Bratcher, Mike, EMNRD

From: Andrew Parker <andrew@rthicksconsult.com>
Sent: Friday, May 18, 2012 6:42 PM
To: Bratcher, Mike, EMNRD
Cc: Jones, Brad A., EMNRD; 'Joe Kostelecky'; 'Randall Hicks'; David_Luna@xtoenergy.com
Subject: Draft Hydrogeology for XTO Nash Draw #29
Attachments: hydroGeologyForBratcherDraft.pdf

Hello Mike:

It is my understanding the Brad would like you to review the hydrogeology section of the C-144. Attached is the hydrogeology section. It is still in draft form and we need to work out a few details. Everyone on this email will be reviewing it at the same time as you as they have not seen the revised edition.

Andrew Parker
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Halliburton System:

XTO Nash Ut #4

A-13-23s-29E 015-21777

32.30963
103.93069

Treated H2O Storage:

XTO Nash Draw Ut #29

J-13-23s-29E 015-29434

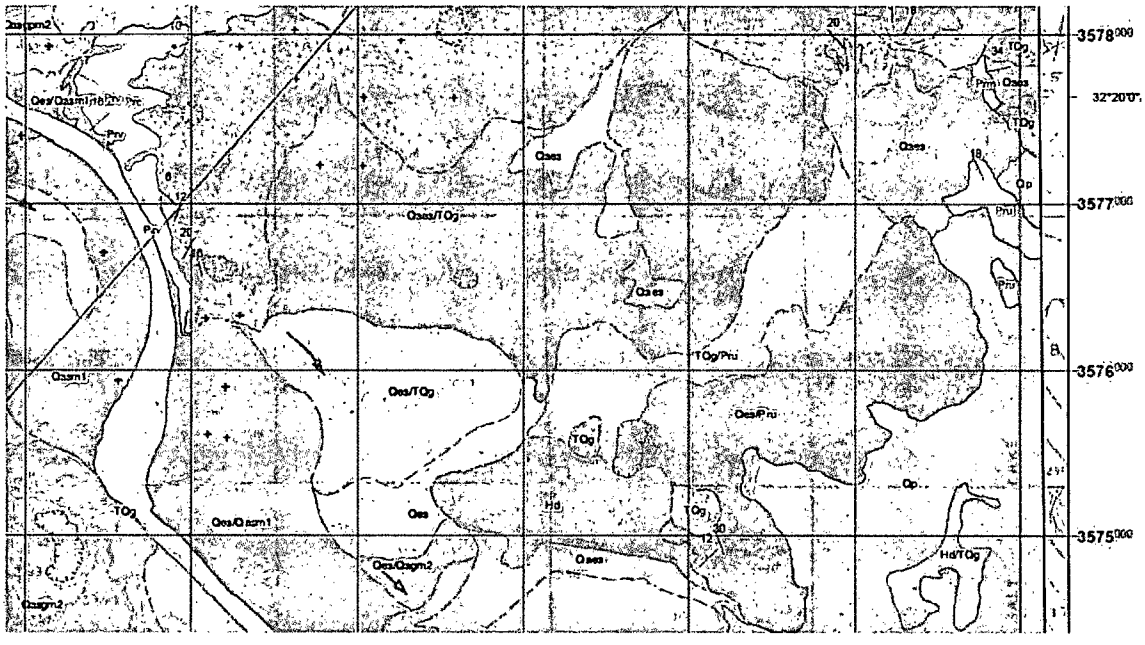
32-30321
103.93718

Hydrogeologic Data

Geology

The temporary pit is located on Quaternary-Piedmont alluvial deposits. Underlying the alluvial deposits is the Rustler Formation that is composed of anhydrite, gypsum, interbedded sandy clay and shale, and irregular beds of dolomite (see Figure 1a). The Rustler overlies the Salado Formation.

The regional dip of the sedimentary rocks is east and southeast, but many irregularities of structure have been produced by solution of salt and gypsum beds (Geology and Ground-Water Resources of Eddy County, New Mexico; G.E. Henrickson and R.S. Jones, 1952). Some of these irregularities in dip are mapped several miles west of the location (see below from the Preliminary Geologic Map of the Loving 7.5 Minute Quadrangle, OF-GM-77, 2004 http://geoinfo.nmt.edu/publications/maps/geologic/ofgm/downloads/77/Loving_v1p-00.pdf). The map shows the middle-Rustler Formation near the Pecos River (Prc) dipping northwest and southwest while the outcrop of pre-Rustler formations (Pru) and upper Rustler (Prm) adjacent to (and presumably beneath) what is mapped as a Salt Lake dip southwest and south-southeast. The location of the temporary pit is east of the mapped area presented below.



The basal beds of the Rustler (Virginia Draw Member, Prv in OF-GM-77) consist of porous gypsum in a large part of Nash Draw and southwest to Malaga Bend. Hendrickson and Jones (1952) state that these basal beds commonly contain brine saturated with sodium chloride. The brackish groundwater within Nash Draw (in the alluvium and lower Rustler) flows southwest past what is mapped as a Salt Lake and discharges into the Pecos River near Malaga Bend.

Above the basal brine aquifer in the Rustler is the 35-foot thick unit of dolomitic limestone at the top of the lower part of the Rustler (probably the Culebra Dolomite, Prc). This brackish aquifer is used by the potash mines to sluice tailings (Hendrickson and Jones, 1952).

Overlying the Rustler are Quaternary alluvial, lacustrine and piedmont deposits. Figure 1a shows that the temporary pit lies on piedmont deposits (Qp) with playa/lacustrine deposits (Qpl) to the west and north and exposures of Rustler to the southeast and southwest.

Depth to Groundwater/Groundwater Elevation

Groundwater data from water wells near the proposed temporary pit are shown on Figure 1a. Water wells showing a total depth of less than 150-feet exhibit depth to water less than 100 feet. Water wells drilled to a total depth of 350 feet show depth to water between 110 and 262 feet. Water wells drilled greater than 350 feet show depth to water greater than 401 feet. One exception is OSE water well C 03015 (approximately 6 miles northeast of the location). Well C03015 has a total depth of 1,316 feet with a depth to water of 262 feet. This well is most likely under artesian pressure or completed across several groundwater zones. Water wells exhibiting depth to water greater than 200 feet are located east of the proposed temporary pit. Water wells exhibiting depth to water less than 100 feet are mostly located directly 1) south and 2) west of the proposed temporary pit.

Figure 1b shows that the Salt Lake is influenced by a tailings pond for the nearby potash mine/mill. In the upper center portion of the aerial photograph, evidence of the tailings pile is clear – emanating from the mill and flowing south into the Salt Lake. The fluids from the tailings pond fill the Salt Lake along with occasional stormwater runoff. The water level in the tailings pond/Salt Lake will vary with the amount of yearly precipitation and mine flooding. High rainfall plus active potash production should result in a higher water level.

West of the proposed temporary pit, groundwater levels (approximately 2,974 feet amsl) in wells adjacent to Salt Lake are coincident with the water level of the tailings pond (approximately 2,970 feet amsl; see Plate 1c). As discussed in the next section, subsurface water that is hydraulically connected to the tailings pond exhibit very high TDS concentrations. Where the TDS is greater than 10,000 mg/L, such as wells near the tailings pond, subsurface water is not "fresh water" as defined by NMOCD Rules.

Recent drilling of a conductor pipe at Nash Draw #49H (see Figure 1a), approximately 0.6 miles northeast of the proposed temporary pit, encountered brackish water at approximately 20-feet below ground surface.

South of the proposed temporary pit is a water well listed in Go-Tech's WAIDS database. This well is a stock well; the WAIDS database provides no total depth or depth to water data. East of the proposed temporary pit, at the eastern edge of Figure 1a, water well data shows depth to water exceeds 200 feet. North-northeast of the proposed pit, New Mexico Bureau of Mines and Mineral Resources Open File Report -95 (http://geoinfo.nmt.edu/publications/openfile/details.cfml?Volume=95) shows a well with a

depth to water of 110 feet (see Figure 1a and Appendix SSI-2). This well is completed at a total depth of 200 feet within the Rustler Formation and is a stock well. Based upon 1) the total depth of the well, 2) the fact that the water is potable to stock, and 3) the water level is 90 feet higher than total depth, we suspect the Rustler is confined in this area. The water level in this well (approximately 2,895 feet amsl) is not coincident with the surface water elevation in the tailings pond (approximately 2,970 feet amsl) or groundwater elevation in wells adjacent to the tailings pond (i.e. C 2707, approximately 2,974 feet amsl).

Southeast of the proposed temporary pit, Open File Report 95 describes a stock well with a depth to water of 54.9 feet (October 1977) and a total well depth of 59.6 feet. The groundwater elevation of this well (2,988 feet amsl) is about 18 feet higher than the water in the tailings pond. This water level is consistent with the groundwater flow map presented in Hendrickson and Jones that shows water from this area flowing toward the Salt Lake/tailings pond thence to the Pecos River.

Water Quality

Water quality data from the Go-Tech's NM WAIDS database shows a water well in Section 18, Township 23S, Range 29E (see Figure 1b and Table 1) with a chloride concentrations ranging from 98,000 mg/L to 203,700 mg/L. This well is near the Salt Lake/tailings pond (4.8 miles west of the location). We believe this well in the WAIDS database is probably the OSE water well identified as C 02706 with a total depth of 17 feet and a depth to water of 10 feet.

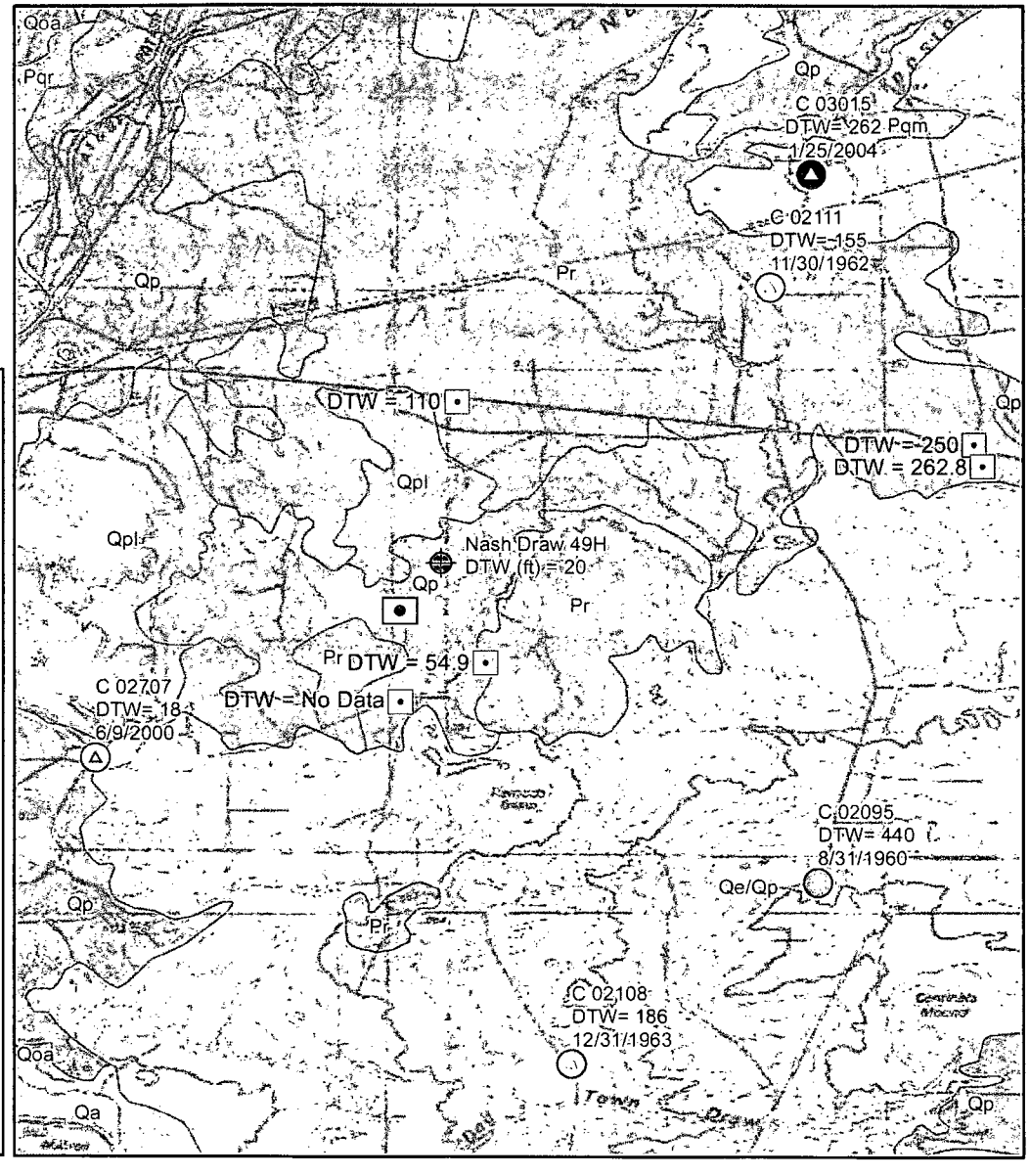
Table 1: Data form GoTech's WAIDS database

SampleID	Township	Range	Section	Formation	Location	Date	Chloride
2046	23S	29E	18		23S.29E.18.100	4/27/1967	139800
2188	23S	29E	18		23S.29E.18.100	3/29/1967	203700
1909	23S	29E	18		23S.29E.18.100	3/29/1967	98000
1925	23S	29E	18		23S.29E.18.100	3/29/1967	179300
27851	23S	29E	24	RSLR	23S.29E.24.41321	4/3/1985	32
27961	23S	29E	24	RSLR	23S.29E.24.41321	4/1/1992	55
28001	23S	29E	24	RSLR	23S.29E.24.41321	7/31/1997	54
27891	23S	29E	24	RSLR	23S.29E.24.41321	7/9/1987	37
10185	23S	29E	30	OAL	23S.29E.30.331322	4/4/1985	1930
27765	23S	30E	2	RSLR	23S.30E.02.44414	4/30/1950	510
27838	23S	30E	2	RSLR	23S.30E.02.44414A	3/13/1985	656
27794	23S	30E	2	RSLR	23S.30E.02.44414A	12/11/1970	589
27814	23S	30E	2	RSLR	23S.30E.02.44414A	10/20/1976	584
27820	23S	30E	19	RSLR	23S.30E.19.123421	12/10/1976	36
27959	23S	30E	34	RSLR	23S.30E.34.32400	4/1/1992	760
28003	23S	30E	34	RSLR	23S.30E.34.32400	8/5/1997	610
27890	23S	30E	34	RSLR	23S.30E.34.32400	7/9/1987	636
27868	23S	30E	34	RSLR	23S.30E.34.32400	8/29/1985	680

The high chloride concentrations in the alluvial sediments near the mapped Salt Lake/tailings pond are not surprising if one understands that the Salt Lake is essentially a tailings pond associated with several potash mines.

We sampled groundwater during the drilling of the conductor pipe at Nash Draw 49H. Field chloride titration exhibited 6,800 mg/L Chloride. Based upon chloride titration concentrations, we conclude the TDS is greater than 10,000 mg/L.

Based upon the geology, lithology, and water quality of the area, we conclude that fresh groundwater is not present beneath the proposed temporary pit. Fresh groundwater exists north, south and east of the site. The fresh water to the north is probably confined within the permeable dolomite of the Rustler. To the south, we conclude that fresh water in the Rustler flows into the brine/brackish water of the tailings pond.



Legend

- Pit location
- Nash Draw 49H Conductor Pipe

Misc. Water Wells

Well Depth (ft)

- No Data
- < 150
- 150 - 350

OSE Water Wells

Well Depth (ft)

- < 150
- 150 - 350
- 351 - 1000
- > 1000

Geology with description

- Pqm, Paleozoic-Quartermaster Formation; red sandstone and siltstone; Upper Permian
- Pqr, Paleozoic-Quartermaster and Rustler Formations; Upper Permian
- Pr, Paleozoic-Ruster Formation; siltstone, gypsum, sandstone, and dolomite; Upper Permian
- Qa, Quaternary Alluvium
- Qe/Qp, Quaternary-Eolian Piedmont Deposits
- Qoa, Quaternary-Older Alluvial Deposits
- Qp, Quaternary-Piedmont Alluvial Deposits
- Qpl, Quaternary-Lacustrine and Playa Deposits

N W E S

0 1 2 Miles

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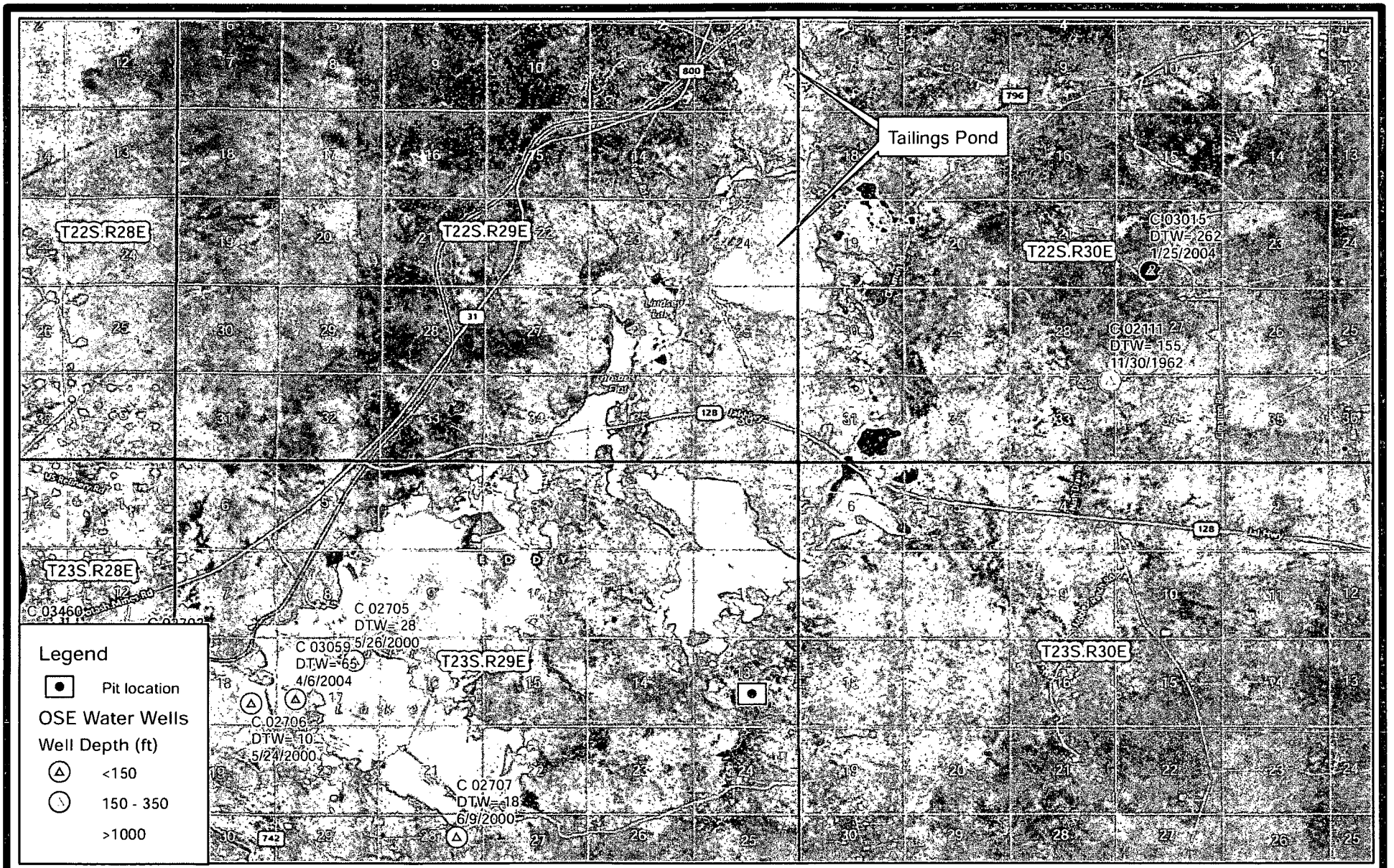
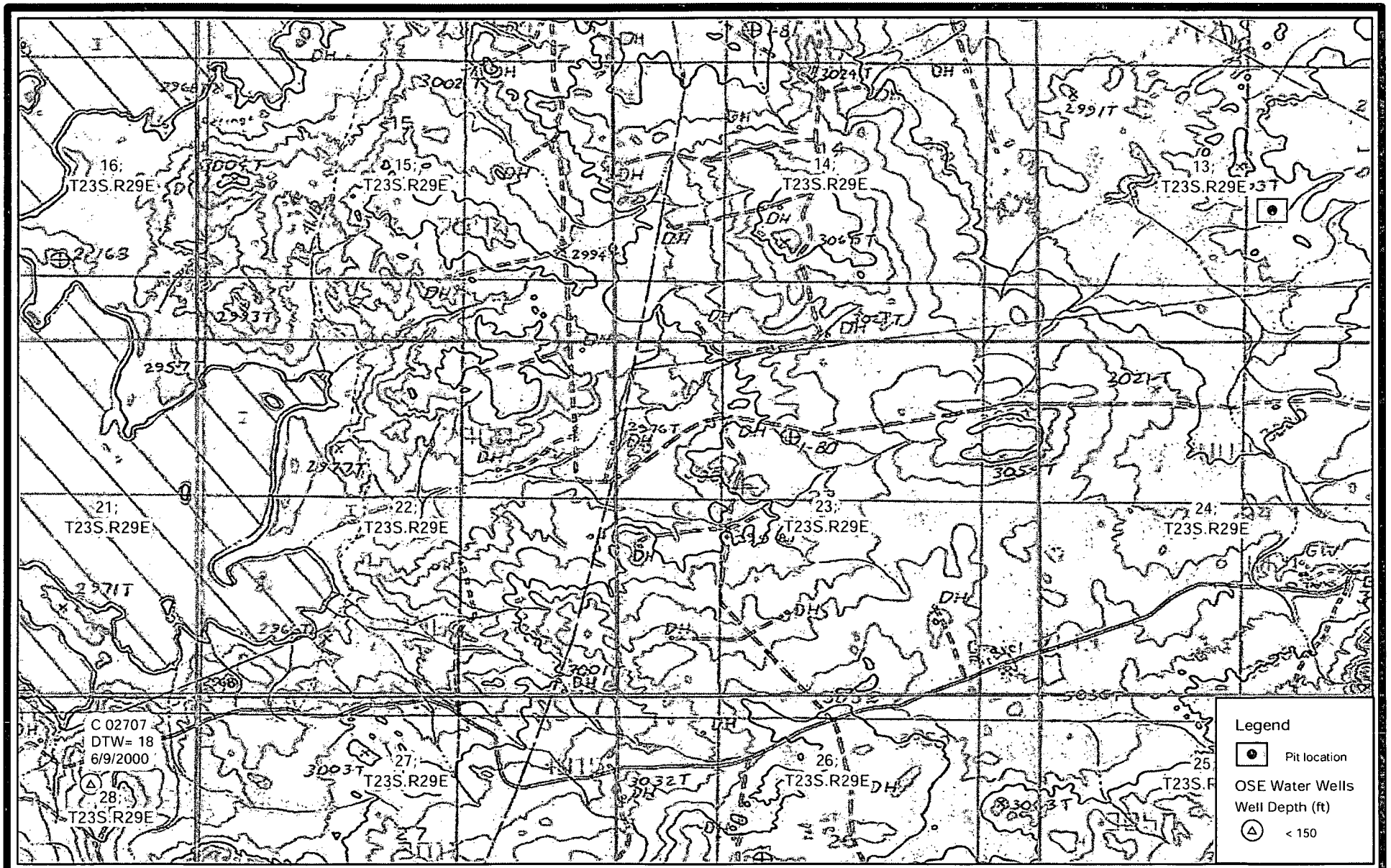
Albuquerque, NM 87104
Ph: 505.266.5004

Nearyby Water Wells and Geology	Figure 1a
XTO Energy: Nash Unit #29	May 2012



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Location of Proposed Pit Relative to Salt Lake/Tailings Pond	Figure 1b
	XTO Energy: Nash Unit #29	May 2012



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Nearyby Water Wells and Topology	Figure 1c
	XTO Energy: Nash Unit #29	May 2012

Records of wells from Eddy County, New Mexico

Location	Well Status	Altitude (feet)	Depth of Well(ft.)	Depth to Water(ft.)	Aquifer	Date of Measurement	Remarks
22.29.33.240	Stock	3020	65	56.2	Qtal ?	Dec.17,1948	
22.30. 2.232	Industrial	3210	344.0	183.12		Mar.16,1976	
2.431	Industrial	3180	217.0	135.85		Mar.16,1976	
4.213		3110	950	dry		1964	
5.431	Industrial	3120		87.5	Rslr	May 18,1949	Yield: 260gpm
5.443	Industrial	3100		68.0	Rslr	May 18,1949	
6.344	Industrial	3145		110.3	Rslr	May 20,1949	Yield: 700gpm
6.424	None	3150		112.4	Rslr	May 18,1949	
6.444	None	3155		117.3	Rslr	May 18,1949	Abandoned
7.244	None	3120	250	85.7	Rslr	May 18,1949	
8.241	None	3155		115.1	Rslr	May 18,1949	
10.310	Domestic/Stock	3130	77	56.0	Rslr/Qtal	Dec.23,1948	
30.240	Stock	3000	75	134.0	Rslr/Qtal	Dec.17,1948	
32.114	Observation	3024	92.0	22.43		Nov.9,1977	Abandoned
22.31.15.130	Domestic	3460		129.0		Mar.16,1976	Windmill
15.130	Unused	3460	167.0	133.32		Mar.16,1976	
15.131	Unused	3460	170.0	126.90		Oct.19,1977	
23.28. 8.131	Irrigation	3032		33.93	Vlfl	Jan.10,1975	
8.421	Irrigation	3022	89	39.66	Vlfl	Jan.15,1965	
23.29.30.333	Irrigation	2970		38		Jul.25,1977	
23.30. 2.440	Stock	3250	300	250	Dckm/Rslr	Dec.22,1948	
4.144		3065	1053	dry			
6.110	Stock	3000	200	110	Rslr	Dec.22,1948	
6.420	Stock	2980			Qtal		
11.222	Stock	3248	284.0	262.76		Dec.19,1977	S.C. 5,800

Records of wells from Eddy County, New Mexico

Location	Well Status	Altitude (feet)	Depth of Well(ft.)	Depth to Water(ft.)	Aquifer	Date of Measurement	Remarks
23.30.19.132	Stock	3036	59.6	54.90		Oct.20,1977	
21.122	Stock	3165			Qtal		Yield: 3gpm
23.31. 5.324		3325	231.0	126.40		Mar.9,1976	
7.220	Stock	3310	180	140	Dckm		Yield: 10(est.)
29.113	Stock	3333	144.0	138.95		Oct.19,1977	
24.29.16.1		2910	180	27		Aug.,1953	
17.44		2920	260	3.5		Oct.7,1953	
26.444	Abandoned oil test	3130	62	42			
24.30.19.421	Stock	3169	279.8	229.94		Dec.19,1977	S.C.>10,000
23.314	Stock, windmill	3437	450.3	448.3+		Oct.19,1977	S.C.2800;29°C
24.30.36.333	Stock	3418	464.2	455 (est.)		Oct.19,1977	S.C.850;23.5°C
24.31.17.111		4521	153.7	78.89		Dec.19,1977	S.C.620
33.232	Abandoned windmill	3460	95.2	dry		Oct.26,1977	
25.29.16.441	Stock	3041	190.6	164.80		Oct.26,1977	
32.211	Stock	2985	698.5	115.3	Rslr	Mar.11,1949	Yield: 2gpm
25.30. 2.000	Stock			295+	Dckm	Mar.11,1949	
8.224	Stock	3223	384.8	324.4	Rslr ?	Oct.26,1977	S.C.3500;23°C
9.100	Stock			295+	Dckm	Mar.10,1949	
21.330	Stock			268	Dckm	Mar.10,1949	Yield:3gpm
25.31. 2.23413	Industrial	3453	1016	400		Aug.18,1966	N.E. well of 2 Oil test
21.000	Stock		420	290	Dckm	Dec.15,1948	
21.412	Stock	3364	429.7	398.27		Oct.26,1977	S.C.1590;25°C
26.29.23.113	Stock	2917	74.0	67.13		Feb.3,1978	
26.30. 5.33441	Industrial	3091	770	171		Apr.3,1972	
8.110	Stock	3080	200	172	Dckm	Dec.15,1948	Yield: 3gpm(est.)