AP - 34

STAGE 1 & 2 WORKPLANS

DATE:

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Interim Report of Investigation and Work Plan
Navajo Refining Company
North Monument 6 in. Gathering Line
Section 30, Township 19S, Range 37E
Lea County, New Mexico

March 4, 2003

Prepared for:

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I. Background

On October 5, 2002, a leak was discovered in a 6 in. crude oil gathering line operated by Navajo Refining Company in the vicinity of Monument, New Mexico. The leak was discovered as a result of an inventory discrepancy and subsequently a section of pipeline located near Maddox Road west of Monument was found to be leaking. The leak area is located in the NW/4, SW/4, Section 30, T19S, R37E, which is approximately two miles west of Monument, New Mexico (Figure 1, Vicinity Map). The location is adjacent to Maddox Road approximately one-half mile north of its intersection with NM 322. The leak location is situated on relatively level ground.

At the time the leak was discovered, Navajo was investigating the likelihood of a leak by digging exploratory holes adjacent to the line to detect petroleum hydrocarbons. When the first detection was made, Navajo notified the NMOCD Hobbs District Office verbally with follow-up submittal of Form #C-141 on October 16, 2002 (Appendix A).

Additional digging using a backhoe was performed under the supervision of Safety and Environmental Solutions (SESI). Heavier equipment including a trackhoe was used to daylight the pipeline so that the extent of the problem could be determined. The entire section of the impacted pipeline was removed and to date it has not been replaced, although a replacement line is planned that would skirt the area about 150 ft. south of the existing location.

II. Investigation Status

Contaminate and Size of Leak

Initial and follow-up excavation exposed 600 ft. of pipeline, which was subsequently removed. Between five and seven leaks were found in that section of line. The length of time the pipeline was leaking and the amount of crude oil released is unknown, but the volume is estimated at 2,100 barrels* using inventory records. The pipeline was relatively new and was installed within the past two years. The leak may have been caused by another party that moved acidized crude oil (oil containing acid from well treatment) into the line. The line was not in operation continuously which meant that a slug of the acid was apparently positioned in the section of line for some time thereby causing the leak.

Crude oil leaked from the pipeline in two major locations. The first was located to the east of Maddox Road at a distance from 300 to 400 ft. east of the road, and the second area is immediately adjacent to Maddox Road on the west side. The impacted soils area is generally a rectangular area approximately 700 ft. by 300 ft. oriented in the direction of the pipeline (east-west) for a total of 210,000 square-feet (4.8 acres) (Plate 1.). Impacts within that area range from free hydrocarbon product in some exploratory boreholes to a show of hydrocarbon product in soil samples collected during drilling.

* The original estimate of 2,024 barrels submitted with Form C-141 on October 16 is revised upwards to 2,100 barrels based on further review of inventory records by Navajo.

Vertical and Horizontal Extent of Contamination in the Vadose Zone

Following discovery of the leak, a backhoe first uncovered the line, then heavy equipment was used to excavate a large trench approximately 15-16 ft. deep adjacent to the north side of the line in the area most heavily impacted by the leaks. For safety reasons a shallow bench area on the north side of the trench was also excavated. (See Appendix B for photographs).

The trench provided a vertical cross-section of the area above and below the pipe, and showed evidence of downward migration of hydrocarbon from the pipeline trench to below the bottom of the trench (See 11/13/02 photographs). Additional digging by the onsite trackhoe determined the presence of saturated hydrocarbons beneath the bottom of the trench. Several soil samples were collected during the early portion of the delineation and the analytical results showed the samples have highly elevated concentrations of petroleum hydrocarbons (Table 1).

Further delineation was performed using a hollow-stem auger. To date, a total of 80 boreholes have been drilled on the east side of Maddox Road and another eight have been drilled on the west side of Maddox Road. Of these boreholes, a total of 64 have been completed as temporary recovery wells with screened PVC and a sand pack (Plate 1, Table 2).

During drilling of the boreholes, samples were collected at various intervals for analysis for total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylenes (BTEX) and the laboratory results are shown in Table 1. Initially, it was intended to collect samples from every borehole. However, as the extent of the problem became apparent, sample collection was generally reduced to documentation of contamination away from the pipeline, and verification samples at outlying boreholes where field observation indicated an unimpacted borehole.

Soil Characteristics

Soils beneath the site are non-homogenous to a depth of 25-30 ft. They consist of a mixture of sand, silt and clay with frequent zones of hard, consolidated caliche and occasional sandstone. The caliche is characterized by being either laminar with thin intermediate zones of fine-grained sand, or well-cemented zones ranging from several inches to over a foot in thickness. Core samples show alternating zones of caliche and thin sand lenses at the surface with increasing clay with depth. However, no consistent "marker" bed of any type of sediment was observed in the area delineated.

Within the soil material zones of enhanced permeability exist either as primary permeability through sand lenses, or as secondary permeability in zones of poorly cemented or fractured caliche. This is evidenced by the detection of significant product in some boreholes and the absence or near absence of product in adjacent wells 25 ft. away. These pathways for vertical and horizontal hydrocarbon movement are called preferential pathways and are discussed further below. However, the presence, or lack thereof, of preferential pathways appears almost random in the area of the leak, and the presence or

absence of hydrocarbon product could be determined only though the drilling of exploratory boreholes.

III. Groundwater Characterization

Immediately following detection of the leaky line, three monitor wells were installed at the site to determine depth to groundwater and for sampling for dissolved petroleum hydrocarbons (BTEX). Two replacement wells were drilled in November and December 2002. Depth to groundwater at the site varies from 18 to 25 ft. below ground surface as measured in the recently installed monitor wells. Redbed was encountered in one well (MW-5) at a depth of 35 ft. Several sets of water level measurements were taken and the results are presented in Table 3. The ground water flow direction and gradient were determined for the site. Groundwater flow is generally east-southeast and the hydraulic gradient in November 2002 was 0.005, which is relatively flat (Figure 2).

No water wells are known to have been affected by the leak. A windmill for stock watering is located approximately one-half mile downgradient from the site. The well was sampled several days following the detection of the leak; no BTEX was detected at a reporting level of 0.002 mg/L. Chloride content was 100 mg/L and total dissolved solids (TDS) was 528 mg/L. Groundwater sampling results are shown in Table 4.

Following installation and development of the first three monitoring wells (MW-1, -2 and MW-3), groundwater samples were obtained for analysis for BTEX. No BTEX was detected in the three wells at a reporting level of 0.002 mg/L. A water sample from one borehole impacted by hydrocarbon product (BH-7) was collected for water chemistry analysis. The results show chloride and TDS at 124 and 636 mg/L, respectively.

A fourth monitoring well was installed 100 ft. downgradient from the last borehole having a show of hydrocarbon product. At the time of drilling in November, there was no indication of hydrocarbon product in the groundwater or the overlying soils. However following well development and purging for sampling in late December hydrocarbon product was detected with a thickness of 1.6 ft. This well was plugged on January 28, 2003.

Similarly, hydrocarbon product was detected in MW-2 on November 18, 2002. A replacement well, MW-5, was drilled on November 22 and MW-2 was plugged on January 23, 2003. Both MW-2 and MW-4 were plugged due to the large zone of water/hydrocarbon mixing that was created by hydrocarbon product coming in contact with a column of water 8 to 12 ft. thick. The water filled borehole exposed a thickness of aquifer to contamination which otherwise would have been protected to some extent by this thickness of undisturbed earth materials. This issue is examined further in Section VI, Discussion.

The remaining monitor wells not impacted by hydrocarbon product, MW-1, 3 and 5, were sampled on December 30, 2002. No BTEX was detected at a reporting limit of 0.002 mg/L.

IV. Product Recovery

Product recovery commenced on October 11, 2002 by pumping borehole BH-4. Boreholes with significant thickness of petroleum hydrocarbons were completed as 2-in. temporary recovery wells. To date 55 recovery wells have been completed. To recover oil, 12-volt purge pumps were placed in wells close to the pipeline and in other wells having a large thickness of oil. The recovered oil is stored in 300- or 800-gallon tanks placed next to the well. Currently, 15 pumps are installed to recover product and additional pumps are being installed. These pumps are operated by a 12-volt battery, a battery charger operating with 110-volt ac power, and a timer with variable on and off settings. Wells not receiving pumps but with significant product thickness are pumped weekly and the product is stored in a tank mounted on a portable trailer.

When the smaller tanks are full, an oilfield pumper transfers fluid to a large 500-barrel frac tank, which has been placed on site. Fluid in the frac tank is gauged following fluid transfer to determine the amount of oil recovered. The oil and water is trucked to Navajo's Lea Refinery in Lovington for processing. As of February 21, 2003, the volume of crude oil recovered to date is 641 barrels, or 26,922 gallons.

V. Discussion and Conceptual Model

Information available from the soil coring indicates a variable lithology at the site. However, at a depth of approximately 20 to 25 ft. fine-grained materials (silt and clay) predominate (See sample borehole logs, Appendix C). The top of the saturated groundwater zone is also present at this depth. The combination of the two allows for the establishment of a relatively thick capillary fringe in the fine-grained sediments. A capillary zone is characterized by water in the soil pores that is under tension (existing at a negative pressure). This phenomenon allows pore spaces to be saturated with water even though they are above the water table. The capillary rise in uniform fine-grained sediments can be several feet or greater. For example, the rise in silt is 3.5 ft. while the rise in medium sand is under 10 in.* Where sediments are non-uniform, the thickness of the capillary zone is variable and, unlike the water table, the top of the capillary fringe is not a planar surface.

The presence of a capillary fringe impedes the downward movement of crude oil at the site. When the capillary fringe is encountered, it acts as a barrier to further vertical migration until and unless the volume of oil is sufficient to overcome the water capillary forces and move the water downward out of the soil pores. Until that occurs the oil will pond and spread laterally on top of the capillary fringe forming what can be called an "oil table" (Figure 3*).

If a monitor well is drilled through the oil into the water-saturated zone, ponded oil will drain into the monitoring well until equilibrium is reached with the oil in the formation. Oil accumulation in the monitor well allows recovery of the free product using conventional pumps.

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* Fetter, C.W. 1993. Chapter 5, Multiphase Flow, *Contaminant Hydrogeology*, Prentice-Hall, Upper Saddle River, NJ.

As the soil coring results at Monument show, in addition to the predominant fine-grained materials, there are thin zones of sand, gravels, and poorly cemented or fractured caliche. These zones will have much higher permeabilities for fluid movement than the finer grained materials. Even though both fine and coarse-grained material above the water capillary fringe is oil saturated, the coarser grained material will allow faster lateral movement of oil to wells drilled for oil recovery.

A typical groundwater monitoring well will have 10 to 15 ft. of screen with the top of the screen extending for several feet above the water table. While this design is appropriate for monitoring dissolved phase hydrocarbons and other constituents in the saturated zone, it is not appropriate for recovery of hydrocarbons at this site. As mentioned above, to a great extent the capillary fringe restricts movement of oil to deeper saturated zones. However, placement of a conventional monitor well circumvents the capillary zone and allows the oil direct contact with the water table, which in turn can allow more soluble oil constituents, such as BTEX, to move from the oil phase to the groundwater as a dissolved contaminant. A well with 10 ft. or greater saturated thickness provides a much greater medium for migration to the water and into the groundwater aquifer than does a well with limited contact with groundwater.

Consequently, at the Monument site, the temporary recovery wells are completed only a maximum of one to two feet into the saturated zone to minimize mixing and recovery of non-hydrocarbon fluid. Also, both MW-2 and MW-4 monitor wells have been plugged by removing or drilling out the casing and circulating a cement/bentonite grout from bottom to top.

The groundwater gradient at the site is relatively flat as described in Section III. However, it would appear that hydrocarbon product movement is quite rapid based on the sudden detection at MW-4. This apparent contradiction is resolved by considering movement of hydrocarbon in horizontal permeable zones in the unsaturated zone. Movement in these zones is unhindered by water and controlled by gravity. These zones have been given the name "preferential pathways" and their occurrence has implications for both delineation and hydrocarbon recovery.

Preferential pathways complicate hydrocarbon delineation because their distribution is generally random throughout the site. No single horizontal zone has yet been identified which may collect and concentrate hydrocarbons. Detection has been solely through the drilling of individual boreholes, identifying permeable zones in the soil cores, and noting the amount of product that flows into an open borehole. Those borings that fill with measurable hydrocarbons are completed as temporary recovery wells.

Preferential pathways, where present, can allow a considerable amount of hydrocarbon to be recovered when they are penetrated by a temporary recovery well. Proof of that at this site are wells where initial recovery was over one hundred gallons of product after pumping for several days. Total recovery to date from wells completed in zones with preferential pathways has been over 25,000 gallons of crude oil.

Figure 4 provides a conceptual model of oil flow at Monument. The figure shows mobile oil on top of the capillary zone and example horizontal preferential pathways.

In addition to preferential pathways that enhance lateral movement of oil, the slope of the water table impacts horizontal movement of oil. Free oil, which has ponded on the top of the water capillary fringe, moves horizontally down the slope of the capillary fringe.

The direction of groundwater movement is important for three reasons. Though the gradient is small at Monument (1 ft. drop every 200 ft.), the slope is sufficient to move hydrocarbon product 280 ft. southeast of the easternmost pipeline leak. Further, if there are areas where the capillary fringe is thin compared to the overlying thickness of oil, hydrocarbon product can break through the capillary fringe directly into the water table and move with the groundwater flow (Figure 4). Finally, groundwater movement is important because dissolved phase hydrocarbon can move into the groundwater through direct contact of oil and water, or by advection/diffusion through the capillary fringe.

VI. Work Plan

Delineation of Contamination

Additional delineation of contamination is to be performed at the site. The focus will be on three areas where current information is inadequate and contamination is known or suspected to occur. The first area is downgradient of the site in the vicinity of the MW-4 location, which now has confirmed hydrocarbon product and was plugged. A replacement monitor well for MW-4 is to be drilled following product delineation in this area.

As discussed in the conceptual model above, movement of product follows preferential pathways in sediments above the water table and along the slope of the water table. Therefore, in addition to the replacement well, a closely nested series of temporary recovery wells is under consideration to capture product moving southeast in the vadose zone in that area. A series of wells is judged more efficient than a trench at this time. Although intersecting all preferential pathways, a trench also provides a large surface area for dispersion of the product such that it is unlikely that a sufficient thickness of hydrocarbon will pond to allow practical recovery of oil without producing high volumes of water using current equipment. The pumps on site are designed for total fluid recovery; construction of recovery trenches at this time will require use of a different product recovery methodology.

The second area to receive focus will be the area adjacent to Maddox Road on the east and west sides of the right of way. Hydrocarbon is known to exist on both sides of the road as a result of pipeline leaks on the west side of the road. However, delineation and recovery is complicated by three other buried pipelines (one natural gas, one domestic water, and one produced injection water) and the road itself. Because of these obstacles, optimal placement of monitor wells is unlikely, which will reduce the efficiency of oil recovery and increase the time for clean up.

The third area remaining to be delineated is to the north in the vicinity of BH-29 and west of BH-76. Based on preliminary drilling, there is recoverable hydrocarbon in the vicinity of BH-29. On the other hand, indications are that product may not be present or present in much lesser amounts between BH-76 and west to the vicinity of Maddox Road.

Where recoverable hydrocarbon is encountered, boreholes will be completed as temporary recovery wells. For locations where hydrocarbons are minimal or not present, soil samples will be obtained for documentation/verification purposes and analyzed for TPH and BTEX.

Additional Excavation

Additional excavation of highly saturated soils along the pipeline trace will be performed. The material will be excavated to the depth of the pipeline. This material was back fill material for the original pipeline trench and was saturated during the time of release. Excavation will not take place immediately because oil recovery is taking place from temporary wells drilled on the south side of the trench. Photographs shown in Appendix B show the extent of impact to these soils.

The excavated material will be segregated on site and either transported to an OCD-permitted commercial facility, or treated on site for eventual backfill into the existing trench. Field and/or laboratory testing will be performed to document TPH levels of remaining material and treated material to be returned to the excavation.

Groundwater Monitoring

During the time product delineation and product recovery is occurring, groundwater elevation measurements and groundwater monitoring will be performed at the site. Existing monitor wells will be checked routinely for hydrocarbons, and water levels and sampling for BTEX performed quarterly. Additional monitor wells will be installed at the site, including one topographically downgradient from now-plugged MW-4 and one to east-northeast of the site. Additional wells will be installed as necessary to provide information on impacts to groundwater. Information collected from groundwater measurements and sampling will be submitted to the NMOCD semi-annually or more frequently if required.

Additional Actions

Several future actions are under consideration to assist with cleanup at the site. Once hydrocarbon product recovery has decreased to some minimum level, consideration will be given to passive venting of the boreholes. More aggressive treatment might be necessary at some areas of the site, especially if utility placement adjacent to Maddox Road prevents installation of recovery wells. This might include vacuum enhanced recovery of product to assist gravity flow to a recovery well. Finally, some sort of a barrier wall to contain the hydrocarbon product could be considered if other solutions are judged ineffective. Specific, detailed cleanup plans cannot be presented at this time because the site is still undergoing delineation. In the interim, work will concentrate on this delineation and on hydrocarbon product recovery using temporarily installed wells.

VII. Report Tables and Figures

Table 1. Results of Investigation Soils Testing, Navajo North Monument 6" Gathering Line Leak

Sample Location and Depth	Sample Date	TPH (mg/Kg)	Benzene (mg/Kg)	Toluene (mg/Kg)	Ethyl-benzene (mg/Kg)	Total Xylenes (mg/Kg)	Total BTEX (mg/Kg)
Excavation Samples:							
Trench A, 12 ft.	10/07/02	40,700	15.1	57.2	61.4	267	401
E. Trench, N. Wall	10/10/02	873	<0.005	<0.005	0.017	0.121	0.138
Borehole Samples:							
BH-1, 20 ft.	10/10/02	9,500	2.90	12.8	15.6	72.5	104
BH-1A, 20 ft.	10/10/02	<10	0.053	0.04	0.014	0.110	0.217
BH-2, 15 ft.	10/10/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-2, 20 ft.	10/10/02	<10	<0.005	<0.005	<0.005	<0.015	<0.006
BH-2, 25 ft.	10/10/02	<10	<0.005	<0.005	<0.005	<0.015	<0.007
BH-9, 13 ft.	10/12/02	<10	<0.005	<0.005	<0.005	<0.015	<0.008
BH-9 20 ft.	10/12/02	3,730	0.567	2.45	4.12	19.2	26.3
BH-10, 20 ft.	10/15/02	118	0.021	0.116	0.184	0.863	1.18
BH-12, 20 ft.	10/15/02	4,940	1.89	3.82	4.87	22.5	33.1
BH-15, 23 ft.	10/16/02	9,880	1.15	2.54	5.37	25.9	35.0
BH-18, 21 ft.	10/19/02	35.6	<0.005	<0.005	<0.005	<0.015	<0.005
BH-18, 24 ft.	10/19/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-20, 22 ft.	10/19/02	532	<0.005	0.065	0.325	1.73	2.12
BH-21, 10 ft.	10/29/02	99.3	<0.005	<0.005	<0.005	<0.015	<0.005
BH-21, 15 ft.	10/29/02	2,910	0.524	3.55	7.76	39.0	50.8
BH-21, 22 ft.	10/29/02	1,500	0.379	1.75	2.73	12.5	17.4
BH-22, 10 ft.	10/29/02	20.2	0.016	0.062	0.043	0.181	0.302
BH-22,13 ft.	10/29/02	857	0.808	3.02	3.73	18.1	25.7
BH-22, 17 ft.	10/29/02	3,210	0.295	1.02	1.20	6.98	9.50
BH-23, 13 ft.	10/29/02	922	0.446	1.62	1.74	7.71	11.5
BH-23, 18 ft.	10/29/02	5,200	2.67	9.18	11.3	50.1	73.3
BH-24, 13 ft.	10/29/02	2,050	0.173	0.524	3.29	17.8	21.8
BH-24, 18 ft.	10/29/02	5,070	3.99	13.8	17.0	79.4	114
BH-25, 15 ft.	10/30/02	3,070	0.326	0.930	3.14	16.3	20.7
BH-25, 17-18 ft.	10/30/02	9,520	1.68	13.100	19.6	88.2	123
BH-26, 10 ft.	10/30/02	296	0.006	0.026	0.032	0.104	0.168
BH-26, 15 ft.	10/30/02	19.4	<0.005	<0.005	<0.005	<0.015	<0.005
BH-26, 20 ft.	10/30/02	132	0.154	1.31	1.98	8.66	12.1
BH-26, 23 ft.	10/30/02	<10	0.007	0.038	0.066	0.343	0.454
BH-27, 15-16 ft.	10/30/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-27, 20 ft.	10/30/02	<10	0.040	0.024	0.015	0.074	0.153
BH-27, 23 ft.	10/30/02	<10	<0.005	<0.005	<0.005	0.026	0.026
BH-28, 15 ft.	10/30/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-28, 18 ft.	10/30/02	659	0.323	0.549	1.05	4.85	6.77
BH-28, 23 ft.	10/30/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-29, 15 ft.	10/30/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-29, 20 ft.	10/30/02	3,940	1.99	7.24	10.1	45.6	64.9
BH-29, 24 ft.	10/30/02	108	0.088	0.477	0.516	2.28	3.36

Table 1. Results of Investigation Soils Testing, Navajo North Monument 6" Gathering Line Leak

Sample Location and Depth	Sample Date	TPH (mg/Kg)	Benzene (mg/Kg)	Toluene (mg/Kg)	Ethyl-benzene (mg/Kg)	Total Xylenes (mg/Kg)	Total BTEX (mg/Kg)
BH-30, 20 ft.	10/31/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-30, 25 ft.	10/31/02	2,750	1.75	10.5	13.8	58.5	84.6
BH-30, 27 ft.	10/31/02	1,240	<0.005	0.135	0.817	4.03	4.98
BH-31, 21-22 ft.	10/31/02	4,140	0.416	4.5	7.23	32.8	44.9
BH-31, 26-27 ft.	10/31/02	272	0.119	0.325	0.464	2.34	3.25
BH-31, 30 ft.	10/31/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
BH-32, 23-24 ft.	10/31/02	5.84	<0.005	<0.005	<0.005	0.093	0.093
BH-32, 25 ft.	10/31/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-33, 21 ft.	10/31/02	1,620	2.10	7.45	8.00	34.3	51.9
BH-33, 25 ft.	10/31/02	13.7	<0.005	<0.005	0.005	0.055	0.060
BH-34, 24 ft.	11/01/02	516	0.02	0.605	1.28	5.77	7.68
BH-34, 26 ft.	11/01/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-35, 22-23 ft.	11/01/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-36, 27.5 ft.	11/01/02	528	0.093	0.355	0.577	2.45	3.48
BH-36, 29 ft.	11/01/02	<10	<0.005	<0.005	0.005	0.034	0.039
BH-37, 25-26 ft.	11/05/02	2,000	0.301	3.11	5.15	23.4	32.0
BH-37, 29 ft.	11/05/02	144	<0.005	<0.005	0.005	0.021	0.026
BH-38, 16-17 ft.	11/05/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-38, 29 ft.	11/05/02	927	<0.005	1.05	2.69	13.4	17.1
BH-39, 25 ft.	11/05/02	1,430	0.442	3.72	5.61	25.3	35.1
BH-39, 27 ft.	11/05/02	5,080	0.467	6.40	11.7	55.6	74.2
BH-41, 25 ft.	11/06/02	1,930	<0.005	0.179	0.997	5.37	6.55
BH-43, 19-20 ft.	11/06/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-44, 15 ft.	11/06/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-44, 17-18 ft.	11/06/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-45, 17-18 ft.	11/07/02	2,060	0.464	3.34	5.87	26.3	36.0
BH-45, 23 ft.	11/07/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-46, 18-19 ft.	11/07/02	169	<0.005	<0.005	<0.005	<0.015	<0.005
BH-46, 22-23 ft.	11/07/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-47, 17-18 ft.	11/07/02	1,460	<0.005	0.011	0.113	1.06	1.18
BH-47, 22-23 ft.	11/07/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-49, 25 ft.	11/08/02	1,150	<0.005	<0.005	0.018	0.164	0.182
BH-50, 20 ft.	11/08/02	1,420	<0.005	<0.005	0.044	0.331	0.375
BH-50, 22-23 ft.	11/08/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-51, 23-24 ft.	11/08/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-51, 27-28 ft.	11/08/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-52, 18-19 ft.	11/08/02	<10	0.021	0.038	0.020	0.102	0.18
BH-53, 28 ft.	11/09/02	180	0.036	0.388	0.892	3.96	5.28
BH-56, 25 ft.	11/12/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-60, 1-2 ft.	11/13/02	13,300	<0.005	0.314	1.54	9.62	11.5
BH-65, 2-3 ft.	11/14/02	11,900	<0.005	0.788	5.33	19.8	25.9
BH-65, 7-8 ft.	11/14/02	3,260	0.336	3.29	5.14	23.4	32.2
BH-68, 17-18 ft.	11/15/02	79.0	0.065	0.239	0.278	1.25	1.83
BH-68, 23 ft.	11/15/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-69, 17 ft.	11/15/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005

Table 1. Results of Investigation Soils Testing, Navajo North Monument 6" Gathering Line Leak

Sample Location and Depth	Sample Date	TPH (mg/Kg)	Benzene (mg/Kg)	Toluene (mg/Kg)	Ethyl-benzene (mg/Kg)	Total Xylenes (mg/Kg)	Total BTEX (mg/Kg)
BH-69, 25 ft.	11/15/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-70, 22 ft.	11/15/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-71, 14 ft.	11/16/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-71, 17-18 ft.	11/16/02	601	0.200	0.719	0.929	4.26	6.11
BH-71, 24 ft.	11/16/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-72, 21 ft.	11/21/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-73, 18 ft.	11/21/02	<10	<0.005	<0.005	<0.005	<0.015	<0.005
BH-74, 16 ft.	11/21/02	<10	0.048	0.277	0.332	1.80	2.46
BH-74, 18 ft.	11/21/02	76.7	<0.005	<0.005	<0.005	<0.015	<0.005
BH-78, 21 ft.	11/23/02	10,900	2.94	13.2	17.0	73.3	106
BH-78, 24 ft.	11/23/02	672	<0.005	<0.005	0.014	0.119	0.133
BH-80, 7-8 ft.	11/23/02	16.0	<0.005	<0.005	<0.005	<0.015	<0.005
BH-80, 14 ft.	11/23/02	21,500	5.83	29.9	35.8	143	215
BH-80, 20 ft.	11/23/02	1,950	<0.005	0.162	1.01	6.04	7.21
West BH-1, 23-24 ft.	10/13/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
West BH-2, 20-24 ft.	10/13/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
West BH-3, 23-24 ft.	10/14/02	727	0.010	0.061	1.127	0.701	1.90
West BH-4, 28 ft.	10/14/02	3,790	0.135	2.82	6.41	30.2	39.6
West BH-6, 25 ft.	10/17/02	950	0.036	0.336	0.503	2.35	3.23
West BH-6, 30 ft.	10/17/02	1,670	1.44	2.79	45.0	21.1	70.3
Monitor Well Samples:							
MW-3, 25 ft.	10/12/02	<10.0	<0.005	<0.005	<0.005	0.009	0.009
MW-4, 13 ft.	11/16/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
MW-4, 16 ft.	11/16/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
MW-4, 22 ft.	11/16/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
MW-4, 30 ft.	11/16/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
MW-5, 20 ft.	11/22/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
MW-5, 35 ft.	11/22/02	<10.0	<0.005	<0.005	<0.005	<0.015	<0.005
Notes:							
Sample from Trench A was from a trench dug 20 ft. north of pipeline and approximately 300 ft. east of Maddox Road							
Sample from East Trench was from a trench dug 20 ft. north of pipeline and approximately 475 ft. east of Maddox Road							
Samples collected by Safety and Environmental Solutions, Inc., Hobbs.							
TPH analyses EPA 600/4-79-020 418.1; BTEX analyses EPA SW-846 method 8260; Cardinal Laboratories, Hobbs, NM							

Table 2. Borehole and Monitor Well Status, Navajo North Monument 6" Gathering Line Leak

Borehole	Date Drilled	Depth Drilled (ft.)	Status
East of Maddox Road:			
BH-1	10/10/02	20	Strong Hydrocarbon odor at 20' plugged back to surface
BH-1A	10/10/02	25	No odor at 25' backfilled to surface
BH-1B	10/17/02	28	Hydrocarbon saturated - completed as recovery well
BH-2	10/10/02	25	No odor at 25' backfilled to surface
BH-3	- -	- -	Not Drilled (area next to pipeline daylighted)
BH-4	10/10/02	25	Hydrocarbon saturated - completed as recovery well
BH-5	10/12/02	25	Hydrocarbon show - backfilled to surface
BH-6	10/13/02	22.5	Hydrocarbon show - backfilled to surface
BH-7	10/13/02	23	Hydrocarbon saturated - completed as recovery well
BH-8	10/13/02	25	Hydrocarbon saturated - completed as recovery well
BH-9	10/12/02	23	H/C saturated - completed as recovery well - Plugged on 10-13
BH-9A	10/13/02	23	Hydrocarbon saturated - completed as recovery well
BH-10	10/15/02	23	**No odor at 23' backfilled to surface**
BH-11	10/15/02	23	Hydrocarbon saturated - completed as recovery well
BH-12	10/15/02	22	Hydrocarbon saturated - completed as recovery well
BH-13	10/15/02	22	Hydrocarbon saturated - completed as recovery well
BH-14	10/16/02	22	Hydrocarbon saturated - completed as recovery well
BH-15	10/16/02	26	Hydrocarbon show - backfilled to surface
BH-16	10/19/02	28	Hydrocarbon saturated - completed as recovery well
BH-17	10/19/02	25	Hydrocarbon saturated - completed as recovery well
BH-18	10/19/02	25	Hydrocarbon show - backfilled to surface
BH-19	10/19/02	24	Hydrocarbon saturated - completed as recovery well
BH-20	10/19/02	23	Hydrocarbon show - backfilled to surface
BH-21	10/29/02	23	Hydrocarbon saturated - completed as recovery well
BH-22	10/29/02	19	Hydrocarbon saturated - completed as recovery well
BH-23	10/29/02	19	Hydrocarbon saturated - completed as recovery well
BH-24	10/29/02	18	Hydrocarbon saturated - completed as recovery well
BH-25	10/30/02	18.5	Hydrocarbon saturated - completed as recovery well
BH-26	10/30/02	23	Hydrocarbon show - backfilled to surface
BH-27	10/30/02	23	Hydrocarbon show - backfilled to surface
BH-28	10/30/02	23	Hydrocarbon show - backfilled to surface
BH-29	10/30/02	24	Hydrocarbon saturated - completed as recovery well
BH-30	10/31/02	28	Hydrocarbon saturated - completed as recovery well
BH-31	10/31/02	30	Hydrocarbon show - backfilled to surface
BH-32	10/31/02	25	Hydrocarbon show - backfilled to surface
BH-33	10/31/02	25	Hydrocarbon show - backfilled to surface
BH-34	11/01/02	28	Hydrocarbon show - backfilled to surface
BH-35	11/01/02	25	**Clean, verification sample collected, backfilled to surface**
BH-36	11/01/02	30	Hydrocarbon saturated - completed as recovery well
BH-37	11/05/02	30	Hydrocarbon saturated - completed as recovery well
BH-38	11/05/02	30	Hydrocarbon odor - backfilled to surface
BH-39	11/05/02	27.5	Hydrocarbon saturated - completed as recovery well

Table 2. Borehole and Monitor Well Status, Navajo North Monument 6" Gathering Line Leak

Borehole	Date Drilled	Depth Drilled (ft.)	Status
BH-40	11/05/02	27.5	Hydrocarbon saturated - completed as recovery well
BH-41	11/06/02	28.5	Hydrocarbon saturated - completed as recovery well
BH-42	11/06/02	27	Hydrocarbon saturated - completed as recovery well
BH-43	11/06/02	25	Hydrocarbon show - backfilled to surface
BH-44	11/06/02	20	**Clean, verification sample collected, backfilled to surface**
BH-45	11/07/02	25	Hydrocarbon saturated - completed as recovery well
BH-46	11/07/02	25	**Clean, verification sample collected, backfilled to surface**
BH-47	11/07/02	25	Hydrocarbon saturated - completed as recovery well
BH-48	11/07/02	27	Hydrocarbon saturated - completed as recovery well
BH-49	11/08/02	29	Hydrocarbon show - backfilled to surface
BH-50	11/08/02	28	Hydrocarbon show - backfilled to surface
BH-51	11/08/02	28	**Clean, verification sample collected, backfilled to surface**
BH-52	11/08/02	28	Hydrocarbon saturated - completed as recovery well
BH-53	11/09/02	28	Hydrocarbon saturated - completed as recovery well
BH-54	11/09/02	28	Hydrocarbon saturated - completed as recovery well
BH-55	11/09/02	26	Hydrocarbon saturated - completed as recovery well
BH-56	11/12/02	25	Hydrocarbon saturated - completed as recovery well
BH-57	11/13/02	12.5	Hydrocarbon saturated - completed as recovery well
BH-58	11/13/02	13.5	Hydrocarbon saturated - completed as recovery well
BH-59	11/13/02	12.5	Hydrocarbon saturated - completed as recovery well
BH-60	11/13/02	15	Hydrocarbon saturated - completed as recovery well
BH-61	11/13/02	15	Hydrocarbon saturated - completed as recovery well
BH-62	11/13/02	15	Hydrocarbon saturated - completed as recovery well
BH-63	11/14/02	13.5	Hydrocarbon saturated - completed as recovery well
BH-64	11/14/02	13.5	Hydrocarbon saturated - completed as recovery well
BH-65	11/14/02	15	Hydrocarbon saturated - completed as recovery well
BH-66	11/14/02	15	Hydrocarbon saturated - completed as recovery well
BH-67	11/15/02	13	Hydrocarbon saturated - completed as recovery well
BH-68	11/15/02	25	Hydrocarbon show - completed as temporary well
BH-69	11/15/02	25	**Clean, verification sample collected, backfilled to surface**
BH-70	11/15/02	20	**Clean, verification sample collected, backfilled to surface**
BH-71	11/16/02	25	Hydrocarbon saturated - completed as recovery well
BH-72	11/21/02	23	Hydrocarbon saturated - completed as recovery well
BH-73	11/21/02	20	**Clean, verification sample collected, backfilled to surface**
BH-74	11/21/02	20	Hydrocarbon show - backfilled to surface
BH-75	11/21/02	18	Hydrocarbon saturated - completed as recovery well
BH-76	11/22/02	19	Hydrocarbon saturated - completed as recovery well
BH-77	11/23/02	24	Hydrocarbon saturated - completed as recovery well
BH-78	11/23/02	24	Hydrocarbon show - backfilled to surface
BH-79	- -	- -	Staked -- to be drilled
BH-80	11/23/02	27.5	Hydrocarbon saturated - completed as recovery well
BH-81	01/24/03	29	Hydrocarbon saturated - completed as recovery well
Number of temporary recovery wells east of Maddox Road: ***52***			

Table 2. Borehole and Monitor Well Status, Navajo North Monument 6" Gathering Line Leak

Borehole	Date Drilled	Depth Drilled (ft.)	Status
West of Maddox Road:			
WBH-1	10/13/02	24.5	No odor at 24.5' backfilled to surface
WBH-2	10/13/02	24	No odor at 24' backfilled to surface
WBH-3	10/13/02	25	Hydrocarbon odor at 25' plugged back to surface
WBH-4	10/14/02	30	No odor at 30' backfilled to surface
WBH-5	10/16/02	28.5	Hydrocarbon show - backfilled to surface
WBH-5A	10/17/02	28.5	Hydrocarbon saturated - completed as recovery well
WBH-6	10/17/02	30	Hydrocarbon show - backfilled to surface
WBH-7	10/17/02	30	Hydrocarbon saturated - completed as recovery well
WBH-8	10/17/02	28	Hydrocarbon saturated - completed as recovery well
Number of temporary recovery wells west of Maddox Road: ***3***			
Monitor Wells:			
MW-1	10/11/02	35	No hydrocarbon sign - completed as monitor well
MW-2	10/12/02	35	No hydrocarbon sign when drilled; 0.71 ft. product 11/18
			MW-2 plugged 01/23/03
MW-3	10/12/02	35	No hydrocarbon sign - completed as monitor well
MW-4	10/16/02	30	No hydrocarbon sign when drilled; 1.62 ft. product 12/30
			MW-4 plugged 01/28/03
MW-5	11/22/02	35	No hydrocarbon sign - completed as monitor well to replace MW-2
Number of sampling monitor wells: ***3***			

Table 3. Water Level Elevation Data, Navajo North Monument 6" Gathering Line Leak

Well Name, Depth Below TOC (ft.)	Elevation Top of Casing (feet)	Measure-ment Date	Depth to Product Below TOC (feet)	Depth to Water Below TOC (feet)	Product Thickness (feet)	Corrected Depth to Water (feet)	Corrected Water Level Elev. (feet)	Water Saturated Thickness (feet)
MW-1	3,670.05	10/14/02	- -	25.51	0	25.51	3,644.54	12.2
37.72		10/20/02	- -	25.44	0	25.44	3,644.61	12.3
		10/21/02	- -	25.44	0	25.44	3,644.61	12.3
		11/18/02	- -	25.02	0	25.02	3,645.03	12.7
		12/27/02	- -	25.17	0	25.17	3,644.88	12.6
MW-2	3,671.40	10/14/02	- -	27.42	0	27.42	3,643.98	10.2
37.65		10/20/02	- -	27.35	0	27.35	3,644.05	10.3
		10/21/02	- -	27.36	0	27.36	3,644.04	10.3
		11/18/02	26.98	27.69	0.71	27.10	3,644.30	10.5
		12/27/02	26.62	29.99	3.37	27.21	3,644.19	10.4
Note: Corrected depth to water = Static DTW - (Prod. Thickness x SG), SG = 0.8251 (API=40); plugged 01/23/03								
MW-3	3,666.41	10/14/02	- -	24.31	0	24.31	3,642.10	13.2
37.47		10/20/02	- -	24.20	0	24.20	3,642.21	13.3
		10/21/02	- -	24.21	0	24.21	3,642.20	13.3
		11/18/02	- -	23.82	0	23.82	3,642.59	13.7
		12/27/02	- -	23.96	0	23.96	3,642.45	13.5
MW-4	3,661.76	11/18/02	- -	20.26	0	20.26	3,641.50	8.7
28.93		12/27/02	- -	20.52	0	20.52	3,641.24	8.4
		12/30/02	20.30	21.92	1.62	20.58	3,641.18	8.3
Note: Corrected depth to water = Static DTW - (Prod. Thickness x SG), SG = 0.8251 (API=40); plugged 01/28/03								
MW-5	3,670.43	12/27/02	- -	26.53	0	26.53	3,643.90	9.3
35.80								
Note:								
TOC -Top of Casing								

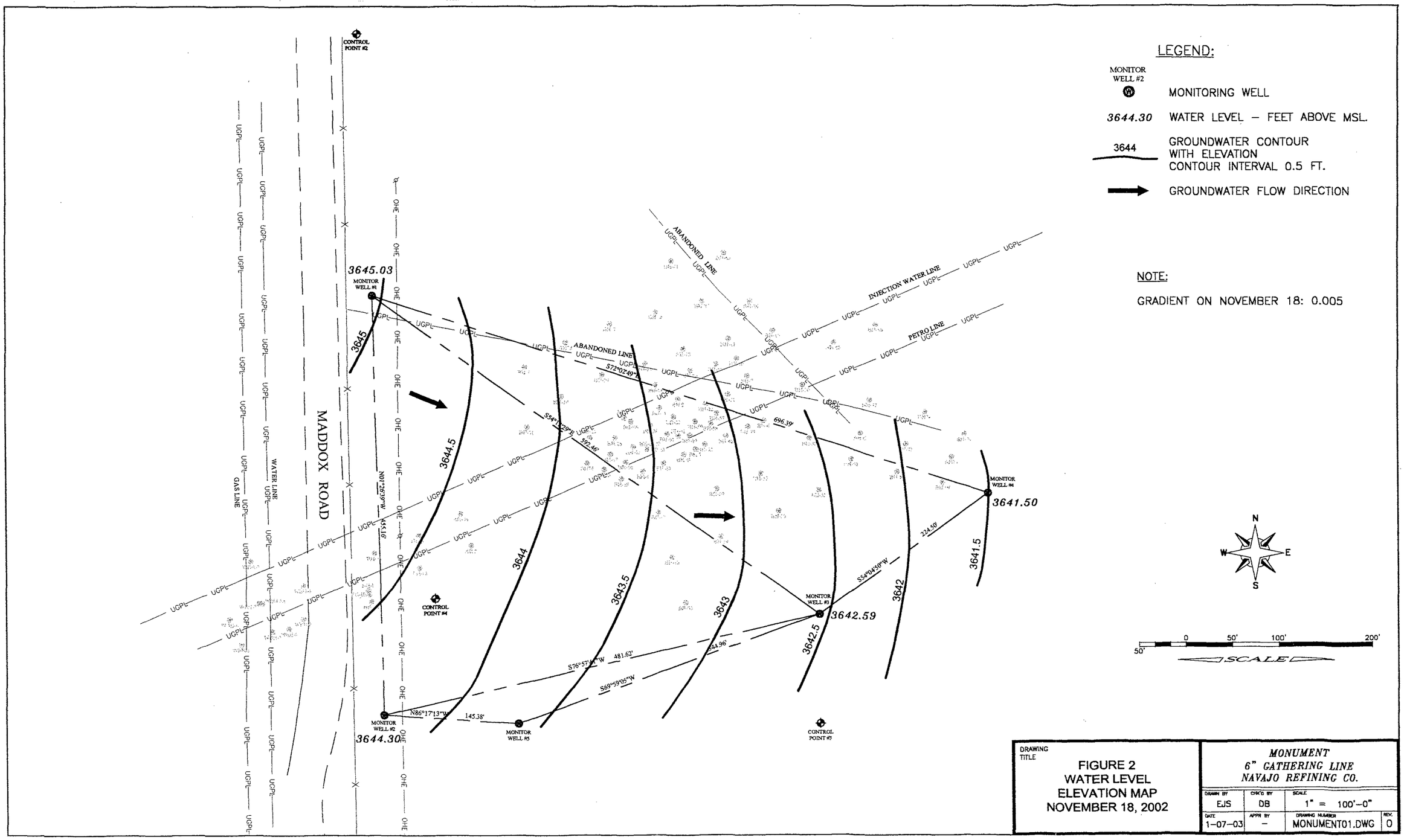
Table 4. Water Quality Sampling, Navajo North Monument 6" Gathering Line Leak

Monitoring Well	Sample Date	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (total, mg/L)	Total BTEX (mg/L)	Chloride (mg/L)	Total Dissolved Solids (mg/L)
MW-1	10/21/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
	12/27/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
MW-2	10/21/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
	12/27/02	Hydrocarbon product detected, plugged 01/23/03						
MW-3	10/21/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
	12/27/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
MW-4	12/27/02	Hydrocarbon product detected, plugged 01/28/03						
MW-5	12/30/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
Sec 30	10/08/02	<0.002	<0.002	<0.002	<0.006	<0.002	- -	- -
Windmill	10/10/02	- -	- -	- -	- -	- -	100	528
BH-7	11/04/02	- -	- -	- -	- -	- -	124	636
Notes:								
Complete water chemistry analyses performed in addition to chloride and TDS shown.								
Analyses performed at Cardinal Laboratories, Hobbs, NM								
Analyses performed using EPA SW-846 methods 8260 (volatile organics) and 160.1 (TDS), and Standard Method 4500-Cl B (Cl).								

Figure 1. Vicinity Map

Name: MONUMENT NORTH
Date: 2/28/2003
Scale: 1 inch equals 2000 feet

Location: 032° 37' 54.8" N 103° 17' 56.6" W
Caption: Figure 1. Vicinity Map
Navajo Monument 6" Line



LEGEND:

MONITOR WELL #2 (W)	MONITORING WELL
3644.30	WATER LEVEL – FEET ABOVE MSL.
3644	GROUNDWATER CONTOUR WITH ELEVATION CONTOUR INTERVAL 0.5 FT.
→	GROUNDWATER FLOW DIRECTION

NOTE:

GRADIENT ON NOVEMBER 18: 0.005

DRAWING TITLE

FIGURE 2
WATER LEVEL
ELEVATION MAP
NOVEMBER 18, 2002

MONUMENT
6" GATHERING LINE
NAVAJO REFINING CO.

DRAWN BY	CHK'D BY	SCALE	
EJS	DB	1" = 100'–0"	
DATE: 1–07–03	APPR BY: –	DRAWING NUMBER: MONUMENT01.DWG	REV: 0

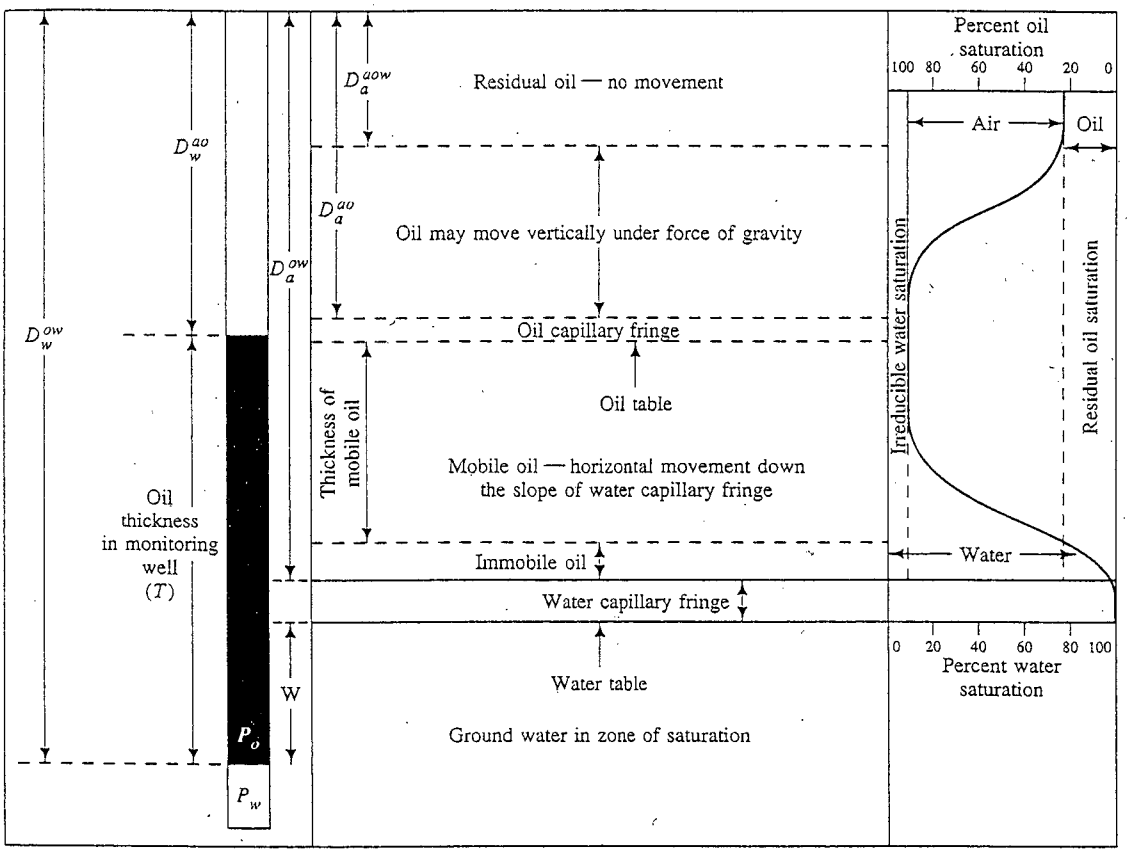


FIGURE 5.19 Comparison of distribution of mobile oil in an aquifer with the thickness of floating oil in a monitoring well for the case where a water capillary fringe exists below the zone of mobile oil.

(Reproduced from *Contaminant Hydrogeology*, by C.W. Fetter, Prentice-Hall, 1993)

Figure 3. Distribution of Mobile Oil in an Aquifer with a Capillary Fringe and a Monitor Well

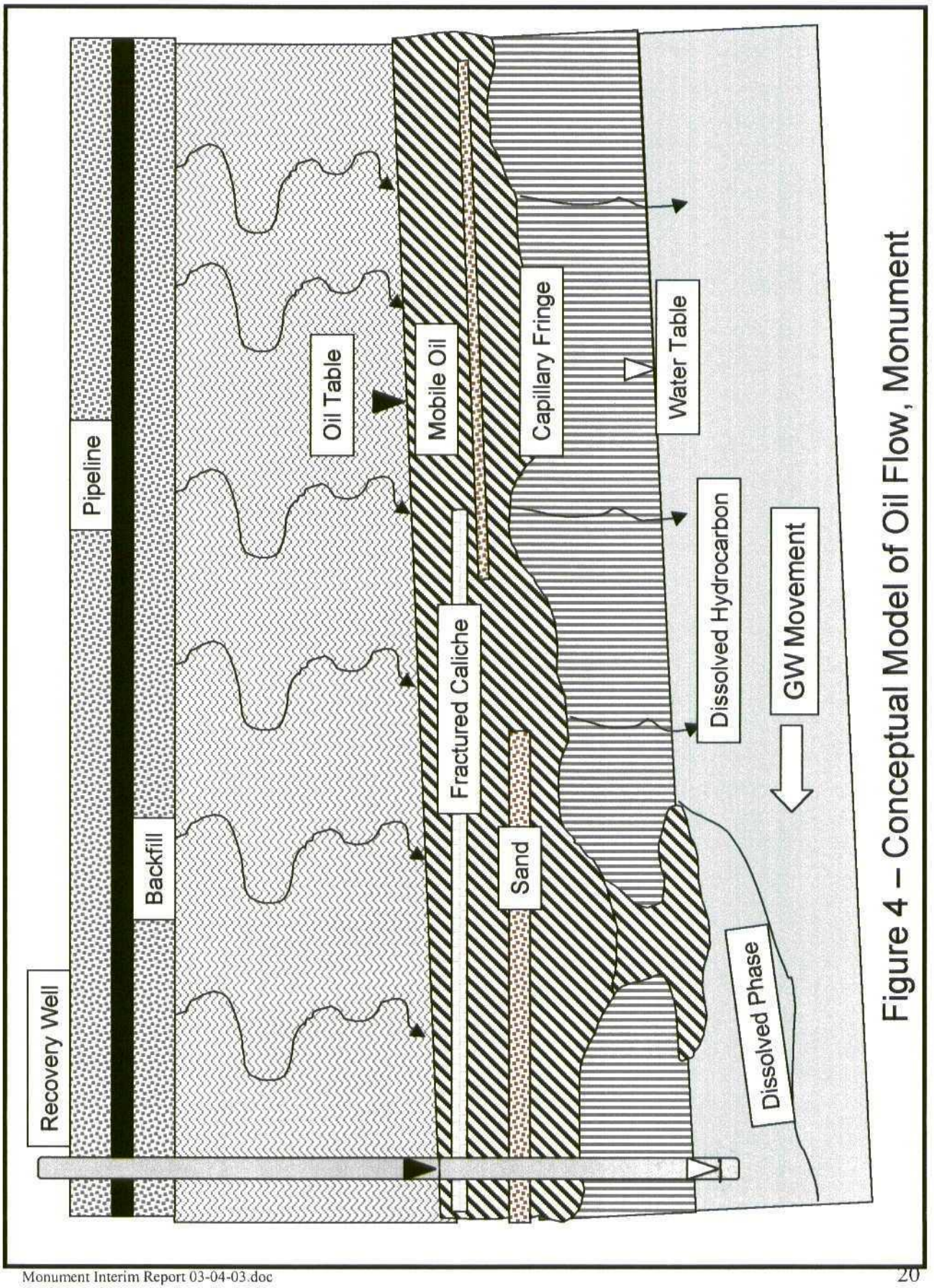


Figure 4 – Conceptual Model of Oil Flow, Monument

VIII. Appendices

Appendix A. Copy of OCD Form C-141

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 South First, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
2040 South Pacheco, Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
2040 South Pacheco
Santa Fe, NM 87505

Form C-141
Revised March 17, 1999

Submit 2 Copies to appropriate District Office in accordance with Rule 116 on back side of form

Release Notification and Corrective Action

OPERATOR

☒ Initial Report ☐ Final Report

Name of Company: Navajo Refining Co.	Contact: Darrell Moore Dickie Townley
Address: 501 E. Main Artesia NM	Telephone No.: 505-748-3311
Facility Name:	Facility Type: Pipeline

Surface Owner	Mineral Owner	Lease No.
State of NM		

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South Line	Feet from the	East/West Line	County
								Lea

10 miles west of Hobbs. Turn South on Maddox Rd. Go 3.5 miles. Leak site is on both sides of Maddox Rd.

NATURE OF RELEASE

Type of Release: Crude Oil	Volume of Release: 2024 bbls.	Volume Recovered:
Source of Release: Leak in Pipeline	Date and Hour of Occurrence: 10/5/02	Date and Hour of Discovery: 10/5/02 11:00 am
Was Immediate Notice Given? ☒ Yes ☐ No ☐ Not Required	If YES, To Whom? Larry Johnson	
By Whom? Dickie Townley	Date and Hour: 10/5/02 4:00 pm	
Was a Watercourse Reached? ☐ Yes ☒ No	If YES, Volume Impacting the Watercourse.	

If a Watercourse was Impacted, Describe Fully.*

Describe Cause of Problem and Remedial Action Taken.* A corrosive was introduced into the pipeline by unknown persons and/or producers. This caused several leaks in the pipeline. We are currently delineating and putting pumps in wells that show free product.

Describe Area Affected and Cleanup Action Taken.* Area affected is still being determined.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to NMOCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the NMOCD marked as "Final Report" does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Signature: Darrell Moore	OIL CONSERVATION DIVISION
Printed Name: Darrell Moore	Approved by District Supervisor:
Title: Env. Mgr. for Watera Waste	Approval Date: / Expiration Date:
Date: 10/16/02 Phone: 505-748-3311	Conditions of Approval: / Attached ☐

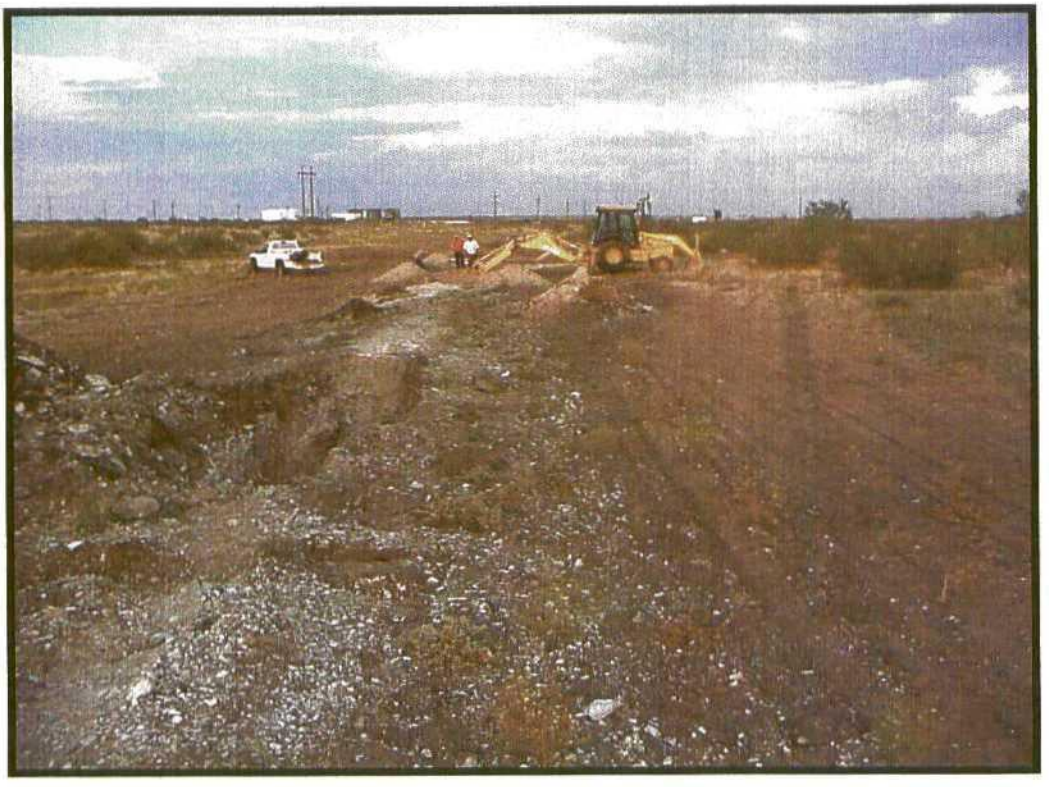
* Attach Additional Sheets If Necessary

Appendix B. Site Photographs

1st Leak Site 10-5-02

1st Leak Site 10-5-02

1st Bell Hole 10-5-02



Delineation Bell Hole 10-5-02

Delineation Bell Hole 10-5-02

2nd Bell Hole 10-5-02

Eastern Trench 10-6-02

Eastern Trench 10-6-02

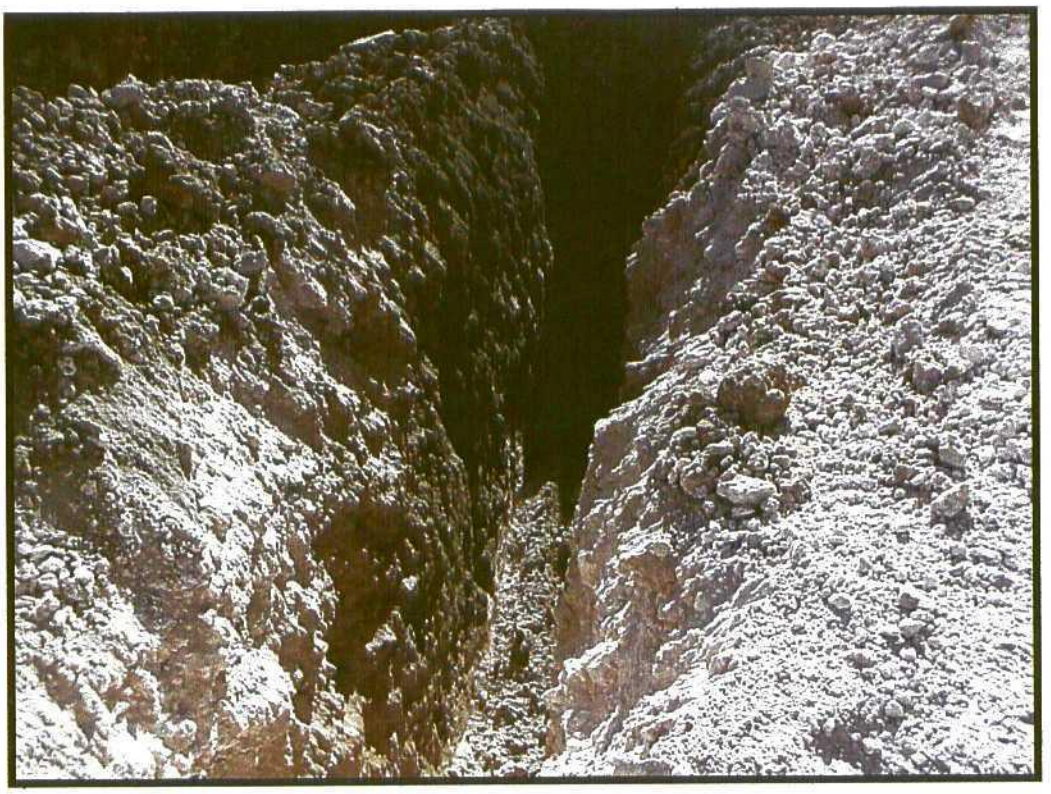
Trench just East of Maddox Rd. Looking West 10-6-02

Trench just East of Maddox Rd. Looking East 10-6-02

Site Looking East from Maddox Rd. 10-6-02

East End Excavation 10-9-02

East End Excavation 10-9-02



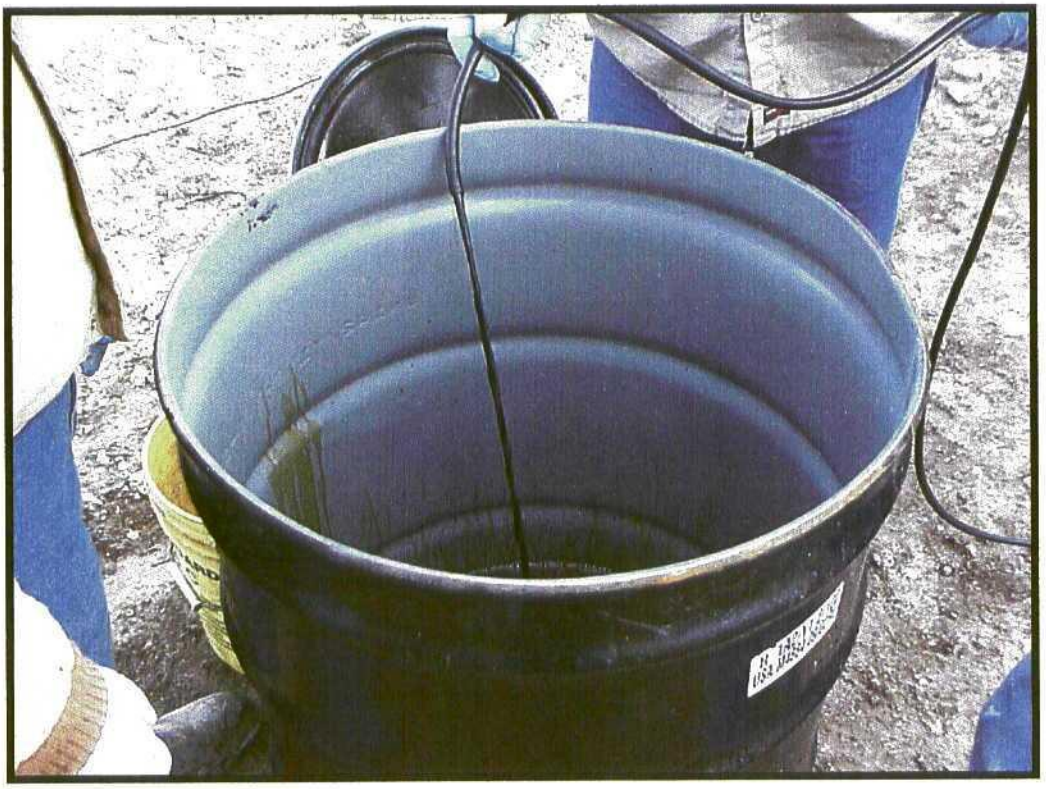
East End Excavation 10-9-02

Bore Hole # 4 Oil Being Bailed 10-10-02

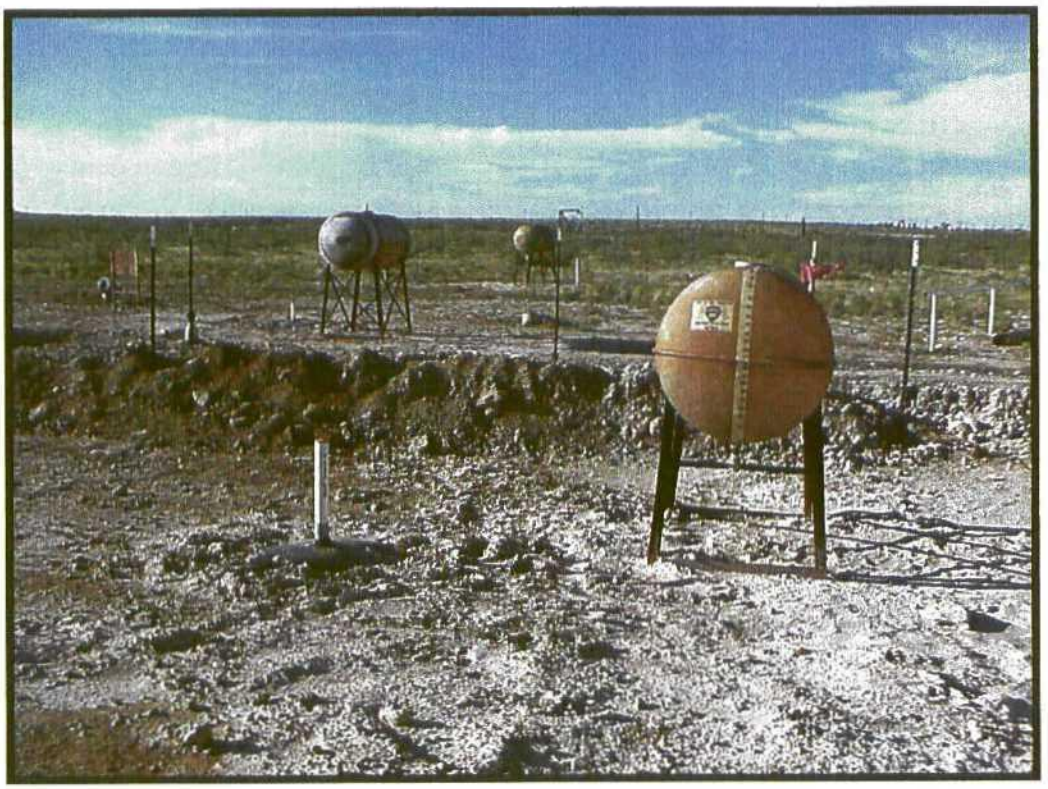
Bore Hole # 4 Core Sample 10-10-02

Bore hole # 4 Core Sample 25' 10-10-02

Bore hole # 4 Core Sample 25' 10-10-02

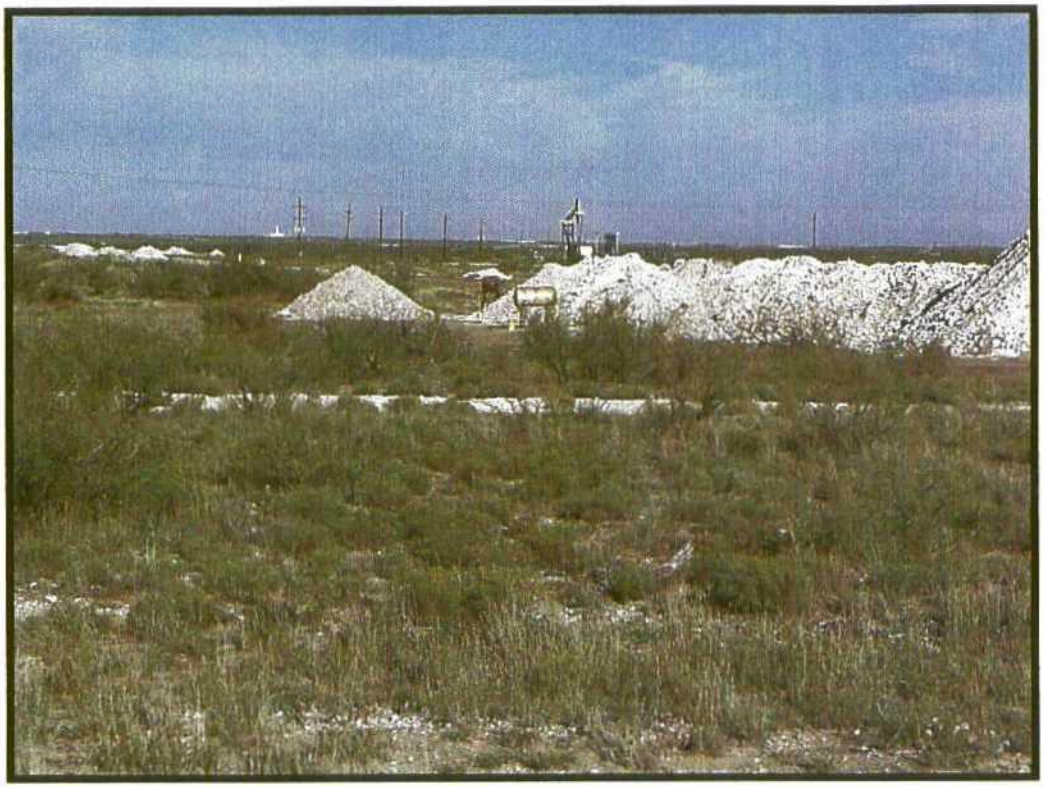


Recovery Well # 4 10-11-02



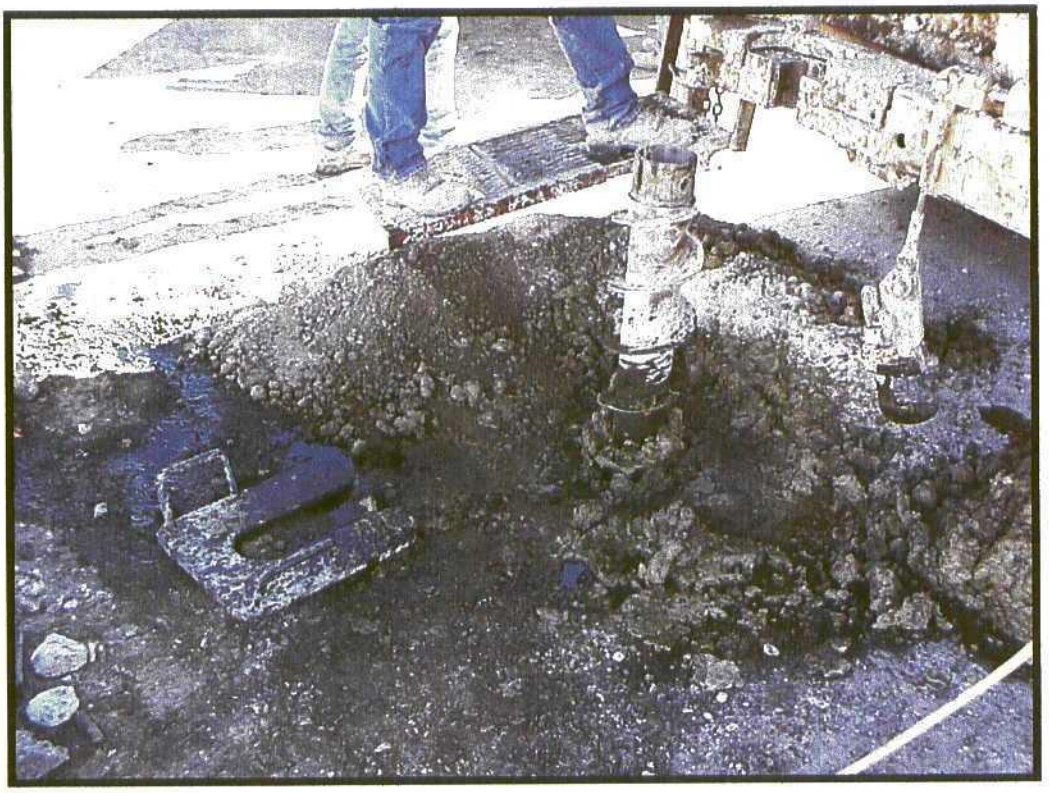
Westside Maddox Road Looking North 10-20-02

East Side Maddox Road Looking East 10-20-02



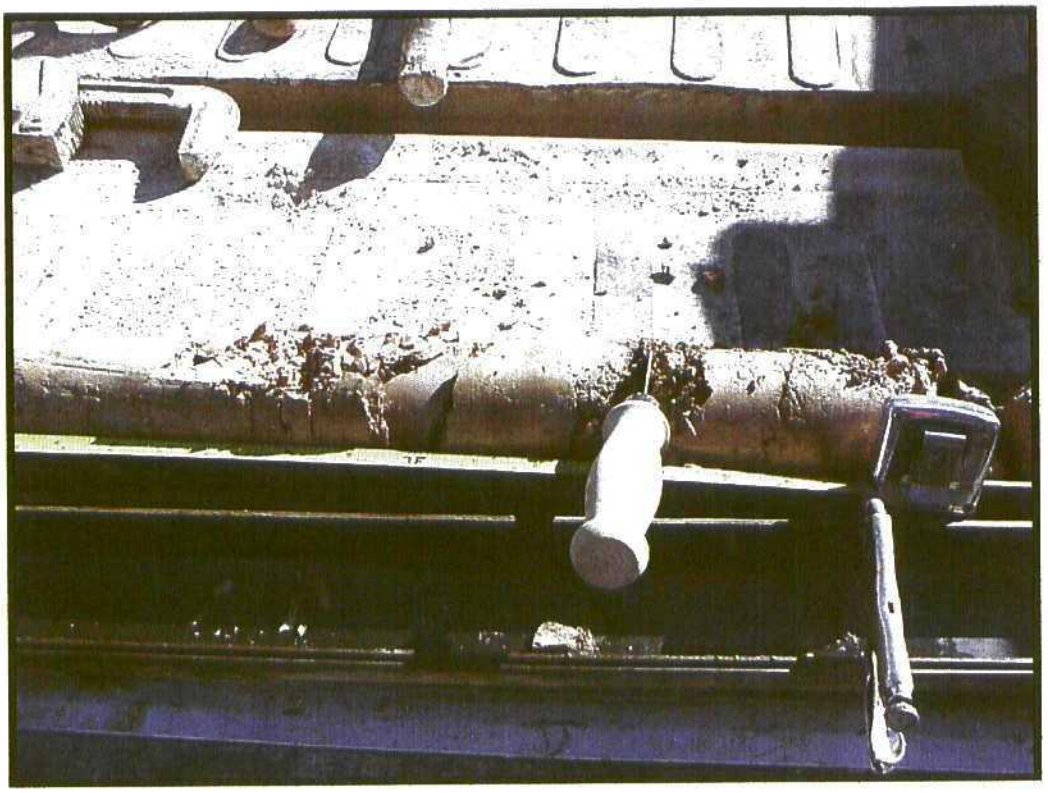
Clean Spoils on East Side 10-20-02

North View of East Side 10-20-02

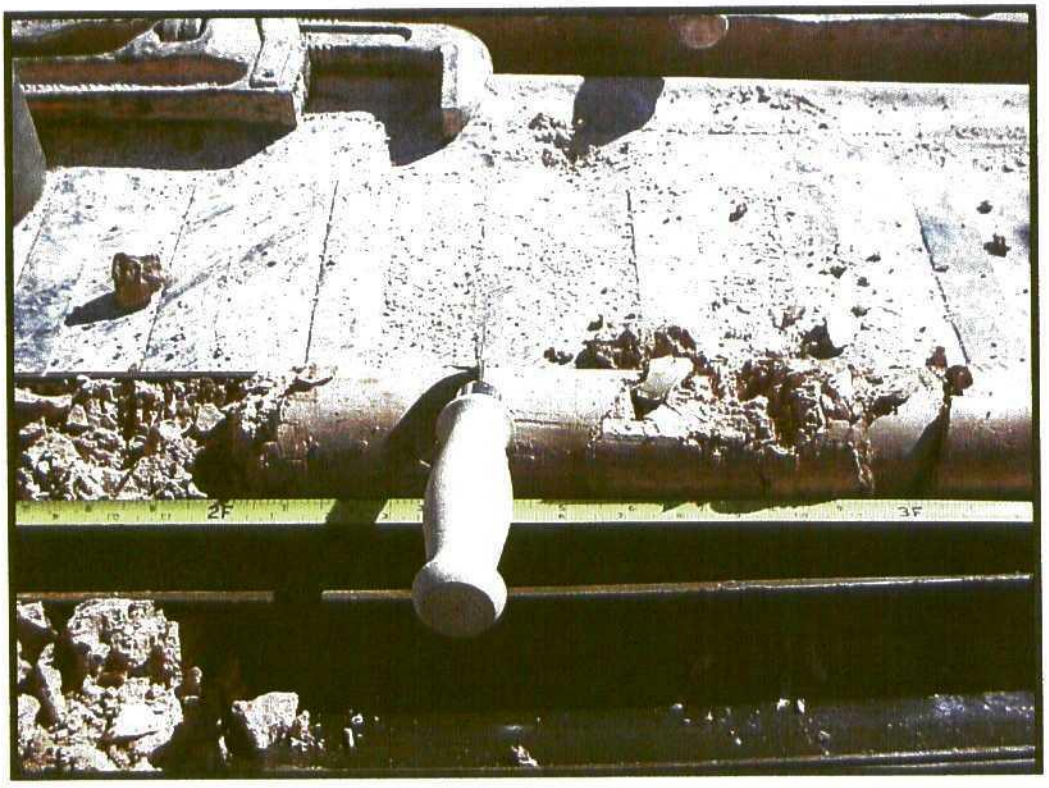


Completing Bore Hole # 41 11/6/02

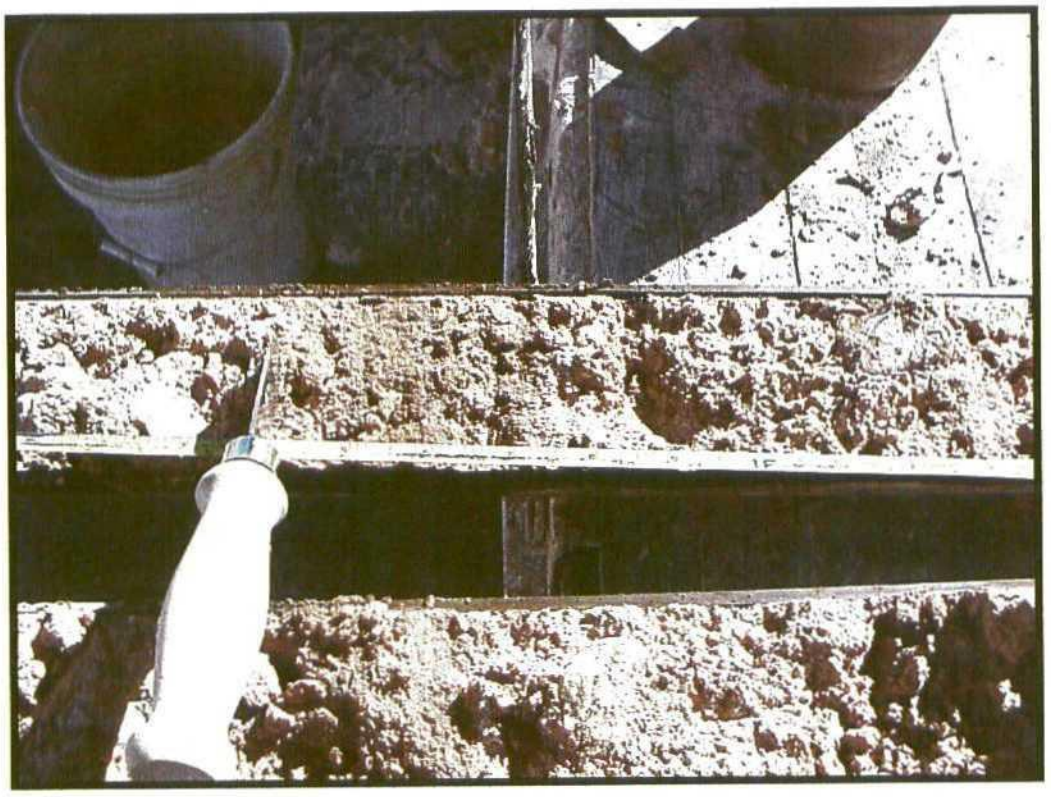
Bore Hole #41 11/6/02



Core Sample Bore Hole # 41 11/6/02



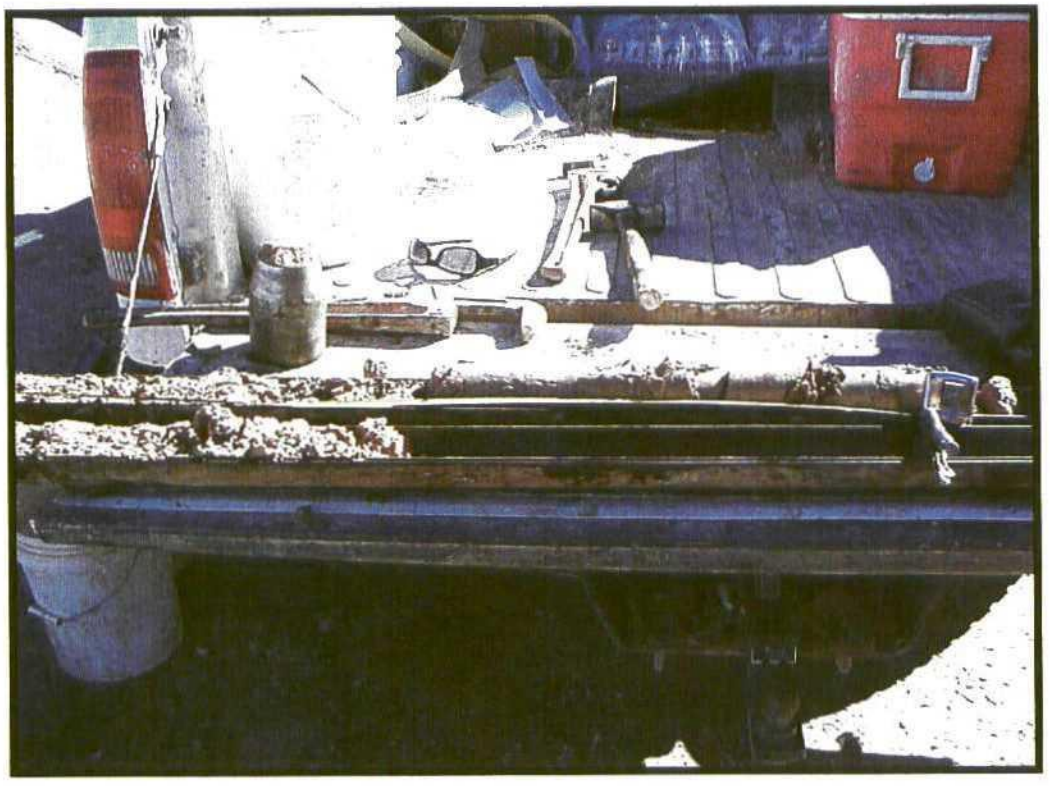
Core Sample Bore Hole # 41 11/6/02



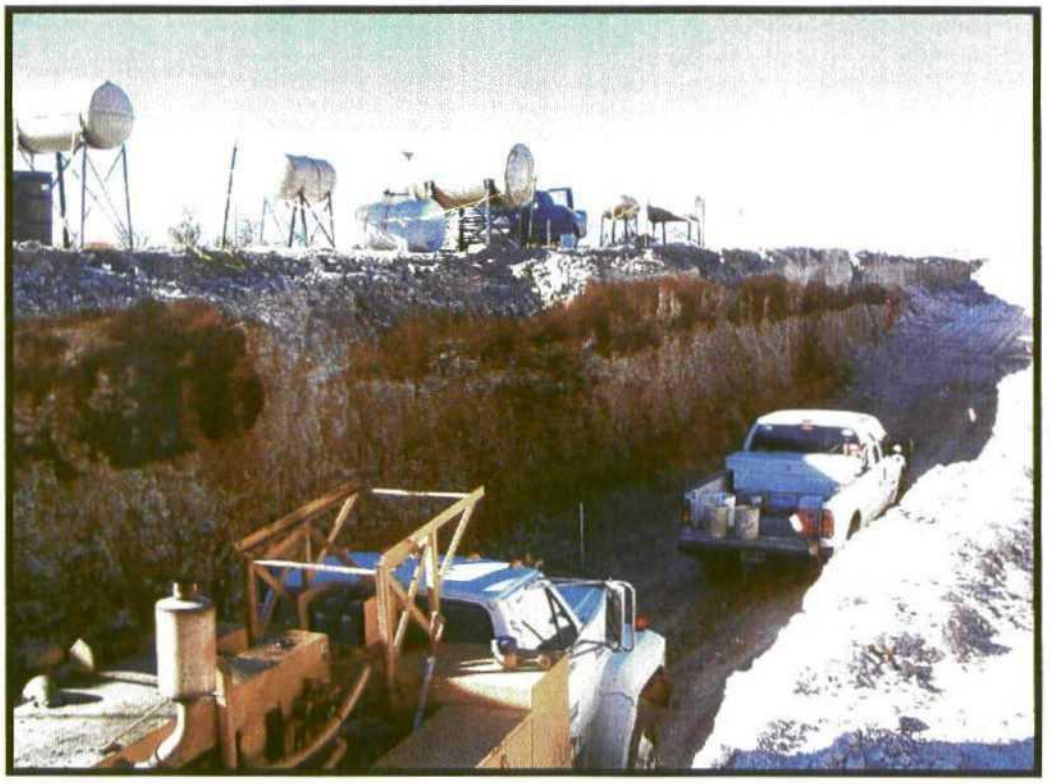
Core Sample Bore Hole # 41 11/6/02

Core Sample Bore Hole # 41 11/6/02

Core Sample Bore Hole # 41 11/6/02



Core Sample Bore Hole # 41 11/6/02



Installation of temporary recovery wells at the Monument pipeline release site, November 13, 2002
The pipeline was located adjacent to the base of the hydrocarbon stained soil on the left wall.

Installation of temporary recovery wells at the Monument pipeline release site, November 13, 2002
The pipeline was located adjacent to the base of the hydrocarbon stained soil on the left wall.

Installation of temporary recovery wells at the Monument pipeline release site, November 13, 2002
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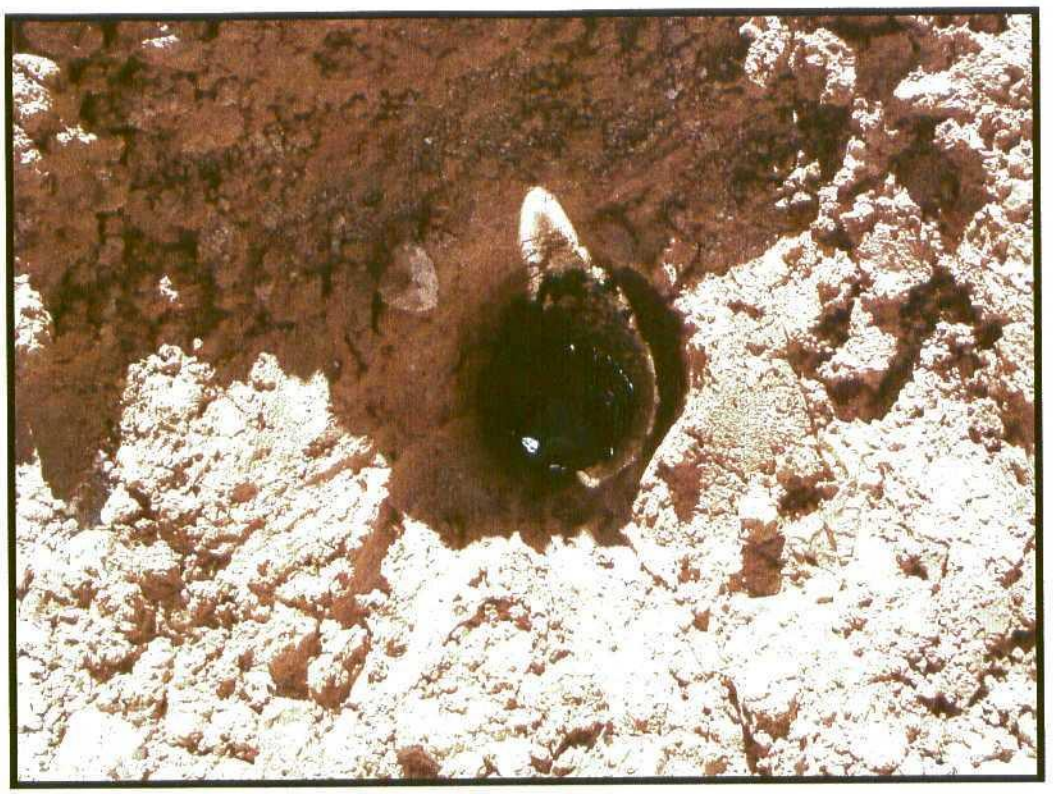
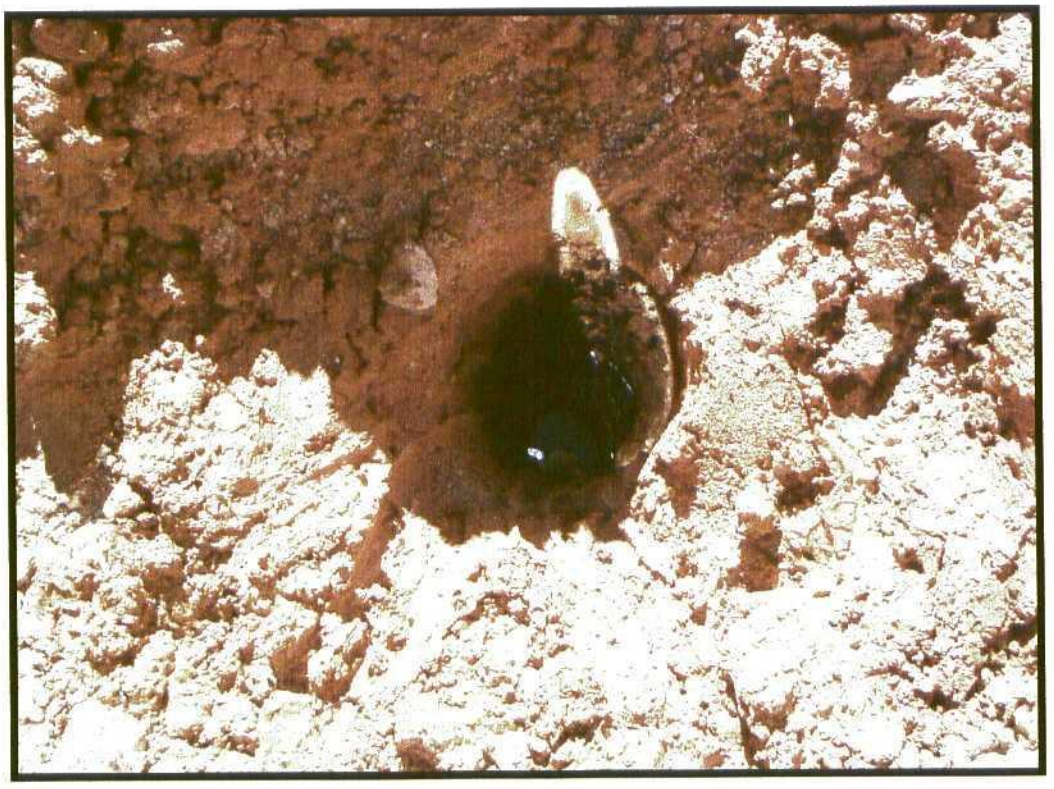


Bore Hole # 57 11/13/02



Bore Hole # 57 11/13/02

Bore Hole # 58 11/13/02

Bore Hole # 58 11/13/02

Bore Hole # 58 11/13/02

Core Sample Bore Hole #61 11/13/02

Core Sample Bore Hole #61 11/13/02

Appendix C. Selected Borehole Logs

LOG OF BORING BH-04

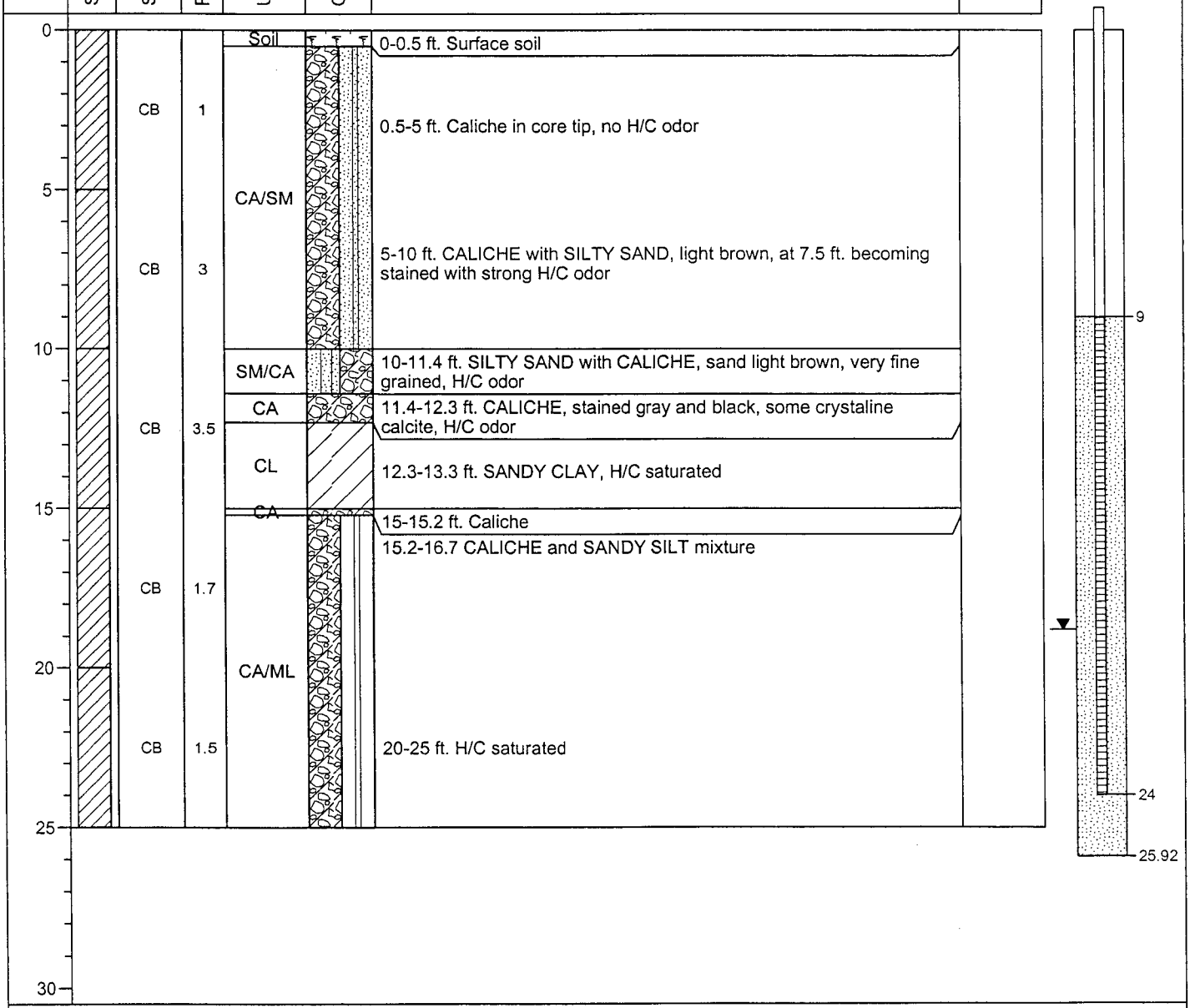
Hydrocarbon Site Investigation
Monument 6" Crude Gathering Line

Navajo Refining Company
Artesia, New Mexico

Date, Time Started:	: 10/10/02, 1600	Drilled By:	: Eco Drilling
Date, Time Completed	: 10/11/02, 1200	Logged By:	: D.G. Boyer
Hole Diameter:	: 8-1/4 in.		
Drilling Method:	: Hollow-stem auger, CME-75		
Sampling Method:	: Cuttings, core barrel		

Sample Condition
- Remoulded
- Undisturbed
- Lost
- Rock Core

Sample Type:
- AR Air Rotary Cuttings
- CB Core Barrel (2.5' or 5')
- CT Auger Cuttings
- NR No recovery



Notes:
In auger stem: DTP 23.03 ft, no water, oil rising in auger
10/11: DTP 19.50 ft. (18.80 ft. BGS), pumped 13 gallon free product in ~7 min.
Completed as 4-in. temporary recovery well with 15 ft. 20-slot screen, sand pack.

H/C - Petroleum hydrocarbon

LOG OF BORING BH-41

Hydrocarbon Site Investigation
Monument 6" Crude Gathering Line

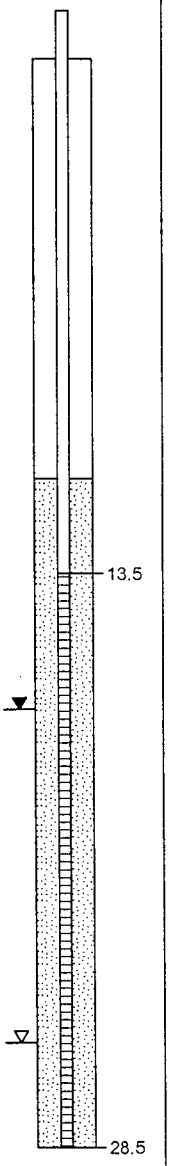
Navajo Refining Company
Artesia, New Mexico

Date, Time Started:	: 11/06/02, 1000	Drilled By:	: Eco Drilling
Date, Time Completed	: 11/06/02, 1140	Logged By:	: D.G. Boyer
Hole Diameter:	: 8-1/4 in.		
Drilling Method:	: Hollow-stem auger, CME-75		
Sampling Method:	: Cuttings, core barrel		

Sample Condition
- Remoulded
- Undisturbed
- Lost
- Rock Core

Sample Type:
- AR Air Rotary Cuttings
- CB Core Barrel (2.5' or 5')
- CT Auger Cuttings
- NR No recovery

Depth in Feet	Samples	Sample Type	Recovery (ft.)	USCS	GRAPHIC	DESCRIPTION	Lab No.
0–10		CT		CA/SM		0-19 ft. Cuttings, CALICHE with SILTY SAND, hard drilling 9-10 ft.	
10–20		CB	3.8	CL		Clayey 19-20 ft. 20-20.7 ft. GRAVELLY CLAY, H/C saturated 20.7-23.8 ft. SILTY CLAY, with frequent caliche rock and sandstone. Occasional fine grained sand, tight, not much saturation	
20–30		CB	3.9	CL		25-28.9 ft. SILTY CLAY, with caliche rock and fragments. H/C saturated at 25 ft.and from 28-28.9 ft. Saturated where have more gravel than clay (center of core also saturated, core comressed walls and squeezed H/C out).	H7194-7



Notes:
Completed as 2-in. temporary recovery well with 15 ft. 20-slot screen, sand pack to 11 ft. BGS
H/C - Petroleum hydrocarbon
Laboratory analyses by Cardinal Laboratories

LOG OF BORING BH-57

Hydrocarbon Site Investigation
Monument 6" Crude Gathering Line

Navajo Refining Company
Artesia, New Mexico

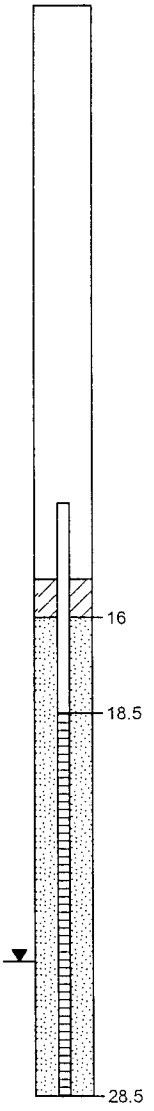
Date, Time Started:	: 11/13/02, 0920	Drilled By:	: Eco Drilling
Date, Time Completed	: 11/13/02, 1025	Logged By:	: D.G. Boyer
Hole Diameter:	: 8-1/4 in.		
Drilling Method:	: Hollow-stem auger, CME-75		
Sampling Method:	: Cuttings, core barrel		

Sample Condition
- Remoulded
- Undisturbed
- Lost
- Rock Core

Sample Type:
- AR Air Rotary Cuttings
- CB Core Barrel (2.5' or 5')
- CT Auger Cuttings
- NR No recovery

Depth in Feet	Samples	Sample Type	Recovery (ft.)	USCS	GRAPHIC	DESCRIPTION	Lab No.
0						0-15 ft. Borehole installed in excavation trench, approximately 15 ft. deep. Measurements approximate from original ground surface.	
15		CB	1.2	GC		15-20 ft. CLAYEY GRAVEL, gravels caliche with sandy clay, unsaturated, H/C odor	
20						20-21.3 CLAYEY GRAVEL, caliche gravel and clay, some H/C saturation.	
		CB	3.6	CL		21.3-23.6 ft. CLAY, with occasional caliche gravel, caliche, and sand, tight	
25						25-26 ft. SANDY CLAY, H/C saturated	
		CB	3.4			26-27.9 ft. CLAY, with occasional sand and caliche, H/C show at 2 ft.	
				CA/CL		27.9-28.4 ft. CALICHE and CLAY, water saturated with H/C also, drilled to 28.5 ft.	
30							

BH-57



Notes:
Completed as 2-in. temporary recovery well with 10 ft. 20-slot screen, sand pack to 1 ft. below excavation base, bentonite to excavation bottom
H/C - Petroleum hydrocarbon

LOG OF BORING BH-58

Hydrocarbon Site Investigation
Monument 6" Crude Gathering Line

Navajo Refining Company
Artesia, New Mexico

Date, Time Started: : 11/13/02, 0920
Date, Time Completed : 11/13/02, 1025
Hole Diameter: : 8-1/4 in.
Drilling Method: : Hollow-stem auger, CME-75
Sampling Method: : Cuttings, core barrel

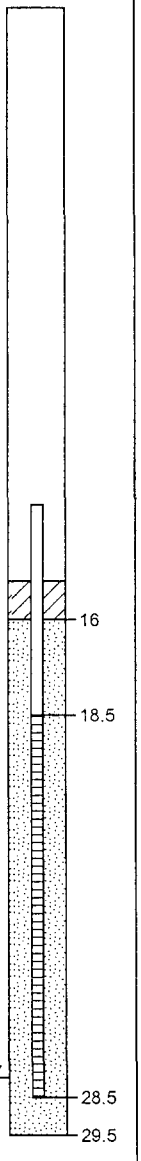
Drilled By: : Eco Drilling
Logged By: : D.G. Boyer

Sample Condition
- Remoulded
- Undisturbed
- Lost
- Rock Core

Sample Type:
- AR Air Rotary Cuttings
- CB Core Barrel (2.5' or 5')
- CT Auger Cuttings
- NR No recovery

Depth in Feet	Samples	Sample Type	Recovery (ft.)	USCS	GRAPHIC	DESCRIPTION	Lab No.
0						0-15 ft. Borehole installed in excavation trench, approximately 15 ft. deep. Measurements approximate from original ground surface.	
15		CB	3	CA		15-17.8 ft. CALICHE, hard, dry, H/C odor	
20		CB	4	CL		light brown, 17.8-18 ft. SANDY CLAY 20-23 ft. CLAY, brown, occasional thin sandy zones 23-23.7 ft. CLAY, brown, soft becoming sandy 23.7-24 ft. SANDY CLAY, brown, sandstone pieces, H/C odor throughout	
25		CB	3.7			25-25.6 ft. SANDY CLAY, brown, strong H/C odor 25.6-28.1 ft. CLAY, mottled brown and chalk color 28.1-28.7 ft. GRAVELLY CLAY, H/C and water saturated	
30							

BH-58



Notes:
Completed as 2-in. temporary recovery well with 10 ft. 20-slot screen, sand pack to 1 ft. below excavation base, bentonite to excavation bottom
H/C - Petroleum hydrocarbon

LOG OF BORING BH-61

Hydrocarbon Site Investigation
Monument 6" Crude Gathering Line

Navajo Refining Company
Artesia, New Mexico

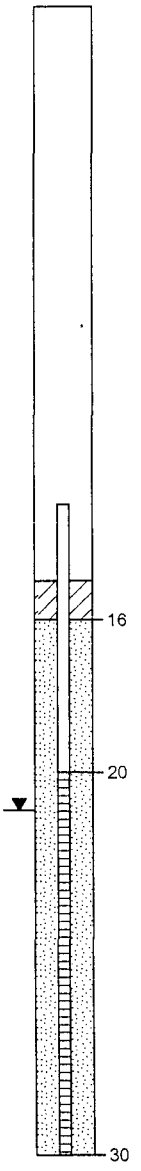
Date, Time Started:	: 11/13/02, 1250	Drilled By:	: Eco Drilling
Date, Time Completed	: 11/13/02, 1400	Logged By:	: D.G. Boyer
Hole Diameter:	: 8-1/4 in.		
Drilling Method:	: Hollow-stem auger, CME-75		
Sampling Method:	: Cuttings, core barrel		

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample Type: AR Air Rotary Cuttings; CB Core Barrel (2.5' or 5'); CT Auger Cuttings; NR No recovery

Depth in Feet	Samples	Sample Type	Recovery (ft.)	USCS	GRAPHIC	DESCRIPTION	Lab No.
0						0-15 ft. Borehole installed in excavation trench, approximately 15 ft. deep. Measurements approximate from original ground surface.	
15				MH/CA		15-15.6 ft CLAYEY, SANDY SILT, with CALICHE, light brown, H/C odor	
				CA/CL		15.6-17 ft. CALICHE with CLAY, caliche rocks to 3 in., clay interstitial, zones of black-grey weathering at 17 ft.	
20		CB	3.6	CL		17-18.6 ft. CLAY with frequent caliche, soft at 18 ft. Gray-black mottling 18-18.5 ft. H/C odor through out. 20-20.8 ft. CLAY, silty, frequent caliche rock, H/C saturated	
		CB	3.9			20.8-23.6 ft. CLAY, with caliche and occasional sand, becoming sandy at 23.6 ft.	
25				SC		23.6-23.9 ft. CLAYEY SAND, fine grained	
		CB	3.9	CL		25-26 ft. SANDY CLAY, H/C saturated 26-28.9 ft. CLAY, with caliche gravel, mottled, H/C saturated in places	
30							

BH-61



Notes:
Completed as 2-in. temporary recovery well with 10 ft. 20-slot screen, sand pack to 1 ft. below excavation base, bentonite to excavation bottom
H/C - Petroleum hydrocarbon

LOG OF BORING BH-80

Hydrocarbon Site Investigation
Monument 6" Crude Gathering Line

Navajo Refining Company
Artesia, New Mexico

Date, Time Started: : 11/23/02, 1345
Date, Time Completed : 11/23/02, 1700
Hole Diameter: : 8-1/4 in.
Drilling Method: : Hollow-stem auger, CME-75
Sampling Method: : Cuttings, core barrel

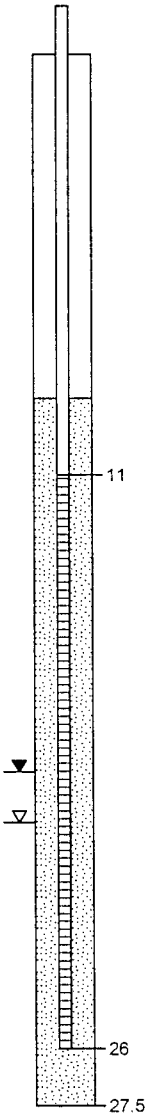
Drilled By: : Eco Drilling
Logged By: : D.G. Boyer

Sample Condition: Remoulded; Undisturbed; Lost; Rock Core

Sample Type: AR Air Rotary Cuttings; CB Core Barrel (2.5' or 5'); CT Auger Cuttings; NR No recovery

Depth in Feet	Samples	Sample Type	Recovery (ft.)	USCS	GRAPHIC	DESCRIPTION	Lab No.
0						Surface soil	
		CB	2.0			coarse grained-2 CALICHE with SILTY SAND, light brown, sand very fine to fine grained, no H/C odor	
5				CA/SM			
		CB	4.4			CALICHE with SILTY SAND, sand very fine to fine grained, chalk color, possible slight H/C odor	H7250-7
10						10-12.4 ft. CALICHE with SILTY SAND, sand very fine to fine grained, light brown, clayey at 12 ft.	
		CB	2.4	CA		12-12.4 ft. CALICHE, light brown, caliche soft to hard, fragments and gravels, very strong H/C odor 15-15.6 ft. CALICHE, rock, thick, massive, hard, laminations	H7250-8
15				CA/ML		CALICHE, with SANDY SILT, light brown, fragments and chips, dry H/C odor, increasing clay, 17-17.7 ft.	
		CB	4.0			17.7-19 ft. SILTY CLAY, stiff, dry, with caliche fragments and chips, very strong H/C odor	
20				CL		19-21.7 ft. SILTY CLAY, with occasional caliche gravels, mottled chalk and brown color, damp, soft, plastic, H/C odor throughout	H7250-9
		CB	4.0			21.7-22.3 ft. GRAVELLY CLAY, H/C saturated 22.3-22.8 ft. SILTY CLAY, H/C saturated	
						22.8-23.6 ft. SANDY CLAY, H/C saturated	
				SC		23.6-25 ft. CLAYEY SAND, brown, fine grained, H/C saturated	
25							
		CB	1.0	Slough		Slough only, core ran out of tube due to oil.	
30							

BH-80

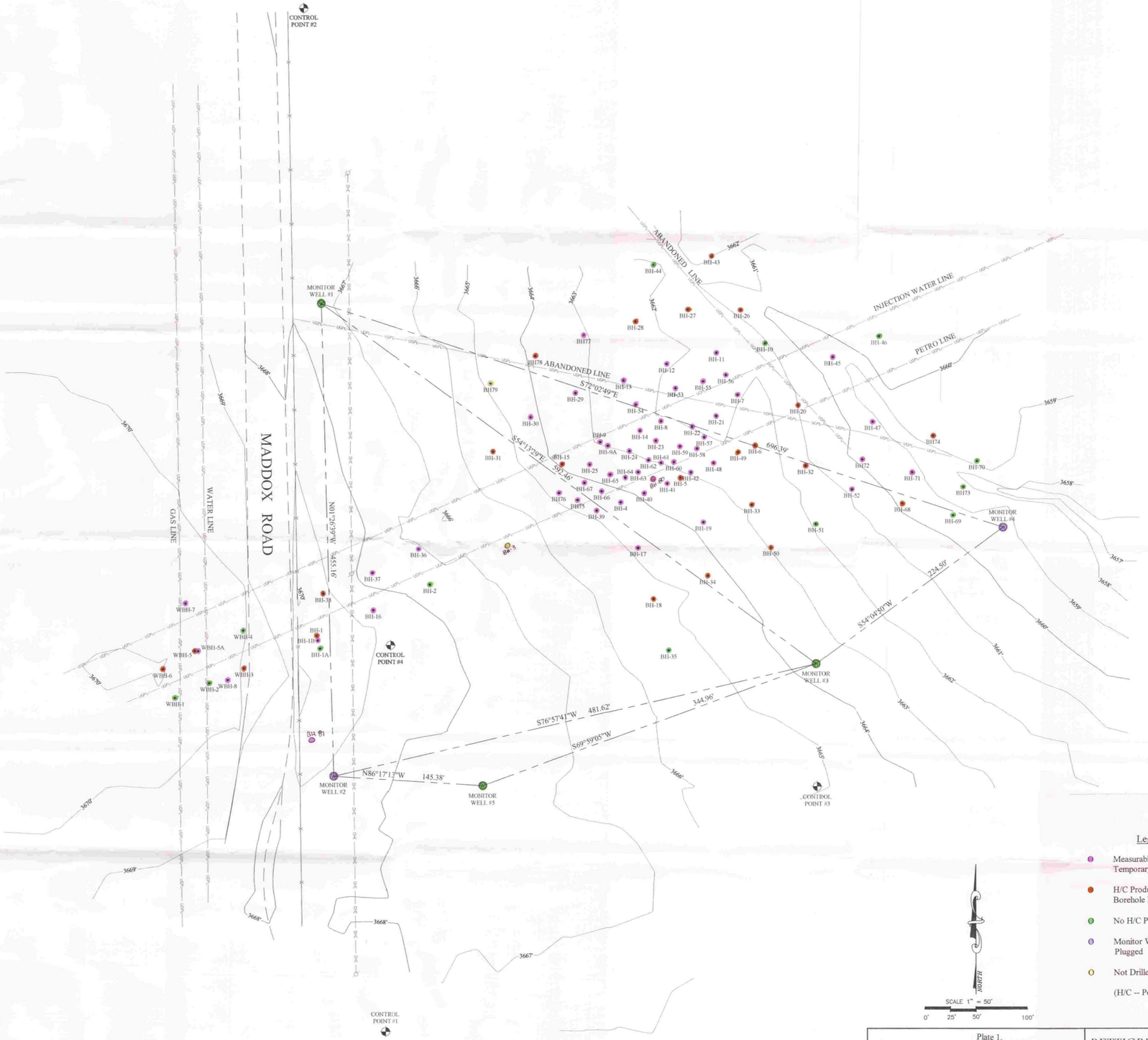


Notes:
Completed as temporary recovery well with 15 ft. screen, 11 bags sand.
Oil came to the surface as driller was cleaning out hole with auger.
H/C - Petroleum hydrocarbon
Laboratory analyses by Cardinal Laboratories

DESCRIPTION	NORTHING	EASTING	ELEVATION @ GROUND	ELEVATION @ CASING
MONITOR WELL #1	595024.03	859738.59	3667.48	3670.05
MONITOR WELL #2	594569.02	859750.07	3668.82	3671.40
MONITOR WELL #3	594677.68	860219.27	3663.64	3666.41
MONITOR WELL #4	594809.38	860401.08	3659.13	3661.76
MONITOR WELL #5	594559.61	859895.14	3668.35	3670.43

DESCRIPTION	NORTHING	EASTING	ELEVATION
CONTROL POINT #1	594323.01	859800.10	3666.91
CONTROL POINT #2	595307.82	859722.10	3667.07
CONTROL POINT #3	594559.22	860219.98	3665.24
CONTROL POINT #4	594695.33	859805.39	3669.31

DESCRIPTION	NORTHING	EASTING	ELEVATION
WBH-1	594645.17	859595.71	3669.9
WBH-2	594659.37	859629.28	3669.9
WBH-3	594673.44	859662.86	3670.0
WBH-4	594709.70	859662.17	3670.2
WBH-5	594690.15	859614.99	3670.5
WBH-5A	594690.00	859618.42	3670.7
WBH-6	594672.54	859583.69	3670.2
WBH-7	594735.74	859606.12	3670.4
WBH-8	594662.41	859647.05	3670.5
BH-1	594704.45	859733.72	3669.7
BH-1A	594692.06	859737.04	3670.0
BH-1B	594699.91	859734.79	3670.0
BH-2	594753.05	859843.87	3667.6
BH-4	594833.12	860029.34	3664.4
BH-5	594857.07	860087.35	3663.2
BH-6	594888.10	860159.99	3661.8
BH-7	594936.60	860143.09	3662.3
BH-8	594911.13	860068.53	3662.2
BH-9	594890.91	860009.77	3662.8
BH-9A	594887.32	860017.27	3662.7
BH-10	594985.77	860169.70	3660.8
BH-11	594976.48	860122.42	3661.6
BH-12	594965.83	860073.96	3662.1
BH-13	594949.96	860032.04	3662.9
BH-14	594901.91	860048.05	3662.2
BH-15	594869.59	859972.80	3663.2
BH-16	594728.86	859788.75	3669.0
BH-17	594788.89	860046.10	3665.3
BH-18	594739.87	860061.05	3665.4
BH-19	594813.97	860109.74	3664.1
BH-20	594926.55	860201.91	3661.1
BH-21	594916.35	860122.24	3661.0
BH-22	594905.91	860098.82	3657.2
BH-23	594892.35	860063.44	3657.8
BH-24	594882.47	860037.86	3658.2
BH-25	594869.25	859999.62	3658.8
BH-26	595017.93	860145.76	3661.0
BH-27	594936.60	860143.09	3662.3
BH-28	595006.38	860043.68	3662.4
BH-29	594937.78	859985.73	3663.7
BH-30	594914.51	859942.26	3664.8
BH-31	594881.48	859905.42	3665.4
BH-32	594868.68	860209.16	3661.4
BH-33	594830.80	860156.86	3662.8
BH-34	594762.17	860113.90	3664.3
BH-35	594690.27	860075.78	3665.6
BH-36	594787.44	859832.86	3666.3
BH-37	594764.42	859787.91	3667.7
BH-38	594744.62	859739.97	3669.2
BH-39	594824.94	860006.26	3665.0
BH-40	594841.96	860052.26	3664.0
BH-41	594851.35	860074.70	3663.5
BH-42	594862.30	860097.54	3663.2
BH-43	595069.96	860117.90	3661.6
BH-44	595061.23	860061.19	3662.3
BH-45	594972.53	860235.16	3659.6
BH-46	594992.53	860280.48	3660.6
BH-47	594910.96	860274.24	3659.6
BH-48	594871.19	860119.79	3662.9
BH-49	594881.58	860143.59	3662.0
BH-50	594789.70	860175.46	3663.0
BH-51	594812.46	860219.09	3662.0
BH-52	594845.96	860253.89	3661.0
BH-53	594942.70	860082.55	3661.8
BH-54	594927.00	860043.92	3662.7
BH-55	594949.26	860109.41	3661.8
BH-56	594955.47	860131.54	3661.3
BH-57	594895.89	860110.61	3647.9
BH-58	594885.00	860103.59	3648.1
BH-59	594887.03	860087.07	3648.3
BH-60	594871.93	860081.10	3648.7
BH-61	594871.18	860068.67	3649.0
BH-62	594873.71	860056.33	3649.4
BH-63	594862.29	860046.44	3649.4
BH-64	594856.95	860033.72	3649.7
BH-65	594859.75	860019.32	3650.3
BH-66	594843.50	860011.14	3651.5
BH-67	594851.76	859994.51	3653.6
BH-68	594832.50	860303.13	3660.1
BH-69	594821.08	860352.27	3659.4
BH-70	594873.36	860375.71	3658.9
BH-71	594862.62	860312.78	3658.8
BH-72	594874.76	860264.13	3660.1
BH-73	594848.58	860362.21	3658.3
BH-74	594897.60	860333.12	3659.3
BH-75	594834.98	859987.79	3654.6
BH-76	594841.90	859969.59	3655.4
BH-77	594993.13	859993.93	3663.4
BH-78	594973.14	859946.69	3664.0
BH-79	594946.73	859903.18	3664.8



Legend

- Measurable H/C Product, Temporary Recovery Well Installed
- H/C Product Show, Non - Recoverable, Borehole Plugged
- No H/C Product, Borehole Plugged
- Monitor Well with H/C Product Plugged
- Not Drilled

(H/C -- Petroleum Hybrocarbon)

NORTH

SCALE 1" = 50'

0' 25' 50' 100'

Plate 1.
Monitor Wells and Boreholes
Navajo Refining 6" Crude Line
Monument, New Mexico

PETTIGREW AND ASSOCIATES
1110 N. GRIMES HOBBS, N.M. 88240
(505) 393-0827

PLAT OF LOCATION SURVEY FOR
Safety & Environmental Solutions, Inc.
HOBBS, NEW MEXICO 88240

REV	DATE	DESCRIPTION	BOOK	HOBBS LOCAL #8	SHEET	SHEET 1
1	11/25/2002	ADDED BORE HOLES				
0	10/15/2002	FINAL PLAT				
00	10/15/2002	PRELIMINARY PLAT	PROJ. No.	2002.1154	DRN BY:	A. GARCIA
	10/14/2002	DATE OF SURVEY	DWG	AutoCAD SES Well & Monument\dwg\SES WELLS.dwg		