

AP - 095

**STAGE 1
WORKPLAN**

9/25/2008

AP095



TETRA TECH

September 25, 2008

Mr. Glenn vonGonten
New Mexico Energy, Minerals, & Natural Resources
Oil Conservation Division, Environmental Bureau
1220 S. St. Francis Drive
Santa Fe, New Mexico 87504

Re: Remediation Plan for the St. Mary Land & Exploration Company, Hopi Federal #2 Reserve Pit at the St. Mary Land & Exploration Co, Located in Section 1, Township 25 South, Range 28 East, Eddy County, New Mexico.

Dear Mr. Gonten:

Tetra Tech (formerly Highlander Environmental Corp.) was contacted by St. Mary Land & Exploration Company (St. Mary) to assess and close a reserve pit at the Hopi Federal #2 well site, located in Section 1, Township 25 South, Range 28 East, Eddy County, New Mexico (Site). The site location coordinates are 32° 09' 51.54" N, 104° 02' 40.93" W. This report details the activities performed at the Site. The Site is shown on Figure 1 and 2.

Background

At the time, St. Mary Land & Exploration Co recently acquired the property from Nance Petroleum Corporation, the Hopi Federal #2 reserve pit was not properly closed. In order to close the reserve pit, a C-144 was submitted to the NMOCD for approval. According to published data, the depth to groundwater was reportedly less than 50' below surface. Once the C-144 was approved, the pit contents (drilling muds) were excavated and transported to proper disposal. The C-144 is included in Appendix A.

Reserve Pit Sampling

On June 13, 2008, test trenches were installed in the bottom of the reserve pit using a trackhoe. The excavation bottom was at 5.0' to 7.0' below surface. The samples collected were field screened for chlorides and were delivered to Trace Analysis, Inc. for laboratory analyses. The results are shown in Table 1. Referring to Table 1, the chloride impact was not defined below 250 mg/kg in the northwest quarter, southeast quarter, southwest quarter and center of the reserve pit. The northeast quarter showed a field chloride concentration of 150 mg/kg at 25.0' below excavation bottom and the laboratory result showed a chloride concentration of 337 mg/kg. The analytical reports and chain-of-custodies are presented in Appendix B.

Tetra Tech

1910 North Big Spring Midland TX 79705

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Hydrogeology

According to the Geology and Groundwater Resources of Eddy County, New Mexico (Report 3), the Rustler and Castile formation (Ochoa Series) is present west and east of the Pecos River. The Salado formation overlies the Castile formation east of the Pecos River and was removed by solution west of the river. The Rustler and Castile formations consist of anhydrite, gypsum, interbedded sandy clay and beds of dolomite. Groundwater from the Castile and Rustler formations west of the Pecos River is historically high in chloride and sulfate concentrations which increase towards the river.

On June 18, 2008, Tetra Tech personnel supervised the installation of a temporary well (TMW-1) on the south edge of the pad to establish groundwater depth at the Site. The groundwater depth was measured at 39.5' below surface.

Borehole Installation and Results

Two (2) boreholes were installed in the northwest quarter and southwest quarter of the reserve pit to define the extents of the chloride impact. BH-1 and BH-2 were installed to total depths of 31' below pit bottom. The results are shown in Table 1. The chloride concentrations in BH-1 (northwest) declined with depth to 1,004 mg/kg at 30-31' below pit bottom. BH-2 (southwest) also declined with depth to 220 mg/kg at 30-31' below pit bottom.

Monitor well Installation and Sampling

On July 8, 2008, Tetra Tech supervised the installation of three (3) monitor wells (MW-1, MW-2 and MW-3) around the perimeter of the reserve pit to evaluate the groundwater quality. The well locations are shown on Figure 3.

The monitor wells and temporary well were drilled using air rotary drilling techniques and constructed of 2" scheduled 40 PVC flush-threaded casing to a total depth of 52' to 58' below surface. The monitor wells were constructed with 5 feet of screen above and 15 feet below the static groundwater level. The temporary well was constructed of 2" PVC and used 40' feet of factory slotted screen, due to the unknown depth to water. The well completion and boring logs are included in Appendix C.

The well screens were surrounded with a graded silica sand to a depth approximately two feet above the screen and a layer of bentonite pellets, approximately 2 feet thick, was placed in the annulus above the sand. The remainder of the annulus was filled with cement and bentonite grout to about one (1) foot below ground. The wells were secured with locking steel shroud protectors, anchored in a concrete pad measuring approximately three feet by three feet.

Following installation, the wells were developed with an electric submersible pump to remove fine grained sediment disturbed during drilling. Water removed from the wells was placed in a 55-gallon drum onsite.



Prior to purging the wells, each well was gauged to measure the depth to groundwater. The static water levels were measured at MW-1 (39.0'), MW-2 (39.8'), MW-3 (dry) and TMW-1 (39.20'). The water levels are shown in Table 2.

On July 7, 2008 and July 14, 2008, the wells were properly purged and sampled for chlorides by method E 300.0 and Major Ions by EPA methods, respectively. A minimum of three casing volumes were purged from each monitor well. The samples were transported to Trace Analysis, Inc., under chain-of-custody control. Table 3 presents a summary of the analyses. The analytical reports and chain-of-custodies are presented in Appendix B.

Groundwater Results

Based on regional gradient, the groundwater flow appears to be southeast towards the river, which is located approximately 1 mile southeast of the Site. Monitor well (MW-3) was dry. Chloride concentrations in all of the wells exceeded New Mexico Water Quality Control Commission standards with results of 708 mg/L (MW-1), 1,820 mg/L (MW-2) and 460 m/L (TMW-1). Wells TMW-1 and MW-1 (up-gradient) may be indicative of background qualities in this area of the county. Based upon the perceived background quality of MW-1, MW-2 did show elevated chloride concentrations. Based on results, a groundwater notification was made to the NMOCD. Stiff diagrams for each well are enclosed in Appendix D.

NMOCD Meeting and Additional Investigation

On August 27, 2008, Tetra Tech and St. Mary personnel met with Mike Bratcher at the NMOCD office in Artesia, New Mexico to discuss the results of sampling. Based upon the site setting and data, it was decided to pump MW-2 for a short period of time to see if chloride concentrations changed over time. Additionally, it was suggested that background soil borings be placed to look at background chloride concentrations away from the reserve pit.

On September 3, 2008, two background soil borings (BG-1 and BG-2) were installed and advanced to depths of 40' each. Samples were collected at 2' intervals and analyzed for chlorides by method SM 4500-Cl B. Table 4 presents a summary of the analyses. The results of the sampling showed background concentrations in both soil borings as high as 2,040 mg/kg. Copies of the soil boring logs are included in Appendix C.

At the time the background soil borings were being installed, all the monitor wells were gauged and surveyed. MW-3, which previously had been dry was gauged and sampled. The sample results for MW-3 were consistent with upgradient MW-1 and do not show an impact from the reserve pit. Using the current water level measurements, a water table map was constructed and showed the groundwater gradient to be east-southeast. The water table map is shown on Figure 4.

In order to evaluate MW-2 further, a submersible pump was placed into the well. The well yield was marginal and recovery slow. The well yield in a 4 hour period was approximately 25 gallons. The monitor well was sampled three separate times; approximately 1.5 hours between the first two samples and 2.5 hour between the second



and third. The results showed a slight decline in chloride concentrations from 2,020 mg/L to 1,920 mg/L. As is established for background qualities in the vicinity of the Pecos River, sulfate concentrations were elevated for MW-2 and MW-3, with sulfate concentration of approximately 2,100 mg/L in MW-2 and approximately 2,300 mg/L in MW-3.

Conclusions

1. Soil borings placed away from the reserve pit showed elevated chloride concentrations as high as 2,040 mg/kg in subsurface soils.
2. The depth to groundwater at the Site measured approximately 40.0' below surface. The hydraulic gradient for the aquifer shows a gradient to the east-southeast direction.
3. According to the Geology and Groundwater Resources of Eddy County, New Mexico (Report 3), the Rustler and Castile formation (Ochoa Series) crop out west of the Pecos River. The Rustler and Castile formations consist of anhydrite, gypsum, interbedded sandy clay and beds of dolomite. Groundwater from the Castile and Rustler formations west of the Pecos River is historically high in chloride and sulfate concentrations, which increase towards the river.
4. MW-3, which previously had been dry, was sampled on September and showed concentrations consistent with upgradient well MW-1 and TMW-1. This well is located on the south central edge of the reserve pit, and does not show impact from the NW or SW corner of the reserve pit. MW-2, east of the reserve pit, appears to have chloride concentrations above background concentrations (700 mg/L) with sample results ranging from 1,800 to 2,000 mg/L, however, limited pumping over a four hour period did show a slight decrease in chloride concentration. The data indicated a limited area of groundwater impact exists in the vicinity of the reserve pit.

Work Plan

Subsurface Soils

Based on the chloride concentrations in the subsurface soils, additional soil will be excavated and transported offsite for proper disposal. The excavation will reduce the loading and chloride residue in subsurface soils, prior to capping the Site. St. Mary proposes to excavate the northwest and southwest portions of the reserve pit from 5.0' up to a depth of approximately 15.0' below excavation bottom. The southeast portion will be excavated to a depth of 2.0' to 3.0' below excavation bottom.

Due to the shallow groundwater encountered, St. Mary proposes to place an impermeable barrier in the bottom of the excavation to encapsulate any residual impacted soil at the bottom of the excavation. The site will then be backfilled with clean fill material and re-contoured to divert surface runoff away from the site.

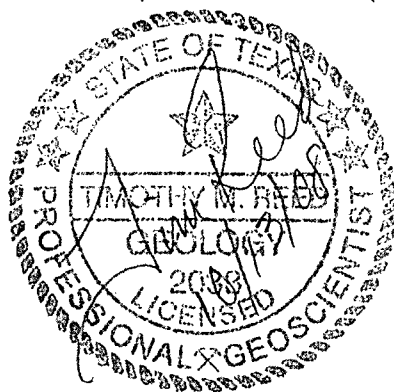


TETRA TECH

Groundwater

The groundwater gradient direction shows to be east-southeast towards the Pecos River, which is located approximately 1 mile southeast of the Site. To remediate the groundwater impact, St. Mary proposes a low-flow pump system be installed in MW-2, and the wells monitored on a quarterly basis. This additional data will be evaluated to determine if the chloride concentrations are decreasing over time. Once completed, the results of the remediation will be submitted to the NMOCD and the BLM.

If you have any question or comments concerning the assessment or the activities performed at the Site, please call me at (432) 682-4559.



Respectfully submitted,
Tetra Tech

Tim Reed, P.G.
Sr. Project Manager

cc: Mike Bratcher – NMOCD, Artesia, NM.

Table 1
St Mary Land & Exploration
Hopi Federal #2 (Reserve Pit)
Eddy County, New Mexico

| Sample ID | Soil Status | | Date Sampled | Sample Depth Below Excavation Bottom | Field Chloride (mg/kg) | Laboratory Chloride (mg/kg) |
|-------------|-------------|---------|--------------|--------------------------------------|------------------------|-----------------------------|
| | Insitu | Removed | | | | |
| NORTHEAST | | | | | | |
| Test Trench | X | | 6/13/2008 | 2.0 | 2,200 | - |
| | X | | 6/13/2008 | 5.0 | 2,050 | - |
| | X | | 6/13/2008 | 10.0 | 1,350 | - |
| | X | | 6/13/2008 | 15.0 | 1,950 | - |
| | X | | 6/13/2008 | 20.0 | 1,300 | - |
| | X | | 6/13/2008 | 22.0 | 400 | - |
| | X | | 6/13/2008 | 25.0 | 150 | 337 |
| NORTHWEST | | | | | | |
| Test Trench | X | | 6/13/2008 | 2.0 | 5,250 | - |
| | X | | 6/13/2008 | 5.0 | 3,750 | - |
| | X | | 6/13/2008 | 10.0 | 2,750 | - |
| | X | | 6/13/2008 | 15.0 | 3,600 | - |
| | X | | 6/13/2008 | 20.0 | 3,300 | - |
| | X | | 6/13/2008 | 22.0 | 1,450 | 1,520 |
| | | | | | | |
| BH-1 | X | | 6/19/2008 | 10-11 | - | 4,124 |
| | X | | 6/19/2008 | 15-16 | - | 6,262 |
| | X | | 6/19/2008 | 20-21 | - | 5,248 |
| | X | | 6/19/2008 | 25-26 | - | 4,433 |
| | | | 6/19/2008 | 30-31 | - | 1,004 |
| SOUTHEAST | | | | | | |
| Test Trench | X | | 6/13/2008 | 2.0 | 12,300 | - |
| | X | | 6/13/2008 | 5.0 | 2,550 | - |
| | X | | 6/13/2008 | 7.0 | 1,850 | 2,340 |
| | | | | | ROCK | |
| SOUTHWEST | | | | | | |
| Test Trench | X | | 6/13/2008 | 2.0 | 4,250 | - |
| | X | | 6/13/2008 | 5.0 | 8,000 | - |
| | X | | 6/13/2008 | 10.0 | 5,100 | - |
| | X | | 6/13/2008 | 15.0 | 4,900 | - |
| | X | | 6/13/2008 | 20.0 | 6,650 | - |
| | X | | 6/13/2008 | 22.0 | 3,000 | 4,310 |
| | | | | | | |
| BH-2 | X | | 6/19/2008 | 10-11 | - | 11,320 |
| | X | | 6/19/2008 | 15-16 | - | 10,235 |
| | X | | 6/19/2008 | 20-21 | - | 904 |
| | X | | 6/19/2008 | 25-26 | - | 1,061 |
| | | | 6/19/2008 | 30-31 | - | 220 |
| CENTER | | | | | | |
| Test Trench | X | | 6/13/2008 | 2.0 | 3,750 | - |
| | X | | 6/13/2008 | 5.0 | 4,450 | - |
| | X | | 6/13/2008 | 10.0 | 4,950 | - |
| | X | | 6/13/2008 | 15.0 | 1,400 | - |
| | X | | 6/13/2008 | 20.0 | 1,900 | - |
| | X | | 6/13/2008 | 22.0 | 350 | 1,380 |

(-) not analyzed

Table 2
St Mary Exploration & Exploration Company
Groundwater Analytical Results
Hopi Federal #2 Reserve Pit
Eddy County, New Mexico

| Monitor Well | Date Sampled | Total Depth (Feet) | Water Level (TOC) (Feet) | Water Level Elevation |
|--------------|--------------|--------------------|-----------------------------|--------------------------|
| MW-1 | 07/14/08 | 52 | 39 | 2904.48 |
| | 09/03/08 | | 39.09 | 2904.23 |
| | | | | |
| MW-2 | 07/14/08 | 52 | 40.91 | 2898.96 |
| | 09/03/08 | | 40.63 | 2899.24 |
| | | | | |
| MW-3 | 07/14/08 | 52 | DRY | - |
| | 09/03/08 | | 45.04 | 2894.01 |
| | | | | |
| TMW-1 | 07/14/08 | 58 | 42 | 2899.01 |
| | 09/03/08 | | 41.66 | 2899.35 |
| | | | | |

(-) Not Analyzed

Table 3

St Mary Exploration & Exploration Company
Groundwater Analytical Results
Hopi Federal #2 Reserve Pit
Eddy County, New Mexico

| Monitor Well | Date Sampled | Dissolved Calcium (mg/L) | Dissolved Magnesium (mg/L) | Dissolved Sodium (mg/L) | Dissolved Potassium (mg/L) | Carbonate Alkalinity (mg/L) | Bicarbonate Alkalinity (mg/L) | Total Alkalinity (mg/L) | Sulfate (mg/l) | Chloride (mg/L) | TDS (mg/L) | Hardness (mg/L) | pH |
|--------------|--------------|--------------------------|----------------------------|-------------------------|----------------------------|-----------------------------|-------------------------------|-------------------------|----------------|-----------------|------------|-----------------|------|
| MW-1 | 07/09/08 | - | - | - | - | - | - | - | - | 765 | - | - | - |
| | 07/14/08 | 737 | 233 | 145 | 12.3 | <1.0 | 58 | 58 | 1610 | 708 | 3040 | 2800 | 7.26 |
| | | | | | | | | | | | | | |
| MW-2 | 07/09/08 | - | - | - | - | - | - | - | - | 2,040 | - | - | - |
| | 07/14/08 | 793 | 345 | 960 | 16.8 | <1.0 | 181 | 181 | 1940 | 1820 | 6340 | 3400 | 7.2 |
| | 09/03/08 | 747 | 333 | 964 | 14.7 | <1.0 | 198 | 198 | 2150 | 2020 | 6320 | 3240 | 7.8 |
| | 09/03/08 | 774 | 327 | 958 | 14.4 | <1.0 | 183 | 183 | 2140 | 2010 | 6560 | 3280 | 7.6 |
| | 09/03/08 | 760 | 317 | 925 | 14.5 | <1.0 | 187 | 187 | 2120 | 1920 | 6360 | 3200 | 7.7 |
| | | | | | | | | | | | | | |
| MW-3 | 07/09/08 | | | | | | | | | | | | |
| | 09/03/08 | 599 | 317 | 268 | 18.6 | <1.0 | 88 | 88 | 2370 | 529 | 4520 | 2800 | 7.98 |
| | | | | | | | | | | | | | |
| TMW-1 | 07/09/08 | - | - | - | - | - | - | - | - | 477 | - | - | - |
| | 07/14/08 | 692 | 80.4 | 132 | 6.16 | <1.0 | 167 | 167 | 1540 | 460 | 2940 | 2060 | 7.54 |
| | | | | | | | | | | | | | |

(-) Not Analyzed

Table 4
St Mary Land & Exploration
Hopi Federal #2 (Reserve Pit)
Eddy County, New Mexico

| Sample ID | Date Sampled | Depth (Feet) | Chloride mg/km |
|------------------|---------------------|---------------------|-----------------------|
| BG-1 | 9/3/2008 | 3-4 | <100 |
| | 9/3/2008 | 6-7 | 190 |
| | 9/3/2008 | 9-10 | 794 |
| | 9/3/2008 | 12-13 | 702 |
| | 9/3/2008 | 15-16 | 1590 |
| | 9/3/2008 | 18-19 | 1540 |
| | 9/3/2008 | 21-22 | 1460 |
| | 9/3/2008 | 24-25 | 1220 |
| | 9/3/2008 | 27-28 | 1350 |
| | 9/3/2008 | 30-31 | 1020 |
| | 9/3/2008 | 33-34 | 205 |
| | 9/3/2008 | 36-37 | <100 |
| | 9/3/2008 | 39-40 | <100 |
| BG-2 | 9/3/2008 | 3-4 | 2040 |
| | 9/3/2008 | 6-7 | 1540 |
| | 9/3/2008 | 9-10 | 675 |
| | 9/3/2008 | 12-13 | 550 |
| | 9/3/2008 | 15-16 | 467 |
| | 9/3/2008 | 18-19 | 924 |
| | 9/3/2008 | 21-22 | 612 |
| | 9/3/2008 | 24-25 | 488 |
| | 9/3/2008 | 27-28 | <100 |
| | 9/3/2008 | 30-31 | <100 |
| | 9/3/2008 | 33-34 | <100 |
| | 9/3/2008 | 36-37 | <100 |
| | 9/3/2008 | 39-40 | <100 |

(-) not analyzed

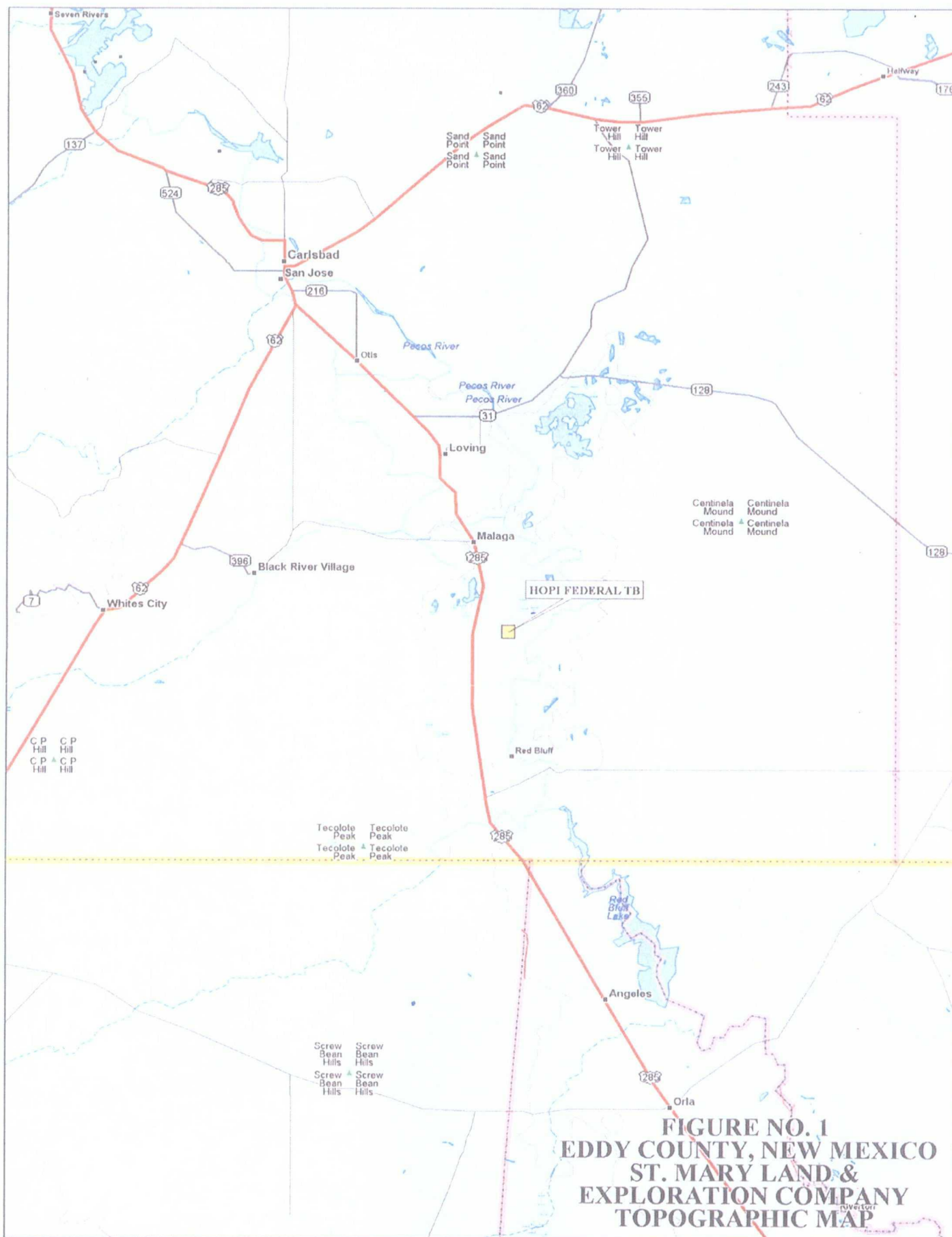


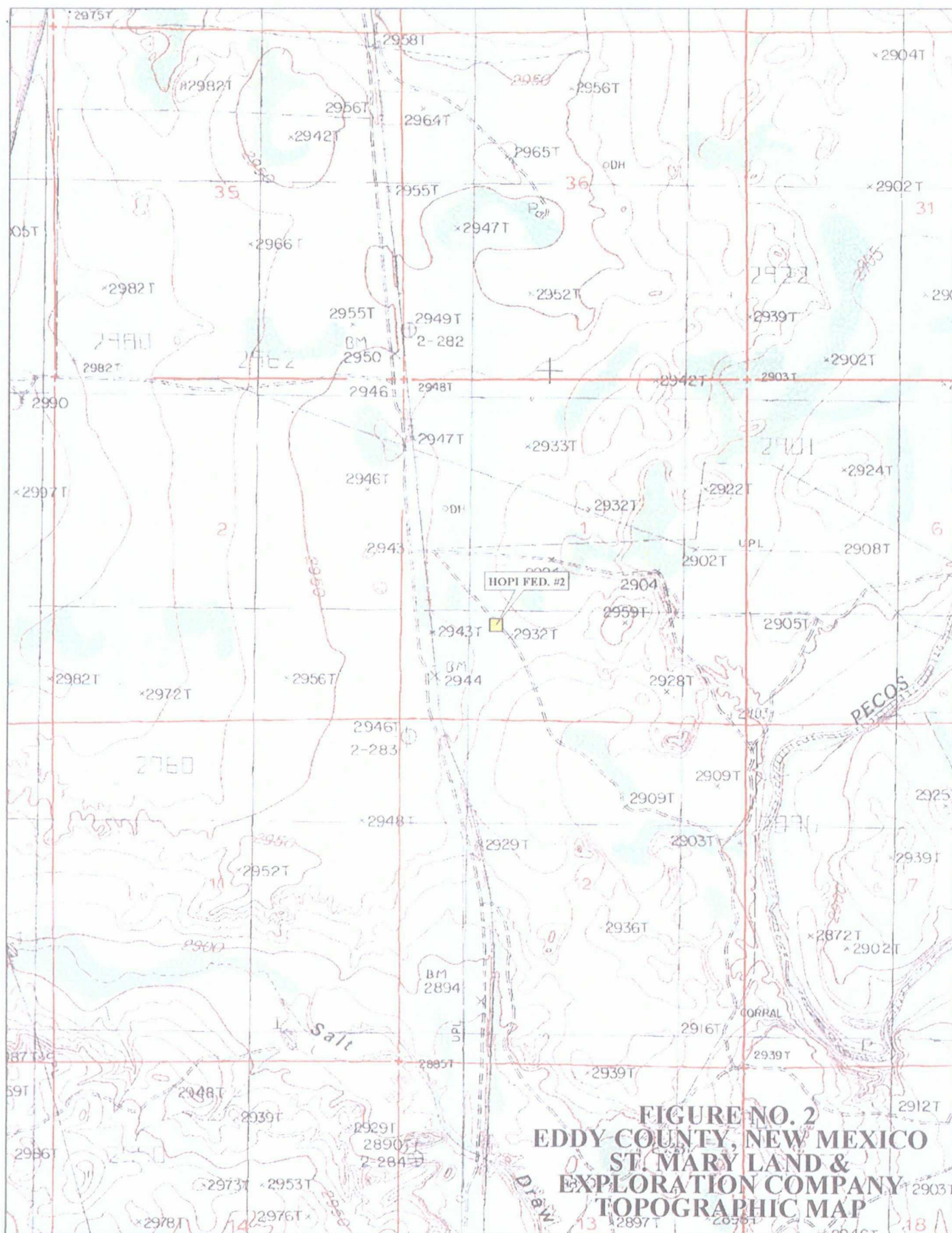
FIGURE NO. 1
EDDY COUNTY, NEW MEXICO
ST. MARY LAND &
EXPLORATION COMPANY
TOPOGRAPHIC MAP



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www.delorme.com

Scale 1 : 400,000
 1" = 6.31 mi





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www.delorme.com

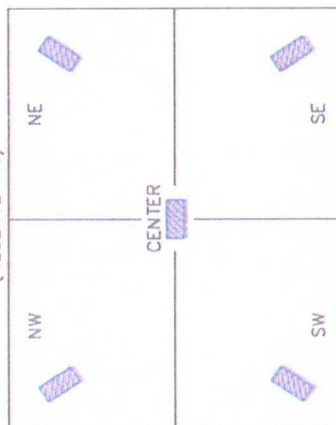
Scale 1 : 24,000
 1" = 2000 ft





MW-1

(RESERVE PIT)



MW-2

MW-3

BH-1

BACKGROUND

BH-2

BACKGROUND

HOPI FED. WELL #2

WELL PAD

TMW-1

FIGURE NO. 3

EDDY COUNTY, NEW MEXICO

ST. MARY LAND
& EXPLORATION

HOPI FED #2
RESERVE PIT

TETRA TECH, INC.
MIDLAND, TEXAS

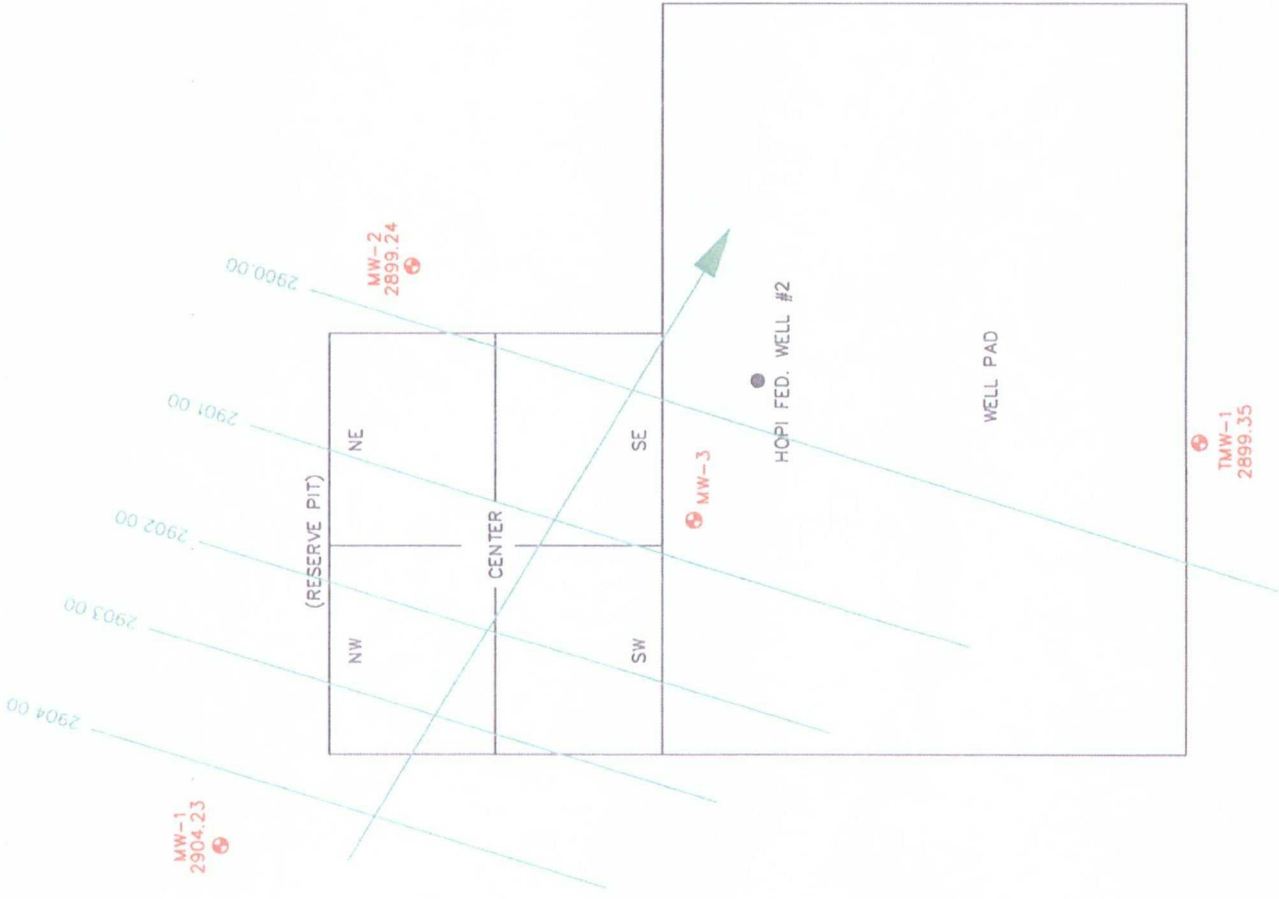
DATE:
7/18/08

DWG. BY:
RC

FILE:
C:\Users\rc\Documents
HOPI FED #2

SCALE: 1" = 60'

■ SAMPLE TRENCH
● MONITOR WELL



SAMPLE TRENCH
MONITOR WELL

SCALE: 1" = 60'
0 60'

FIGURE NO. 4

EDDY COUNTY, NEW MEXICO

ST. MARY LAND
& EXPLORATION

HOPi FED #2
RESERVE PIT

TETRA TECH, INC.
MIDLAND, TEXAS

DATE:
7/18/08

DWG. BY:
RC

FILE:
ST. MARY.LS008
HOPi FED #2

SAMPLE LOG

Boring/Well: TMW-1
Project Number: 3506
Client: St. Mary Land & Exploration
Site Location: Hopi Federal #2
Location: Eddy County, New Mexico
Total Depth: 59
Date Installed: 06/18/08

| DEPTH (Ft) | OVM | SAMPLE DESCRIPTION |
|------------|-----|---|
| 0-5 | -- | Tan/red sand clay and broken caliche |
| 5-10 | -- | Tan/red fine grain sand and clay |
| 10-15 | -- | White, gypsum, some dense |
| 15-20 | -- | White, gypsum, some dense |
| 20-25 | -- | White, gypsum, some dense |
| 25-30 | -- | White, gypsum, some dense, tan/brown streak of clay @ 30' |
| 30-35 | -- | White, gypsum, some dense |
| 35-40 | -- | White, gypsum, tan/brown streak of clay |
| 40-45 | -- | White, gypsum, some dense |
| 45-50 | -- | White, gypsum, some dense, karst @ 45-51' |
| 55-58 | | White, gypsum and trace of sandy clay |
| | | |

Total Depth is 58 feet

Groundwater encountered at 39 feet

WELL CONSTRUCTION LOG

EXISTING GRADE

6 ³/₄" DIA. DRILLED HOLE

WELL CASING
2" DIA.

Installation Date(s) 6-18-08
Drilling Method AIR ROTARY
Drilling Contractor SCARBROUGH DRILLING
Development Technique(s) and Date(s) PUMP ON JULY 10, 2008

Water Removed During Development 22 gals.
Static Depth to Water 39.20 ft. below
Ground Level
Well Purpose TEMPORARY MONITOR WELL

Remarks -

17 ft. 18 ft.

WELL SCREEN 2"
SLOT DIA. 0.020

☒ SAND PACK

58 ft.

58 ft.

DATE: 7-10-08

**Highlander
Environmental**

CLIENT: ST. MARY LAND & EXPLORATION
PROJECT: HOPI FEDERAL #2
LOCATION: EDDY COUNTY, NM

WELL NO.

TMW-1

SAMPLE LOG

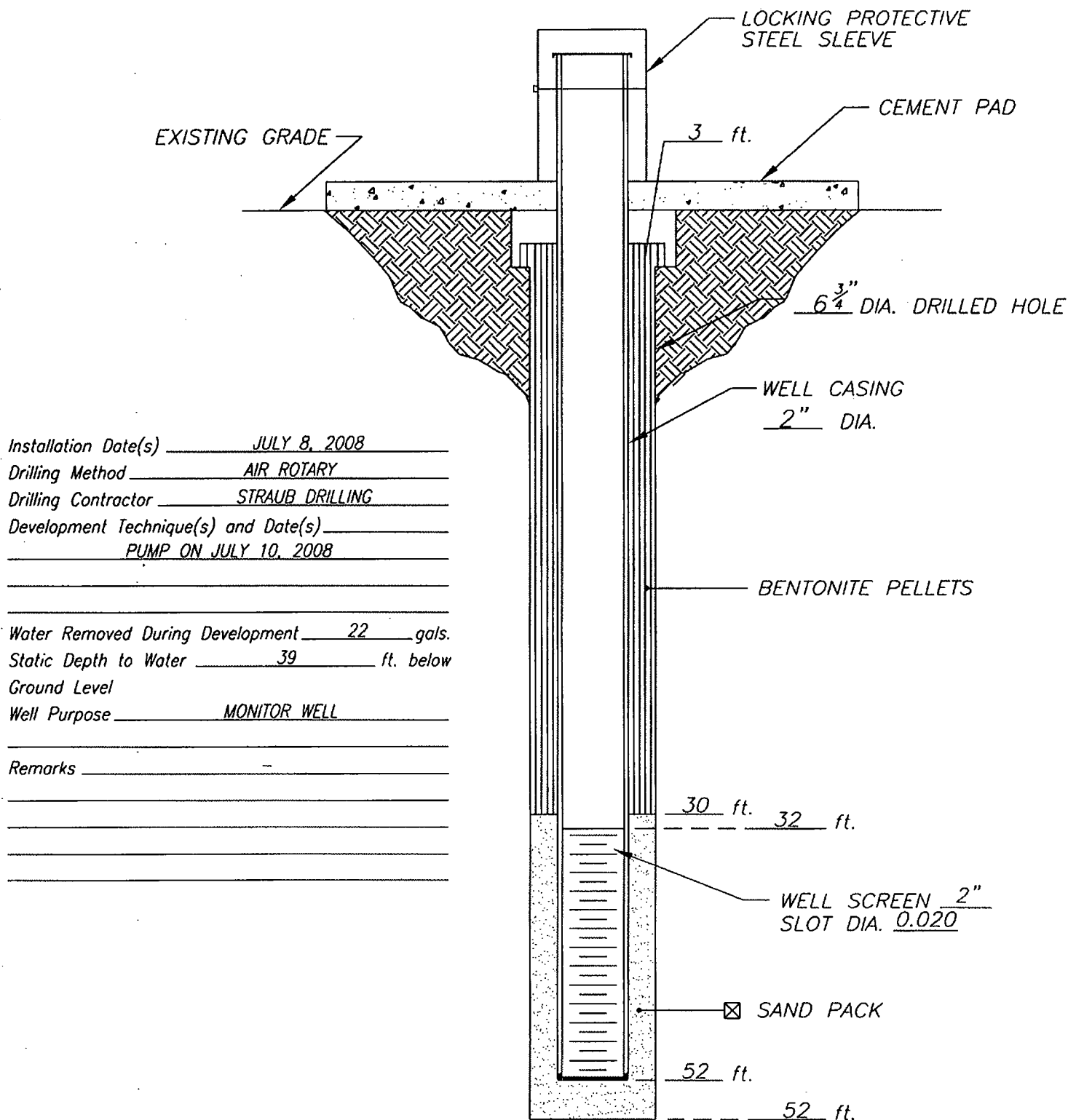
Boring/Well: MW-1
Project Number: 3506
Client: St. Mary Land & Exploration
Site Location: Hopi Federal #2
Location: Eddy County, New Mexico
Total Depth: 52
Date Installed: 07/08/08

| DEPTH (Ft) | OVM | SAMPLE DESCRIPTION |
|------------|-----|--|
| 0-5 | -- | Tan fine grain sand intermixed with gypsum |
| 5-10 | -- | Tan/red fine grain sand |
| 10-15 | -- | Light tan fine grain sand |
| 15-20 | -- | Tan fine grain sand |
| 20-25 | -- | Red to tan fine to medium grain sand |
| 25-30 | -- | Red to tan fine to medium grain sand |
| 30-35 | -- | Red medium grain sand (moist) |
| 35-40 | -- | Red to tan medium grain sand with gypsum |
| 40-45 | -- | Red medium grain sand intermixed with clay |
| 45-50 | -- | Red medium grain sand intermixed with clay |
| 50-52 | -- | Red clay intermixed with some medium grain sand. |

Total Depth is 52 feet

Groundwater encountered at 39 feet

WELL CONSTRUCTION LOG



DATE: 7-10-08

**Highlander
Environmental**

CLIENT: ST. MARY LAND & EXPLORATION
PROJECT: HOPI FEDERAL #2
LOCATION: EDDY COUNTY, NM

WELL NO.

MW-1

SAMPLE LOG

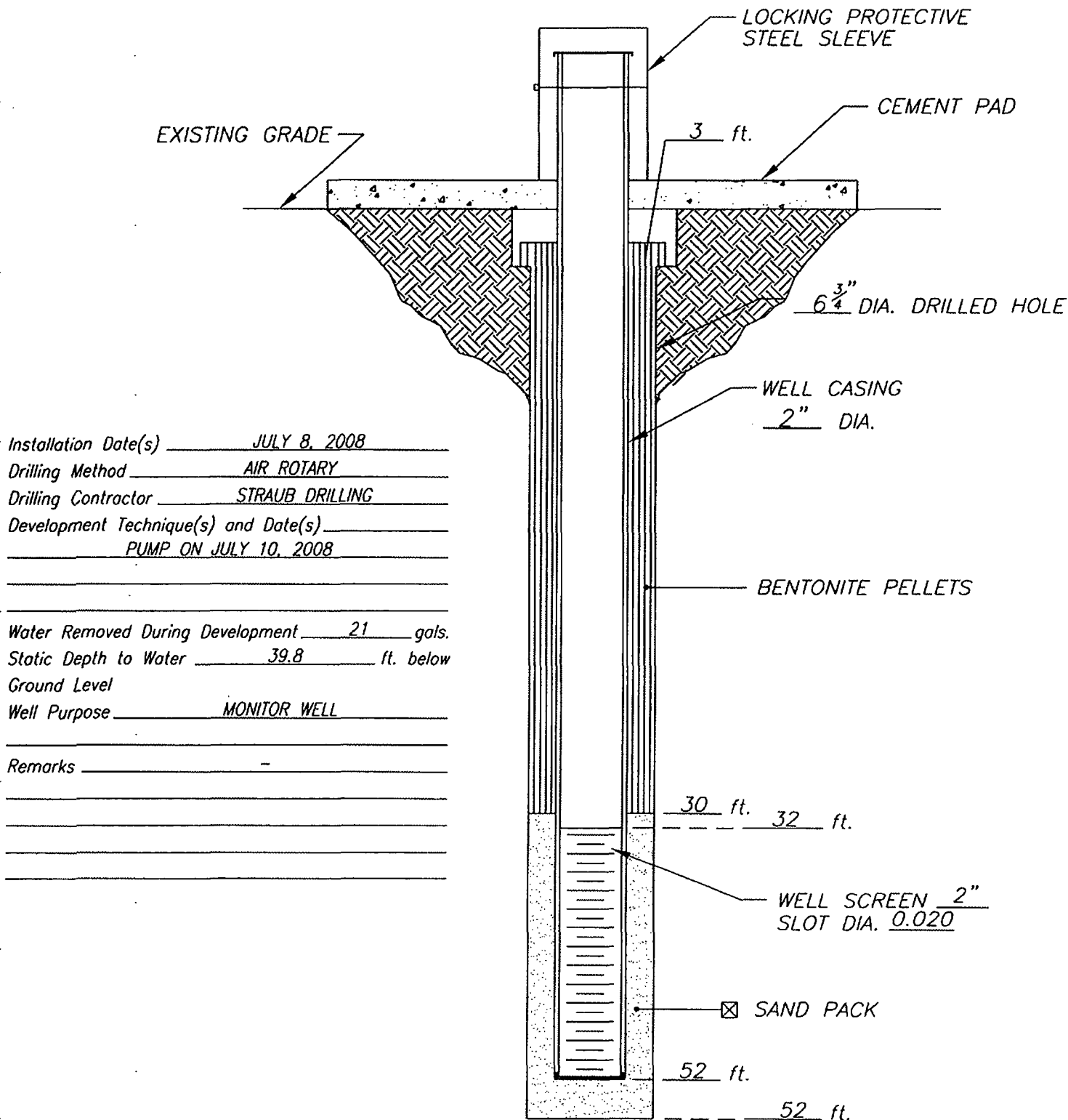
Boring/Well: MW-2
Project Number: 3506
Client: St. Mary Land & Exploration
Site Location: Hopi Federal #2
Location: Eddy County, New Mexico
Total Depth: 52
Date Installed: 07/08/08

| DEPTH (Ft) | OVM | SAMPLE DESCRIPTION |
|------------|-----|---|
| 0-5 | -- | Tan fine grain sand with gypsum |
| 5-10 | -- | Tan/red fine grain sand with clay intermixed |
| 10-15 | -- | Red find grain sandy red clay (dry) |
| 15-20 | -- | Tan/red fine grain clayey sand |
| 20-25 | -- | Red fine grain sandy clay (moist) |
| 25-30 | -- | Red fine grain sandy clay (moist) |
| 30-35 | -- | Red fine grain sandy clay (moist) with gypsum |
| 35-40 | -- | Red fine grain sandy clay (wet) |
| 40-45 | -- | Red fine grain sandy clay (wet) |
| 45-50 | -- | Red fine grain sandy clay (wet) |
| 50-52 | -- | Red fine grain sandy clay (wet) |

Total Depth is 52 feet

Groundwater encountered at 39 feet

WELL CONSTRUCTION LOG



DATE: 7-10-08

**Highlander
Environmental**

CLIENT: ST. MARY LAND & EXPLORATION
PROJECT: HOPI FEDERAL #2
LOCATION: EDDY COUNTY, NM

WELL NO.

MW-2

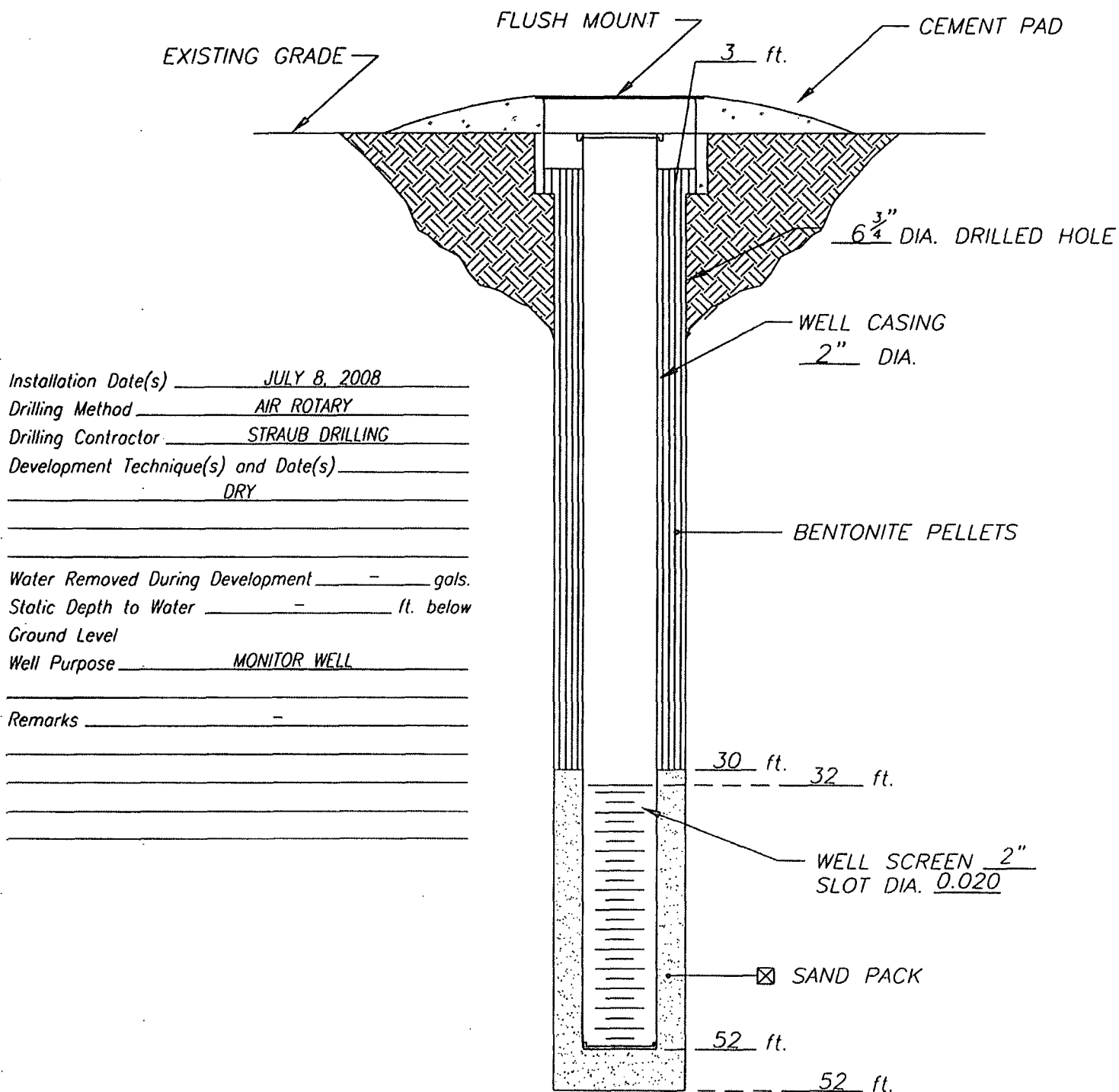
SAMPLE LOG

Boring/Well: MW-3
Project Number: 3506
Client: St. Mary Land & Exploration
Site Location: Hopi Federal #2
Location: Eddy County, New Mexico
Total Depth: 52
Date Installed: 07/08/08

| DEPTH (Ft) | OVM | SAMPLE DESCRIPTION |
|------------|-----|---|
| 0-5 | -- | Tan fine grain sandy intermixed with clay |
| 5-10 | -- | Tan to red fine grain silty sand (dry) |
| 10-15 | -- | Tan to red fine grain silty sand with some clay intermixed |
| 15-20 | -- | Tan to red fine grain silty sand with some clay intermixed |
| 20-25 | -- | Reddish brown silty with some sand intermixed |
| 25-30 | -- | Gray clay with gypsum intermixed |
| 30-35 | -- | Dark brown sandy clay with small amounts of gypsum intermixed |
| 35-40 | -- | Dark brown silt with clay intermixed |
| 40-45 | -- | Light tan/whitish mix of powdery silt |
| 45-50 | -- | Grayish red clay (dry) |
| 50-52 | -- | Grayish red clay (dry) |

Total Depth is 52 feet No groundwater encountered

WELL CONSTRUCTION LOG



DATE: 7-10-08

**Highlander
Environmental**

CLIENT: ST. MARY LAND & EXPLORATION
PROJECT: HOPI FEDERAL #2
LOCATION: EDDY COUNTY, NM

WELL NO.

MW-3

consisting of halite and other potassium salts, and in the area east of the area removed by solution. Eddy County, but it occurs as. Potash ore is mined

this formation. In the spaces capable of trans- enters the potash mines rustler formation contains er water at Malaga Bend lo formation (Robinson

on unconformably over- east of the Pecos River, group or its equivalents e bedding of the Rustler face of the Salado forma- ss from about 200 feet in heast of Carlsbad. It con- nd green sandy clay, and

mines can be divided into t thick and an upper an- yre, and others, 1942, pp. y shale but includes some te unit contains irregular istent basal dolomite.

e Rustler formation in the Robinson and Lang, 1938, wo parts: The upper part,

RUSTLER FORMATION NEW MEXICO

| THICKNESS Ft. | DEPTH Ft. |
|------------------|--------------|
| 30 | 30 |
| 30 | 60 |
| 100 | 160 |
| 30 | 190 |
| 20 | 210 |
| 35 | 245 |
| 30 | 275 |
| 70 | 345 |
| 20 | 365 |
| 130 | 495 |
| 5 | 500 |

generally about 200 feet thick, includes all beds lying above the 35-foot dolomitic limestone unit, and the lower part, about 300 feet thick, includes the 35-foot dolomitic limestone unit and all beds below it down to the Salado formation.

In the northern part of the county the Rustler crops out east of the Pecos River in the eastern part of a belt of gypsum and redbeds. In this area the Rustler overlies the Chalk Bluff formation and is not easily distinguished from it. South of Carlsbad the west boundary of the main outcrop area of the Rustler approximately follows the Pecos River, but it extends a few miles west of the river near the south county line. The east boundary of the outcrop area of the Rustler is largely concealed by the mantle of the so-called Mescalero sands which cover both the Rustler and the overlying Triassic redbeds. The Rustler also crops out west of the Pecos in the Frontier Hills.

In its outcrop areas the Rustler yields water to many stock wells and some domestic wells. It also furnishes some of the water used by the International Minerals and Chemical Co., and the Potash Co. of America for refining potash. In the Carlsbad area it yields some water for small-scale irrigation. The water from the Rustler generally is not desirable for domestic use because of its high chloride and sulfate content. In certain areas wells penetrating the lower part of the Rustler yield a concentrated brine derived from the underlying Salado formation which cannot be used even for livestock. This brine aquifer at the base of the Rustler discharges salt water into the Pecos River in the vicinity of Malaga Bend (Robinson and Lang, 1938, pp. 77-100).

TRIASSIC SYSTEM

Dockum group

Overlying the Rustler formation in Eddy County are redbeds and sandstones of the Dockum group. The lower part of these beds has been considered Permian and correlated with the Dewey Lake redbeds by some geologists (DeFord, Willis, and Riggs, 1940). The total thickness of the Dockum group east of Artesia is about 1,000 feet. The formations of the Dockum group exposed in Eddy County are the Pierce Canyon redbeds, the Santa Rosa sandstone, and redbeds that possibly represent the Chinle formation.

The Pierce Canyon redbeds overlie the Rustler formation. They are about 350 feet thick and consist of red sandy shale and fine-grained sandstones marked with greenish-gray reduction spots. The formation thins to the north and is absent north of the latitude of Artesia. The Pierce Canyon redbeds crop out in the upper part of Nash Draw, in Clayton Basin, in some of the canyons on the east side of the Pecos River south of Malaga, and in other isolated areas east of the Pecos.

The Santa Rosa sandstone overlies the Pierce Canyon redbeds south of the latitude of Artesia and the Rustler formation north of Artesia. The Santa Rosa is 200 to 300 feet thick and consists of gray