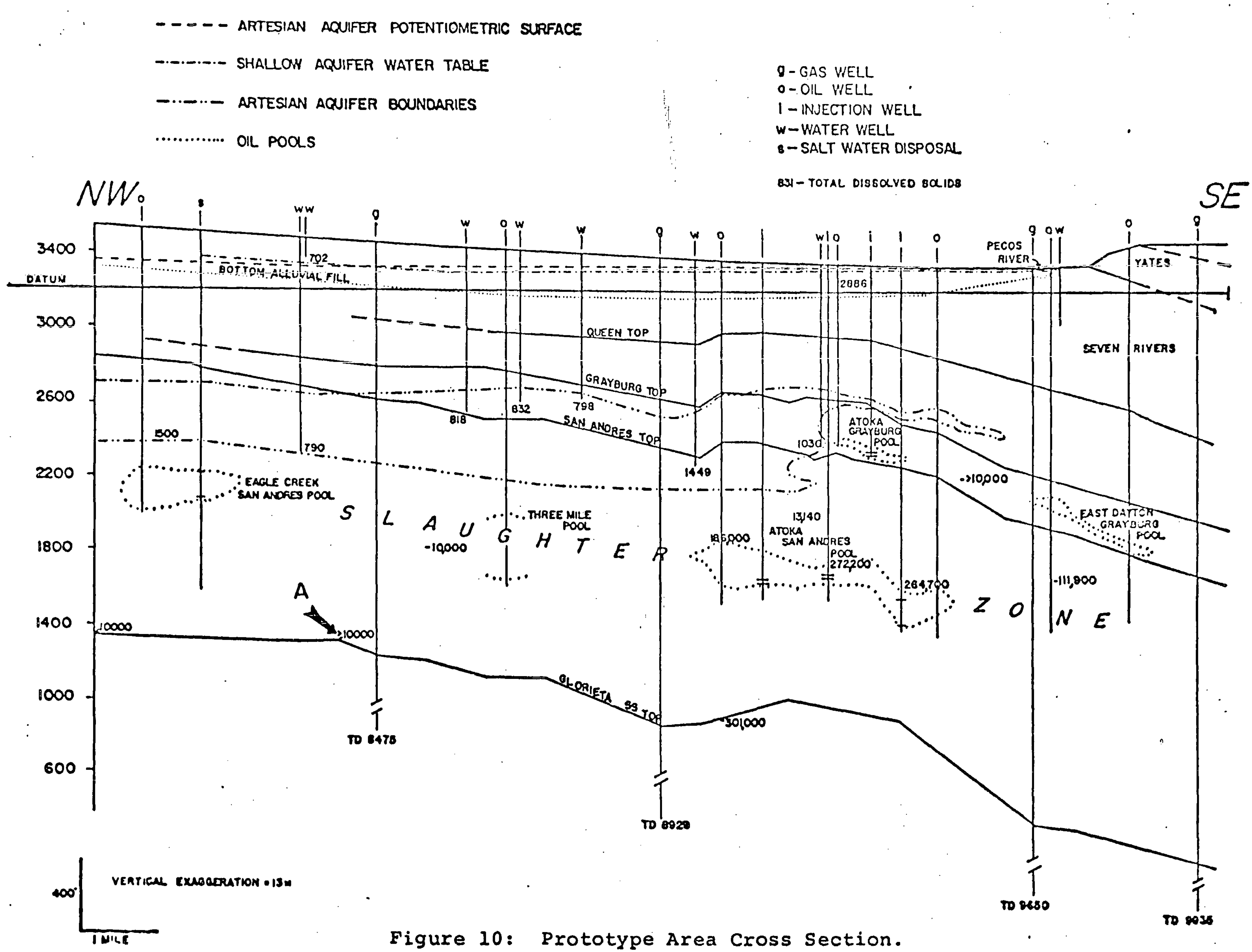


Figure 10: Prototype Area Cross Section.

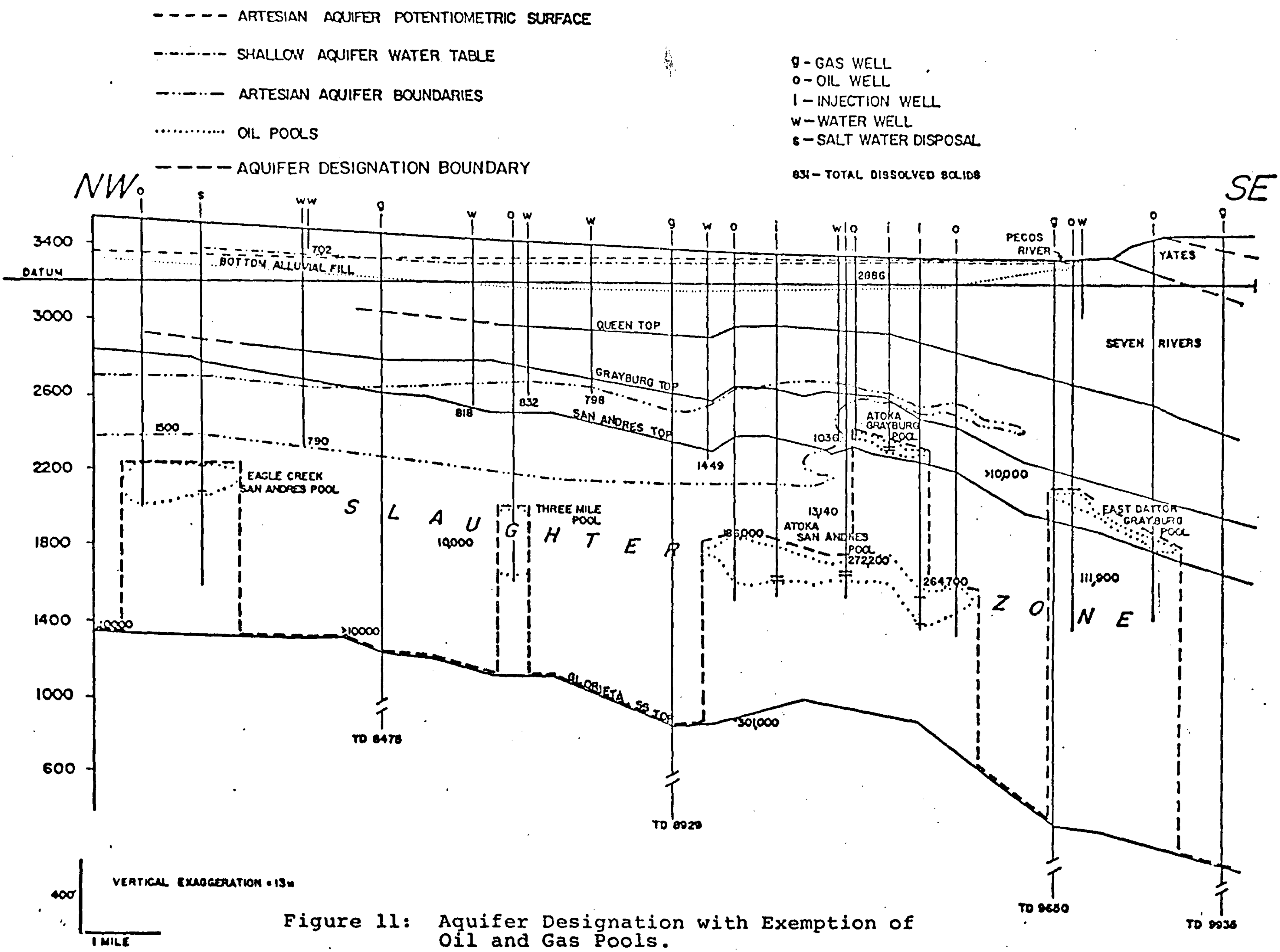


Figure 11: Aquifer Designation with Exemption of Oil and Gas Pools.

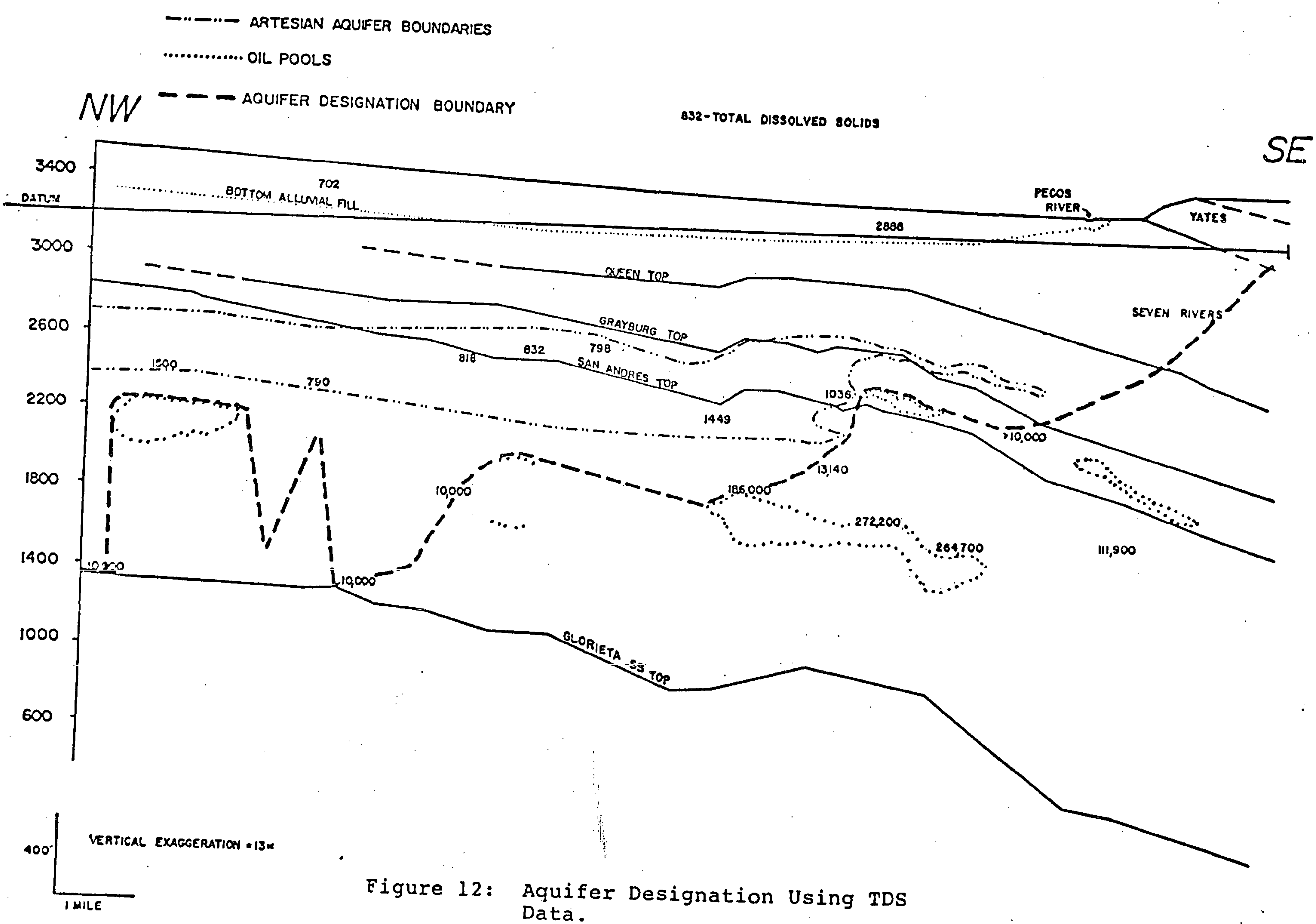


Figure 12: Aquifer Designation Using TDS Data.

Source. M. Holland, 19

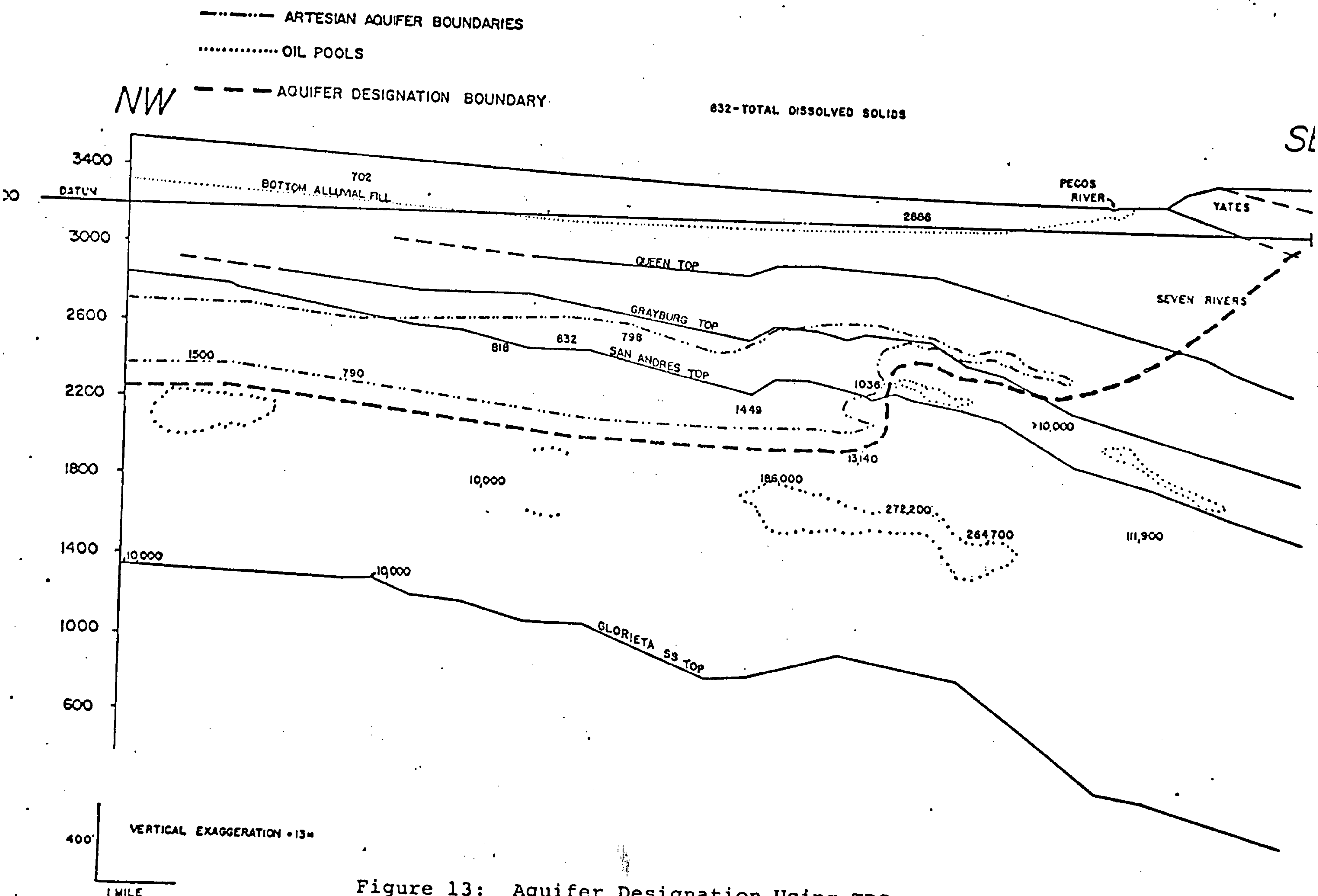


Figure 13: Aquifer Designation Using TDS and Porosity Data
Source: M. Holland, 19

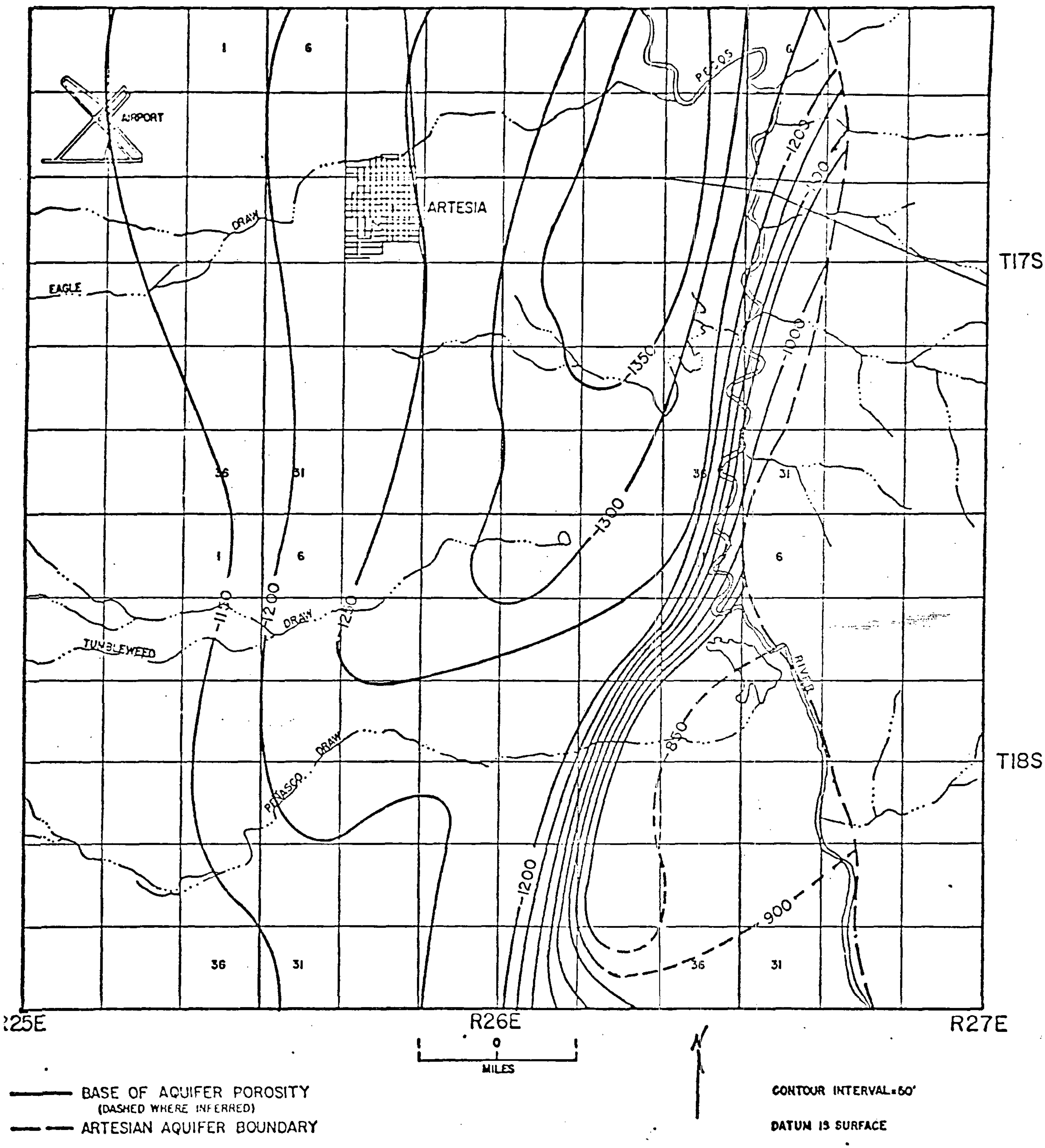


Figure 14: Base of Artesian Aquifer.

Source: M. Holland, 1979.

Table 1. Geohydrologic Data.

Formation	Average Permeability (millidarcies)	Average Porosity %	Transmissibility gpd/ft	Storage Coefficient	Coefficient of Leakage (feet)
Alluvium			100,000	0.10	20,000
Yates	11.27c	10.21c			
Seven Rivers	2.47c	10.65c			
Queen	1.98c	9.21c	60,000k		
Grayburg	1.73	9.86			
Artesian Aquifer			150,000	.00005	25,000
Upper San Andres	up to 2.0	6.0	100,000k		
Slaughter	up to 12.0	4.83			
Glorieta	0.28	21.0			
Yeso	2.02	1.29			

The values for porosity and permeability were calculated from data in USGS files, except for those marked with a "c" which are county-wide averages taken from Hiss (1975). The other values are taken from Hantush (1955); the value marked with a "k" was taken from Kinney et.al. (1968).

Table 2. Water Wells Data.

Abbreviations used: Irr-Irrigation, Dom-Domestic, PS-Public Supply, Ind-Industrial, S-Stock, Qal-Valley fill, Pya-Yates Fm, Psr-Seven Rivers Fm., Pq-Queen Fm, Pgb-Grayburg Fm, Psa-San Andres Fm, TDS-Total Dissolved Solids, C in TDS column indicates calculated value, Cl-Chlorides, SpC-Specific Conductance, CS in comments column indicates well used in cross section. All water rights numbers have the prefix RA.

Location Number	Owner	Surface Elevation (feet)	Well Depth	Aquifer	Water Production (feet)	Diam. Casing (inches)	Bottom Depth of Casing (feet)	Driller	Date Drilled	Water Level (feet)	Date Sample Meas.	Yield (gpm)	SpC (mmho)	Cl (mg/l)	TDS (mg/l)	Use	Water Rights Number	Comments
[illegible]	Fred Savoie	3,493	1,238	Psa	-	8	-	-	-	156.6	1-61	-	-	-	-	Irr	-	
[illegible]	Haines	3,495	166	Qal	-	-	-	-	-	-	-70	-	-	131	1,210C	-	-	CS
[illegible]	J.W. Collins	3,464	-	Qal	-	-	-	-	-	-	4-55	-	1,280	33	971C	Irr	-	
[illegible]	Artesia Country Club	3,455	225	Qal	-	12	-	-	-	159	1-74	-	1,275	40	893C	Irr	-	
[illegible]	-	3,503	-	Qal-Psr	-	6	-	-	-	145.9	8-48	-	-	-	-	Com	-	
[illegible]	Artesia Country Club	3,505	-	Qal	-	-	-	-	-	-	7-40	-	946	18	904	Irr	-	
[illegible]	-	3,496	-	Psa	-	-	-	-	-	-	-	-	-	18	1,020C	-	-	
[illegible]	-	3,479	-	Psa-Pgb	-	-	-	-	-	1133.2	5-60	-	2,970	30	1,560C	-	-	
[illegible]	N.T. Gissler	3,530	-	Qal	-	-	-	-	-	-	5-49	-	869	32	628	-	-	
[illegible]	J. Park	3,442	1,148	Psa	-	-	-	-	-	136.3	1-64	-	1,129	14	790C	PS	-	CS
[illegible]	N.T. Gissler	3,464	-	Qal	-	-	-	-	-	-	2-68	-	1,018	17	713C	-	-	
[illegible]	-	3,482	121	Qal	-	-	-	-	-	-	2-39	-		29	702	-	-	CS
[illegible]	J.M. Jackson	3,465	-	Pgb	-	-	-	-	-	162.5	1-63	-	-	-	-	Dom	-	
[illegible]	Fred Savoie	3,324	83	Qal	-	8	-	-	-	15.2	1-53	-	-	-	-	Irr	-	
[illegible]	State of New Mexico	3,357	23	Qal	-	-	-	-	-	18.0	1-58	-	2,540	133	2,060	Dom	-	
[illegible]	[illegible]	3,365	330	Qal-Pq	-	12.5	-	-	-	38.7	1-59	-	1,200	34	840C	Irr		
[illegible]	T.J. Sivley	3,398	300	Qal-Pq	95-175 260-271	14	302	F. Osbourn	5-68	80	5-68	-	-	-	-	Irr	5,416	
7.26.5.330	W.M. Simmons	3,403	188	Qal	88-133 147-155	12.25	190	C.N. Gray	2-55	35	12-55	-	-	-	-	-	1,513	
7.26.6.1131	David Garret	3,449	241	Qal	180-186 227-238	7	241	Bristow	5-78	160	5-78	-	-	-	-	Dom	6,300	
[illegible]	Jack Garret	3,452	210	Qal	160-185	7	210	F. Osbourn	8-77	155	8-77	-	-	-	-	Dom	6,167	
[illegible]	J.W. Collins	3,427	156	Qal	-	7	-	W.C. Gray	12-52	78.4	1-52	-	1,250	36	875C	Irr	2,991	
[illegible]	Harvey Yates Co.	3,428	252	Qal	55-80 120-130 215-246	12.25	252	Yates Pet.	2-77	-	-	-	-	-	-	Irr	1,604	
7.26.7.333	-	3,430	-	Qal	-	-	-	-	-	-	2-39	-	1,220	53	954	-	-	
7.26.7.433	J.B. Champion	3,411	160	Qal	-	8	30	J. Hammond	8-68	115	8-68	-	-	-	-	Irr	2,178	
7.26.9.244	Continental Oil Co.	3,364	1,123	Psa	-	12.5, 8.625	850	F. Osbourn	6-66	135	6-66	-	-	-	-	Ind	1,097	
[illegible]	City of Artesia	3,371	1,158	Psa	860-870 1015-1020 1140-1150	13.375 10.75	662	City of Artesia	5-46	-	-74	-	1,208	13	842C	PS	2,231	5th St. Well
[illegible]	City of Artesia	3,367	1,223	Psa	365-388 980-993 1020-1076	13.375 10.75	658	Pearson Bros.	7-46	-	-74	-	1,151	17	930	PS	2,397	Chisom St. W
7.26.10.110	Meady	3,336	218	Qal	25-35 96-134	7	139	A.F. Smith	12-63	65	12-63	-	-	-	-	Dom	4,922	
7.26.10.333	V.L. Gates	3,348	278	Qal	-278	13.375 10.75	278	Pearson Bros.	1-39	11.6	3-59	1,000	2,980	135	2,500	-	1,341	
7.26.10.333a	V.L. Gates	3,348	294	Qal	280-920	12.5	294	W. Beaty	5-60	15.8	1-50	-	-	-	-	Dom Irr	4,196	
[illegible]	V.L. Gates	3,348	1,262	Psa	1080-1106	12.5, 10	930	Pearson Bros.	6-26	-	3-59	-	2,740	325	1,744C	-	307	plugged to 11
[illegible]	Elizabeth Sullivan	3,341	1,007	Psa-Pgb	-	-	-	-	-	-	8-64	-	1,355	37	948.5	Irr	-	
[illegible]	Mrs. [illegible] Sullivan	3,342	1,095	Psa	607-1095	13.375, 8	1,095	Pearson Bros.	2-54	-	7-73	850	1,366	145	956C	-	397	
[illegible]	D.C. Sullivan	3,340	210	Qal	-	13	-	-	-	44.2	1-66	-	2,020	142	1,322C	Irr	-	
7.26.11.333	-	3,325	1,133	Psa	-	-	-	-	-	-	7-40	-	5,510	1,060	3,950	-	-	
7.26.11.333a	William T. Halderman	3,325	955	Pgb	752-841 908-955	13.375 10.75	705	M. Brunig	2-46	-	7-63	-	2,402	310	1,595C	-	763	
7.26.11.433	Blaine Haines	3,313	1,034	Pgb	643-1034	13, 6.625	760	R. Johnson	4-47	-	1-59	1,000	420	80	1,100C	Irr	777	
[illegible]	Blaine Haines	3,314	1,040	Pgb	864-931 975-1008	-	-	-	-	-	-74	-	1,459	64	1,060C	-	-	
7.26.12.244	George H. Settlemire	3,301	175	Qal	140-160	7	167	R. Monk	7-61	130	7-61	-	-	-	-	Dom	4,436	
7.26.13.310	E.P. Bach	3,300	100	Qal	-	-	-	-	-	-	6-54	-	1,070	17	749C	Irr	-	
7.26.14.133	-	3,325	961	Pgb	-	-	-	-	-	-	3-59	-	1,120	15	854	-	-	
7.26.14.211	G.E. Sharp	3,314	241	Qal	213-241	8, 7, 5	241	D.N. Gray	8-51	213	8-51	-	4,330	815	3,110	-	2,749	
7.26.14.2112	G.E. Sharp	3,313	1,013	Pgb	806-879	10.75 8.75	990	M. Brunig	4-52	06.2	1-74	600	-	171	1,277C	Irr	695	

Table 2 (continued).

Location Number	Owner	Surface Elevation (feet)	Well Depth	Aquifer	Water Production (feet)	Diam. Casing (inches)	Bottom Depth of Casing (feet)	Driller	Date Drilled	Water Level (feet)	Date Sample Meas.	Yield (gpm)	SpC (mmho)	Cl (mg/l)	TDS (mg/l)	Use	Water Rights Number	Comments
17.26.15.111	Charles Allison	3,340	240	Qal	194-240	10, 8	240	Gray Bros.	1-36	-	5-75	600	-	145	1,234C	-	1,227	
17.26.15.133	Jackson/Mason	3,350	240	Qal	180-240	14	220	Black	10-44	-	7-73	900	-	215	1,290C	-	1,503F	
17.26.15.133a	Jackson/Rowley	3,350	1,231	Psa-Pgb	586-1231	13.375 8.375	1,025	Schrock	4-55	42	4-55	800	-	400	1,659C	-	2,050	
17.26.15.211	J.M. Vogel	3,340	225	Qal	155-225	10	220	Gray Bros.	8-34	29.7	3-75	970	-	190	1,309C	Irr	1,163	
17.26.15.233	-	3,342	1,253	Psa	-	-	-	-	-	-	7-40	-	8,200	1,860	5,803	-	-	
17.26.15.313	G.E. Sharp	3,353	-	Qal	-	-	-	-	-	-	2-39	-	969	13	736	-	-	
17.26.15.411	W.M. Jackson	3,344	200	Qal	-	16	-	-	-	40.1	1-65	-	2,040	80	1,640	-	Irr	
17.26.15.413	W.M. Jackson	3,342	850	Pgb	653-850	14	-	-	-	60.2	1-65	-	-	-	-	-	1,578	
17.26.17.12111	City of Artesia	3,388	1,050	Psa	852-919 943-1050	15.5 12.5	849	M. Brunig	1-43	-	-74	-	1,142	14	799C	PS	621	Standpipe
17.26.19.32131	City of Artesia	3,428	1,107	Psa	933-1068	13.375 10.75	825	E. Shrock	3-63	-	-74	-	1,523	60	1,078C	PS	821-S	
17.26.21.311	Dean and Taylor	3,377	821	Pgb	-	9,6	704	S. Butler	1-06	-	7-40	1,494	981	14	770	-	-	
17.26.22.233	R.L. Paris	3,345	135	Qal	112-135	8,7	135	D.N. Gray	12-49	-	6-39	-	1,940	47	1,650	-	2,552	
17.26.22.240	H.L. Greer	3,328	103	Qal	-	-	-	-	-	-	11-54	-	2,510	70	1,433C	-	-	
17.26.23.120	E.P. Bach	3,318	925	Pgb	786-925	13.375, 8	886	M. Brunig	4-46	-	6-54	-	1,710	124	1,198C	Irr	386	
17.26.23.130	G. Duncan	3,325	115	Qal	-	-	-	-	-	-	11-54	-	2,820	84	1,553C	-	-	
17.26.23.3111	Jim W. Berry	3,326	893	Pgb	755-762 805-893	10, 8	886	Pearson Bros.	6-35	-	3-66	-	1,190	18	833C	-	1,252	
17.26.26.211	L.R. Sperry	3,312	941	Pgb	-	14	-	-	-	29.5	1-66	-	1,100	24	864	Irr	1,199	
17.26.26.331	-	3,321	892	Pgb	-	-	-	-	-	-	-	-	1,120	24	866	-	1,199-S17	
17.26.26.3311	G. Farmer	3,322	958	Pgb	820-880	12.5, 8	-	-	-	-	-74	-	1,332	17	976C	-	-	
17.26.29.111	Don Menefee	3,400	1,150	Pgb-Psa	700-1150	12.5, 8	860	Pearson Bros.	5-52	-	-	1,000	-	50	1,060C	Irr	1,925-S	CS
17.26.29.113	-	3,406	145	Qal	-	-	-	-	-	-	7-40	-	1,140	30	920	-	-	
17.26.29.131	C.E. Martin	3,407	201	Qal	8-23 132-198	20	-	Black Bros.	3-37	49.0	1-50	-	-	-	-	Irr	1,430	CS
17.26.30.211	Don Menefee	3,423	200	Qal	152-167	16	200	Young and Montgomery	4-64	40	4-64	250	-	-	-	-	1,826	
17.26.32.1111	Zeleny	3,405	793	Pgb	-	-	-	-	-	-	-69	-	1,202	17	841C	-	-	CS
17.26.32.1211	Floyd Sherrill	3,405	861	Pgb	-	11.625, 8	758	Dayton Deep Well Co.	1-10	-	-74	1,667.2	1,169	18	818C	Irr	1,167	CS
17.26.33.1111	Adolph Zeleny	3,381	793	Pgb	714-730	8	707	Butler	6-10	-	-74	623	1,241	23	832	-	775	CS
17.26.33.343	J.B. Snider	3,369	766	Pgb	730-745	8	729	Sperry & Lukas	2-11	-	3-59	1,539	1,140	31	798C	-	-	
17.26.33.343a	Bradshaw	3,369	800	Pgb	-	-	-	-	-	-	-74	-	1,287	21	964C	-	-	CS
17.27.7.230	-	3,310	275	Psr	-	-	-	-	-	-	11-54	-	13,300	3,430	8,014C	-	-	
17.27.16.344	Moore & Stout	3,435	1,042	Psr-Pq	370-380 630-640 1034-1042	5.5	934	W. Beaty	1-60	260	-74	-	1,424	38	1,026C	Dom	4,114	
17.27.19.100	-	3,299	50	Qal	-	-	-	-	-	-	10-39	-	12,000	2,910	8,590	-	-	
.25.1.113	Pedro Lopez	3,466	200	Qal	155-165 175-195	7	200	W. Beaty	9-54	160	9-54	-	-	-	-	-	3,310	
.25.1.13113	Pedro Lopez	3,463	325	Pq	187-280	7	280	Tidwell	9-54	180	9-54	12	-	-	-	Dom	6,077	CS
.25.3.111	E.R. Powell	3,535	223	Qal	184-223	6.625, 5	223	D.N. Gray	5-57	184	5-57	-	-	-	-	Dom	3,772	
.25.10.310	E.R. Powell	3,526	300	Pgb	275-295	7, 5.5	300	D.N. Gray	8-59	168	8-59	-	-	-	-	Dom	4,068	
.25.22.111	Four Dinkas Ranch	3,537	-	Psa	-	-	-	-	-	-	3-66	-	1,430	12	1,001C	-	-	
.25.23.111	Four Dinkas Ranch	3,503	-	Psa	-	-	-	-	-	-	3-64	-	1,140	10	798C	-	-	
.25.23.111a	G.W. Phelps	3,503	-	Qal	-	-	-	-	-	117.8	1-50	-	-	-	-	S	-	
.25.23.210	Paul Haines	3,478	700	Pgb	-	-	-	Classen & Alford	5-05	-	-	960	-	-	-	-	-	
.25.24.100	G.W. Chisholm	3,463	588	Pgb	-	8.25,6.25	522	G.W. Chisholm	3-06	-	-	644	-	-	-	-	-	
.25.24.4234	David Fasken	3,344	204	Qal	155-203	7	205	F. Osbourn	12-70	158	12-70	-	-	-	-	-	5,620	
.25.26.440	Resler and Sheldon	3,480	1,400	Psa	860-980	7, 4.5	1,400	Waters Drlg.	6-57	-	-	-	-	-	-	-	-	
.25.36.310	Mark B. Kincaid	3,504	142	Qal	58-81	6.625	81	A. Beaty	11-62	81	11-62	-	-	-	-	Dom	4,722	
.25.36.313	Lee Drlg. Co.	3,509	430	Pgb	380-430	7	380	A.F. Smith	12-58	270	12-58	-	-	-	-	-	3,975	
.26.2.111	J.W. and W. C. Bradshaw	3,315	955	Pgb	770-792 837-887	3.375, 10.75	898	M. Bruning	1-50	29.8	1-65	-	1,310	17	917C	Irr	772-S	
.26.2.333	S.O. Higgens	3,320	202	Qal	62-165	10	165	Gray Bros.	11-35	34.0	1-75	-	-	-	-	Irr	1,288	CS
.26.8.233	W.S. Miller	3,408	822	Pgb	666-224	8	704	S.A. Butler	7-07	-	3-59	-	1,330	18	931C	-	-	

Table 2 (continued).

Location Number	Owner	Surface Elevation (feet)	Well Depth	Aquifer	Water Production (feet)	Diam. Casing (inches)	Bottom Depth of Casing (feet)	Driller	Date Drilled	Water Level (feet)	Date Sample Meas.	Yield (gpm)	SpC (mmho)	Cl (mg/l)	TDS (mg/l)	Use	Water Rights Number	Comments
26.9.2333	L.F. Chumbley	3,397	974	Pgb-Psa	903-974	13.375	766	Shrock	8-59	86.9	1-70	-	1,259	9	830C	Irr	1,895	CS
26.9.444	Frank Waters & William Hudson	3,351	1,727	Psa	-	8.625, 5.5	1,727	Waters	6-56	-	-59	-	-	108,000	186,000	Oil	-	
26.10.133	-	3,350	1,100	Psa	-	-	-	-	-09	-	-	1,500	-	27	1,499C	-	1,029	CS
26.10.331	-	3,348	716	Pgb	-	-	-	-	-	-	9-58	-	1,840	23	1,159C	-	-	CS
26.10.331a	Borden Aaron & L.H. Johnson	3,348	863	Pgb	653-722 797-844	13.375	649	R. Johnson	5-48	-	-73	-	2,172	102	1,341C	Irr	137	
26.11.431	Brainard Bros.	3,314	700	Pgb	27-58 545-563 657-690	10	520	D. Suiken	8-44	-	-	1,050	-	-	-	-	277	
26.13.111	Donald Fanning	3,299	150	Qal	40-60 95-107	16, 14	150	A.F. Smith	1-59	16	1-59	-	-	-	-	Irr	1,587-H	CS
26.14.232	Jones and MacArthur	3,307	955	Pgb-Psa	-	8.625	785	Mahres	7-56	2.7	1-75	-	1,487	24	1,036C	Irr	-	CS
26.14.443	Donald Fanning	3,310	170	Qal	45-94	16, 14	170	D.N. Gray	9-54	28	9-54	-	5,160	700	2,886C	Irr	1,524-B	
26.15.4211	J.H. Everst	3,331	760	Pgb	624-635	10	640	M. Brunig	2-38	16.4	1-63	-	1,590	24	1,073C	Irr	950	CS
26.17.322	T. Vandiver	3,400	240	Qal	90-240	16	230	A.F. Smith	7-60	70	7-60	-	-	56	1,396C	Irr	3,101+58	
.17.3333	Tom Vandiver	3,418	-	Psa	-	-	-	-	-	-	3-66	-	1,185	18	830C	-	-	
.18.212	Tom Vandiver	3,416	228	Qal	-	-	-	-	-	-	3-66	-	1,210	60	847C	-	-	
.18.221	T. Vandiver	3,404	258	Qal	50-60 240-253	16	257	A.F. Smith	3-59	115	3-59	1,000	-	19	1,023C	Irr	1,381-55	
.18.323	William McCrary	3,429	235	Qal	80-85	14	235	W.C. Gray	-37	56.8	1-50	-	-	-	-	Irr	-	
.18.332	T. Vandiver	3,428	1,167	Psa	-	-	-	-	-	-	-	1,200	-	14	1,206C	-	1,496	
.18.3324	F.F. Thorpe	3,429	1,061	Psa-Pgb	600-1055	13.375	575	Shrock	3-62	-	-74	1,100	1,404	10	956C	Irr	747	
.19.411	T. Vandiver	3,414	315	Qal	220-240	12	240	A.F. Smith	4-57	115	4-57	1,000	-	46	1,237C	Irr	1,381-56	
.20.441	Great Western Drilling	3,425	158	Qal	125-158	-	-	Abbott	8-60	125	8-60	-	-	-	-	Dom	4,283	
.21.2233	Joe Lee	3,355	1,099	Pgb-Psa	805-1049	13.375, 10.625	522	Shrock	5-55	61.7	1-66	-	2,967	248	1,741C	-	888	
.22.323	Velma Lee Round	3,352	106	Qal	75-103	6	106	W. Beaty	8-57	40	8-57	-	-	-	-	Dom	3,771	
.24.131	Angelino Mackey	3,305	80	Qal	-	12.5	-	-	-	46.2	1-66	-	-	-	-	Irr	-	CS
.25.444	-	3,285	-	Pgb-Psa	-	-	-	-	-	-	-	-	4,250	290	2,190	-	-	
.27.344	-	3,360	1,405	Psa	-	-	-	-	-	-	-74	-	2,097	12	1,240C	-	-	
.29.141	Noble Drilling Co.	3,478	160	Qal	130-155	7	160	W. Beaty	2-60	100	2-60	-	-	-	-	Dom	4,160	
.30.200	Gardner Bros.	3,445	205	Qal	150-160 195-205	7	205	A.F. Smith	3-63	190	3-63	-	-	-	-	Dom	4,784	
.32.112	M.B. Kincaid	3,419	152	Qal	120-145	6.625	152	W. Beaty	12-59	90	12-59	-	-	-	-	Dom	4,136	
.34.3132	E.G. Minton	3,356	871	Pgb	673-810	13, 10	642	Pearson Bros.	8-51	59.7	1-75	-	1,260	15	882C	Irr	1,703	
.5.442	-	3,492	381	Psr	325-350	-	-	-	-	-	-	-	-	-	-	-	-	
.9.140	Humble Oil & Refining	3,545	-	Pya	160-170	-	-	-	-	-	11-56	-	-	278	3,810	Ind	-	
.9.334	Humble Oil & Refining	3,512	-	Pya	210-215	-	-	-	-	-	11-56	-	-	384	4,510	Ind	-	
.20.140	-	3,375	399	Psr	38-40 147-155	-	-	-	-	-	-	-	-	-	-	-	-	CS
.21.333	Moorhead Federal	3,372	1,622	Pgb-Psa	1190-1270	-	-	-	-	-	-	-	-	-	-	-	-	
.33.420	Yates Petroleum	3,392	-	Pgb-Psa	1258-1388 2940-2950	-	-	-	-	-	-	-	-	-	-	-	-	

[illegible]

[illegible]: SWD-Salt water disposal, Inj-Injection, QW-Water quality, TDS-Total dissolved solids, Cl-Chlorides, SpC-Specific Conductance, [illegible] in TDS column indicates calculation from chlorides, CS-cross section, Pyo-Yates Fm., Pq-Queen Fm, Pgb-Grayburg Fm., Psa-San Andres Fm., [illegible] Fm. NOTE: Casing Depth indicates depth of casing string protecting fresh water. Most depths of formations interpreted by owners and [illegible] in well records, thus some discrepancy exists.

Location	Owner	Well Name	Well Elevation	Well Type	Total Depth	Casing Depth	Depth to top of Grayburg	Depth to top of San Andres	Depth to top of Glorieta	Depth to base of Upper Porosity zone	Production or Injection Interval	QW of Source	Depth	Cl (mg/l)	TDS (mg/l)	Depth to base of fresh Water	Comments
[illegible]	Yates Pet. Co.	Artesia Airport #2	3,526	Dry	8,080	1,136	455	690	1,975	1,150	-	Psa	1,870	5,500	10,000C	1,870	
[illegible]	Yates Pet. Co.	Federal CB #1	3,528	Oil	1,492	1,410	-	701	-	-	1,302	-	-	-	-	-	
[illegible]	Yates Pet. Co.	J Lazy J #3	3,526	Oil	1,470	1,133	345?	719	-	-	1,300-1,439	-	-	-	-	-	
[illegible]	Yates Pet. Co.	Federal PO #4	3,534	Oil	1,537	1,134	-	728	-	-	1,289-1,518	-	-	-	-	-	CS
[illegible]	Yates Pet. Co.	J Lazy J #2	3,527	Oil	1,522	1,155	618	722	-	-	1,340-96007	-	-	-	-	-	Water intervals 205-2
[illegible]	Yates Pet. Co.	Gissler AV #2	3,482	SWD	1,980	1,260	-	707	-	-	1,260-1,410	-	-	-	-	-	
[illegible]	Yates Pet. Co.	Gissler AV #10	3,530	Oil	1,501	1,158	-	732	-	-	1,326-1,440	-	-	-	-	-	
[illegible]	Yates Pet. Co.	Mitchell IN #2	3,480	Gas	9,500	1,262	-	-	-	1,440	-	Psa	1,870	5,500	10,000C	1,870	
[illegible]	Western Oil Co.	Flint #1	3,458	Gas	8,518	1,182	-	803	-	1,170	-	Psa	1,280	2,100	4,500C	1,360	
[illegible]	Western Oil Co.	Flint #2	3,442	Gas	10,243	1,261	-	-	2,180	-	-	Psa	-	-	-	2,150	
[illegible]	Yates Pet. Co.	Powell CG #1	3,491	Gas	8,740	1,238	-	778	2,160	1,260	-	Psa	-	-	-	2,150	
[illegible]	Yates Pet. Co.	Arco E.C. State #2	3,446	Gas	8,594	1,263	615	820	-	1,180	-	Psa	1,310	3,900C	7,500C	1,320	
[illegible]	Yates Pet Co.	Hunter FL #1	3,345	Gas	8,589	1,374	-	964	2,225	1,310	-	Psa	1,800	24,000C	41,000C	1,800	
[illegible]	Yates Pet. Co.	Caffall FD #1	3,336	Gas	8,662	1,404	750	948	2,357	1,420	-	Psa	-	-	-	1,420	
[illegible]	Yates Pet. Co.	Siegenthaller IC #1	3,364	Gas	8,627	1,420	730	910	2,350	-	-	Psa	-	-	-	1,500	
[illegible]	Yates Pet. Co.	Tom Brown Com.	3,337	Gas	8,725	1,402	770	970	2,323	1,370		-	-	-	-	-	
[illegible]	Morris R. Antwell	KD #1	3,315	Gas	8,918	1,500	800	1,230	-	1,365	-	Psa	1,540	18,000C	31,000C	-	
[illegible]	Yates Pet. Co.	Houlik EJ #1 Com.	3,315	Gas	8,841	1,420	-	1,025	2,426	1,338	-	Psa	1,530	1,200C	2,900C	1,539	
[illegible]	Texas Pac. Oil Co.	J.H. Ansley #1	3,320	Gas	8,806	1,500	-	1,012	2,510	1,350	-	-	-	-	-	1,570	
[illegible]	Yates Pet. Co.	Neller EG Com.	3,432	Gas	8,475	1,300	650	815	2,210	-	-	-	-	-	-	-	CS
[illegible]	Yates Pet. Co.	Caskey EV Com. #1	3,428	Gas	8,570	1,282	-	848	2,239	-	8,015-8,166	-	-	-	-	-	
[illegible]	Yates Pet. Co.	Halderman EN Com. #1	3,434	Gas	8,595	1,280	-	840	2,223	1,193	8,387-8,412	Psa	1,640	2,400C	5,000C	1,955	
[illegible]	Yates Pet. Co.	Patterson El #1	3,442	Gas	8,640	1,269	622	826	2,220	-	8,002-80307	Psa	-	-	-	1,630	
[illegible]	Floyd E. Sherrell	Floyd Sherrell #1	3,389	Oil	1,790	1,285	-	895	-	-	1,416-1,754	-	-	-	-	-	CS
[illegible]	David Faskin	Marjorie Naylor #1	3,283	Dry	9,095	1,402	-	1,075	2,450	1,330	-	Psa	1,592	41,000	69,000C	-	
[illegible]	Mesa Retailers	Martin Fee #1	3,297	Dry	2,478	1,409	930	1,138	-	-	-	Psa	-	-	-	4,409	top Queen 492
[illegible]	Coquina Oil Co.	Superior Federal #1	3,442	Gas	8,625	1,306	-	803	2,128	1,148	-	Psa	1,360	9,000	16,000	-	
[illegible]	Coquina Oil Co.	Superior Johnson Com.	3,487	Gas	8,650	1,300	-	-	2,100	-	-	-	-	-	-	2,150	
[illegible]	Amoco Prod. Co.	Johnson #1	3,498	Gas	8,720	1,200	549	790	-	-	-	-	-	-	-	2,130	
[illegible]	Yates Pet. Co.	Scout Federal EH #2	3,502	Gas	9,090	1,205	-	742	2,082	-	-	-	-	-	-	2,050	
[illegible]	David Fasken	Higgins Cahoon #1	3,288	Gas	9,074	1,908	-	1,025	2,385	1,302	-	-	-	-	-	1,950	
[illegible]	David Fasken	Mary Brainard Com. #1	3,332	Gas	8,929	1,287	-	993	-	-	-	Psa	1,300	7,500C	13,500C	-	CS - QW Doubtful
[illegible]	William Ross	Rogers Com. F#1	3,322	Gas	9,045	1,937	-	-	-	-	-	-	-	-	-	-	
[illegible]		Armstrong S #1	3,393	Gas	8,853	1,318	-	900	-	-	-	Psa	1,410	3,000C	6,000C	1,415	
[illegible]	Yates Pet. Co.	6 Federal #2	3,415	Gas	8,730	1,247	625	814	2,246	-	-	-	-	-	-	1,700	top Queen 440
[illegible]	Yates Pet. Co.	Ferguson DY #1	3,408	Gas	8,901	1,313	613	922	-	1,252	-	Psa	1,335	12,000C	21,000C	-	QW doubtful
[illegible]	Yates Pet. Co.	Vandiver DO #1	3,423	Gas	8,906	1,305	578	887	-	-	-	Psa	1,345	7,000C	12,000C	-	QW doubtful
[illegible]	Reading and Bates	Torrington #1	3,406	Dry	8,970	1,300	-	918	2,380	-	-	-	-	-	-	1,850	
[illegible]	Texas Pac. Oil Co.	Kissinger Com. #1	3,335	Gas	9,045	1,219	-	998	2,490	-	-	-	-	-	-	1,809	Water production to 87
[illegible]	Gulf Oil Co.	(Stroup 4) #102	3,326	Inj	1,742	1,239	-	976	-	-	1,672-82	-	-	-	-	-	
[illegible]	Collier & Collier	Kissinger #1	3,331	Oil	1,654	1,032	760	1,005	-	-	1,546-88	-	-	-	-	-	CS, top Queen 415
[illegible]	Gulf Oil Co.	(Eva Holland) #118	3,349	Oil	1,850	1,844	703	961	-	-	1,513-1,748	-	-	-	-	-	CS, water: 1107-1130
[illegible]	Gulf Oil Co.	(Ralph Rogers) #116	3,337	Oil	1,724	1,719	-	964	-	-	1,651-1,668	-	-	-	-	-	
[illegible]	David Fasken	Rogers 10 #1	3,328	Gas	9,207	1,802	663	962	-	1,218	-	Psa	1,893	13,000C	23,000C	-	
[illegible]	Gulf Oil Co.	#101	3,305	Inj	1,783	1,218	-	996	-	-	1,696-1,706	-	-	-	-	-	CS
[illegible]	Mobil Oil Co.	Brainard Gas Com. #2	3,307	Gas	9,000	1,497	713	1,008	2,333	1,220	8,853-8,888	-	4,550	17,500	30,207C	-	
26.11.32-0	Gulf Oil Co.	(Standard Johnson) #114	3,326	Oil	1,714	1,186	-	968	-	-	1,646-1,678	-	-	-	-	-	
26.11.3343	Gulf Oil Co.	(Standard Aaron) #120	3,330	Oil	1,696	1,178	-	956	-	-	1,636-68	-	-	-	-	-	top Slaughter 1638
26.11.413	Gulf Oil Co.	(Magnolia-Fanning) #113	3,316	Inj	1,797	1,225	720	1,020	-	1,220	1,654-1,672	Psa	1,700	140,000	234,700C	-	CS
26.11.433	Mobil Oil Co.	Reed-Brainard #1	3,315	Oil	1,736	802	700	1,010	-	-	-	Psa	1,700	155,800	264,700C	-	Cored:1630-1803, Psa av poros. 5.31%, avg. per
26.11.440	Mobil Oil Co.	Reed-Brainard #2	3,308	Oil	1,749	840	743	990	-		-	-	-	-	-	-	Cored: 967-966, Pgo av poros. 17.2% Avg. perm. .1 md.
26.11.441	Mobil Oil Co.	Brainard Gas Com. #1	3,320	Gas	9,181	1,256	-	1,045	2,366	-	9,046-9,102	-	-	-	-	-	
26.12.133	Mobil Oil Co.	Fred Brainard #1	3,303	Oil	1,742	1,210	745	993	-	-	-	Psa	1,742	160,100	272,200	-	
26.12.3314	Mobil Oil Co.	D.E. Fanning #3	3,301	Oil	1,800	-	-	1,052	-	-	-	Psa	1,700	160,000	268,000C	-	
26.12.423	Yates Pet. Co.	Gates Whatley Fed.#1	3,286	Oil	1,748	908	-	1,007	-	-	-	Psa	1,680	39,290	66,500C	-	
26.13.111	Maddox Energy Co.	Higgins Trust #1	3,287	Gas	9,342	950	-	1,042	2,424	-	-	-	-	-	-	-	Water zones: 225-430, 500, 540-810, top Queen

Location	Owner	Well Name	Well Elevation	Well Type	Total Depth	Casing Depth	Depth to top of Grayburg	Depth to top of San Andres	Depth to top of Glorieta	Depth to base of Upper Porosity zone	Production or Injection Interval	QW of Source	Depth	CL (mg/l)	TDS (mg/l)	Depth to base of fresh water	Comments
16.13.124	Gulf Oil Co.	(Nat. Leavitt 11) #100C	2,995	Inj	982	960	972	-	-	-	972-82	-	-	-	-	-	CS, Cored: 977-86, Pg avg. poros. 15.42%, av .40 md.
16.13.132	Gulf Oil Co.	(Nat. Leavitt 9) #138	3,300	Inj	1,770	1,770	970	-	-	-	1,712-22	-	-	-	-	-	Cored: 1645-95, Psa a poros. 4.08%, avg. per md.
16.13.114	Gulf Oil Co.	(Nat. Leavitt 2) #101	3,298	Oil	978	960	967	-	-	-	-	-	-	-	-	-	Water: 710-30
16.13.132	Gulf Oil Co.	(J. Mac Leavitt 3) #103	3,300	Inj	975	955	-	-	-	-	969-75	-	-	-	-	-	
16.13.2523	Maddox Energy Co.	Leavitt Com. #1	3,295	Gas	9,355	1,952	-	-	2,441	-	9,031-93	-	-	-	-	-	Water: 225-526,636-75, 718-76
16.13.312	Gulf Oil Co.	(Illamex Fanning 2)#143	3,304	Oil	1,772	1,100	695	993	-	-	1,762-68	-	-	-	-	-	Top Queen 320, top Slau 1,765
16.13.321	Gulf Oil Co.	(Nat. Fanning 1) #142	3,297	Oil	1,826	1,103	-	1,032	-	-	1,783-93	-	-	-	-	-	Top Slaughter 1783
16.13.411	Gulf Oil Co.	(Fanning A-2) #141	3,295	Inj	1,953	1,096	833	1,068	-	-	1,681-833	-	-	-	-	-	CS
16.13.431	Gulf Oil Co.	(Kewanee 2) #153	3,290	Oil	2,020	2,015	908	1,134	-	-	1,758-914	-	-	-	-	-	Top Queen 406
16.14.131	Kewanee Oil Co.	Atcka Grayburg Unit #1	3,314	Oil	955	785	-	-	-	-	1,670-80	-	-	-	-	-	Top Slaughter 1,670
16.14.213	Dean A. Wolf	Jerry Nelson Com. #1	3,314	Gas	9,150	1,120	-	-	2,310	-	960-65	-	-	-	-	-	
16.14.214	Gulf Oil Co.	(Illamex Terry) #131	3,305	Inj	1,700	1,100	-	-	-	-	1,650-64	-	-	-	-	-	
16.14.222	Gulf Oil Co.	(Illamex 4) #130	3,300	Inj	1,742	1,100	950	-	-	-	785-955	-	-	-	-	-	Open hole, no water bel
16.14.224	Gulf Oil Co.	(Nat. Leavitt 10) #102	3,302	Inj	965	950	960	-	-	-	-	Psa	1,356	7,800	14,000C	-	
16.14.233	Llano Inc.	Terry Com. #1	3,312	Gas	9,303	1,170	-	-	2,327	-	-	-	-	-	-	1,660	
16.15.4112	Std. Oil of Texas	C.R. Martin et. al. #1	-	Gas	9,086	-	-	-	-	-	-	-	-	-	-	-	
16.17.424	Yates Pet. Co.	Sears #1	3,385	Dry	1,678	1,219	-	990	-	Water: 1146-1208	-	Psa	-	215,000	360,000C	-	Water: 1,146-208
16.18.1310	Maddox Energy Co.	Jones D #4	3,285	Oil	1,965	855	-	-	-	-	1,710-873	-	-	-	-	-	Water: 765-855, CS
16.18.332	Yates Pet. Co.	Vandiver CN #1	3,427	Gas	8,900	1,212	-	848	2,201	-	-	-	-	-	-	2,190	
16.18.441	Fundamental Oil	Thorpe Sears #1	3,412	Gas	8,959	1,210	-	883	-	1,218	-	-	-	-	-	2,210	
16.19.141	Mtn. States Pet.	McCan Gas Com. #1	3,432	Gas	8,954	1,200	605	820	-	-	-	-	-	-	-	-	
16.21.220	Merit Oil Co.	Mildred Lee #1	3,358	Oil	1,685	1,125	695	920	-	-	-	Psa	1,576	137,000	228,900C	-	
16.26.341	Bassett & Birney	Kimmel #2	3,316	Oil	1,115	1,000	-	-	-	-	-	-	-	-	-	1,770	
16.27.341	Ralph Nix	Hondo Kelly #1	3,360	Gas	9,385	1,250	775	1,107	2,540	-	-	-	-	-	-	1,790	
16.34.113	Yates Pet. Co.	Wright J.A. #4	3,361	Oil	6,040	1,145	-	1,066	2,632	-	-	-	-	-	-	-	
16.34.134	Magnolia Oil Co.	G.F. Wright #1	3,367	Oil	4,199	1,295	-	1,047	2,612	-	-	Pya	2,994	175,000	293,000C	-	
17.6.3314	Hondo Oil & Gas	W. M. Stirling Jr. #1	3,359	Oil	1,775	-	908	1,155	-	-	-	Psa	1,700	134,500	228,000C	-	Cored: 1,680-716, Psa a poros. 5.12%, avg. perm.
17.7.221	Atlantic Refining	Vandagriff Federal C #3	3,999	Oil	1,826	1,205	-	1,205	-	-	-	Psa	1,760	119,800	206,000	-	
17.7.2132	Atlantic Refining	Vandagriff Federal A #2	3,388	Oil	1,824	1,200	-	1,150	-	-	-	-	-	120,000	207,300	-	
17.7.4223	Hondo Oil & Gas	Gant Federal #2	3,359	Oil	1,824	-	-	1,125	-	-	-	-	-	-	-	-	Cored:1,093-101, Pgb avg poros. 6.82%, avg. perm. md.
17.18.131	Gulf Oil Co.	Jones D #4	3,285	Oil	1,965	955	860	1,084	-	-	1 710-873	-	-	-	-	-	Water: 765-855
17.18.222	Norwood Oil Co.	Gulf Jackson	3,200	Oil	1,785	1,000	-	1,448	-	-	1,048-578	-	-	-	-	-	
17.19.343	British Amer. Oil	Pluma Unit #1	3,295	Dry	6,015	1,388	1,066	1,335	-	-	-	-	-	-	-	-	Top Queen 574
17.20.310	Parker Drilling	Kaiser #1	3,290	Oil	1,948	1,140	-	-	-	-	1,233-95	-	-	-	-	-	CS, water 570-750
17.20.3124	Yates Oil Co.	Rio Pecos CB #2	3,290	Gas	9,650	1,558	-	-	3,008	-	9,265-303	-	-	-	-	-	
17.27.130	ARCO	Trigg Federal #1	3425	Gas	9,935	2,500	=	1,875	3,580	-	9,781-95	-	-	-	-	-	Queen 1,065, CS
17.28.131	John H. Trigg	Federal B-#3	3,416	Oil	1,666	-	1,382	1,661	-	-	-	-	-	-	-	-	Cored: 1,595-666, avg p 8.94%. avg. perm. .15 md
17.28.222	Harlan Oil Co.	Federal B #2	3,405		1,625		1,368	-	-	-	1,578-91; 1,604-21	-	-	-	-	-	CS, top Queen 835, water: 1,150-300
17.28.3114	Yates Oil Co.	Gorman Federal JD #1	3,390		1,680	1,678	1,389	1,675	-	-	1,657-659	Pgb	1,673	66,970	111,900C	-	Top Queen 915, water:1,180-360
17.29.320	John Trigg	Federal Resler #1	3,405	Dry	1,778	plugged	1,476	1,771	-	-	-	-	-	-	-	-	Top Queen 994, water: 1,250-430
17.28.420	Yates Oil Co.	Federal CG #1	3,418	Dry	1,100	254	-	-	-	-	-	-	-	-	-	-	Top Queen 1,040
17.29.120	Yates Oil Co.	Rio Pecos BG Com. #1	3,305	Gas	9,768	1,448	1,190	1,455	3,079	-	9,336-57	-	-	-	-	-	Top Queen 700
17.29.222	Hondo Oil & Gas	Federal T #1			1,585	-	-	1,574	-	-	-	Pgb	1,570	160,000	268,000C	-	

Table 4. Lithologic descriptions of units identified in Figure 2.

1. Alluvial Fill - unconsolidated sands, silts, and gravels.

2. Yates Formation - gypsum with minor dolomite and siltstone.

3. Seven Rivers Formation - anhydrite with shale, dolomite, and sandstone.

4. Queen Formation - sandstones with some sandy dolomite

5. Grayburg Formation - porous sandstone and sandy dolomite.

6. San Andres Formation - limestone and dolomite, with a more sandy and porous upper portion. The lower portion, or Slaughter Zone, has several anhydrite horizons and irregular high porosity development; the area between the upper zone and Slaughter lacks good porosity development.

7. Glorieta Sandstone Member - sandstone and siltstone with calcareous cement.

8. Yeso Formation - dark gray shales with carbonate-cemented siltstones, limestones, and anhydrite.