POTENTIAL WATER SUPPLIES FROM DEEPER AQUIFERS

Although aquifers beneath the entire County were evaluated, only the areas exhibiting the greatest potential to have relatively high well yields were included in the ranked sites. Data collected from an exploratory well drilling and testing program should be evaluated to assess additional potential sites.

Specific township and range blocks were ranked based on their potential for exploratory wells in the Triassic-age Santa Rosa aquifer, and the Permian-age Capitan and San Andres aquifers. Figure 12 presents the highest-ranking locations for exploratory wells in the Santa Rosa, Capitan, and San Andres aquifers overlain on water level changes that occurred between 1981 and 1998. Thus, the best locations for exploratory wells can be compared and contrasted with the areas with the greatest water level declines. The outcome of the ranking process is presented in Appendix A, and the top-ranking locations are summarized in Table 3. The locations for exploratory wells were ranked based on the parameters listed below:

A) Site accessibility, roads, and topography.
   1) Poor: Little to no existing road access, steep topography
   2) Moderate: Some road access (dirt), moderate to low topography
   3) Good: Road access (dirt), low topography
   4) Excellent: Road access (paved), low topography

B) Estimated drilling depth to penetrate saturated thickness of target aquifer
   1) Poor: Greater than 4,000 ft
   2) Moderate: 2,000 to 4,000 ft
   3) Good: 500 to 2,000
   4) Excellent: less than 500

C) Proximity to the Lea County Underground Water Basin (the area of high demand)
   1) Poor: Greater than 40 miles from area of high demand
   2) Moderate: Between 20-40 miles from area of high demand
   3) Good: Between 10-20 miles from area of high demand
   4) Excellent: less than 10 miles from area of high demand

D) Availability of data
   1) Poor: No specific data available for area
   2) Moderate: One type of data available for area (for example, water quality)
   3) Good: Two types of data available for area (for example, water quality and permeability)
   4) Excellent: Three types of data available for area (for example, water quality, permeability, and well yield)

E) Water quality

1) Poor: Chloride concentration over 5,000 mg/L, total dissolved solids concentration over 10,000 mg/L, hydrocarbon contamination
2) Moderate: Chloride concentration between 2,500 and 5,000 mg/L, total dissolved solids concentration between 5,000 and 10,000 mg/L
3) Good: Chloride concentration between 1,000 and 2,500 mg/L, total dissolved solids concentration between 2,500 and 5,000 mg/L
4) Excellent: Chloride concentration less than 1,000 mg/L, total dissolved solids concentration less than 2,500 mg/L

F) Presence of interpreted faults that may be surrounded by fractures that have the potential to increase permeability (OR) in the case of the Capitan aquifer, absence of submarine canyons (which have lower transmissivity than Capitan aquifer)

1) Poor: No faults are interpreted to be present in area (OR) High density of submarine canyons (more than 25 percent of block is occupied by submarine canyons)
2) Moderate: A fault and/or structural high are interpreted to be present in area (OR) 13 to 25 percent of block occupied by submarine canyons
3) Good: Faults with two different orientations are interpreted to intersect in area (OR) 10 to 12.5 percent of block occupied by submarine canyons
4) Excellent: Faults with three different orientations are interpreted to intersect in area (OR) zero to 9.5 percent of block occupied by submarine canyons

G) Saturated thickness of aquifer

1) Poor: 50 to 100 ft
2) Moderate: 100 to 200 ft
3) Good: 200 to 500 ft
4) Excellent: 500 to 1,000 ft or more

H) Well yield

1) Poor: available data indicates well yields less than 50 gpm
2) Moderate: available data indicates well yields between 50 and 100 gpm
3) Good: available data indicates well yields between 100 and 150 gpm
4) Excellent: available data indicates well yields over 150 gpm

I) Permeability

1) Poor: zero or no nearby measurement
2) Moderate: 1 to 99 millidarcies
3) Good: 100 to 999 millidarcies
4) Excellent: 1,000 millidarcies or more

The location with the highest points for a particular aquifer is the best location for that aquifer.

Table 3. Summary of specific locations for exploratory wells in the Triassic-age Santa Rosa aquifer, Permian-age Capitan aquifer, and Permian-age San Andres aquifer

aquifer	township/range block	rank	specific locations within township/range block	approximate depth to top, ft bgl	depth of well completed, ft bgl	approximate thickness, ft
Santa Rosa	T21S, R37E Eunice	1 (26 points)	Southeast quarter, where TDS was 1,900 and 543 mg/L and intersecting faults are present.	125 1,100	350 1,325	225
	T21S, R36E west of Eunice	2 (25 points)	Northwest quarter, where TDS was 803 mg/L, and southeast quarter, where NW-trending fault is present.	197 1,175	447 1,425	250
	T20S, R38E between Eunice and Hobbs	2 (25 points)	Central portion (Sections 3 to 5, 8 to 10, 15, 16, 22), where faults appear to bisect a structural high. This is the first-ranked location for San Andres aquifer exploration.	125 1,100	350 1,325	225
	T19S, R38E south of Hobbs	2 (25 points)	Sections 1 to 3, 5, 10 to 12, 15, 16, 20, 21, 27, 28, 29, 31, 33, 34, where intersecting faults are present. This is a first-ranked location for San Andres aquifer exploration.	150 to 200 1,125-1,175	400 1,325-1,425	200 to 250
Capitan	T21S, R34E west of Eunice	1 (29 points)	Central part of eastern half (Sections 24 and 25), where permeability was 1,230 millidarcies, chloride was 2,600 mg/L, and aquifer is relatively thick.	4,000 to 4,500	5,390	1,500
	T24S, R36E northwest of Jal	2 (28 points)	Northwest quarter, where permeability was 10,369 millidarcies and aquifer is relatively thick.	3,750 to 3,900	5,713	1,500 to 2,000
	T21S, R35E	3 (25 points)	Northwest quarter (Sections 7 and 18), near location where chloride was measured at 1,600 and aquifer is relatively thick.	4,000 to 4,200	5,390	1,500
San Andres	T20S, R38E between Eunice and Hobbs	1 (27 points)	Central portion (Sections 3 to 5, 8 to 10, 15, 16, 22) where faults appear to bisect structural high. In Section 8, chloride was 2,900 mg/L. In Section 7, permeability was 82 millidarcies.	4,200	5,200	1,000
	T19S, R38E south of Hobbs	1 (27 points)	Sections 1 to 3, 5, 10 to 12, 15, 16, 20, 21, 27, 28, 29, 31, 33, 34, where intersecting faults are present. In Section 5, permeability was 113 millidarcies and chloride was 3,400 mg/L. In Section 15, permeability was 9 millidarcies.	4,056	5,370	1,314
	T22S, R37E south of Eunice	2 (26 points)	Sections 6, 8, 15, 16, 17, 21, 27, 28, 29, 34, where NW-trending fault is located. In Section 29, permeability was 123 millidarcies.	3,922	4,985	1,063
	T19S, R37E southwest of Hobbs	2 (26 points)	Sections 8, 9, 14, 15, 23, 24, 25, where NW-trending fault is located. In Section 8, chloride was 2,700 mg/L. In Section 25, chloride was 5,000 mg/L and permeability was 118 millidarcies.	4,056 to 4,224	5,370	1,146 to 1,314

TDS total dissolved solids mg/L milligrams per liter ft bgl feet below ground level

Triassic-Age Santa Rosa Aquifer

The Santa Rosa aquifer may provide potable water and stock water supplies in Lea County. Although wells tapping the Santa Rosa aquifer in this area may produce water with relatively low TDS concentrations, there may be hydrocarbon contamination and low well yields, as experienced by the City of Jal and the Town of Oil Center. Wells completed in the Santa Rosa aquifer are much shallower (about 3,500 feet shallower) than those completed in the Capitan and San Andres aquifers, but the little well yield information that is available suggests much lower well yields compared to the Capitan and San Andres aquifers. In two instances, potential locations for exploratory wells in the Triassic-age Santa Rosa aquifer coincide with locations for exploratory wells in the San Andres aquifer. In these locations, an exploratory well could be used to assess the water-producing potential of the Santa Rosa aquifer and the San Andres aquifer.

The first-ranked location for exploratory wells in the Santa Rosa aquifer is Township 21 South, Range 37 East, near Eunice (Table 3; Fig. 13). The top of the Santa Rosa aquifer is present at a depth of 125 feet in this area, and the aquifer is about 225 feet thick. The southeast quarter of Township 21 South, Range 37 East is considered to be the best location in this township/range block because intersecting faults are present and TDS measurements were 543 and 1,900 mg/L.

A second-ranked location for exploratory wells in the Santa Rosa aquifer is Township 21 South, Range 36 East, west of Eunice (Table 3; Fig. 13). The top of the Santa Rosa aquifer is present at a depth of 197 feet in this area, and the aquifer is about 250 feet thick. The northwest quarter is considered to be one of the best locations in this township/range block because TDS was measured to be 803 mg/L in this area. The southeast quarter of Township 21 South, Range 36 East is another good location in this township/range block because a northwest-trending fault is present.

Another second-ranked location for exploratory wells in the Santa Rosa aquifer is Township 20 South, Range 38 East, between Eunice and Hobbs (Table 3; Fig. 13). The top of the Santa Rosa aquifer is present at a depth of 125 feet in this area, and the aquifer is about 225 feet thick. The central portion of Township 20 South, Range 38 East, including Sections 3, 4, 5, 8, 9, 10, 15, 16, and 22, is considered to be the best location in this township/range block

because faults appear to bisect the structural high in this area. The central portion of Township 20 South, Range 38 East is also the first-ranked location for exploratory wells in the San Andres aquifer.

Yet another second-ranked location for exploratory wells in the Santa Rosa aquifer is Township 19 South, Range 38 East, south of Hobbs (Table 3; Fig. 14). The top of the Santa Rosa aquifer is present at a depth of 150 to 200 feet in this area, and the aquifer is 200 to 250 feet thick. Sections 1, 2, 3, 5, 10, 11, 12, 15, 16, 20, 21, 27, 28, 29, 31, 33, and 34 of Township 19 South, Range 38 East, are considered to be the best locations in this township/range block because intersecting faults are present in these Sections. This is also a second-ranked location for exploratory wells in the San Andres aquifer.

Capitan Aquifer and San Andres Aquifer

The Capitan aquifer has the potential to produce large quantities of water, though the water is typically of poor quality. However, water with chloride concentrations of less than 5,000 mg/L (roughly corresponding to TDS concentrations of 10,000 mg/L; Wallace, 1993) has been found in the Capitan aquifer in Township 20 South, Range 34 East, in Township 21 South, Ranges 33, 34, and 35 East, and south along the Capitan reef into Texas (Hiss, 1980; Wallace, 1993).

Water with chloride concentrations of less than 5,000 mg/L has also been found in the Permian-age San Andres aquifer adjacent to the Capitan aquifer between Hobbs and Jal (Fig. 5). This area of better quality water in the San Andres aquifer coincides with the structural high on the top of the Yates Formation and the Rustler Formation. The area shows relatively high porosity and permeability in the San Andres aquifer and good hydraulic connectivity with the adjacent Capitan aquifer (Hiss, 1975).

The area also coincides with the 'Hobbs Channel' (Fig. 15). In the past, ground water flowing out of the Capitan aquifer and into the San Andres aquifer was concentrated along the Hobbs Channel. Before the Pecos River incised into the Permian-age rocks near Carlsbad, the Capitan aquifer received recharge from the Guadalupe Mountains located west of Carlsbad and ground water flowed eastward along the aquifer. After the Pecos River incised into the Capitan aquifer, ground-water flow in the aquifer reversed directions. More recent extensive development of oil and ground-water resources in the Delaware Basin has further re-

configured ground-water flow, and flow is no longer concentrated along the Hobbs Channel (Fig. 5; Hiss, 1980). Water of better quality may have been transported along the reef and into the Hobbs Channel in the past, and is now moving back into the Capitan aquifer and flowing south through the aquifer toward Texas.

Specific Locations for Exploratory Wells in the Capitan Aquifer

The first-ranked location for exploratory wells in the Capitan aquifer is Township 24 South, Range 36 East, northwest of Jal (Table 3; Fig. 16). The top of the Capitan aquifer is present at a depth of 3,750 to 3,900 feet in this area and the aquifer is about 1,500 to 2,000 feet thick. A series of wells completed in the Capitan aquifer to depths of about 4,000 feet in the northwest quarter of Township 24 South, Range 36 East, specifically in Sections 4, 9, and 16, have relatively low chloride concentrations that range from 2,300 to 2,400 mg/L and TDS concentrations that range from 6,900 to 7,000 mg/L. These wells have estimated yields of 250 gpm, but the wells have the potential to be pumped at higher rates. After pumping, the wells recover nearly instantaneously and the static water level is about 200 feet below ground level. Since the water levels in the wells are about 3,550 feet above the top of the aquifer, they are artesian wells. Other wells completed in the Capitan aquifer in this area would also probably be artesian wells. Although the wells in Sections 4, 9, and 16 do not produce oil or gas, a well in the neighboring Section 3 produces oil and water from the Tansill and/or Yates Formations of the Artesia Group, which overlies the San Andres aquifer and is adjacent to, and somewhat interfingered with, the Capitan aquifer. Another well in Section 2 produces gas. This demonstrates that the presence of hydrocarbon as well as TDS concentrations in the Capitan aquifer may vary from one section to another, fluctuating over small distances based on the presence and density of fractures, and the nature of the contact or transition zone between the Permian-age marine shelf and Capitan aquifer. The northwest quarter of Township 24 South, Range 36 East is considered to be the best location in this township/range block because of the known high productivity and relatively good water quality associated with wells, and the permeability measurement of 10,369 millidarcies in this area. The Capitan aquifer is also relatively thick in this area, about 1,500 to 2,000 feet thick.

Another first-ranked location for exploratory wells in the Capitan aquifer is Township 21 South, Range 34 East, west of Eunice (Table 3; Fig. 17). The top of the Capitan aquifer is present at a depth of 4,000 to 4,500 feet in this area, and the aquifer is about 1,500 feet thick.

The central part of the eastern half of Township 21 South, Range 34 East, specifically Sections 24 and 25, is considered to be the best location in this township/range block because of the chloride measurement of 2,600 mg/L, the permeability measurement of 1,230 millidarcies, and the relatively high thickness of the aquifer in this area.

The second-ranked location for exploratory wells in the Capitan aquifer is Township 21 South, Range 35 East, west of Eunice (Table 3; Fig. 17). The top of the Capitan aquifer is present at a depth of 4,000 to 4,500 feet in this area, and the aquifer is about 1,500 feet thick. The northwest quarter of Township 21 South, Range 35 East, specifically Sections 7 and 18, are considered to be the best location in this township/range block because of the chloride measurement of 1,600 mg/L and the relatively high thickness of the aquifer in this area.

Specific Locations for Exploratory Wells in the San Andres Aquifer

The first-ranked location for exploratory wells in the San Andres aquifer is Township 20 South, Range 38 East, between Eunice and Hobbs (Table 3; Fig. 13). The top of the San Andres aquifer is present at a depth of 4,200 feet in this area, and the aquifer is about 1,000 feet thick. The central portion of Township 20 South, Range 38 East, specifically Sections 3, 4, 5, 8, 9, 10, 15, 16, and 22, are considered to be the best location in this township/range block because faults appear to bisect the structural high in this area. Although faults do not appear to be present in Section 7, permeability was determined to be 82 millidarcies. This location was also a second-ranked location for exploratory wells in the Santa Rosa aquifer.

Another first-ranked location for exploratory wells in the San Andres aquifer is Township 19 South, Range 38 East, south of Hobbs (Table 3; Fig. 13). The top of the San Andres aquifer is present at a depth of about 4,060 feet in this area, and the aquifer is about 1,314 feet thick. Sections 1, 2, 3, 5, 10, 11, 12, 15, 16, 20, 21, 27, 28, 29, 31, 33, and 34 of Township 19 South, Range 38 East, are considered to be the best locations in this township/range block because intersecting faults are present in these Sections. In Section 5, permeability was 113 millidarcies and chloride was 3,400 mg/L. In Section 15, permeability was 9 millidarcies. This location was also a second-ranked location for exploratory wells in the Santa Rosa aquifer.

A second-ranked location for exploratory wells in the San Andres aquifer is Township 22 South, Range 37 East, south of Eunice (Table 3; Fig. 18). The top of the San Andres aquifer is present at a depth of 3,922 feet in this area, and the aquifer is about 1,063 feet thick.

Four wells completed in the San Andres aquifer in Section 15 have reported yields of about 220 gpm. These wells have perforations from 3,900 to 4,600 feet. The pumps are set at about 2,600 feet, and the water level remains at about 1,200 feet during pumping, indicating that the wells are capable of producing water at rates greater than 220 gpm. Since the water levels in the wells are about 2,700 feet above the top of the aquifer, they are artesian wells. Other wells completed in the San Andres aquifer in this area would also probably be artesian wells. One of these wells produced water with a TDS concentration of 9,556 mg/L and chloride concentration of 3,489 mg/L. The sulfate concentration was relatively high, 2,031 mg/L. Small amounts of oil and gas are also produced from these wells; the produced water has a slight sheen. Some water samples have shown elevated hydrogen disulfide (Warren, oral communication, 2002). Sections 6, 8, 15, 16, 17, 21, 27, 28, 29, and 34, of Township 22 South, Range 37 East, are considered to be the best locations in this township/range block because a northwest-trending fault is present. In Section 15, well yields were about 220 gpm, and in Section 29, permeability was 123 millidarcies.

Another second-ranked location for exploratory wells in the San Andres aquifer is Township 19 South, Range 37 East, southwest of Hobbs (Table 3; Fig. 14). The top of the San Andres aquifer is present at a depth of 4,056 to 4,224 feet in this area, and the aquifer is about 1,146 to 1,314 feet thick. Sections 8, 9, 14, 15, 23, 24, and 25, of Township 19 South, Range 37 East, are considered to be the best locations in this township/range block because a northwest-trending fault is present. In Section 8, chloride was 2,700 mg/L. In Section 25, chloride was 5,000 mg/L and permeability was 118 millidarcies.

WATER RIGHTS CONSIDERATIONS

The NMOSE may have concerns about the potential hydraulic impacts on the Pecos River from pumping water from the deep aquifers, particularly from the Capitan and San Andres. These concerns could give rise to litigation regarding the potential need to purchase water rights in the Pecos Valley, or, possibly requiring additional studies, including ground-water flow modeling, to more fully understand the hydrogeology.

DRAFT
10/19/04

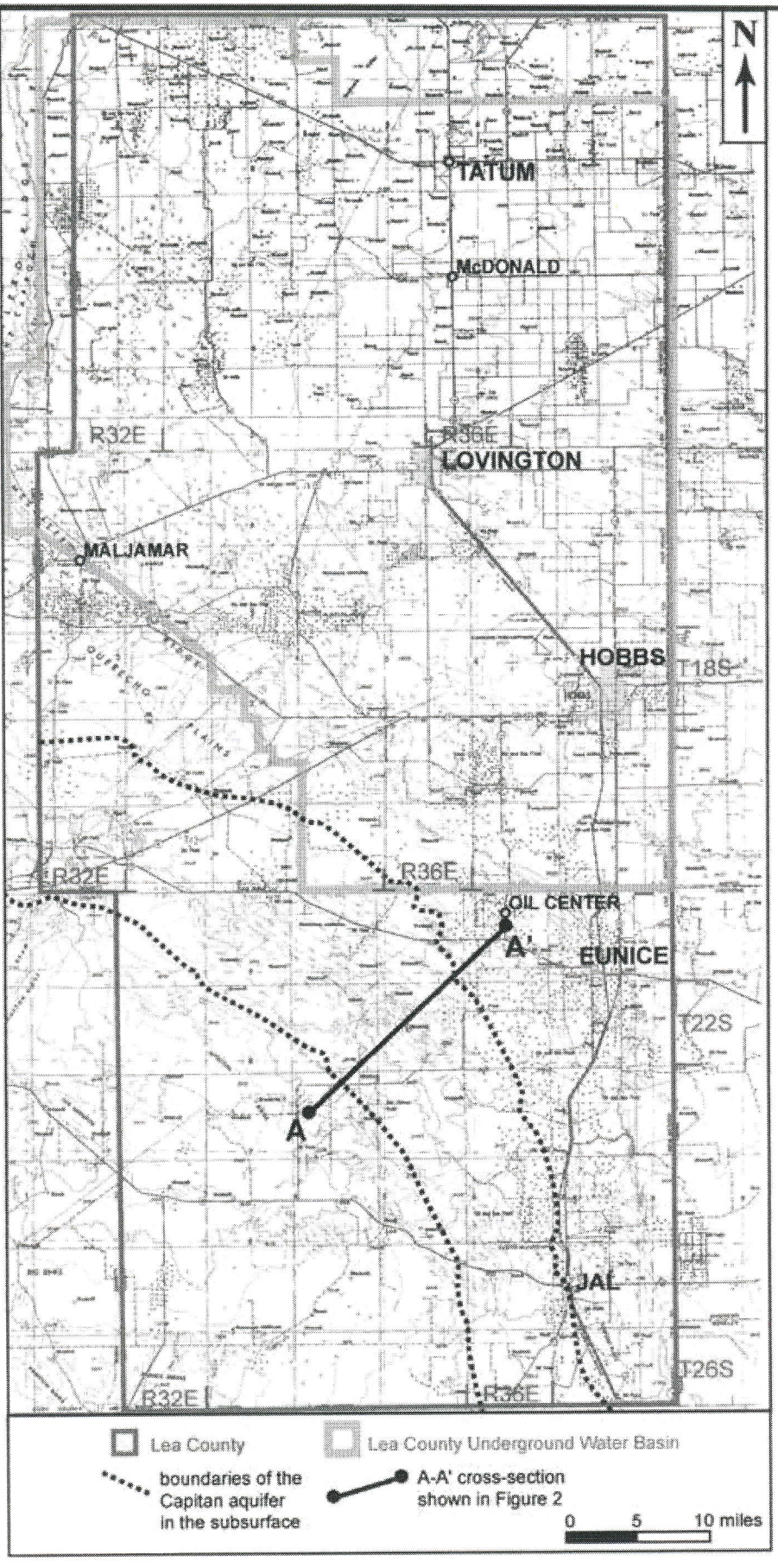

Figure 1. Map of Lea County showing the boundaries of the Lea County Underground Water Basin, approximate boundaries of the Capitan aquifer, and the line of the cross-section shown in Figure 2.

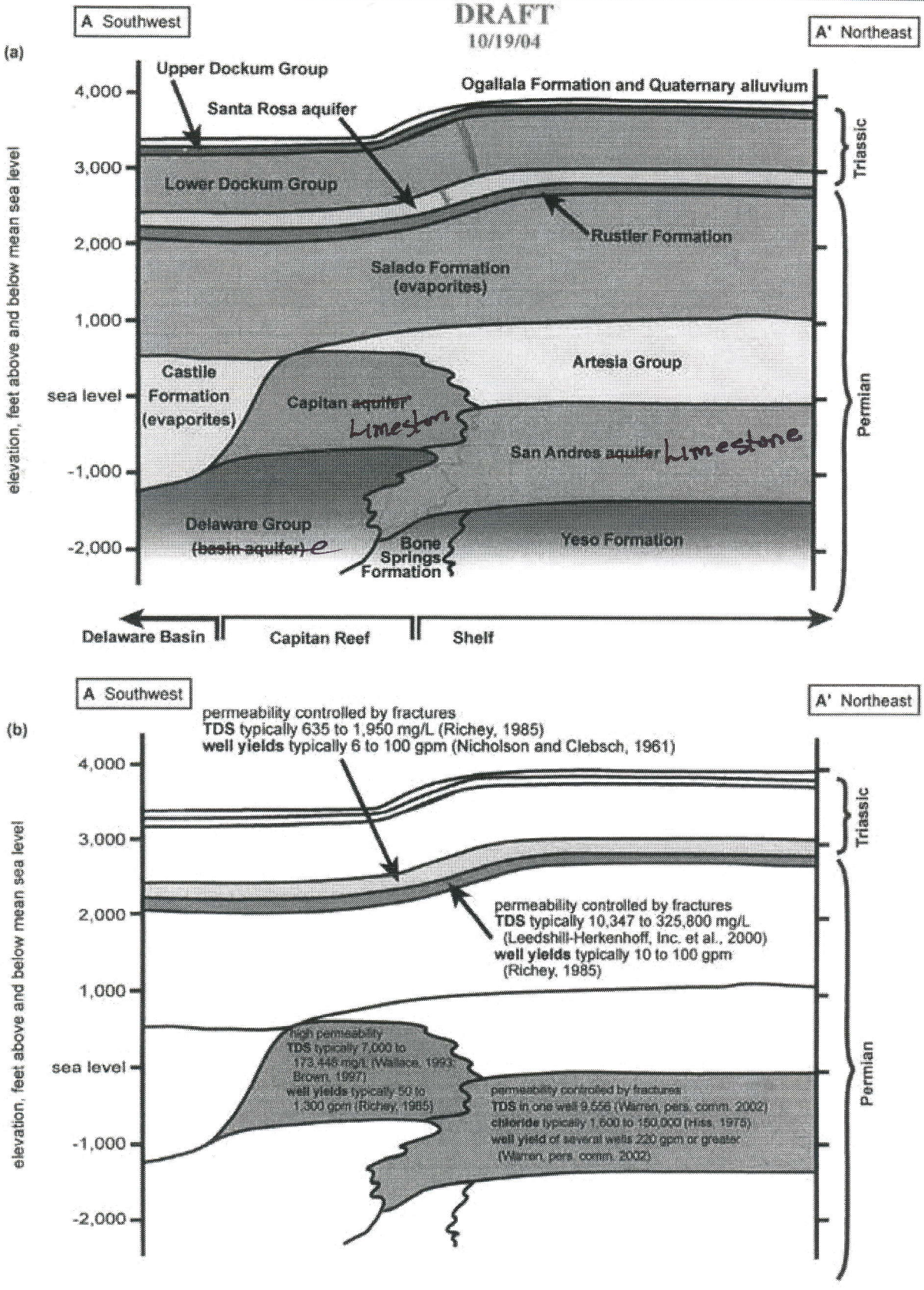

Figure 2. Schematic A-A' southwest-northeast geologic cross-section showing the deep aquifers of Lea County (a), and highlighting the deep aquifers that may provide water supplies (b). Line of section is shown in Figure 1.