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U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of LOUISIANA ENERGY SERVICES 4
Docket No. 70-3103-ML Official Exhibit No. NIRS/PC 37
OFFERED by: Applicant/Licensee Intervenor NIRS/PC
NRC Staff Other
IDENTIFIED on 2/7/05 Witness/Panel G. Rice
Action Taken: ADMITTED REJECTED WITHDRAWN
Reporter/Clerk Bellrany Engel

GROUND-WATER REPORT 6

Geology and Ground-Water Conditions in Southern Lea County, New Mexico

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UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
New Mexico Institute of Mining and Technology,
State Bureau of Mines and Mineral Resources Division
and the New Mexico State Engineer

1961

STATE BUREAU OF MINES AND MINERAL RESOURCES
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TABLE 3. STRATIGRAPHIC UNITS IN SOUTHERN LEA COUNTY, N. MEX.

Geologic age		Geologic unit	Thickness (ft)	General character	Water-bearing properties
Cenozoic Quaternary	Recent and Pleistocene	Sand	0-30±	Dune sand, unconsolidated stabilized to drifting, semiconsolidated at depth; fine- to medium-grained.	Above the zone of saturation, hence does not yield water to wells. Aids recharge to underlying formations by permitting rapid infiltration of rainwater.
		Alluvium	0-400±	Channel and lake deposits: alternating interbedded calcareous silt, fine sand, and clay; thickest in San Simon Swale; less than 100 feet thick in most places.	Saturated and highly permeable in places in east end of Laguna Valley. Forms continuous aquifer with Ogallala formation. Wells usually yield less than 30 gpm. Locally above the water table.
Cenozoic Tertiary	Pliocene	Ogallala	0-300±	Semiconsolidated fine-grained calcareous sand capped with thick layer of caliche; contains some clay, silt, and gravel.	Major water-bearing formation of the area. Unsaturated in many localities, such as north side of Grama Ridge, west side of Eunice Plain, Antelope Ridge area, and Rattlesnake Ridge. Greatest saturated thickness along east side of Eunice Plain, west of Monument Draw, where wells yield up to 30 gpm. Highest yields, up to 700 gpm, obtained from wells along south edge of Eunice Plain, east of Jal.
Mesozoic Cretaceous		Undifferentiated	35±	Small isolated and buried residual blocks of limestone, about 3 miles east of Eunice.	Possibly small isolated bodies of water locally.
Mesozoic Triassic Dockum group		Chinle formation	0-1,270±	Claystone, red and green; minor fine-grained sandstones and siltstones; underlies all of eastern part of southern Lea County area; thins westward; absent in extreme west.	Yields small quantities of water from sandstone beds. Yields are rarely over 10 gpm. Water has high sulfate content.
		Santa Rosa sandstone	140-300±	Sandstone, chiefly red but locally white, gray, or greenish-gray; fine- to coarse-grained; exposed in extreme west; underlies Cenozoic rocks in western part of area, and is present at depth in eastern part	Yields small quantities of water over most of the area. Some wells are reported to yield as much as 100 gpm. Water has high sulfate content.
Paleozoic	Permian and Triassic	Undifferentiated	90-400+	Siltstone, red, shale, and sandstone; present at depth under all of southern Lea County.	No wells are known to be bottomed in the red beds. Probably can yield very small quantities of high-sulfate water.
Paleozoic	Ordovician through Permian		6,500-17,000±	Thick basin deposits ranging in character from evaporites to coarse clastics; thinnest on the east side of the area over the Central basin platform, thickest toward the southwest.	No presently usable water supply available from these rocks. Source of highly mineralized oil-field waters.
Precambrian				Granite, granodiorite and other igneous and metamorphic rocks; complex structure.	Not hydrologically significant.

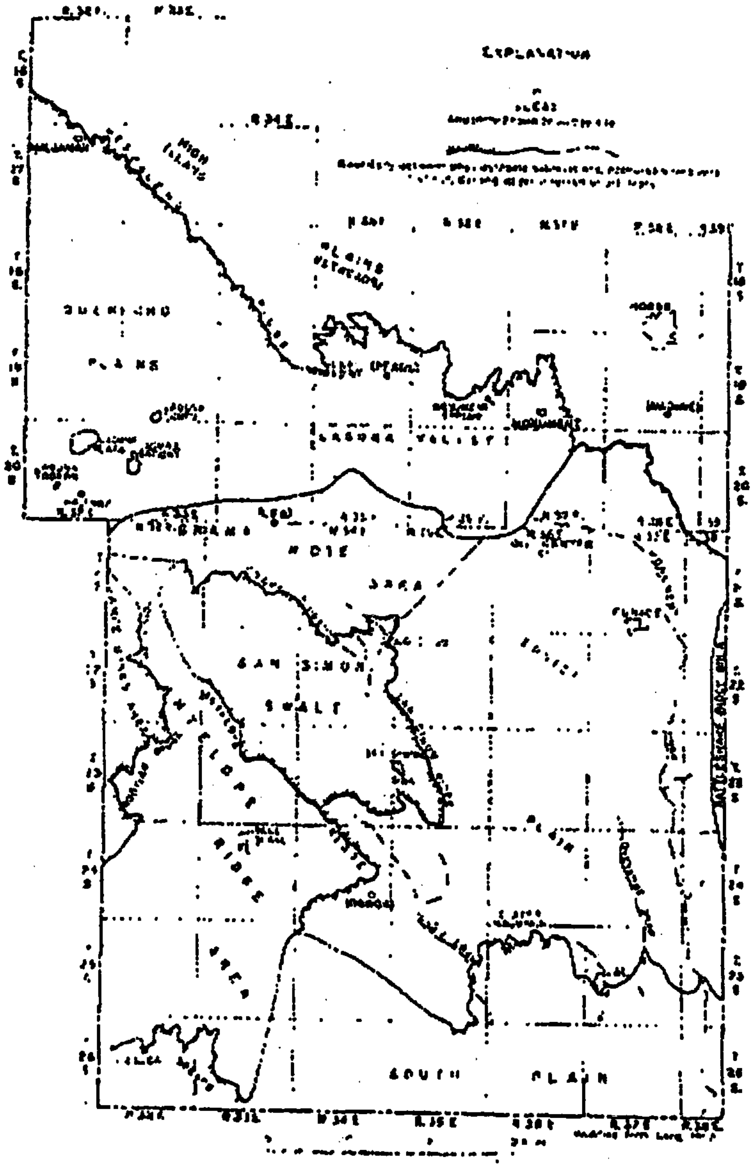

Figure 3

PHYSIOGRAPHIC SUBDIVISIONS OF SOUTHERN LEA COUNTY, N. MEX.

Plains in New Mexico (fig. 3). The so-called ridge, a nearly perpendicular cliff, faces west to southwest. The cliff is capped by a thick layer of resistant caliche, locally called caprock, which underlies the High Plains.

At the northwestern corner of the area, Mescalero Ridge trends southeasterly and rises sharply about 150 feet above the area immediately adjacent to the southwest. The trend is relatively straight for a distance of about 24 miles. The escarpment has neither large reentrants nor deep gullies, and the sharp relief is maintained throughout this distance.

In the northwestern part of T. 19 S., R. 35 E., the ridge curves sharply to the east. The relief is more subdued here, and the scarp has been dissected by large reentrants, which cut back into it as much as 4 or 5 miles (fig. 3). The scarp, owing in part to a heavy cover of dune sand, is barely discernible in the eastern part of Lea County in Tps. 20 and 21 S. In T. 21 S., the ridge extends from Lea County southeast into northern Andrews County, Texas. The subdued relief of the scarp beyond where it turns eastward is caused by erosion resulting from runoff. That runoff is channeled toward the scarp by the southeasterly trending nonintegrated drainage system of the Llano Estacado, whereas further west on the High Plains rainfall is channeled away from the scarp.

The High Plains surface is uniformly flat and slopes about 17 feet per mile between 15 degrees and 20 degrees south of east. Most of the rainfall runoff is caught in shallow depressions, locally called buffalo wallows, where it remains until it seeps into the ground or evaporates. These depressions range in size from a few feet to more than a quarter of a mile in diameter and from a few inches to about 20 feet in depth. They are scattered in a random fashion, but some are connected by a poorly defined drainage pattern resulting from original irregularities in the surface.

The shallow depressions and small sand dunes are the only significant relief features on the Llano Estacado. Otherwise it is a flat, gently sloping plain, treeless, and marred only by slight undulations and covered with short prairie grass.

Querecho Plains and Laguna Valley

Immediately southwest and south of Mescalero Ridge is a vast sand dune area covering approximately 400 square miles. The western portion of this sand area, called Querecho Plains (fig. 3), extends westward from the scarp to Nimenim Ridge, about 6 miles west of the Lea–Eddy County line. The continuation of this sandy area eastward is known as Laguna Valley (fig. 3). On the south this area is bordered by an area of higher elevation extending from about Halfway to Oil Center. West of about R. 35 E. the land slopes to the west. The eastern part of Laguna Valley (east of R. 35 E.) slopes to the east. Querecho Plains and Laguna Valley are covered almost entirely by dune sand which is stable or semi-stable over most of the area, but which locally drifts. The surface is very irregu-

TABLE 4. LOG OF THE TRIASSIC SECTION, CONTINENTAL OIL CO. NO. 2 BELL LAKE UNIT
SE¼SW¼ SEC. 30, T. 23 S., R. 34 E.

Age	Formation and thickness (ft)	Depth (ft)	Thickness (ft)	Description
	Ogallala	0– 60	60	Caliche, white, sandy.
Tertiary	125	60– 125	65	Sandstone, tan, fine- to medium-grained, sub-rounded, calcareous.
		125– 210	85	Sandstone, fine, and siltstone, greenish-gray; slightly calcareous.
		210– 280	70	Siltstone and clay, red and green; some sandstone, green, fine-grained, calcareous.
Triassic	Chinle 325	280– 300	20	Sandstone, light-gray, fine- to very fine-grained, slightly calcareous; much pyrite with many small euhedral crystals.
		300– 450	150	Siltstone and clay, red and green; some sandstone, green, fine-grained, calcareous.
		450– 680	230	Sandstone, red, generally fine to medium-grained but ranging from very fine to coarse, angular, friable, moderately calcareous with silica and ferric-oxide cement; some gravel, chert, and gypsum.
Triassic	Santa Rosa 310	680– 720	40	Clay and siltstone, red.
		720– 760	40	Sandstone, red, fine- to very fine-grained, friable, moderately calcareous; some siltstone and clay.
		760– 790	30	Siltstone, red, noncalcareous, micaceous, green streaks, and spots; some gypsum.
Triassic or		790– 800	10	Clay, red, silty, micaceous.
Permian,		800– 820	20	Siltstone, red, clayey, micaceous.
undifferentiated		820–1,000	180	Siltstone, red, noncalcareous, micaceous, green streaks, and spots, some gypsum.
	495	1,000–1,010	10	Clay, red, silty.
		1,010–1,255	245	Siltstone, red, noncalcareous, micaceous, green streaks and spots; some gypsum.
Permian	Rustler	1,255–1,270	15+	Anhydrite.

and Permian cannot be definitely determined because of their similar lithologies and a lack of fossils. Table 3 summarizes the geologic and hydrologic characteristics of the Mesozoic and younger formations found in the southern Lea County area.

Triassic

The Triassic rocks of the area consist chiefly of a sequence of red beds, the Dockum group, which are separated from the rocks of Late Permian or Triassic age by an erosional unconformity. The Dockum group is divisible into the Santa Rosa sandstone and the Chinle formation; however, the distinction cannot be made throughout the area because of lithologic similiarities and poor exposures. The Santa Rosa is a fine- to coarse-grained sandstone, which ranges in thickness from about 140 feet to more than 300 feet; it contains minor shale layers. In some places the sand grains approach silt size; elsewhere the rock is conglomeratic. It is generally red, but it contains white, gray, and greenish-gray sands. The Santa Rosa is exposed in the face of Livingston Ridge in Eddy County (T. 21 S., R. 31 E.) and in the southwestern parts of T. 20 S., R. 32 E. Triassic rocks of the Dockum group, undifferentiated, are exposed in the face of The Divide and in the Paduca Breaks (see fig. 9).

The uppermost formation of the Dockum group is the Chinle, which ranges in thickness from zero to 1,270 feet. It is thickest in the eastern part of the area and entirely absent in the western part, where it has been removed by post-Mesozoic erosion. The Chinle is dominantly red and green claystone but also contains minor fine-grained sandstone and siltstone. The Chinle is exposed in the south-facing scarp of Custer Mountain, where it consists of badly weathered red claystone with green streaks and nodules. About 3 miles west of Custer Mountain about 40 feet of the Chinle is exposed in the sides of an isolated mesa (fig. 14). At that locality it consists of alternating beds of red and green claystone, ranging in thickness from 1 to 4 feet, and a 4-foot bed of greenish-gray, very fine-grained argillaceous sandstone which has thick cross-bedding and rounded claystone granules as much as 1 cm in size. The beds dip gently to the northeast.

About 2 miles southeast of Monument the Chinle formation is exposed in a large pit. Here, the rock consists of micaceous red clay containing green reduction spots. The clay was mined and ground for use as drilling mud for many years.

Because of lithologic similarities between the sandstones of Chinle and the Santa Rosa sandstone, some exposures have been mapped as Dockum group, undifferentiated. Inasmuch as the Triassic rocks in the western part of the county generally dip toward the east or southeast, the area shown as Dockum group in Tps. 21-24 S., R. 32 E. may be part of the Santa Rosa sandstone. The exposures are generally poor because of the extensive cover of drift sand, but an outcrop in the Paduca Breaks

Oil and Refining Co. and the Magnolia Petroleum Co. were injecting water into three depleted oil wells. Injection was begun in January 1951; during the 3-year period 1951 through 1953, the total quantity injected was about 52 acre-feet. The injection rate declined with time as pressure increased in the formation. During the first year the total input was 22 acre-feet under gravity flow, whereas in the third year the total input was only 14 acre-feet under pressures ranging from 450 psi to 900 psi.

In sec. 34, five injection wells were operated by the Humble Oil and Refining Co., the Skelly Oil Co., and the Gulf Coast and Western Oil Co. Injection was begun in December 1953, and the first 8 months of operation indicated an initial injection rate of about 30 acre-feet per year.

With one exception, all the water used in these repressuring projects was potable shallow water derived from the Ogallala formation near Eunice. The water produced from well 22.37.34.331 came from the Glorieta sandstone at a depth of 5,500 feet. The water from the Glorieta is of very poor quality and required treatment for the removal of hydrogen sulfide, carbonate, and sulfate before it could be used. Nearly half the water used in sec. 34 was treated sulfurous water from the Glorieta. The cost of chemicals in the treating process was estimated to be about a dollars per acre-foot of water treated.

Public Supplies

Eunice

Until 1954 the Eunice public water supply was obtained from the Ogallala formation. Over a period of years a well field consisting of 15 wells and covering an area of about half a section had been developed on the west and south sides of town. When initially pumped, the wells each yielded about 100 gpm; but within a few months the rate declined because the screens became clogged with very fine sand. Rehabilitation and repairs were frequently needed. With continued growth of the town, its water needs exceeded the well-field supply, and critical shortages were experienced during the summer months of the early 1950's. The need for additional water led to the abandonment of the old well field and to the construction of a pipeline to an area 10 miles north of town, where the city had bought two irrigation wells and converted them to public-supply wells. The wells (20.33.8.232 and 231) are pumped alternately, whereas in the old well field almost all the wells had to be pumped continuously in order to keep up with the demand. The water-bearing formation at the new field apparently is Quaternary alluvium; the high yield of the aquifer is due primarily to its high transmissibility. The saturated thickness in the new field is 30 to 50 feet, whereas in the old field the saturated thickness was 30 to 40 feet.

Water consumption in Eunice through 1958 was at an estimated rate of 246 acre-feet per year, or about 70 gallons per person per day for the population of about 3,100. Assuming per capita consumption to about 80 gallons per day per person the consumption rate at Eunice will exceed 500 acre-feet per year when the town reaches a population of 6,000.

Jal

The water-supply problem at Jal is a repetition of the experience at Eunice. Continued growth forced the city to abandon its old water-supply system, which consisted of five wells within the city limits, each bottomed in the Santa Rosa sandstone and each producing about 25 gpm. The city bought an abandoned irrigation well about 5 miles east of town and converted it to a public supply. It also drilled a second well so that one well could be used as a standby. The well (25.37.15.312a) is bottomed in the Ogallala formation; at the time the saturated thickness was about 80 feet, which is unusually thick for the southern Lea County area. The new well was tested at 750 gpm with a drawdown of only 15 feet. It was placed in operation in July 1954.

By 1959 this supply was no longer dependable during periods of peak demand for water, because the aquifer had been seriously depleted by pumping for industrial and municipal supply. The city undertook a program of test drilling in secs. 18 and 19, T. 26 S., R. 36 E., and developed two production wells capable of a combined yield of more than 700 gpm. This water became the prime source of supply for Jal in April 1960. The well field east of the city was kept as a standby source.

In 1960 the per capita use of water in Jal was about 100 gpd. The supply of water developed southwest of the city will permit a substantial increase in per capita consumption.

Oil Center

The entire water supply at Oil Center is provided by one well (21.36.9.222), bottomed apparently in the Chinle formation. The sustained yield of this well is about 6 gpm, or less than 8 acre-feet per year. The supply is inadequate and is made to do only by careful husbanding. It is possible that if the well were deepened another 100 to 200 feet, an adequate supply might be found in the Santa Rosa formation.

Monument

Monument has no public water supply. Water is obtained from private shallow wells bottomed in Quaternary alluvium. The wells in this area are adequate, but there is danger of contamination. One contaminated well located 1 mile south of town is discussed in the section on contamination. The total consumption probably exceeds that of Oil

TABLE 6. RECORDS OF WELLS IN SOUTHERN LEA COUNTY, N. MEX. (continued)

Location No.	Owner	Aquifer	Depth of well (feet)	Altitude of well (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Year completed	Surface diameter of wells	Method of lift	Use of water	Remarks
21.37.31.210	City of Eunice	Tr	350	3,430	—	1941	—	8	N	N	Old public-supply well. WBZ 320-350 feet. Chemical analysis in table 8. EY 10 gpm.
33.211	—	To	103M	3,450	99.8	11-12-53	—	10¾	N	N	—
33.233	City of Eunice	To	135	3,433	100	1934	—	8	Te	P	City well 1. Perforated 100-130 feet. Chemical analysis in table 8.
35.121	Gulf Oil Corp.	Qal	110	3,373	61	3-17-53	-	10¾	Te	In,D	Gulf Eunice Plant, well 21.
35.412	do.	Qal	87	3,360	30	11-14-53	—	7	Te	In,D	Gulf Eunice Plant, well 17. WBZ sand and gravel, 65-74 feet.
21.37.36.114	P. Wallach	Qal	66±M	3,370	47.3	10- 9-53		6	Lw	S	
36.344	do.	Qal	—	3,360	49.8	10- 9-53	—	6¼	Lw	S	—
21.38.8.133	Ray McNeil	Qal	90±	3,550	70.6	12- 7-58	—	7	N	N	—
8.133a	do.	To	90?	—	—	—	—	—	Lw	—	Chemical analysis in table 8.
8.133b	do.	To	108	—	—	—	—	—	N	N	do.
8.144	Humble Oil Co.	—	135	3,563	Dry	—	—	—	—	—	Plugged and abandoned
22.33.15.200	San Simon Ranch	Tr	504	3,510	—	—	—	—	Lw	S	WBZ 120-470 feet.
22.34.12.111	do.	Qal	62	3,530	48	—	1951	—	Lw	D,S	—
12.111	do.	Qal	163M	3,515	12.8	3-17-51	—	—	Lw	S	Is an infiltration tunnel about 70 feet long and 5 feet in diameter feeding 2 windmills, 1 centrifugal pump and 1 siphon.
22.36.1.333	Gulf Oil Co.	To	150	3,490	111.2	11-12-53	—	—	Lt	I.	Chemical analysis in table 8.
2.414	—	—	—	—	—	—	—	—	Lw	S	Chemical analysis in table 8.
8.443	United Carbon Co.	Tr	1,000±	3,550	700	-	—	8	Lr	In,D	Three wells, EY 30 gpm each. Chemical analysis in table 8.
11.234	Texas-Pacific Coal and Oil Co.	To	120±	3,500	113.8	11-12-53	-	8	Lw	D	Chemical analysis in table 8.
13.222	Ohio Oil Co.	Tr(?)	—	3,455	Flowing						
25.434	R. L. Robinson	To	—	3,430	118.5	11-23-53	—	7	N	N	Capped and flowing.
							—	—	Lt	S	—

Location No.	Owner	Aquifer	Depth of well (feet)	Altitude of well (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Year completed	Surface diameter of wells	Method of lift	Use of water	Remarks
22.36.33.314	do.	To	197	3,450	187.4	11-23-53	--	—	Lw	S	--
1.132	G. Sims	Qal	-	3,350	47.6	10-14-53	--	—	N	N	Open, uncased hole.
1.440	do.	Qal	—	—	—	-	--	—	Lw	S	Chemical analysis in table 8.
2.142	Humble Oil Co.	Qal	56M	3,360	53.3	10- 9-53	—	7	N	N	Initial yield, 68 gpm.
3.133	Sinclair Oil and Gas Co.	To	120	3,425	90	--	1936	—	Je	D	—
3.134	do.	—	133M	3,470	Dry	9-29-53	-	—	N	N	—
3.440	Cities Service Oil Co.	To	—	3,390	75.8	9-29-53	--	7½	N	N	—
4.211	City of Eunice	To	155	3,445	110	1953	1953	10	Te	P	Well 12. Initial yield, 100 gpm; yield in 1953, 60 gpm.
4.213	do.	To	155	3,440	114.8	9- 6-54	1952	10	Te	P	Well 11. EY 60 gpm.
4.214a	Eunice Cemetery Assn.	To	115±M	3,435	109.2	9-29-53	—	6½	N	N	—
22.37.4.233	City of Eunice	To	155	3,438	110	1951	1951	8	Te	P	Well 9.
4.321	Sinclair Oil and Gas Co.	To	114±M	3,420	90.1	9-29-53	—	7¾	N	N	—
4.324	Skelly Oil Co.	To	164	—	<139	-	1950	8⅝	Tt	In,D	Skelly Eunice Plant 1, well 13. Initial yield, 150 gpm; dropped to 20 gpm.
8.441	Shell Oil Co.	To	163	3,400	60	1933	1936	6⅝	Lw	D	--
8.313a	Humble Oil Co.	To	166M	3,400	72.7	9-29-53	1914	9⅝	N	N	Humble—J. L. Greenwood well 2.
9.331	do.	To	160	—	—	-	1945	7⅝	Te	D	Humble—J. L. Greenwood well 4.
9.333	do.	To	172	--	--	—	1946	4	Te	In	Humble—J. L. Greenwood well 5. Water used for oil well flooding.
22.37.9.441	Humble Oil Co.	To	104±M	3,410	85.5	9-29-53	1940	6⅝	N	N	Humble—J. L. Greenwood well 1.
10.213	Gulf Oil Corp.	To	226	3,400	100	1950		—	Lr	D	Gulf Brunson lease well.
10.320	Skelly Oil Co.	To	—	3,395	81.0	9-29-53	--	11¾	N	N	—
11.324	—	Qal	100M	3,350	45.3	10-16-53	1952	5	N	N	—
11.414	Leo Sims	Qal	—	3,345	58.7	10-14-53	—	6⅝	Lw	S	—
12.114	G. Sims	Qal	84M	3,340	33.0	10-14-53	-	7	N	N	—
12.443	do.	Qal	59M	3,335	53.8	10-14-53	-	15	N	N	..
12.413a	do.	Qal	56M	3,335	33.3	10-14-53	—	--	N	N	Uncased and open.
15.333	H. O. Sims	To	—	3,330	81.0	9- -53	—	4¾	Lw	D,S	
16.132	Skelly Oil Co.	To	135	—	—	—	-	7	Tt	In,D	Skelly Eunice Plant 1, well 11. EY 40 gpm
16.143	do.	To	136	3,365	80.9	9-28-53	1947	8⅝	Tt	In,D	Skelly Eunice Plant 1, well 10.
22.37.21.221	—	To(?)		3,360	74.3	9- -53	—	6⅝	N	N	—