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REPORTS

JUNE DATE: 1993

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2R-6

PRELIMINARY SUBSURFACE INVESTIGATION

AMOCO ARTESIA STATION
SECTION 10, T18S, R27E
EDDY COUNTY, NEW MEXICO

CURA PROJECT NO. 15-93313.2

AMOCO OIL COMPANY
SUITE 300
ONE MID AMERICAN PLAZA
OAKBROOK TERRACE, ILLINOIS 60181-4723

June 15, 1993

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OIL CONSERVATION DIV.
SANTA FE

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1.0 PROJECT SUMMARY

1.1 EXECUTIVE SUMMARY

The site, Amoco Artesia Station, is located approximately 9 miles southwest of the city of Artesia in Eddy County, New Mexico and is utilized as a crude oil pipeline pump station.

Following the initial discovery by Amoco of crude oil leaking from a 30,000 barrel tank (Tank 7264), one boring (B-1) and three monitor wells (MW-1 through MW-3) were completed on May 17 and 18, 1993 to establish a baseline of the subsurface soil and groundwater conditions with respect to petroleum hydrocarbons.

Measurable hydrocarbon concentrations were detected in the soil samples during drilling operations. The total BTEX (benzene, toluene, ethylbenzene, xylenes) levels in the soils ranged from less than the method detection limit of 0.050 ppm in the 25 to 25.5 foot sample interval of monitor well MW-2 to 8178.830 ppm in the 26 to 26.5 foot interval of monitor well MW-2. TPH (total petroleum hydrocarbons) levels ranged from less than the method detection limit of 10 ppm in the 15 to 17 foot sample interval of monitor well MW-1 to 19,300 ppm in the 26 to 26.5 foot interval of monitor well MW-2.

Monitor wells MW-1 through MW-3 were gauged for depth to groundwater and crude oil thickness on May 21, 1993. Depth to groundwater across the site ranges from approximately 16.5 to 25.5 feet below ground surface with an apparent groundwater gradient in the south-southwest direction.

The monitor wells were not sampled and analyzed for total dissolved BTEX and TPH due to the presence of crude oil at the water table. Crude oil was observed at the water table with thicknesses ranging from 0.21 in monitor well MW-1 to 1.75 feet in monitor well MW-2. Monitor well MW-1 was sampled for total dissolved solids (TDS) and recorded a level of 6,270 mg/l (ppm).

1.2 SCOPE OF SERVICES

The following scope of services was conducted for the Preliminary Subsurface Investigation:

- Met onsite with Amoco Pipe Line Company to determine boring locations in order to delineate the extent of hydrocarbon-impacted soils derived from a leaking crude oil storage tank.
- Performed four soil borings and obtained soil samples to aid in classifying subsurface conditions with respect to petroleum hydrocarbons.
- Three of the borings were converted to monitor wells (MW-1, MW-2, and MW-3).
- Surveyed monitor well elevations on a relative datum, determined static fluid levels in each monitor well, and measured phase-separated hydrocarbon thickness (if any).
- Developed and sampled one monitor well (MW-1) for total dissolved solids.
- Constructed a soil hydrocarbon concentration map to help delineate the horizontal and vertical extent of hydrocarbon-affected soils.
- Assembled soil profile columns from soil boring logs and reviewed the soil classification for the site area.

- Prepared a groundwater contour map from static water level measurements in order to establish the apparent groundwater gradient.
- Prepared a crude oil thickness map to depict the extent of phase-separated hydrocarbons.
- Summarized findings in the Preliminary Subsurface Investigation report.

2.0 INTRODUCTION

CURA was contracted by Amoco Pile Line Company (Amoco) to conduct a Preliminary Subsurface Investigation following the initial discovery of a leaking crude oil storage tank at the Amoco Artesia Station.

The purpose of the Preliminary Subsurface Investigation was to establish a baseline of the subsurface soil and groundwater conditions with respect to petroleum hydrocarbons. Boring and monitor well locations were chosen under the direction of Amoco Pipe Line Company and the New Mexico Oil Conservation Division based on the location of the suspected crude oil source (Tank 7264), property boundaries, apparent surface gradient, and direction to local watercourses (Pecos River and Scoggin Draw). The site, Amoco Artesia Station, is located approximately 9 miles southeast of the city of Artesia in Eddy County, New Mexico (Appendix A, Figure 1).

3.0 SITE DESCRIPTION

Amoco Artesia Station is utilized as a crude oil pipe line pumping station in which subsurface crude oil field lines from various oil field leases are manifolded into two main subsurface discharge pipelines operated by Amoco Pipeline Company. One currently inactive 30,000 barrel aboveground crude oil storage tank (Tank 7264) is located near the southwestern corner of the site (Appendix A, Figure 2). The tank is approximately 25 years old and is surrounded by an earthen dike (approximately 200 feet by 300 feet). Seven temporary crude oil storage tanks (500 barrel tanks) are located near the center of the site within another diked area adjacent to the earthen dike surrounding Tank 7264. The pumping station is located along the east-central portion of the site.

Amoco Artesia Station is surrounded by barbed-wire fencing with a cattleguard entrance located near the northeast corner of the site boundary. The site is located in a rural area within the Empire Oil Field. No residences, public buildings, or surface bodies of water were observed within a one-half mile radius of the facility. A dry arroyo, Scoggin Draw, is located along the eastern boundary and drains from the northeast to southwest. A crude oil pipeline booster station operated by Pride Petroleum is located near the eastern boundary of the site with a subsurface pipeline that runs north-south along the east side of Scoggin Draw. An offsite produced water booster station operated by ARCO Oil and Gas Company is located adjacent to the southwest boundary of the site.

4.0 SITE HYDROGEOLOGY

The site is located in north-central Eddy County, New Mexico within the Pecos River Valley Drainage Basin, approximately 2.6 miles east-northeast of the Pecos River.

According to the USGS Spring Lake, New Mexico, topographic quadrangle, the site is approximately 3,450 feet above mean sea level (Appendix A, Figure 3). The general trend of the local topography and surface drainage of the site area slopes moderately to the southeast toward Scoggin Draw. Scoggin Draw is a usually dry watercourse located along the eastern boundary of the site and drains from the northeast to the southwest.

The subsurface geology of the site area consists primarily of gypsum from the Yates Formation of middle Permian Age. The Yates Formation is described as also containing siltstone and dolomite, however, gypsum dominates the outcrop in the site area. The Yates Formation ranges in thickness from 250 to 350 feet in the site area with an approximate regional dip of 4° towards the southeast. A stratagraphic section of the Pecos River Valley Drainage Basin is depicted in Appendix A (Figure 4).

The soils on site belong to the Gypsum Land-Cottonwood complex. The Gypsum Land consists of gypsumferous materials that range from white, chalky soils to light colored, crystalline gypsum rocks. Fine to coarse gypsum crystals are common. Gypsum Land is well-drained, with a low water holding capacity. The Cottonwood Series consists of well-drained, calcareous, light colored soils that are shallow or very shallow over beds of gypsum. Soils of the Cottonwood Series typically have a surface layer of light gray to light brownish-gray loam. These soils are underlain by gypsiferous material at a depth of about 9 inches. The Gypsum Land - Cottonwood complex soils have a moderate permeability. The soils described in the soil survey are generally consistent with the observed soils on site.

Water wells in the site area are uncommon due to low well yields and the poor water quality (high total dissolved solids levels) that typify the shallow groundwater east of the Pecos River. The shallow groundwater is transmitted through a complex system of fractures and solution cavities - mostly enlarged joints and openings along bedding planes.

Currently, the groundwater in the site area is not used as a drinking water source. The drinking water in Artesia, the nearest municipality (approximately 9 miles northwest of the site), is supplied from 8 wells located within or near the city limits which produce from the San Andres Formation. The artesian wells were completed to depths ranging from approximately 1,000 to 1,200 feet. Artesian pressure in the wells allows pumping levels that range from depths of approximately 50 feet in the winter to 250 feet in the summer during the irrigation season according to Mr. Tommy Howell, Supervisor of the City of Artesia Water Office.

A field survey of the site and surrounding area was conducted to identify potential receptors (residences, public buildings, water supply wells, and surface bodies of water) in the site vicinity. No residences, public buildings, or surface bodies of water were identified within a one-half mile radius of the site. A water well search was conducted based on information provided by the New Mexico State Engineers Office in Roswell, New Mexico. The search revealed one registered water well (Location No. 18.27.10.214) located approximately 2,000 feet northeast of the site. The well was completed at a depth of 130 feet in 1958. Current status (active, plugged, abandoned) of the well is unknown. A copy of the well record and log of the well is included in Appendix C.

5.0 HYDROGEOLOGIC INVESTIGATION AND FINDINGS

5.1 SOIL INVESTIGATION

5.1.1 SOIL BORING LOCATIONS

The locations of borings B-1 and monitor wells MW-1 through MW-3 were chosen under the direction of Amoco Pipe Line Company based on the location of the suspected crude oil source (Tank 7264), property boundaries, apparent surface gradient, and direction to local watercourses (Pecos River and Scoggin Draw). Boring B-1 was located approximately 40 feet southwest of the edge of Tank 7264 within the earthen dike surrounding the tank. Monitor well MW-1 was placed near the center of Scoggin Draw within the southeast corner of the site boundary in the apparent downgradient direction of the observed local surface drainage. Monitor well MW-2 was placed approximately 150 feet southwest of Tank 7264 near the southwest corner of the site in the relative direction of the Pecos River. Monitor well MW-3 was located approximately 100 feet northeast of Tank 7264.

5.1.2 SOIL SAMPLING OPERATIONS

Subsurface conditions were variable for boring B-1 and monitor wells MW-1, MW-2, and MW-3. The soils in boring B-1 and MW-2 consisted of a thin (0 to 1-foot thick) layer of reddish-brown gypsumiferous calcareous silt (ML) underlain by light gray gypsum rock to a depth of approximately 29 feet. The gypsum rock was composed of fine to coarse crystals and contained approximately 5 to 10 fractures per linear vertical foot. The fractures were predominately horizontal and oriented along the apparent bedding planes of the gypsum formation. The subsurface soils in monitor well MW-1 consisted of approximately 16 feet of reddish-brown gypsumiferous calcareous silty clay (CL) underlain by light gray gypsum rock to a depth of approximately 27 feet. In monitor well MW-3, a reddish-brown gypsumiferous calcareous silt (ML) was encountered to a depth of approximately 11 feet. This unit was underlain by an approximately 1-foot thick layer of dark gray silty clay (CL). Light gray gypsum rock was then observed to a depth of 17 feet when another layer of dark gray silty clay (CL) approximately 2-foot thick was encountered. Below the lower clay unit light gray gypsum rock was observed to the bottom of the boring at a depth of approximately 22.5 feet. Water and crude oil was observed in a narrow (0.5 to 1-foot thick) fractured zone at a depth of approximately 18 to 26 feet in the borings during drilling and sampling operations. The soil boring logs included in Appendix B provide a more detailed description of the subsurface conditions.

Soil samples were retrieved from the borings to be analyzed for benzene, toluene, ethylbenzene, xylenes (BTEX) and total petroleum hydrocarbons (TPH). Samples were obtained at various intervals in each boring using a split spoon sampling device and rock core barrel. The soil sample obtained from each interval was split into two separate containers. One sample was placed into a glass jar with teflon-lined lids and zero head space and preserved at 4°C in accordance with EPA protocol for shipment to the laboratory. The other soil sample from each interval was placed in a one quart size plastic bag and field-screened (head space analysis) with a flame ionization detector (FID) Century 128 Organic Vapor Analyzer (OVA) utilizing procedures consistent with OCD guidelines. The OVA detects volatile petroleum and non-petroleum organic compounds in ppm methane equivalent.

5.1.3 SOIL SAMPLE ANALYTICAL RESULTS

OVA readings ranged from <1 ppm in various intervals of the borings to >1,000 ppm in the water-bearing intervals of each boring. A minimum of two samples from each boring were submitted for laboratory analysis except for monitor well MW-1 in which one sample was submitted. The sample with the highest relative OVA reading and the sample immediately above the interval where groundwater was first encountered in each boring unless noted otherwise were submitted to the laboratory for BTEX and TPH analysis using EPA-approved analytical methods (EPA Method 8020 and EPA Method 418.1, respectively). Complete OVA readings and a listing of those samples submitted to the laboratory are presented in Table 1. Monitor wells MW-1 through MW-3 and boring B-1 exhibited hydrocarbon staining and odors within the water-bearing interval. Hydrocarbon staining and/or odors were also observed during sampling operations in various intervals of boring B-1 and in the 11 to 12 foot interval of monitor well MW-3.

TABLE 1
SOIL SAMPLE ANALYTICAL RESULTS

Soil Samples Obtained During Boring Operation Conducted on May 17, 1993

Boring/ Monitor Well	Sample Interval (feet)	OVA	Benzene	Toluene	Ethyl-benzene	Xylenes	Total BTEX	TPH
B-1	4 - 4.5	50						
	6 - 6.5	120	<0.050	0.217	<0.050	0.442	0.659	1,818
	8 - 8.5	8						
	10 - 10.5	50						
	15 - 15.5	8						
	20 - 20.5	30	0.051	0.082	<0.050	0.361	0.494	738
	23 - 23.5	>1,000	PSH	PSH	PSH	PSH	PSH	PSH
MW-1	5 - 6	<1						
	10 - 11	<1						
	15 - 17	<1	0.178	<0.050	<0.050	0.059	0.237	<10
	19.5 - 20	>1,000	Insufficient Sample Recovery					
	20 - 27	<1						
MW-2	5 - 7	<1						
	10 - 11	<1						
	15 - 15.5	<1						
	20 - 25	<1						
	25 - 25.5	<1	<0.050	<0.050	<0.050	<0.050	<0.050	14
	26 - 26.5	>1,000	<0.050	43.310	13.110	122.410	178.830	19,300

TABLE 1
SOIL SAMPLE ANALYTICAL RESULTS

Soil Samples Obtained During Boring Operation Conducted on May 17, 1993

Boring/ Monitor Well	Sample Interval (feet)	OVA	Benzene	Toluene	Ethyl-benzene	Xylenes	Total BTEX	TPH
MW-3	2 - 4	2						
	6 - 8	<1						
	10 - 12	>1,000	6.314	46.518	10.031	67.646	130.509	18,900
	17 - 19	>1,000	0.910	5.941	2.379	22.262	31.492	3,650

OVA results listed in parts per million (ppm) equivalent methane.
BTEX results in mg/kg (parts per million; ppm) method detection limit listed in appendix D.
TPH results in mg/kg (parts per million; ppm) method detection limit listed in appendix D.
Analyses were conducted using EPA Method 8020 (BTEX) and EPA Method 418.1 (TPH) by CURA Environmental Laboratories.
PSH - Phase Separated Hydrocarbons (crude oil).

Total BTEX (benzene, toluene, ethylbenzene, xylenes) levels in the soils ranged from below the method detection limit of 0.050 ppm in 25 to 25.5 foot sample interval of monitor well MW-2 to 178.830 ppm in the 26 to 26.5 foot interval of monitor well MW-2. TPH (total petroleum hydrocarbons) levels ranged from less than the method detection limit of 10 ppm in the 15 to 17 foot interval of monitor well MW-1 to 19,300 ppm in the 26 to 26.5 foot interval of MW-2. Total BTEX and TPH concentrations are illustrated on the Hydrocarbon Concentration Map (Appendix B, Figure 5) to indicate soil sample depths and the corresponding hydrocarbon concentration levels.

A summary of the analytical results is presented in Table 1. Laboratory reports and the chain-of-custody are included in Appendix D.

5.2 GROUNDWATER ASSESSMENT

5.2.1 MONITOR WELL INSTALLATION AND SAMPLING OPERATIONS

Three on-site monitor wells (MW-1 through MW-3) were installed during this investigation. Monitor well MW-1 was placed within Scoggin Draw in the apparent downgradient direction of the observed local surface drainage near the southeast corner of the site. Monitor well MW-2 was located near the southwest corner of the site (approximately 150 feet southwest of Tank 7264) in the relative direction of the Pecos River which is located approximately 2.6 miles west-southwest of the site. Monitor well MW-3 was placed approximately 100 feet northeast of Tank 7264 in a depression within the earthen dike surrounding the tank. Hydrocarbon staining and odors were observed in monitor wells MW-1 through MW-3 within the narrow (0.5 to 1 foot thick) water-bearing interval encountered during drilling operations. Groundwater was encountered at approximately 19, 26 and 18 feet below ground surface, respectfully, in monitor wells MW-1, MW-2, and MW-3 during drillings operations.

The monitor wells were constructed of four-inch diameter schedule 40 PVC casing with a 0.02-inch factory-slotted well screen. The well screen in monitor well MW-1 extends from 24 to 14 feet. Monitor wells MW-2 and MW-3 contain well screens extending from 29 to 19 feet and 22.5 to 10.5 feet below ground surface, respectively.

The monitor wells were completed with a sand pack extending from the bottom of the boring to approximately 2 feet above the casing/screen junction. A clean silica sand with a grain size larger than the well screen (sieve size 10 to 20) was used as the sand pack in the annular space between the casing and borehole. Above the sand pack, an approximately 5 foot thick bentonite plug was installed in the annular space between the casing and borehole to provide a watertight seal between the surface and subsurface. A 4 to 10-foot thick seal of non-shrink grout was placed on top of the bentonite seal. A watertight locking well cap was installed and a secured watertight monument type well cover was grouted in place for each monitor well.

5.2.2 GROUNDWATER GRADIENT AND FLOW

During rock core sampling operations for monitor wells MW-1, MW-2, and MW-3, a shallow water-bearing interval was encountered within a narrow (0.5 to 1-foot thick) fractured zone at a depth of approximately 18 to 26 feet below ground surface. This shallow water-bearing interval may represent perched groundwater conditions.

After the monitor wells were installed on May 18, 1993, they were gauged for depth to groundwater and crude oil thickness on May 21, 1993 using a KECK (Model KIR-89) Oil-Water Interface probe. The depth to groundwater across the site ranges from approximately 16.5 to 25.5 feet below ground surface based on water level measurements presented in Table 2.

Based on gauging data, the apparent groundwater gradient beneath the site is in the south-southwest direction, approximately parallel to the downgradient direction of Scoggin Draw which is a tributary to the Pecos River. Crude oil was observed immediately above the water table with thicknesses ranging from 0.21 feet in monitor well MW-1 to 1.75 feet in monitor well MW-2 on May 21, 1993. Approximately 3

1/2 gallons of crude oil was recovered from the on site monitor wells. A summary of relative groundwater elevations and phase-separated hydrocarbon thickness measurements is presented in Table 2. A groundwater gradient map and crude oil thickness map are illustrated in Figures 5 and 6 of Appendix A.

TABLE 2
SUMMARY OF RELATIVE GROUNDWATER LEVEL ELEVATIONS AND PHASE-SEPARATED HYDROCARBON THICKNESSES
Groundwater Elevations Obtained May 21, 1993

Monitor Well	Relative Ground Surface Elevation (feet)	Relative Top of Casing Elevation (feet)*	Depth to Water Below Top of Casing (feet)	Corrected Relative Groundwater Elevation (feet)**	Phase-Separated Hydrocarbon Thickness (feet)
MW-1	92.68	94.77	20.73	73.87	0.21
MW-2	100.42	102.52	27.56	73.53	1.75
MW-3	92.65	93.88	17.81	74.95	1.36

* Measured from a relative datum (benchmark = 100.00 feet) located at the base of the south side of Tank 7264. The monitor well casings were marked to provide consistent reference points for future gauging operations.
** Correction Equation for Phase-Separated Hydrocarbons: Corrected Groundwater Elevation = Top of Casing Elevation - (Depth to Water Below Top of Casing - [SG] [PSH Thickness])
Specific Gravity (SG) = 0.82 for crude oil.

5.2.3 GROUNDWATER ANALYTICAL RESULTS

The monitor wells were not sampled on May 21, 1993 for total dissolved BTEX or TPH due to the presence of phase-separated hydrocarbons (crude oil) immediately above the water table. A total dissolved solids (TDS) was obtained from monitor well MW-1 for groundwater classification purposes. Prior to sampling, monitor well MW-1 was surge bailed to remove the fine granulated materials and then purged by bailing the well dry (approximately 6 gallons). The monitor well was then allowed to recover to static water level before obtaining groundwater samples for laboratory analysis. Monitor well MW-1 recorded a TDS (total dissolved solids) value of 6,270 mg/l (ppm).

A summary of analytical results is presented in Table 3. Laboratory reports and the chain-of-custody are included in Appendix E.

TABLE 3
WATER SAMPLE ANALYTICAL RESULTS

Water Samples Obtained on May 21, 1993

Monitor Well	pH	Conductivity	TDS
MW-1	6.40	6,230	6,270

TDS results listed in mg/l (parts per million; ppm) with a method detection limit of 1 ppm.
Conductivity results listed in mocrosiemens per centimeter (μS/cm).
pH results listed in standard units (S.U.).
Analysis was conducted using EPA Method 160.1 (TDS) by CURA Environmental Laboratories.

5.2.4 WASTE MANAGEMENT

The liquids generated from monitor well development operations (approximately 6 gallons) were temporarily stored on site in a labelled 55-gallon steel drum pending disposal. Approximately 3.5 gallons of crude oil was hand bailed from monitor wells MW-1, MW-2, and MW-3 on May 21, 1993 and was placed into the sump.

6.0 FINDINGS

1. Although water wells are uncommon in the site area due to low yields and poor groundwater quality, one registered water well was identified approximately 2,000 feet northeast (upgradient) of the site. The current status of this water well is unknown. No other potential receptors were identified within a one-half mile radius of the site.

2. The surface geology of the site area is composed primarily of fractured gypsum rock of the Yates Formation which is of Permian Age. A reddish-brown gypsumiferous calcareous silty clay unit of varying thickness (0 to 16 feet) was also observed at some of the boring locations. This unit appeared to thicken towards the southeast portion of the site, particularly along Scoggin Draw.

3. Soil sample analyses indicated total BTEX levels ranging from <0.050 ppm in the 25 to 25.5 foot interval of monitor well MW-2 to 178.830 ppm in the 26 to 26.5 foot interval of monitor well MW-2. TPH concentrations ranged from <10 ppm in the 15 to 17 foot interval of monitor well MW-1 to 19,300 ppm in the 26 to 26.5 foot interval of monitor well MW-2.

4. During rock core sampling operations for monitor wells MW-1 through MW-3, a shallow water-bearing interval was encountered within a narrow (0.5 to 1 foot thick) fractured zone at a depth of approximately 18 to 26 feet below ground surface. This shallow water-bearing zone may represent perched groundwater conditions.

5. Groundwater was measured at depths ranging from 16.5 to 25.5 feet below ground surface during gauging operations conducted on May 21, 1993. The apparent groundwater gradient is to the south-southwest, approximately parallel to the downgradient direction of Scoggin Draw.

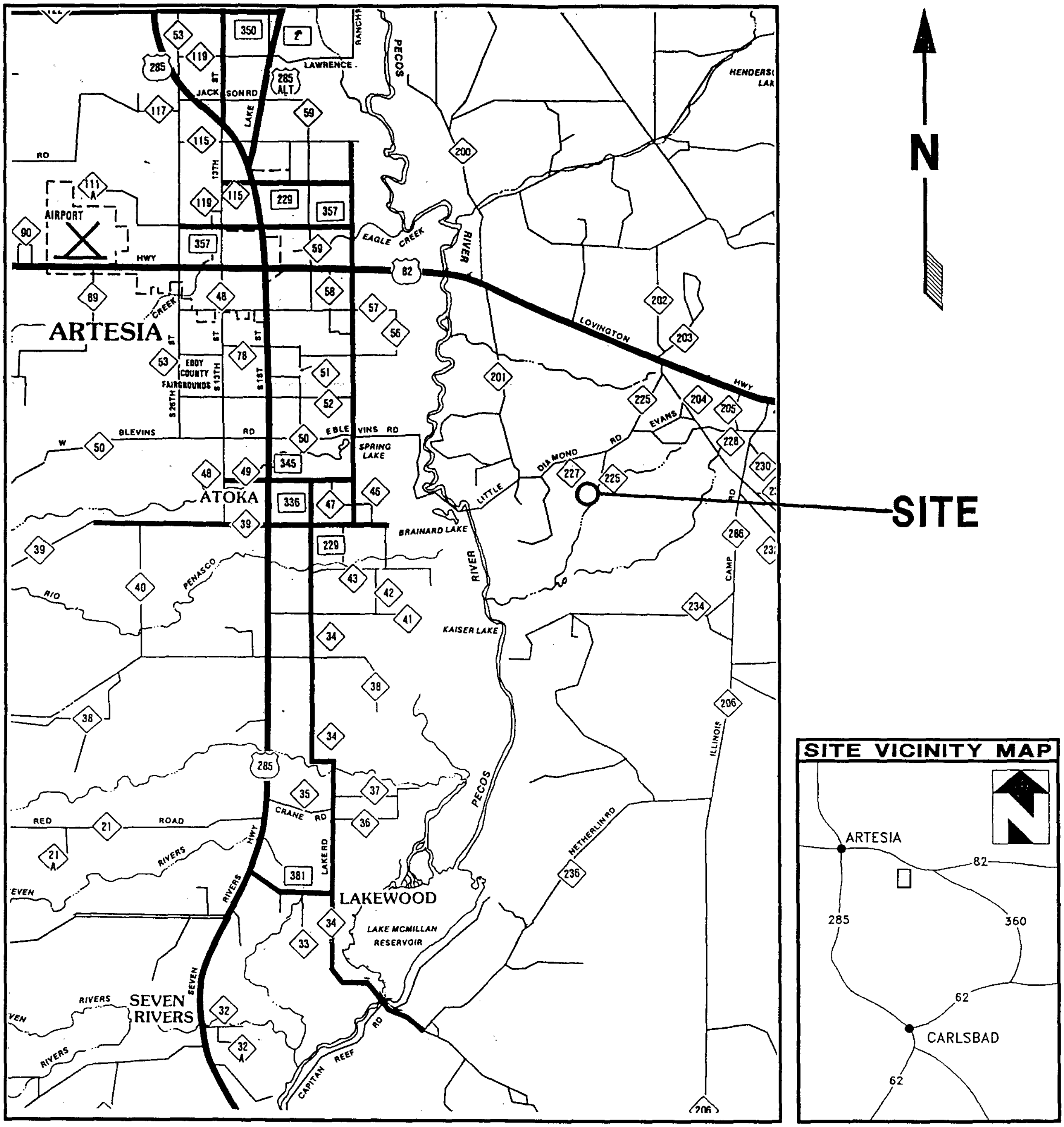
6. Crude oil was observed immediately above the water table with thicknesses ranging from 0.21 feet in monitor well MW-1 to 1.75 feet in monitor well MW-2 indicating that offsite migration is probable.

7. Monitor well MW-1 was sampled for total dissolved solids (TDS) and recorded a level of 6,270 mg/l (ppm).

7.0 APPENDICES

APPENDIX A

FIGURES



SITE LOCATION MAP

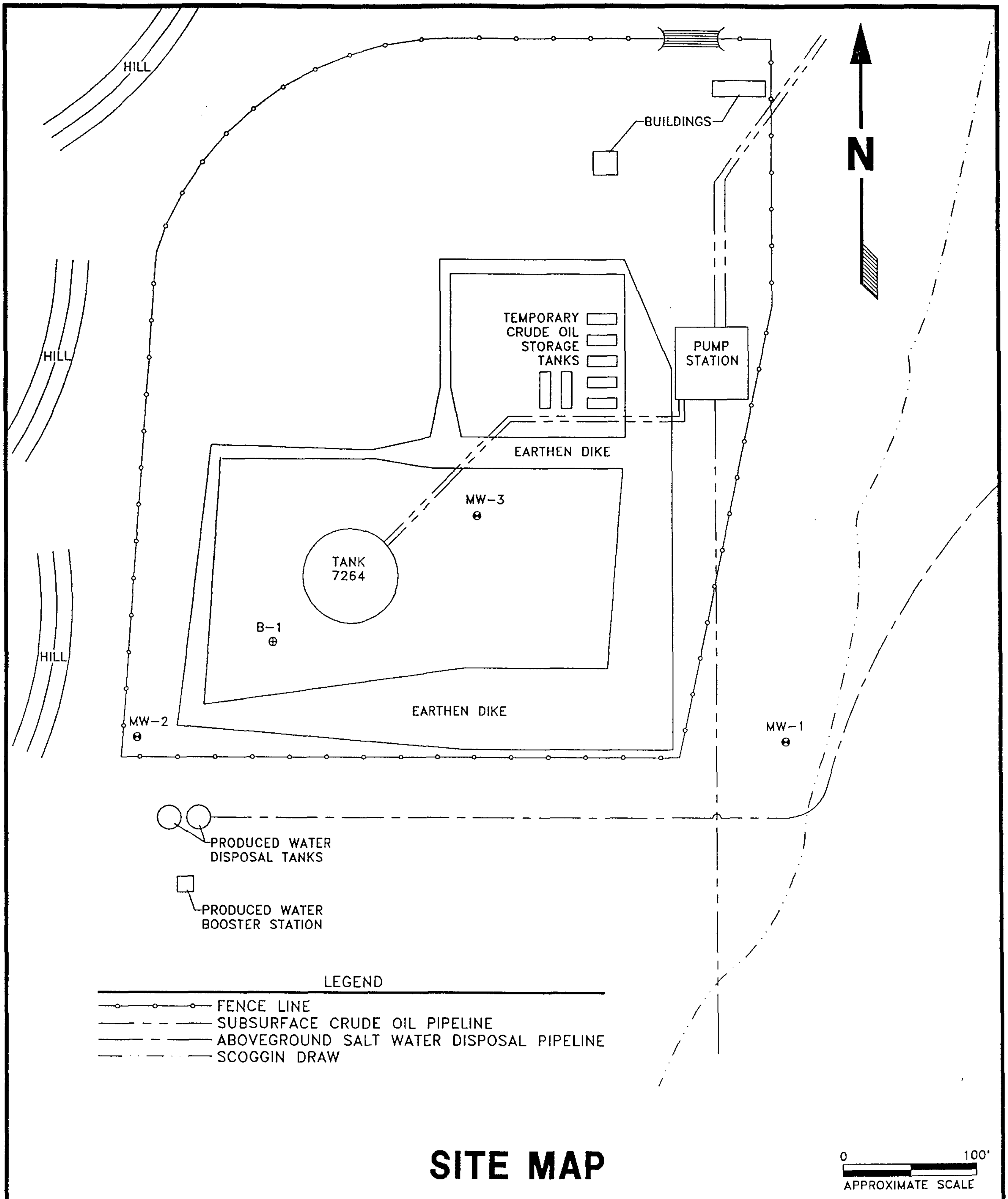
REF: MASS MARKETING/MERCHANT MAPS DIVISON (1993)

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

AMOCO ARTESIA STATION
SECTION 10, T18S, R27E
EDDY COUNTY, NEW MEXICO

DATE:	SCALE:
MAY 1993	1" ≃ 3.3 MI
PROJECT NO.	FIGURE NO.
15-93313	1



SITE MAP

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

AMOCO ARTESIA STATION
SECTION 10, T18S, R27E
EDDY COUNTY, NEW MEXICO

DATE:	SCALE:
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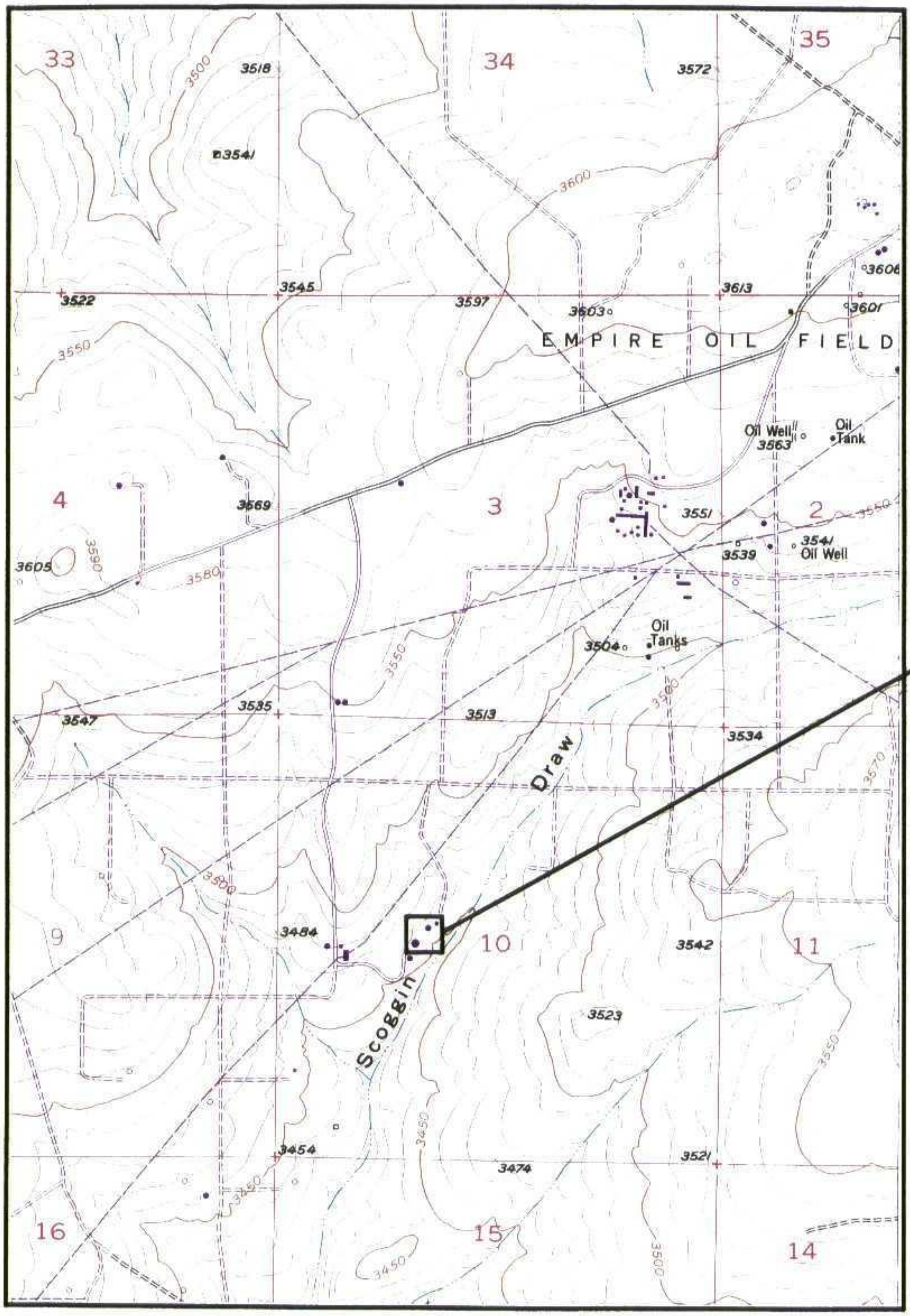
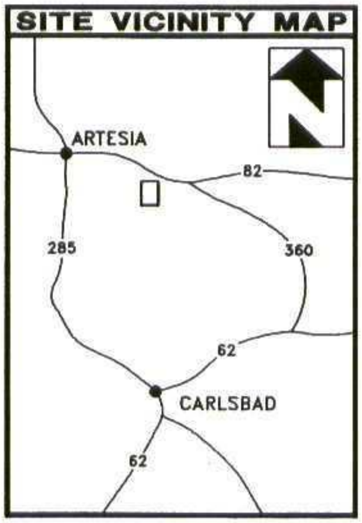
PROJECT NO.	FIGURE NO.
15-93313	2





SITE VICINITY MAP

TOPOGRAPHIC MAP

REF: USGS SPRING LAKE, NEW MEXICO QUADRANGLE 1955
PHOTOREVISED 1975

INC. 2735 VILLA CREEK DRIVE - TWO METRO SQUARE BLDG. C - SUITE 250 - DALLAS, TX 75234 620-7117 FAX - 620-8219	AMOCO ARTESIA STATION SECTION 10, T18S, R27E EDDY COUNTY, NEW MEXICO	DATE: MAY 1993	SCALE: 1"≃ 2000'
		PROJECT NO. 15-93313	FIGURE NO. 3

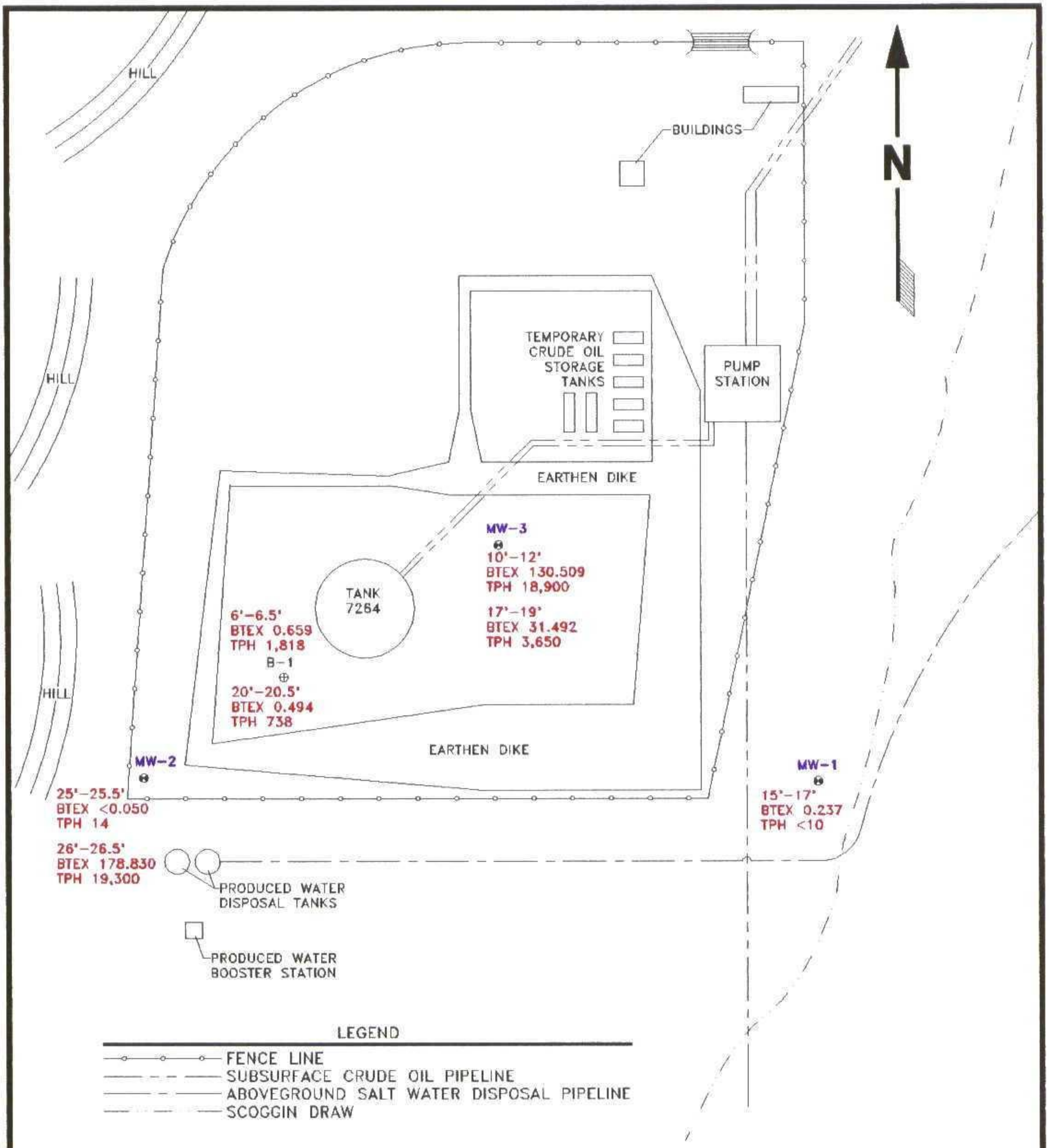
STRATIGRAPHIC SECTION - PECOS RIVER DRAINAGE BASIN

			Formations & Members	Thick	Description
Holocene and Pleistocene			Assorted surficial deposits	0 - 300	Valley alluvium, terrace and pediment gravel, caliche soils, aeolian sand, travertine
Pleistocene-Pliocene			Gatuna Formation	0 - 200	Sandstone, sand gravel, siltstone, limestone, red, brown, tan, gray, yellowish
Oligocene			Sierra Blanca Volcanics	700 - 4,000	Andesite breccia and tuff; some flows
Paleocene			Cub Mountain Formation	500 - 2,000	Sandstone, mudstone, conglomerate, arkose; white, buff, lavender, purple, maroon
Cretaceous			Mesaverde Formation	500 - 1,500	Sandstone, shale, coal, conglomerate; buff, gray, black
			Mancos Shale	400 - 700	Shale, siltstone, with local thin sandstone and limestone; black, grayish-black
			Dakota Sandstone	100 - 150	Sandstone, conglomerate, black shale; gray to tan
Upper Triassic			Chinle Shale	0 - 300	Mudstone with some claystone and thin sandstone; reddish-brown
			Santa Rosa Sandstone	0 - 300	Sandstone, conglomerate, mudstone; brown, buff, lavender
PERMIAN	Ochoan Series		Dewey Lake Formation	200 - 250	Sandstone, siltstone; orange-brown; commonly laminated
			Rustler Formation: Upper Member	150 - 200	Dolomite, gypsum, mudstone, white, red-brown, green, gray, deep orange; Magenta dolomite at base
			Lower Member	100 - 250	Dolomite, gypsum, mudstone, sandstone; white, red-brown, gray, green; salt in subsurface; Culebra dolomite at base
			Salado Formation	0 - 2,500	Gypsum, mudstone, thin local dolomite; white red, brown, green, deep orange, breccia residue at surface, thick salt, potash in subsurface
			Castile Formation Upper Member (surface)	1,000 +/-	Gypsum (anhydrite), salt; white, gray
			Lower Member (surface)	1,000 +/-	Laminated gypsum (anhydrite) and limestone, laminated limestone, laminated gypsum; gray, black, white
	Guadalupian Series	Artesia Group	Tansill Formation	200 - 300	Dolomite and siltstone (south); dolomite, gypsum, and anhydrite (north); Ocotillo siltstone tongue near exposed top
			Yates Formation	250 - 300	Siltstone, sandstone, dolomite, limestone and gypsum (south); gypsum, siltstone and thin dolomite (north)
			Seven Rivers Formation	450 - 600	Dolomite, siltstone (south); gypsum and siltstone (north)
			Queen Formation	200 - 400	Dolomite and sandstone (south); gypsum, red mudstone, dolomite (north); Shattuck member near top
			Grayburg Formation	250 - 450	Dolomite and sandstone (south); gypsum, mudstone, dolomite (north)
			San Andres Formation: Fourmile Draw Member	0 - 700	Dolomite, gypsum, reddish mudstone; sandstone locally at top; thin-bedded
			Bonney Canyon Member	0 - 300	Dolomite, local limestone; gray, light-gray, local black; thin-bedded
	Leonardian Series,		Rio Bonito Member	250 - 350	Dolomite, limestone, sandstone (Glorieta); gray, brownish gray; thick-bedded
			Yeso Formation	0 - 1,400	Sandstone, siltstone, dolomite, gypsum; tan, red-yellow, gray, white
Precambrian			Syenite, gneiss, and diabase		

REF: Adapted from New Mexico State Bureau of Mines and Mineral Resources, Memoir 24 (1971)

PECOSRIV.FRM (06/07/93)

CURA INC. 2735 VILLA CREEK DRIVE - TWO METRO SQUARE BLDG. C - SUITE 250 - DALLAS, TEXAS (214) 620 - 7117	AMOCO ARTESIA STATION SECTION 10, T18S, R27E EDDY COUNTY, NEW MEXICO	DATE: MAY 1993	SCALE: NONE
		PROJECT NO. 15-93313	FIGURE NO. 4



SOIL HYDROCARBON CONCENTRATION MAP

-SAMPLES OBTAINED ON 05/17/93

-RED NUMBERS INDICATE BTEX AND TPH CONCENTRATIONS IN mg/kg (ppm)

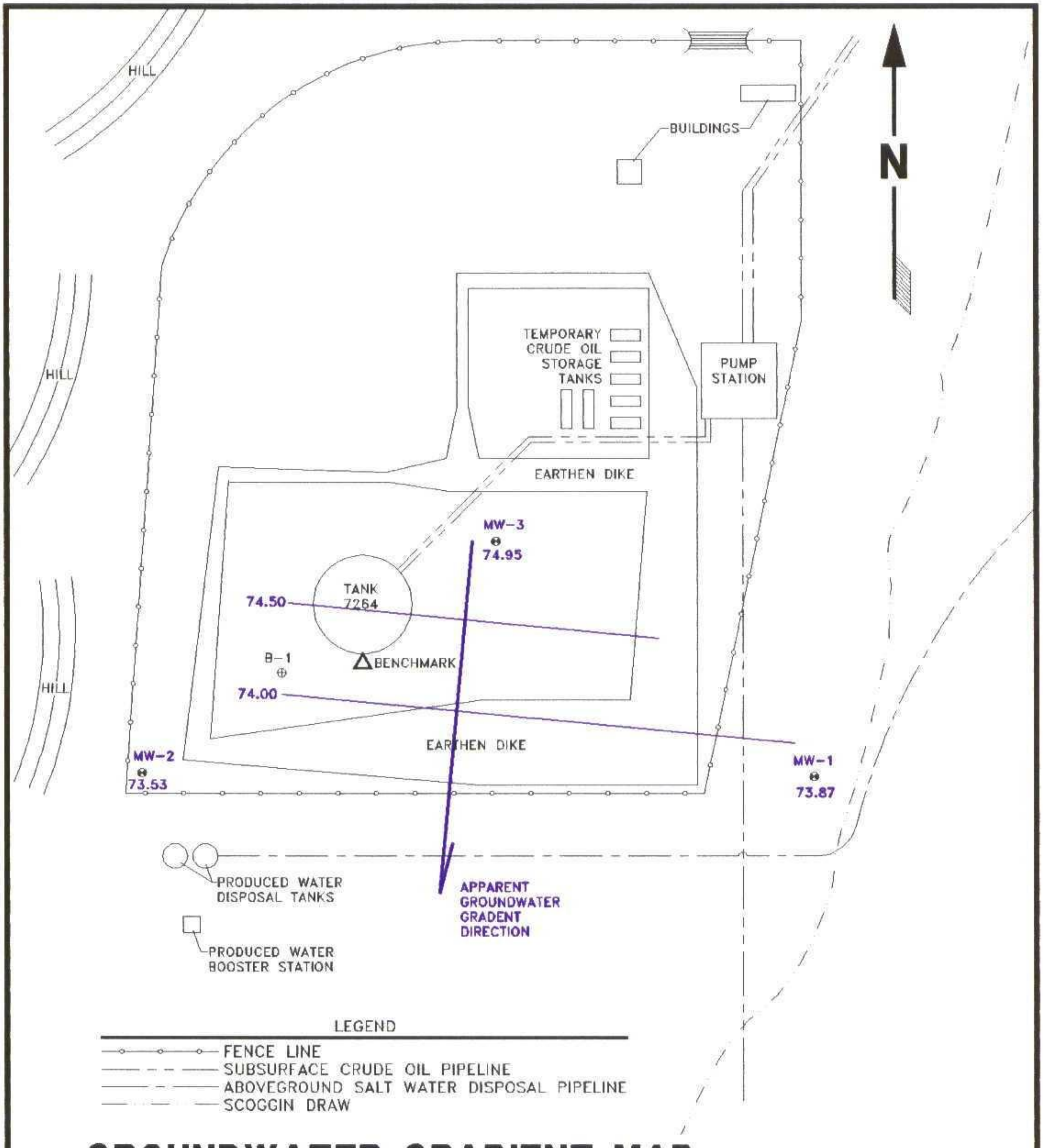
0 100'
APPROXIMATE SCALE

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

AMOCO ARTESIA STATION
SECTION 10, T18S, R27E
EDDY COUNTY, NEW MEXICO

DATE:	SCALE:
MAY 1993	SEE ABOVE
PROJECT NO.	FIGURE NO.
15-93313	5



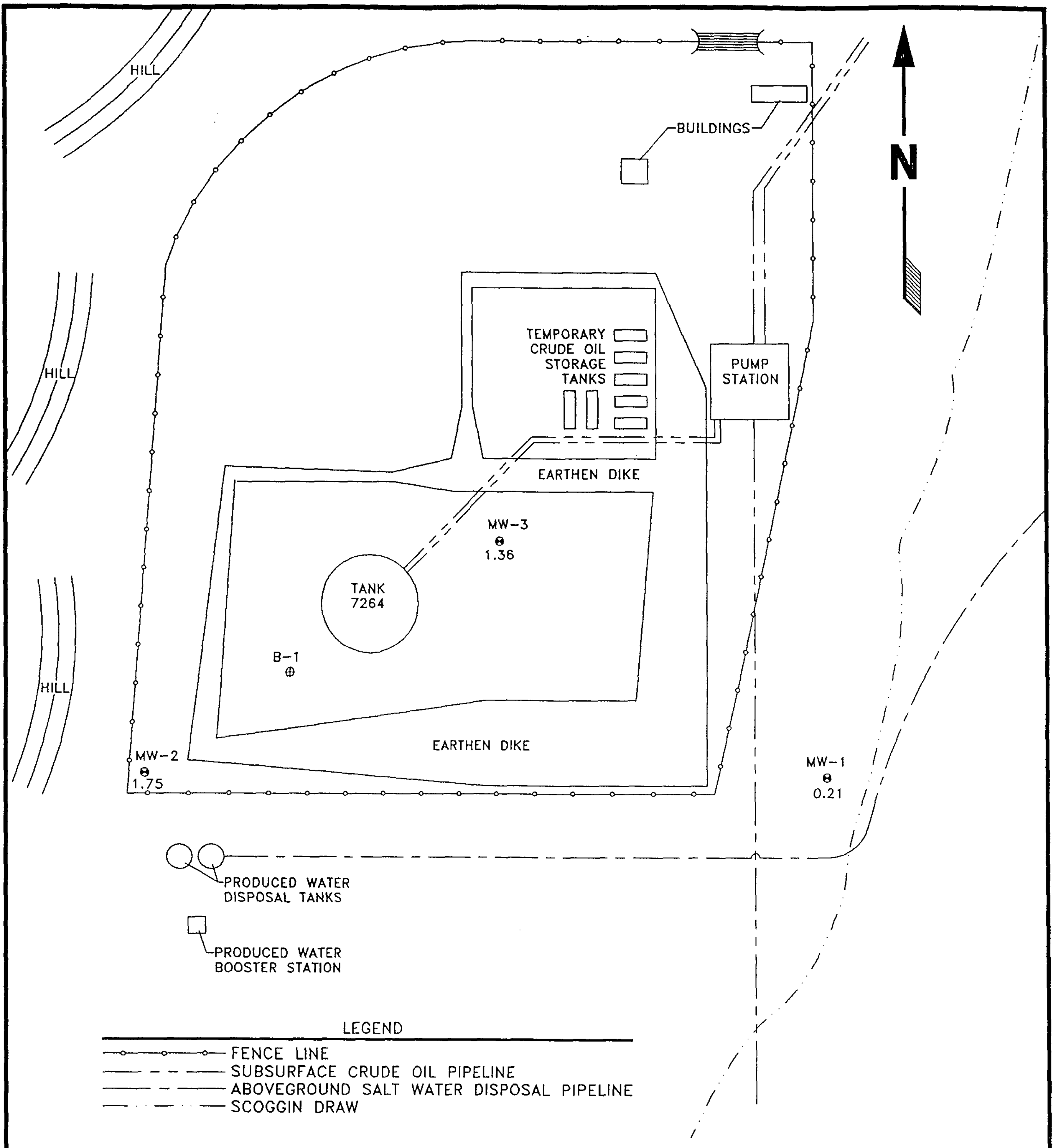
GROUNDWATER GRADIENT MAP

-STATIC WATER LEVELS OBTAINED 05/21/93
-CONTOUR INTERVAL = 0.50 FEET

0 100'
APPROXIMATE SCALE

△ -BENCHMARK (100.00 FEET) LOCATED AT SOUTHERN BASE OF TANK 7264

CURA INC. 2735 VILLA CREEK DRIVE - TWO METRO SQUARE BLDG. C - SUITE 250 - DALLAS, TX 75234 620-7117 FAX - 620-8219	AMOCO ARTESIA STATION SECTION 10, T18S, R27E EDDY COUNTY, NEW MEXICO	DATE: MAY 1993	SCALE: SEE ABOVE
		PROJECT NO. 15-93313	FIGURE NO. 6



CRUDE OIL THICKNESS

-MEASUREMENTS OBTAINED 05/21/93
-CRUDE OIL THICKNESS REPORTED IN FEET

0 100'
APPROXIMATE SCALE

CURA INC.
2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

AMOCO ARTESIA STATION
SECTION 10, T18S, R27E
EDDY COUNTY, NEW MEXICO

DATE:	SCALE:
MAY 1993	NTS
PROJECT NO.	FIGURE NO.
15-93313	7

APPENDIX B

BORING/WELL LOGS

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

RECORD OF SUBSURFACE EXPLORATION

Project No.: 15-93313	Well/Boring #: B-1	Date Drilled: 05/17/93
Project: AMOCO ARTESIA STATION SECTION 10, T1BS, R27E EDDY COUNTY, NEW MEXICO	Depth of Boring: 23.5 FEET Depth of Well: -	Diameter of Boring: 5 INCHES Diameter of Screen: -
Drilling Co: HI-PLAINS DRILLING	Length of Screen: -	Diameter of Casing: -
Driller: BARRY SIMMONS	Length of Casing: -	Slot Size: -
Drilling Method: AIR ROTARY	Logged By: G.J.V.	Well Material: -

DEPTH FEET	SOIL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	OVA (PPM)	WELL DESIGN	REMARKS
0	Reddish-brown gypsumiferous calcareous SILT (ML)					0
	Light gray GYPSUM					
2.5						2.5
		1	SS	50		
5.0						5.0
		2	SS	120	■	BTEX=0.659 mg/kg (ppm) TPH=1,818 mg/kg (ppm)
7.5						7.5
		3	SS	8		
10.0						10.0
		4	SS	50		
12.5						12.5
15.0						15.0
		5	SS	8		
17.5						17.5
20.0		6	SS	30	■	BTEX=0.494 mg/kg (ppm) TPH=738 mg/kg (ppm) 20.0
22.5						▽ 22.5
		7	SS	>1000		● Crude oil and water @ 23'
	Bottom of boring @ 23.5 feet					
25.0						25.0
27.5						27.5
30.0						30.0

ABBREVIATIONS AND SYMBOLS

SS-Driven Split Spoon
ST-Pressed Shelby Tube
CA-Continuous Flight Auger
RC-Rock Core
THD-Texas Highway Department Cone
T-5' Continuous Sampler

HSA-Hollow Stem Augers
CFA-Continuous Flight Augers
DC-Driving Casing
MD-Mud Drilling

WATER LEVEL
▽ At Completion
▼ After Hours
● Water on Rods

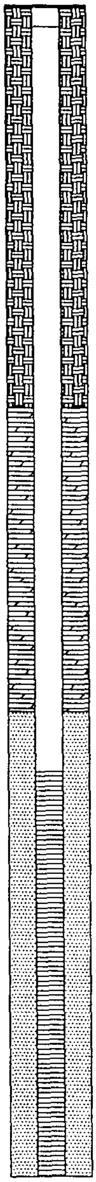
■ Sample submitted to lab
▤ Bottom Cap
▤ Factory-Slotted Well Screen
░ Sand Pack
☐ Well Casing
▤ Bentonite Seal
▦ Volclay Grout Seal

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

RECORD OF SUBSURFACE EXPLORATION

Project No.: 15-93313	**Well/Boring #:** MW-2	**Date Drilled:** 05/17/93
Project: AMOCO ARTESIA STATION SECTION 10, TIBS, R27E EDDY COUNTY, NEW MEXICO	**Depth of Boring:** 29 FEET **Depth of Well:** 29 FEET	**Diameter of Boring:** 8 INCHES **Diameter of Screen:** 4 INCHES
Drilling Co: HI-PLAINS DRILLING	**Length of Screen:** 10 FEET	**Diameter of Casing:** 4 INCHES
Driller: BARRY SIMMONS	**Length of Casing:** 19 FEET	**Slot Size:** 0.02 INCH
Drilling Method: AIR ROTARY	**Logged By:** G.J.V.	**Well Material:** SCH 40 PVC

DEPTH FEET	SOIL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	OVA (PPM)	WELL DESIGN	REMARKS
0	Light gray GYPSUM					0
2.5						2.5
5.0						5.0
		1	SS	<1		
7.5						7.5
10.0		2	SS	<1		10.0 Thin clay streaks from 10'-16'
12.5						12.5
15.0		3	SS	<1		15.0
17.5						17.5
20.0						20.0
				<1		
22.5						22.5
		4	RC	<1		■ BTEX <0.050 mg/kg (ppm) TPH=14 mg/kg (ppm)
						●
25.0				>1000		25.0 ■ BTEX=178.830 mg/kg (ppm) TPH=19,300 mg/kg (ppm) Crude oil and water from 26'-27' Thin clay streak @ 27'
27.5						27.5
	Bottom of boring @ 29.0 feet					
30.0						30.0

ABBREVIATIONS AND SYMBOLS

SS-Driven Split Spoon
ST-Pressed Shelby Tube
CA-Continuous Flight Auger
RC-Rock Core
THD-Texas Highway Department Cone
CT-5' Continuous Sampler

HSA-Hollow Stem Augers
CFA-Continuous Flight Augers
DC-Driving Casing
MD-Mud Drilling

WATER LEVEL
▽ At Completion
▼ After Hours
● Water on Rods

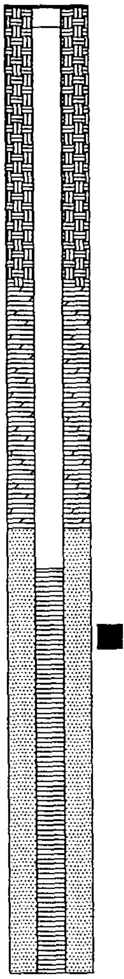
■ Sample submitted to lab
▨ Bottom Cap
▨ Factory-Slotted Well Screen
▨ Sand Pack
☐ Well Casing
▨ Bentonite Seal
▨ Volclay Grout Seal

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

RECORD OF SUBSURFACE EXPLORATION

Project No.: 15-93313	Well/Boring #: MW-1	Date Drilled: 05/17/93
Project: AMOCO ARTESIA STATION SECTION 10, T18S, R27E EDDY COUNTY, NEW MEXICO	Depth of Boring: 27 FEET Depth of Well: 24 FEET	Diameter of Boring: 8 INCHES Diameter of Screen: 4 INCHES
Drilling Co: HI-PLAINS DRILLING	Length of Screen: 10 FEET	Diameter of Casing: 4 INCHES
Driller: BARRY SIMMONS	Length of Casing: 14 FEET	Slot Size: 0.02 INCH
Drilling Method: AIR ROTARY	Logged By: G.J.V.	Well Material: SCH 40 PVC

DEPTH FEET	SOIL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	OVA (PPM)	WELL DESIGN	REMARKS
0	Reddish-brown gysumiferous calcareous silty CLAY (CL)					0
2.5						2.5
5.0		1	SS	<1		5.0
7.5						Thin clay streaks from 6'–26' 7.5
10.0		2	SS	<1		10.0
12.5						12.5
15.0	Light gray gypsum	3	SS	<1	■	15.0 BTEX=0.237 mg/kg (ppm) TPH <10 mg/kg (ppm)
17.5						17.5
20.0		4	SS	>1000		▽ Insufficient sample ● recovery 20.0
				<1		
22.5		5	RC	<1		22.5
25.0				<1		25.0
27.5	Bottom of boring @ 27.0 feet					27.5
30.0						30.0

ABBREVIATIONS AND SYMBOLS

SS-Driven Split Spoon
ST-Pressed Shelby Tube
CA-Continuous Flight Auger
RC-Rock Core
THD-Texas Highway Department Cone
CT-5' Continuous Sampler

HSA-Hollow Stem Augers
CFA-Continuous Flight Augers
DC-Driving Casing
MD-Mud Drilling

WATER LEVEL
▽ At Completion
▼ After Hours
● Water on Rods

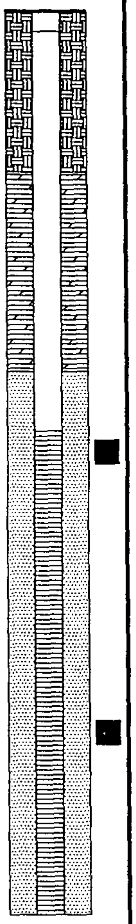
■ Sample submitted to lab
▤ Bottom Cap
▨ Sand Pack
▤ Bentonite Seal
▤ Factory-Slotted Well Screen
☐ Well Casing
▦ Volclay Grout Seal

CURA INC.

2735 VILLA CREEK DRIVE - TWO METRO SQUARE
BLDG. C - SUITE 250 - DALLAS, TX 75234
620-7117 FAX - 620-8219

RECORD OF SUBSURFACE EXPLORATION

Project No.: 15-93313	Well/Boring #: MW-3	Date Drilled: 05/17/93
Project: AMOCO ARTESIA STATION SECTION 10, TIBS, R27E EDDY COUNTY, NEW MEXICO	Depth of Boring: 22.5 FEET Depth of Well: 22.5 FEET	Diameter of Boring: 8 INCHES Diameter of Screen: 4 INCHES
Drilling Co: HI-PLAINS DRILLING	Length of Screen: 12 FEET	Diameter of Casing: 4 INCHES
Driller: BARRY SIMMONS	Length of Casing: 10.5 FEET	Slot Size: 0.02 INCH
Drilling Method: AIR ROTARY	Logged By: G.J.V.	Well Material: SCH 40 PVC



DEPTH FEET	SOIL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	OVA (PPM)	WELL DESIGN	REMARKS
0	Reddish-brown gypsumiferous calcareous SILT (ML)					
2.5		1	SS	2		
5.0						
7.5		2	SS	<1		
10.0	Dark gray silty CLAY (CL)	3	SS	>1000	■	BTEX=130.509 mg/kg TPH=18,900 mg/kg (ppm)
12.5	Light gray GYPSUM					
15.0						No sample recovery @ 15'
17.5	Dark gray silty CLAY (CL)	4	SS	>1000	■	BTEX=31.492 mg/kg (ppm) TPH=3,650 mg/kg (ppm) ● Crude oil and water 18'–19'
20.0	Light gray GYPSUM					
22.5	Bottom of boring @ 22.5 feet					
25.0						
27.5						
30.0						

ABBREVIATIONS AND SYMBOLS

SS-Driven Split Spoon
ST-Pressed Shelby Tube
CA-Continuous Flight Auger
RC-Rock Core
THD-Texas Highway Department Cone
CT-5' Continuous Sampler

HSA-Hollow Stem Augers
CFA-Continuous Flight Augers
DC-Driving Casing
MD-Mud Drilling

WATER LEVEL
▽ At Completion
▼ After Hours
● Water on Rods

■ Sample submitted to lab
▤ Bottom Cap
▨ Sand Pack
▤ Bentonite Seal
▤ Factory-Slotted Well Screen
☐ Well Casing
▦ Volclay Grout Seal

APPENDIX C

WATER WELL SEARCH

Form WR-23 Orig in S.F. STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well Pan American Petroleum Corporation
Street and Number Box 68
City Hobbs State New Mexico
Well was drilled under Permit No. .... and is located in the
SE ¼ NW ¼ NE ¼ of Section 10 Twp. 18 S Rge. 27 E

(B) Drilling Contractor Ed. Burke License No. WD-111
Street and Number Box 306
City Hobbs State New Mexico
Drilling was commenced July 31 19 58
Drilling was completed July 31 19 58

Elevation at top of casing in feet above sea level .... Total depth of well 130
State whether well is shallow or artesian Shallow Depth to water upon completion 50

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation
	From	To		
1	50	82	32	Sand & Gravel
2	94	99	5	" " "
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth		Feet	Type Shoe	Perforations	
			Top	Bottom			From	To
7	23	10	0	124.9	124.9	none	62	124.9

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet		Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
From	To				

Section 5 PLUGGING RECORD

Name of Plugging Contractor .... License No. ....
Street and Number .... City .... State ....
Tons of Clay used .... Tons of Roughage used .... Type of roughage ....
Plugging method used .... Date Plugged .... 19........
Plugging approved by:

....
Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug		No. of Sacks Used
	From	To	

FOR USE OF STATE ENGINEER ONLY

Date Received AUG 6 1958 NB

OFFICE
GROUND WATER SUPERVISOR
ROSWELL, NEW MEXICO

File No. RA-3917 Use O.W.P. Location No. 18.27.10.214

Section 6

LOG OF WELL

Depth in Feet		Thickness in Feet	Color	Type of Material Encountered
From	To			
0	6	6		Surface Soil
6	28	22		Sandy Clay
28	31	3		Gyp.
31	46	15		Sandy Clay
46	50	4		Gyp.
50	68	18		Grey Water Sand.
68	82	14		Sand & Gravel
82	94	12		Sandy Clay
94	99	5		Water Sand & Gravel
99	126	27		Sandy Clay
126	130	4		Red Clay

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Edward B Burke

Well Driller

APPENDIX D
ANALYTICAL RESULTS

CHAIN OF CUSTODY

CLIENT
CURA, Inc.

CLIENT ADDRESS
3001 N. Big Spring Street, Suite 101, Midland, Texas 79705

BILLING ADDRESS
2735 Villa Creek Drive, Bldg. C., Suite 250, Dallas, Texas 75234

CONTACT/PHONE
Gil Van Deventer (915)570-8408 FAX (915)570-8409

P.O. NUMBER

CEL CURA ENVIRONMENTAL LABORATORIES INCORPORATED
2209 WISCONSIN, #200 - DALLAS, TEXAS
(214) 620-7966

PROJECT NUMBER: 115913111 3000 | PHASE/SUB TASK: 012

PROJECT NAME/ADDRESS: AMOCO ARTESIA STATION EDDY COUNTY, NEW MEXICO

SAMPLERS (Signature): Gil Van Deventer

G D O [✓ Other]

	DATE	TIME	MATRIX TYPE	Comp	Grab	STATION LOCATION/IDENTIFICATION	Number of containers	Preservations	TPH 418.1	BTEX 8020						SPECIAL REQUIREMENTS/TAT
1)	5/17/93	1030	Rock		✓	B-1 (6'-6.5')	1	ice	✓	✓						Normal
2)	5/17/93	1100	Rock		✓	B-1 (20'-20.5')	1	ice	✓	✓						
3)	5/17/93	1300	Soil		✓	MW-1 (15'-17')	1	ice	✓	✓						
4)	5/17/93	1500	Rock		✓	MW-2 (25'-25.5')	1	ice	✓	✓						
5)	5/17/93	1515	Rock		✓	MW-2 (26'-26.5')	1	ice	✓	✓						
6)	5/17/93	1600	Soil		✓	MW-3 (10'-12')	1	ice	✓	✓						
7)	5/17/93	1615	Soil		✓	MW-3 (17'-19')	1	ice	✓	✓						✓
																FAX & send results to Midland

SAMPLE REMAINDER DISPOSAL

☐ Return via ______________ (shipping charges may be incurred) OR ☐ Request CEL to dispose of all sample remainders*

RELINQUISHED BY: (Signature) Gil Van Deventer	DATE/TIME 5/19/93 1530	RECEIVED BY: (Signature) C Allen	DATE/TIME 17:10 5/20/93	CONDITION OF SAMPLES: CEL #411
RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	DATE/TIME	
RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED FOR CEL LABORATORY BY: (Signature)	DATE/TIME	DUE DATE

* If sample remainder is determined to be hazardous a minimum additional charge of $20.00 per sample will be assessed prior to disposal and billed to client.

PF92013D.FRM (rev. 10/14/92)

CEL
CURA ENVIRONMENTAL LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

CEL INC. Lab Report No:93-0411-01
Client: Cura, Inc.
Project Number: 15-93313.2
Sample Identification: B-1 (6'-6.5')
Sample Type: Soil
Depth Interval:N/A

Date Reported:05/28/93
Date Received:05/20/93
Volatiles Extraction Date:05/27/93
Volatiles Analysis Date:05/27/93
TPH Extraction Date:05/28/93
TPH Analysis Date:05/28/93

********* Results *********				Analytical Detection Limit	
Benzene –	<	50	ug/kg (ppb)	50	ug/kg (ppb)
Toluene –		217	ug/kg (ppb)	50	ug/kg (ppb)
Ethylbenzene –	<	50	ug/kg (ppb)	50	ug/kg (ppb)
Xylenes –		442	ug/kg (ppb)	50	ug/kg (ppb)
Total BTEX(calculated)–		659	ug/kg (ppb)	50	ug/kg (ppb)
*TPH – *(Total Petroleum Hydrocarbons)		1,818	mg/kg (ppm)	10	mg/kg (ppm)
Ignitability –	N/A		degrees fahrenheit		

Method: BTEX – EPA Method 8020/5030
TPH – EPA Method 418.1/ 3550
Ignitability – EPA Method 1010 per SW-846 Guidelines.

C Ables
Chuck Ables
Laboratory Manager

Yanqi Li
for Xiang-Yong Chi
Environmental Chemist

CEL
CURA ENVIRONMENTAL LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

CEL INC. Lab Report No:93-0411-03
Client: Cura, Inc.
Project Number: 15-93313.2
Sample Identification: MW-1 (15'-17')
Sample Type: Soil
Depth Interval:N/A

Date Reported:05/28/93
Date Received:05/20/93
Volatiles Extraction Date:05/27/93
Volatiles Analysis Date:05/27/93
TPH Extraction Date:05/28/93
TPH Analysis Date:05/28/93

********* Results *********				Analytical Detection Limit	
Benzene -		178	ug/kg (ppb)	50	ug/kg (ppb)
Toluene -	<	50	ug/kg (ppb)	50	ug/kg (ppb)
Ethylbenzene -	<	50	ug/kg (ppb)	50	ug/kg (ppb)
Xylenes -		59	ug/kg (ppb)	50	ug/kg (ppb)
Total BTEX(calculated)-		237	ug/kg (ppb)	50	ug/kg (ppb)
*TPH - *(Total Petroleum Hydrocarbons)	<	10	mg/kg (ppm)	10	mg/kg (ppm)
Ignitability -		N/A	degrees fahrenheit		

Method: BTEX - EPA Method 8020/5030
TPH - EPA Method 418.1/ 3550
Ignitability - EPA Method 1010 per SW-846 Guidelines.

Chuck Ables
Laboratory Manager

Yanqi Li
for Xiang-Yong Chi
Environmental Chemist

CEL CURA ENVIRONMENTAL LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

CEL INC. Lab Report No:93-0411-04
Client: Cura, Inc.
Project Number: 15-93313.2
Sample Identification: MW-2 (25'-25.5')
Sample Type: Soil
Depth Interval:N/A

Date Reported:05/28/93
Date Received:05/20/93
Volatiles Extraction Date:05/27/93
Volatiles Analysis Date:05/27/93
TPH Extraction Date:05/28/93
TPH Analysis Date:05/28/93

********* Results *********			Analytical Detection Limit
Benzene -	<	50 ug/kg (ppb)	50 ug/kg (ppb)
Toluene -	<	50 ug/kg (ppb)	50 ug/kg (ppb)
Ethylbenzene -	<	50 ug/kg (ppb)	50 ug/kg (ppb)
Xylenes -	<	50 ug/kg (ppb)	50 ug/kg (ppb)
Total BTEX(calculated)-	<	50 ug/kg (ppb)	50 ug/kg (ppb)
*TPH - *(Total Petroleum Hydrocarbons)		14 mg/kg (ppm)	10 mg/kg (ppm)
Ignitability -	N/A	degrees fahrenheit	

Method: BTEX - EPA Method 8020/5030
TPH - EPA Method 418.1/ 3550
Ignitability - EPA Method 1010 per SW-846 Guidelines.

Chuck Ables
Laboratory Manager

for Xiang-Yong Chi
Environmental Chemist

CEL
CURA
ENVIRONMENTAL
LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

CEL INC. Lab Report No:93-0411-05

Date Reported:05/28/93

Client: Cura, Inc.

Date Received:05/20/93

Project Number: 15-93313.2

Volatiles Extraction Date:05/27/93

Sample Identification: MW-2 (26'-26.5')

Volatiles Analysis Date:05/27/93

Sample Type: Soil

TPH Extraction Date:05/28/93

Depth Interval:N/A

TPH Analysis Date:05/28/93

********* Results *********				Analytical Detection Limit	
Benzene –	<	50	ug/kg (ppb)	50	ug/kg (ppb)
Toluene –		43,310	ug/kg (ppb)	50	ug/kg (ppb)
Ethylbenzene –		13,110	ug/kg (ppb)	50	ug/kg (ppb)
Xylenes –		122,410	ug/kg (ppb)	50	ug/kg (ppb)
Total BTEX(calculated)–		178,830	ug/kg (ppb)	50	ug/kg (ppb)
*TPH – *(Total Petroleum Hydrocarbons)		19,300	mg/kg (ppm)	10	mg/kg (ppm)
Ignitability –	N/A		degrees fahrenheit		

Method: BTEX – EPA Method 8020/5030
TPH – EPA Met >
Ignitability – EPA Method 1010 per SW-846 Guidelines.

Chuck Ables
Laboratory Manager

for Xiang-Yong Chi
Environmental Chemist

CEL
CURA
ENVIRONMENTAL
LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

CEL INC. Lab Report No:93-0411-06	Date Reported:05/28/93
Client: Cura, Inc.	Date Received:05/20/93
Project Number: 15-93313.2	Volatiles Extraction Date:05/27/93
Sample Identification: MW-3 (10'-12')	Volatiles Analysis Date:05/27/93
Sample Type: Soil	TPH Extraction Date:05/28/93
Depth Interval:N/A	TPH Analysis Date:05/28/93

********* Results *********			Analytical Detection Limit	
Benzene -	6,314	ug/kg (ppb)	50	ug/kg (ppb)
Toluene -	46,518	ug/kg (ppb)	50	ug/kg (ppb)
Ethylbenzene -	10,031	ug/kg (ppb)	50	ug/kg (ppb)
Xylenes -	67,646	ug/kg (ppb)	50	ug/kg (ppb)
Total BTEX(calculated)-	130,509	ug/kg (ppb)	50	ug/kg (ppb)
*TPH - *(Total Petroleum Hydrocarbons)	18,900	mg/kg (ppm)	10	mg/kg (ppm)
Ignitability -	N/A	degrees fahrenheit		

Method: BTEX - EPA Method 8020/5030
TPH - EPA Method 418.1/ 3550
Ignitability - EPA Method 1010 per SW-846 Guidelines.

Chuck Ables
Laboratory Manager

for Xiang-Yong Chi
Environmental Chemist

CEL
CURA ENVIRONMENTAL LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

CEL INC. Lab Report No:93-0411-07	Date Reported:05/28/93
Client: Cura, Inc.	Date Received:05/20/93
Project Number: 15-93313.2	Volatiles Extraction Date:05/27/93
Sample Identification: MW-3 (17'-19')	Volatiles Analysis Date:05/27/93
Sample Type: Soil	TPH Extraction Date:05/28/93
Depth Interval:N/A	TPH Analysis Date:05/28/93

********* Results *********			Analytical Detection Limit	
Benzene -	910	ug/kg (ppb)	50	ug/kg (ppb)
Toluene -	5,941	ug/kg (ppb)	50	ug/kg (ppb)
Ethylbenzene -	2,379	ug/kg (ppb)	50	ug/kg (ppb)
Xylenes -	22,262	ug/kg (ppb)	50	ug/kg (ppb)
Total BTEX(calculated)-	31,492	ug/kg (ppb)	50	ug/kg (ppb)
*TPH - *(Total Petroleum Hydrocarbons)	3,650	mg/kg (ppm)	10	mg/kg (ppm)
Ignitability -	N/A	degrees fahrenheit		

Method: BTEX - EPA Method 8020/5030
TPH - EPA Method 418.1/ 3550
Ignitability - EPA Method 1010 per SW-846 Guidelines.

Chuck Ables
Laboratory Manager

for Xiang-Yong Chi
Environmental Chemist

CHAIN OF CUSTODY

CLIENT
CURA, Inc.

CLIENT ADDRESS
3001 N. Big Spring Street, Suite 101, Midland, Texas 79705

BILLING ADDRESS
2735 Villa Creek Drive, Bldg. C., Suite 250. Dallas, Texas 75234

CONTACT/PHONE GCW
Gil Van Deventer (915)570-8408 FAX (915)570-8409

P.O. NUMBER

CEL
CURA ENVIRONMENTAL LABORATORIES INCORPORATED
2209 WISCONSIN, #200 - DALLAS, TEXAS
(214) 620-7966

PROJECT NUMBER 1593313000
PHASE: SUB TASK 012

PROJECT NAME/ADDRESS Amoco Pipeline.
Sec 10, T185, B27E

SAMPLERS (Signature) Bill Smith

G D O Other

DATE	TIME	MATRIX TYPE	Comp	Grab	STATION LOCATION/IDENTIFICATION	Number of containers	Preservations	ANALYSIS PARAMETERS TDS							SPECIAL REQUIREMENTS/TAT
5-21-93	1500	H_2O		✓	MW-1	1		1							NORMAL

SAMPLE REMAINDER DISPOSAL
☐ Return via ____________ (shipping charges may be incurred) OR ☐ Request CEL to dispose of all sample remainders*

RELINQUISHED BY: (Signature) Bill Smith	DATE/TIME 1000 5-25-93	RECEIVED BY: (Signature) Jessica M. Rigdon	DATE/TIME 5-26-93/11:00am
RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED FOR CEL LABORATORY BY: (Signature)	DATE/TIME

CONDITION OF SAMPLES: Good

CEL# 429

DUE DATE

* If sample remainder is determined to be hazardous a minimum additional charge of $20.00 per sample will be assessed prior to disposal and billed to client.

PF520.5D.FRM (rev. 10/14/92)

CEL
CURA ENVIRONMENTAL LABORATORIES
2209 Wisconsin Street, Suite 200 • Dallas, Texas 75229 • 214/241-3745 • FAX 620-7963

Project No: 15-93313.2
Sample Type: Water
Analyst: YQL
Method: EPA 160.1

Date Reported: 06/09/93
Date Received: 05/26/93
Date Analyzed: 06/03/93
Detection Limit: 10 mg/l

TOTAL DISSOLVED SOLIDS

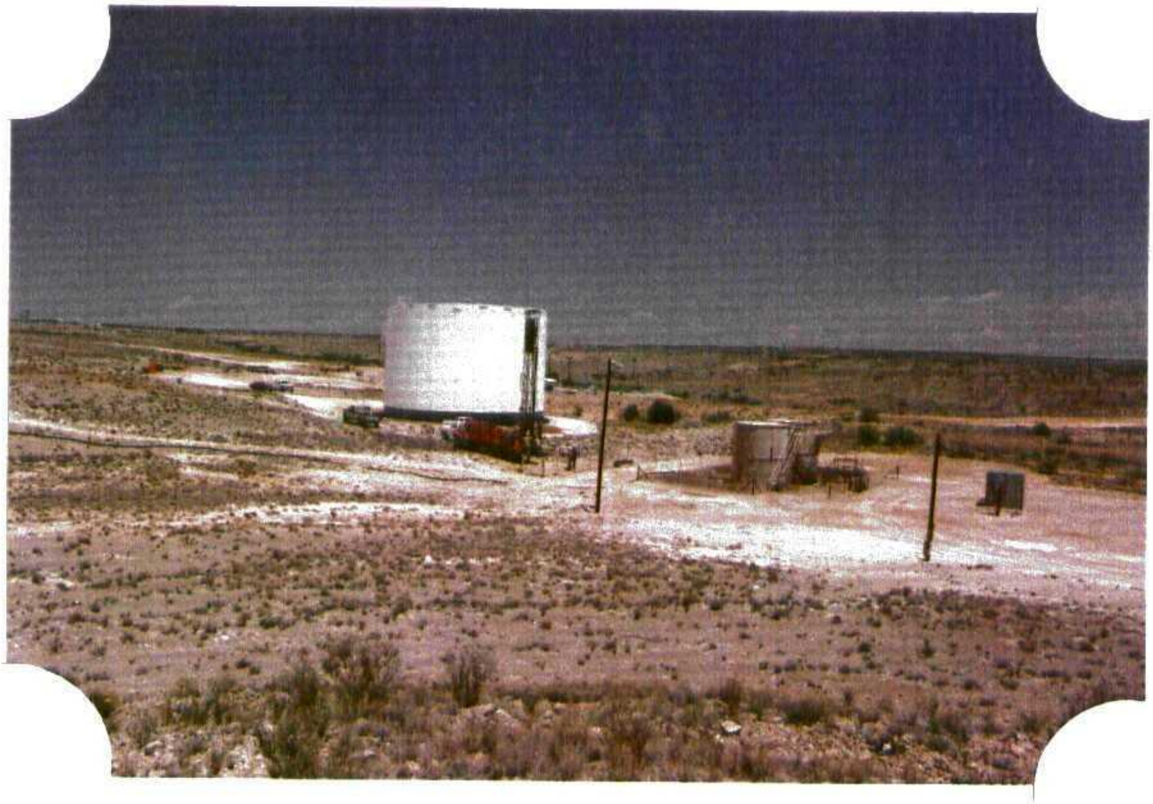
REPORT NUMBER	SAMPLE ID	RESULTS mg/l
293-0429-01	MW-1	6270

C Ables
Chuck Ables
Laboratory Manager

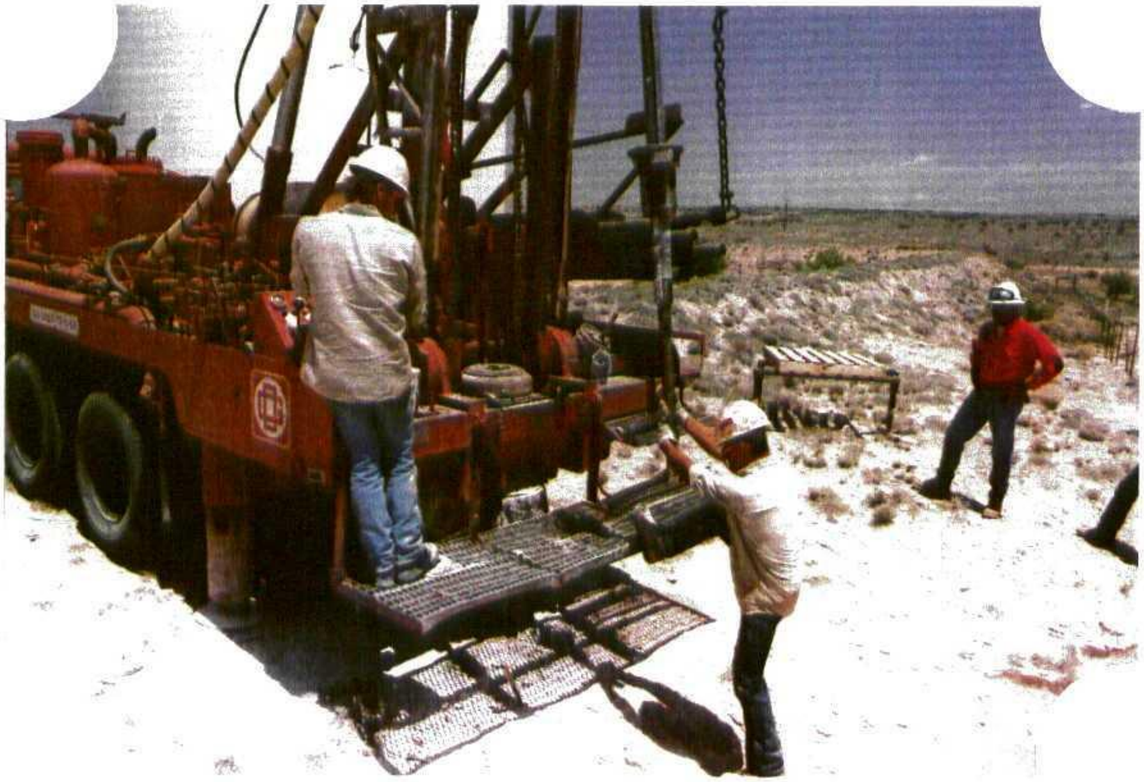
for
Yanqi Li
Analytical Chemist

APPENDIX E

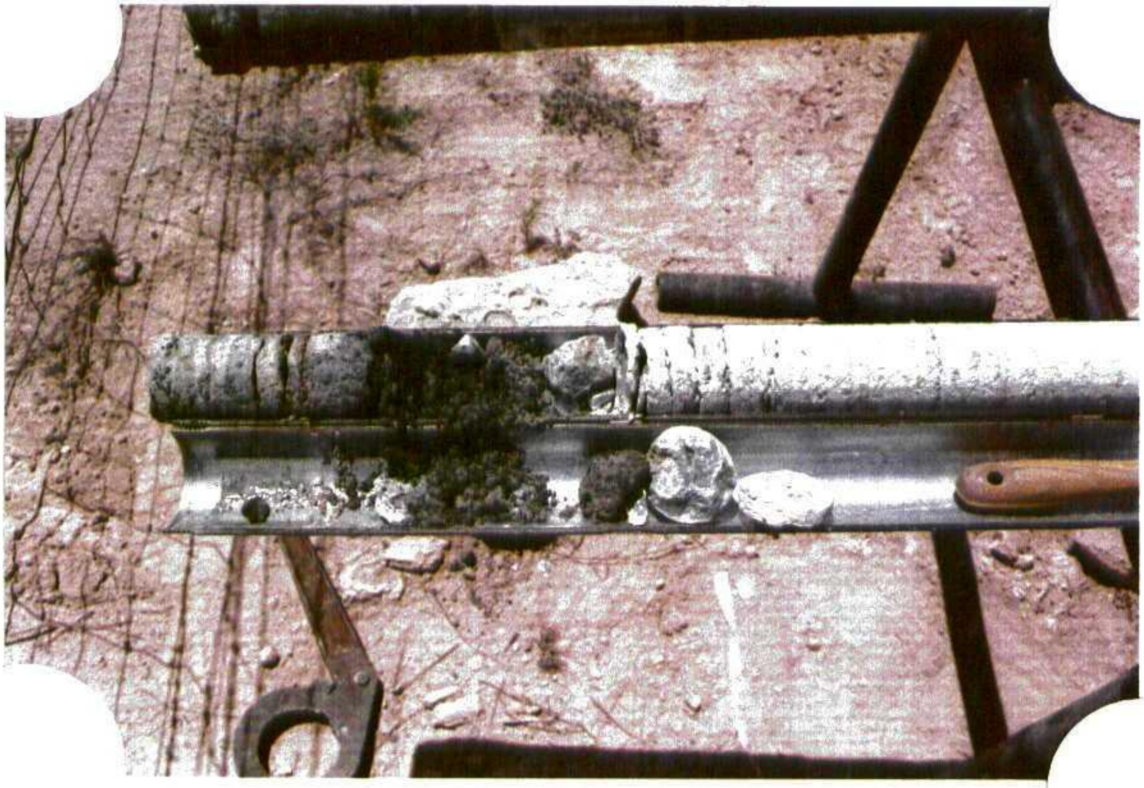
PHOTO-DOCUMENTATION



Photograph 1: View of the Amoco Artesia Station (the "site") looking northeast. Drilling operations for MW-2 are shown in the background. An offsite produced water booster station is shown on right side of the photograph.



Photograph 2: Split spoon sampling operations for MW-2.



Photograph 3: Close up view of the bottom portion of a rock core sample obtained from the 20 to 27 foot interval of MW-2 showing the narrow crude oil and water saturated zone.

Photograph 4: View of monitor well screening operations for MW-2.

Photograph 5: View looking northwest showing drilling operations for MW-1 located in Scoggin Draw near the southeast corner of the site.

Photograph 6: View of well completion operations (bentonite seal) for MW-3 located approximately 100 feet northeast of Tank 7264 (background).

APPENDIX F

CONTRACTOR SAFETY MANUAL

AMOCO

Contractor Safety Manual

Amoco Pipeline Company

Contractor Safety Manual

Contractor note: For additional information in this manual, please contact the company job representative.

1992

1. Bidding Contracts

1.1 Site Visit

Bidders are encouraged to examine the site, plans and specifications for the work to be completed and to thoroughly acquaint themselves with the conditions to be encountered, including but not limited to any safety and health considerations that may affect the welfare of their employees.

1.2 Safety Information

Bids must contain complete safety information if requested in order to be considered for the contract. Contractors working on a regular or repetitive basis or under a master contract must update safety information as requested. If the safety information is requested, then a completed Amoco Contractor Safety & Health Questionnaire form shall be submitted with the bid package.

2. Compliance with Government Regulation

2.1 Occupation Safety and Health Act (OSHA)

All contract work shall be performed in accordance with all applicable laws and regulations concerning employee safety and health such as OSHA regulations in 29 CFR, Parts 1910 and 1926. It is the contractors' responsibility to ascertain if the state in which the work is being performed has an OSHA approved state plan. Contractors are also responsible for determining which portions of the standards apply to the work to be performed.

2.2 Environmental Protection Laws

All products furnished or work performed shall be in compliance with all applicable federal, state, and local laws and regulations regarding the environment, including but not limited to, the Federal Clean Air Act, Clean Water Act, Resource Conservation Recovery and Toxic Substances Control Act, and the Safe Drinking Water Act.

2.3 Department of Transportation Regulations

2.3.1 All pipeline construction and maintenance projects shall be performed in accordance with applicable DOT regulations in 49 CFR, Part 195 or Part 192.

2.3.2 Contractors and their subcontractors who have personnel who perform on a pipeline facility in operations, maintenance, or emergency-response function regulated by 49 CFR Part 192 or 195 must have and administer a formal, anti-drug plan. This anti-drug plan must comply (in Amoco's opinion) with 49 CFR Parts 40 and 199.

2.4 Other Laws

It is the contractor's responsibility to adhere to all other federal, state, and local laws, regulations, and ordinances applicable to his work.

3. Orientation Meeting

3.1 A contractor orientation meeting will be held prior to the beginning of any work being performed. Extent and formality of the meeting will be based on the scope of the job and will be at the discretion of the company job representative. For contractors who perform work on a regular or repetitive basis under a master contract, the orientation meeting shall be held periodically as deemed necessary by the company job representative.

3.2 The purpose of the orientation meeting is to familiarize the contractor with the job location, with the requirements of the Contractor Safety Program, and to identify known hazards, which may be encountered at the job site that the contractor would not normally encounter.

3.3 The orientation meeting will be conducted by the company job representative with the contractor's job representative and an appropriate representative from all subcontractors that may be involved in the project. If subcontractors are not chosen at the time of contract letting, or not present at the orientation, it shall be the contractor's responsibility to advise the subcontractor of all safety requirements addressed at the orientation meeting.

4. Safety Rules

4.1 General

4.1.1 Contractors and their subcontractors shall inform *any* and *all* of their supervisors and employees of the necessity to comply with all of the requirements contained in the Contractor Safety Manual.

4.1.2 In case of violations of the requirements of this manual, the company job representative is authorized to take whatever actions deemed necessary.

4.1.3 Smoking is not permitted except in areas designated by the company job representative.

4.1.4 The use of intoxicants or narcotics while at work, or reporting for work while under the influence is strictly forbidden. Contractors shall immediately remove all violators of these rules from the premises.

4.1.5 Firearms are not permitted on company property or job sites.

4.1.6 Contractor personnel shall operate vehicles in a reasonable and safe manner on the job site and on company premises.

4.1.7 Gambling, fighting or conduct that may be termed as horseplay are not permitted on company premises or job sites.

4.1.8 Contractor shall observe good housekeeping practices. Buildings, materials, and properties of the company shall be kept clean and orderly to the extent possible.

4.2 Personal Protective Equipment

4.2.1 Contractors and their subcontractors are required to wear hard hats and safety glasses at all times while on company property, which includes all right-of-ways.

4.2.2 Contractors are required to protect their employees from hazards on the job. The contractor shall be responsible for assessing the hazards and requiring their employees to use other appropriate personal protective equipment. This equipment may include:

a. Respiratory protective equipment

b. Monitoring meters for H_2S, combustible and toxic gases, and oxygen deficiency (all must be FM or UL approved for use in Class I atmosphere)

c. Goggles or face shields

d. Protective clothing

e. Safety footwear and gloves

f. Hearing protection

g. Appropriate attire for the job

Note: Pancake Shields are not allowed on any Amoco Pipeline job sites.

4.2.3 Contractors shall be responsible for supplying all safety equipment for their personnel necessary to perform the work at hand.

4.3 Hot Work

4.3.1 Hot work is defined as any work that involves sources of ignition or temperatures sufficiently high to cause the ignition of flammable gas mixtures.

4.3.2 Contractors required to perform hot work on or near company facilities shall supply and maintain a combustible gas indicator, which carries a Factory Mutual and/or UL approval for use in Class I atmospheres. See definition of classified areas at the end of this booklet.

4.3.3 Contractors shall assure that their employees required to perform atmospheric tests using combustible gas detectors are knowledgeable in the use of such detectors. Amoco recommends instruments that continually monitor the atmosphere be used so that any change in conditions will be detected.

4.3.4 Before any hot work may be performed within the fenced area around pipeline stations, within 50 feet of a pipeline construction site, within the perimeter of tank dikes, within 100 feet of leak sites or anywhere else where flammable gas mixtures may exist, atmospheric tests shall be performed to ensure that flammable vapors are not present.

4.3.5 Prior to performing any welding or hot work in a classified area, the Amoco Pipeline Company Hot Work/Vehicle Entry Permit (Form 19-707) must be completed by the appropriate company supervisor or his/her designee and the contractor's job representative or welder to be sure that all safety precautions have been taken. The company job representative will verify with Operations to ensure safe line conditions for welding. The contractor's job representative should check with the company representative to be sure this verification has been done.

4.3.6 Vehicle entry into tank dikes or within 50 feet of mainline pumps, valves or other station equipment, which is subject to failure, are classified areas and shall be treated as such except where tanks have been cleaned, ventilated and freed of vapors.

4.3.7 Contractors shall furnish and maintain a minimum of two 80-BC rated dry chemical fire extinguishers or their equivalent at each job site where hot work is to be performed. The extinguishers are to be readily accessible and manned by a standby individual when hot work is being performed.

4.4 Entry into Confined Space

4.4.1 A confined space is any enclosure that is subject to developing a hazardous atmosphere (i.e., oxygen deficient, flammable or toxic) and that has a limited means of access.

4.4.2 Contractors shall develop and implement confined space entry procedures for their employees required to enter into confined spaces encountered in pipeline construction, maintenance, and repair projects including entry:

- into tanks;
- onto the internal floating roof of covered floating roof tanks
- onto the roof of external floating roof tanks when the roof is 4 feet or more below the rim of tank
- into trenches or ditches (over 4 feet deep) where product outages, leaks or oxygen deficiencies may create a hazardous atmosphere; and
- into manifold buildings or other buildings where a hazardous atmosphere might be likely to exist.

4.4.3 Contractors shall provide and maintain combustible gas, oxygen deficiency, and toxic gas monitors if the work involved requires entry into confined space.

4.4.4 The confined space entry procedure shall require that atmospheric tests be performed to determine if the atmosphere within the space is immediately dangerous to life or health (IDLH) or above threshold limit values (TLV) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or permissible exposure limits (PEL) established by OSHA prior to anyone entering the space. These tests shall include measurements of the oxygen content, flammability, and toxicity of the environment within the space.

4.4.5 If the atmosphere has been determined not to be IDLH, then entry into the space shall be permitted, and work may proceed, provided that TLVs or PELs will not be exceeded. If there is a possibility that TLVs or PELs will be exceeded, appropriate precautions must be taken. In any case, the atmospheric tests for oxygen content, flammability, and toxicity must be performed as necessary by the company job representative, unless a continuous monitor with an audible alarm is strategically placed within the space to monitor the environment. A written permit shall be completed and posted outside the entrance.

4.4.6 Entry into confined spaces with atmospheres that are unknown or have been determined to be IDLH is strictly prohibited, unless the contractor provides suitable fresh air breathing equipment for each person entering the space, and has developed and implemented a written Respiratory Protection Program that complies with 29 CFR 1910.134.

4.5 Electrical Safety

4.5.1 Contractors installing, maintaining or repairing electrical equipment for company facilities shall perform all work in accordance with the requirements of the current National Electrical Code and government laws and regulations.

4.5.2 Contractors shall develop and implement a control of hazardous energy source procedure, which adequately protects their employees from accidental energization of equipment or machinery being worked on. Implementation of this procedure must be coordinated with the company job representative.

4.6 Hazard Communication

4.6.1 Contractors shall provide Amoco with written verification that their employees and subcontractors have received hazardous chemical training specified in 29 CFR 1910.1200.

4.6.2 Contractors and their subcontractors shall provide Amoco, before commencing work, both a list of hazardous chemicals and safety data sheets for all contractor-owned hazardous chemicals on site.

4.6.3 Prior to beginning work that involves potential employee exposure to a hazardous chemical, contractor and Amoco shall meet to discuss the labeling system each uses for its hazardous chemicals.

4.6.4 Amoco will provide contractors with copies of material safety data sheets for Amoco-owned hazardous chemicals on site to which the contractor's employees may be exposed. Contractor shall promptly disseminate such information to its employees and subcontractors and assure that appropriate precautions are taken.

4.6.5 Respiratory protection may be required due to potential exposure to a hazardous chemical i.e., benzene.

4.7 HAZWOPER

4.7.1 Contractor's personnel shall be certified to meet training guidelines set forth under Hazardous Waste Operations and Emergency Response regulation (HAZWOPER) 29 CFR 1910.120.

4.7.2 The contractor's personnel shall be able to produce certification via cards or other types of documentation.

5. First Aid and Industrial Accidents

5.1 Contractors shall provide and maintain first-aid requirements for their employees and those of their subcontractors.

5.2 Contractors shall promptly report to the company job representative all accidents and occupational injuries or illnesses involving employees or subcontractors, or which cause damage to company or third-party property.

5.3 The contractor shall furnish a copy of the completed workers' compensation first report of injury form (in states where completion of the form is required by regulations), and assist the company to the extent requested in investigating any incident in which it is involved directly or indirectly.

6. Hot Work/Vehicle Entry Permits

APL Hot Work/Vehicle Entry Permit must be completed in required classified areas. The contractor shall:

6.1 Verify with company job representative that a-c are complete.

a. Checked with the operations control center when work is to be performed on the pipeline.

b. Checked with the operations control center regarding the nature of the product in the line.

c. Checked with the operations control center to determine what the pressure and flow rate is in the pipeline.

6.2 Designate a competent person for a trenching or excavation site.

6.3 Determine soil classification.

6.4 Check trenching or excavations for adequate shoring or sloping.

6.5 Check that the hydrocarbon contaminated excavated soil, if any, is positioned a minimum of 2 feet away and downwind from the trench.

6.6 Check the trench for ingress and egress.

6.7 Check for placement of fire extinguishers and standby personnel.

6.8 Check the atmosphere for flammability and combustibility.

6.9 Check the atmosphere for oxygen content (confined space).

6.10 Check the atmosphere for toxicity (H_2S, xylene, benzene, etc.)

6.11 Check cathodic protection and bonding.

Appendix

Definitions of classified areas:

Class I, Division 1: Is an area that is normally hazardous, which means that ignitable or explosive flammable vapors are normally present.

Examples of Class I, Division 1 classified areas for pipeline operations include:

1. The entire area inside the perimeter of any tank dike.
2. Within 50 feet horizontally in all directions from any edge of pumps, manifolds or meters located outdoors.
3. Within 25 feet horizontally in all directions of any indoor pumps, valves or piping.
4. Within 50 feet of all leak sites or pipeline repair operations where line is going to be or has been opened. This may be expanded due to size of leak.

Class I, Division 2: Is an area that is potentially hazardous, which means that ignitable or explosive flammable vapors are not normally present, but could be.

Example of a Class I, Division 2 classified area for pipeline operations is an area:

1. Within 20 feet of excavated pipeline that has not been and will not be opened.

APPENDIX G

HYDROGEN SULFIDE (H_2S)

SAFETY MANUAL

INTRODUCTION

HYDROGEN SULFIDE GAS (H_2S) is a toxic, poisonous gas.

> **REMEMBER**
> H_2S is a toxic poisonous gas which can be worked in safety.

Death and injury from H_2S exposure are unnecessary. The equipment, training, techniques and procedures to protect yourself and your fellow employees are available.

The purpose of this manual is to provide you with basic information you need to know when working in known or suspect H_2S areas.

- Hazards and Characteristics
- Physical Effects
- Toxicity
- First Aid and Artificial Respiration
- Protection
- Emergency Rescue
- Resuscitators
- Detection
- Effects on Metal
- Location Safety

HAZARDS & CHARACTERISTICS

THE PRINCIPAL HAZARD IS DEATH BY INHALATION. When the amount of gas absorbed into the blood stream exceeds that which is readily oxidized, systemic poisoning results, with a general action on the nervous system. Labored respiration occurs shortly and respiratory paralysis will follow immediately at higher concentrations.

Death will occur from asphyxiation unless the exposed person is removed immediately to fresh air and breathing stimulated by artificial respiration. Other levels of exposure may cause the following symptoms individually or in combinations:

• Headache • Dizziness • Excitement •
• Nausea • Coughing • Drowsiness •
• Dryness and sensation of pain in nose, throat and chest •

Detection of H_2S, solely by smell, is highly dangerous as the **sense of smell is rapidly paralyzed by the gas.**

1. Extremely toxic, ranking second to Hydrogen Cyanide and five (5) to six (6) times more toxic than Carbon Monoxide.
2. Colorless.
3. Offensive odor, often described as that of rotten eggs.
4. Heavier than air -- specific gravity 1.189. (Air = 1.00 @ 60°F.) Vapors may travel considerable distance to a source of ignition and flashback.
5. Forms an explosive mixture with air in concentrations between 4.3 and 46 percent by volume.
6. Auto-ignition point of 500°F -- Cigarette burns at 1,400°.
7. Burns with a blue flame and produces Sulphur Dioxide (SO_2), which is less hazardous than H_2S, but very irritating to eyes and lungs and can cause serious injury. Chemical pneumonia can develop in a few hours.
8. Soluble in both water and liquid hydrocarbons.

9. Produces irritation to eyes, throat, and respiratory system.
10. Threshold Limit Value (TLV) -- Maximum of eight (8) hour exposure without respiratory equipment -- 10 PPM.
11. Corrosive to all electrochemical series metals.
12. Boiling point (-79° F).
13. Melting point (-117° F).

TOXICITY

IMPORTANT

It is extremely important that you are aware of the toxicity of H_2S and SO_2 as compared with other very poisonous gases.

COMMON NAME	CHEMICAL FORMULA	SPECIFIC GRAVITY SG AIR = 1	THRESHOLD[1] LIMIT	HAZARDOUS[2] LIMIT	LETHAL[3] CONCENTRATION
Hydrogen Cyanide	HCN	0.94	10 ppm	150 ppm/hr	300 ppm
Hydrogen Sulfide	H_2S	1.18	10 ppm 15 ppm[4]	250 ppm/hr	600 ppm
Sulfur Dioxide	SO_2	2.21	5 ppm	---------	1,000 ppm
Chlorine	CI_2	2.45	1 ppm	4 ppm/hr	1,000 ppm
Carbon Monoxide	CO	0.97	50 ppm	400 ppm/hr	1,000 ppm
Carbon Dioxide	CO_2	1.52	5,000 ppm	5%	10%
Methane	CH_4	0.55	90,000 ppm	Combustible above 5% in Air	

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1 Threshold Limit - concentration at which it is believed that all workers may be repeatedly exposed day after day without adverse effects.

[2] Hazardous Limit - concentration that may cause death.

[3] Lethal Concentration - concentration that will cause death with short-term exposure.

[4] STEL - Short Term Exposure Limit - 15 PPM for a duration of no longer than 15 minutes. OSHA V54, No. 12 Table C5-1 dated, January 19, 1989.

PHYSICAL EFFECTS

There are physical effects you should know about H_2S.
REMEMBER: 1% = 10,000 Parts Per Million (PPM).

CONCENTRATION			PHYSICAL EFFECTS
Percent (%)	PPM	Grains/ 100 Std. Ft. 3[1]	
0.000002	.02	.0015	Odor Threshold
0.000005	.05	.65	Obvious and unpleasant odor.
0.001	10	1.30	Safe for 8 hours exposure.
WEAR RESPIRATORY PROTECTION OVER 15 PPM			
0.01	1002	6.48	Kills smell in 3 to 15 minutes; may sting eyes and throat.
0.02	2002	12.96	Kills smell shortly; stings eyes and throat.
0.05	500	32.96	Dizziness; breathing ceases in a few minutes; needs prompt artificial respiration.
0.07	700	45.36	Unconscious quickly; death will result if not rescued promptly.
0.10	1,0004	64.80	Unconscious at once; followed by death within minutes.

CAUTION

Hydrogen Sulfide is a colorless and transparent gas and is flammable. It is heavier than air and may accumulate in low places.

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[1] At 15.00 psia and 60°F.

DETECTION

Knowing the limitations and capabilities of your detection devices can save your life.

When testing, always be prepared for a high concentrations of gas.

CAUTION
DO NOT RELY ON YOUR NOSE TO DETECT H_2S.

Following are some common detection devices:

LEAD ACETATE, AMPULES OR COATED STRIPS:

These change color (usually turn brown or black) in the presence of H_2S. The color change indicates the concentration. For use only in low concentrations of gas. They should be used as an alternate method of detection.

HAND-OPERATED TUBE DETECTORS:

This type of detector incorporates a pump, colormetric detector tube, and a scale that gives a reading of H_2S. The pump draws air to be tested through the detector tube to react with lead acetate-coated silica gel granules. Presence and amount of gas on the tube is shown by the length of color change on the tube. Read the scale to determine concentration. Special tubes may be used for SO_2 detection and measurement. For your protection, it is advised that you take frequent readings with this type of detector.

PERSONAL ELECTRONIC MONITORS:

The units are usually hand-held or belt-mounted and measure the H_2S concentration at the sensor head continuously. Monitors give an audible alarm, some readout, at a preset level of H_2S.

FIXED-MONITORING SYSTEMS:

Monitors H_2S concentration continuously at various locations where sensor heads are placed. Alarms are actuated when concentrations reach set levels. Excessive exposure to water and acetylene gas can set alarms off on some systems.

TUTWILER METHOD:

Chemical analysis for determining H_2S concentrations. The test can be run on very low to high concentrations. Extremely accurate and recommended by various site regulatory agencies.

PROTECTION

There are three (3) categories of breathing equipment you will find on location:

1. ESCAPE UNIT (an air capsule)
2. WORK UNIT (air line with escape bottle)
3. RESCUE UNIT (30 minutes which can also be used for work)

BEYOND 15 PPM OF H2S, ALWAYS WEAR YOUR BREATHING EQUIPMENT.

ESCAPE UNITS have a small, self-contained air supply and are designed to give you enough air to reach a safe area in event of an emergency.

WORK UNITS allow you to work for an extended period in an H_2S or poison gas environment. They have an air line from a supplied breathable air source. The unit also has an auxiliary self-contained air supply (bottle) for escape.

RESCUE UNITS provide a self-contained (30 Minutes) supply of air, usually carried on your back. They weigh about 35 pounds. DO NOT COUNT ON A FULL 30 MINUTES since time will vary with breathing and work. Audible alarm warns when air supply is low. After alarm sounds you have 5 to 7 minutes of air left. Rescue units may also be used as work units.

Read the instruction for care, use, maintenance and operation of 30 minute units on location.

EMERGENCY RESCUE

1. Put on proper rescue respiratory equipment.
2. Move the victim to fresh air at once ... UPWIND or CROSSWIND.
3. If victim is unconscious and breathing has stopped, apply mouth-to-mouth respiration immediately and continue until a resuscitator is brought in, or normal breathing is restored.
4. After reviving a victim -- NEVER leave him alone.
5. Call the Doctor.

REMEMBER:

Cool-headed action in rescue is critical. It is the ONLY HOPE for the victim, and it is the only hope for YOU, the rescuer, as well. YOU CAN NOT RESCUE HIM IF YOU ARE NOT PREPARED!

RESUSCITATORS

To operate the oxygen resuscitator on your location:

Place a blanket under the victim's shoulders -- to open the airway. Open the oxygen supply by turning valve on top of supply bottle to the right. On the mouthpiece you will find a green or red push button. Place the mask over the victim's nose and mouth and press the button to supply oxygen to his lungs. When the victim's lungs expand, release the button so the victim can exhale. Repeat this procedure at the rate of about twelve (12) times per minute. The supply setting on the mask should be in the OFF position.

FIRST AID & ARTIFICIAL RESPIRATION

REMEMBER

Artificial Respiration must always be started as rapidly as possible, because the average person may die in six (6) minutes or less if his oxygen supply is cut off. It is often impossible to tell exactly when a person has stopped breathing. He may be very near death when you first discover him.

ARTIFICIAL RESPIRATION
(Mouth-to-Mouth)

Place the victim on his back. If foreign matter is visible in the victim's mouth, wipe it out with your finger. Place the palm of one hand on the forehead and 2 fingers on the boney part of the chin and tilt his head backward to open the airway.

Maintain the backward head-tilt and pinch the victim's nostrils shut with the thumb and forefinger of your hand that is pressing on the forehead. Give 2 slow full breaths.

Open your mouth widely, take a deep breath, seal your mouth tightly around the victim's mouth and blow into the victim's mouth. Volume is important. You should provide at least one breath every five seconds, or twelve per minute. If the victim's airway is clear only moderate resistance to the blowing effort will be felt.

Watch the victim's chest. When you see it rise, stop blowing. Raise your mouth and turn your head to the side and listen for exhalation. Watch the victim's chest to see that it falls. When the victim's exhalation is finished, repeat the blowing cycle. As the victim attempts to breathe, coordinate your blowing with his breathing. After reviving the victim watch closely and treat for shock. NEVER LEAVE THE VICTIM ALONE; have someone else contact a doctor.

EFFECTS ON METAL

Hydrogen Sulfide is very corrosive to all electrochemical series metals. It can also cause hydrogen embrittlement in steel pipe having a tensile strength of 95,000 psi or more.

Blistering and pitting are two other signs of corrosion that can indicate the presence of H_2S.

Metal components used in H_2S service or potential H_2S areas should be those manufactured to resist Sulfide Stress Cracking (SSC). SSC is a corrosive action causing unsuitable metals to crack under normal operations.

APE and NACE set down the requirements of the metals to be used in H_2S service.

LOCATION SAFETY

WARNING SIGNS -- "NO SMOKING" signs should be strategically located around the rig and location. The following locations are appropriate: in the godhouse, on the rig floor, around the substructure, lower landing of all stairs leading to rig floor, mud pits, shale shaker. Designated smoking areas should be set up on all locations.

"POISON GAS" signs should be placed at strategic points on the location, lower landing of all stairs to rig floor, and all areas around substructure.

BUDDY SYSTEM -- When H_2S reaches high risk concentrations, workers should team together and work in pairs (Buddy System). The system is effective only if the workers stay together, and are watching for early signs of H_2S poisoning.

LANYARDS AND SAFETY BELTS -- If the distance between buddies must be extended more than arms length, a lifeline should be secured between them. The lifeline should be at least 400 lb. test, soft, fire-resistant rope. Also, in high-risk work areas such as inside vessels, tanks, or in a cellar, workers should have a lifeline.

CASCADE SYSTEM -- is a supplied breathing air system usually consisting of 300 cu. ft. compressed air bottles inter-connected to provide breathing air to the workers. The system is set up with a regulator to reduce the air pressure going to the work area. From a cascade system low pressure hose(s) connect to manifold(s) into which each worker can connect the hose line for his work-escape unit (breathing equipment).

BRIEFING AREAS -- Each drilling and workover location usually provides at least 2 briefing areas. Briefing areas should be located on opposite sides of the location in order for one area to be upwind at all times. The upwind Briefing Area is the protection center in the event of an H_2S emergency. These are the areas where rescue and work units, in addition to other safety equipment, are usually stored and maintained.

WINDSOCKS -- STREAMERS -- Wind will disperse H_2S very rapidly. Windsocks or streamers should be installed around the location for determining prevailing wind and present wind direction. API RP-49 states that, "a windsock should be installed on the top of the derrick and at least three sets of wind streamers or streamer poles should be displayed; one set at the location entrance and one set at each of the briefing areas". ALL PERSONNEL ON LOCATION SHOULD DEVELOP WIND DIRECTION CONSCIOUSNESS.

BUG BLOWERS -- Large blowers or fans may be used to disperse H_2S vapors. In calm and extremely light winds, bug blowers are effective in reducing H_2S concentrations in the work area. Bug Blowers should be non-spark, explosion-proof type. Often bug blowers are hooked up in conjunction with the H_2S alarm system to come on automatically when H_2S concentrations reach a set level.

FLARE GUN -- In the event of an H_2S gas release, and after all measures to shut in the well or repair the source of release have failed, and the public is in danger, then the flare gun could be used to ignite the source of H_2S. Also, in the event of failure of the flare pilot light, the flare gun could be used.

Reference: Safety International, Odessa, Texas.

APPENDIX H

MATERIAL SAFETY DATA SHEETS

MATERIAL SAFETY DATA SHEET

PETROLEUM CRUDE OIL

MSDS NO: 02008185

MANUFACTURER/SUPPLIER:
Amoco Pipeline Company
One Mid-America Plaza
Suite 300
Oakbrook Terrace, IL 60181

EMERGENCY HEALTH INFORMATION: (800) 447-8735
EMERGENCY SPILL INFORMATION: (800) 424-9300
CHEMTREC, U.S.A.
OTHER PRODUCT SAFETY INFORMATION: (312) 856-3907

IMPORTANT COMPONENTS: Crude oil (CAS 8002-05-9).
Hydrogen sulfide (CAS 7783-06-4) ACGIH TLV 10 ppm; OSHA PEL 20 ppm (ceiling), peak 50 ppm for 10 minutes if no other exposure occurs.
Benzene (CAS 71-43-2) ACGIH TLV 10 ppm; OSHA PEL 1 ppm, STEL 5 ppm.

WARNING STATEMENT: Danger! Flammable liquid and vapor. May release toxic hydrogen sulfide vapors which can be harmful or fatal. Can cause skin irritation on prolonged or repeated contact. Harmful or fatal if aspirated into the lungs. Cancer hazard.

HMIS/NFPA CODES: (HEALTH;2)(FLAMMABILITY;4)(REACTIVITY;0), Chronic health hazard.

APPEARANCE AND ODOR: Yellow to dark brown liquid; typical petroleum odor.

HEALTH HAZARD INFORMATION

EYE

EFFECT: No significant health hazards identified.

FIRST AID: Flush eyes with plenty of water.

PROTECTION: None required; however, use of eye protection is good industrial practice.

SKIN

EFFECT: Can cause skin irritation on prolonged or repeated contact. Possible cancer hazard based on skin painting studies in laboratory animals. See Toxicology Section.

FIRST AID: Wash exposed skin with soap and water. Remove contaminated clothing, including shoes, and thoroughly clean and dry before reuse. Get prompt medical attention if irritation develops.

PROTECTION: Avoid skin contact. Wear protective clothing and gloves. Wash thoroughly after handling.

HEALTH HAZARD INFORMATION - CONTINUED

INHALATION

EFFECT: Toxic gases can be given off. Can be harmful or fatal if vapors are inhaled. Can cause blood disorders. See Toxicology Section.

FIRST AID: If worker is overcome, rescuer must wear supplied-air respirator to remove worker to uncontaminated area. Give artificial respiration if not breathing. Give oxygen if breathing is difficult. Get immediate medical attention.

PROTECTION: If ventilation is inadequate, use NIOSH/MSHA certified respirator which will protect against organic vapor/mist. If operating conditions cause high vapor concentration or TLV is exceeded, use supplied-air respirator approved by NIOSH/MSHA.

INGESTION

EFFECT: Possible aspiration hazard. Harmful or fatal if aspirated into lungs.

FIRST AID: If swallowed, do NOT induce vomiting. Get immediate medical attention.

FIRE AND EXPLOSION INFORMATION

EXTINGUISHING MEDIA: Agents approved for Class B hazards (e.g., dry chemical, carbon dioxide, halogenated agents, foam, steam) or water fog.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Flammable liquid. Vapor may explode if ignited in enclosed area. Product gives off vapors that are heavier than air which can travel considerable distances to a source of ignition and flashback.

PRECAUTIONS: Firefighters should wear positive pressure, self-contained breathing apparatus. Keep away from ignition sources (e.g., heat, sparks and open flames). Runoff to sewer may cause a fire or explosion hazard.

FLASHPOINT: Flammable - varies widely (-45°F to over 200°F).

REACTIVITY INFORMATION

DANGEROUS REACTIONS: Avoid contact with strong oxidizers.

HAZARDOUS DECOMPOSITION: Burning can produce carbon monoxide and/or carbon dioxide and other harmful products.

STABILITY: Stable.

CHEMICAL AND PHYSICAL PROPERTIES

SOLUBILITY IN WATER: Negligible, below 0.1%

SPECIFIC GRAVITY (WATER = 1): 0.75 TO 1

VISCOSITY: 31-9000 SUS @ 68°F; 22-1230 SUS @ 122°F, approximate

VAPOR DENSITY (AIR = 1): Greater than 1

STORAGE AND ENVIRONMENTAL PROTECTION

SPILLS AND LEAKS: Remove or shut off all sources of ignition. Use appropriate protective equipment. Isolate area. Attempt to shut off leaking cylinders. Contain and remove by mechanical means.

WASTE DISPOSAL: Disposal must be in accordance with applicable federal, state, or local regulations. Determine waste classification at time of disposal. Conditions of use may render the spent product a hazardous waste. Enclosed-controlled incineration is recommended unless directed otherwise by applicable ordinances.

SPECIAL PRECAUTIONS: Keep out of sewers and waterways. Avoid strong oxidizers.

STORAGE REQUIREMENTS: Store away from heat, ignition sources, and open flame in accordance with applicable federal, state or local regulations. Keep container closed. Ground lines and equipment during transfer.

TOXICOLOGICAL INFORMATION

Crude oil is a naturally occurring complex mixture of hydrocarbons whose exact composition and physical properties can vary widely depending upon its source.

SKIN: Repeated or prolonged contact may result in defatting, oil acne, redness, itching, inflammation, cracking and possible secondary infection.

From skin painting studies in laboratory animals, it has been concluded that most, if not all, petroleum crudes, regardless of source, possess carcinogenic activity to some degree. This means that workers who practice poor personal hygiene and who are repeatedly exposed by direct skin contact to crude oil over many years may potentially be at risk of developing skin cancer. However, intermittent or occasional skin contact with petroleum crude oils is not expected to have serious health effects as long as good personal hygiene measures, such as those outlined in this material safety data sheet, are followed. Crude oil has not been identified as a carcinogen by NTP, IARC or OSHA.

INHALATION: Hydrogen sulfide (H2S) gas may accumulate in storage tanks and bulk transport compartments containing petroleum crudes. Prolonged breathing (greater than one hour) of concentrations of H2S around 50 ppm can produce eye and respiratory tract irritation; levels of 250 to 600 ppm will result in fluid in the lungs, and concentrations around 1000 ppm will cause unconsciousness and death in a short period of time. Symptoms of hydrogen sulfide exposure may include excitation, euphoria, headache, dizziness, drowsiness, blurred vision, fatigue, tremors, convulsions, loss of consciousness, coma, respiratory arrest and death. Since the sense of smell rapidly becomes insensitive to this toxic, colorless gas, odor cannot be relied upon as an indicator of concentrations of the gas. Always exercise caution when working around closed containers of crude oil.

Crude oils contain small, variable amounts of benzene. Chronic exposure to high levels of benzene has been shown to cause cancer (leukemia) and other adverse blood effects in humans.

INGESTION: Aspiration into lungs may cause chemical pneumonia and can be fatal. Aspiration into the lungs can occur while vomiting after ingestion.

REGULATORY INFORMATION

CERCLA REPORTABLE QUANTITY:
This product is exempt from the CERCLA reporting requirements under 40 CFR Part 302.4. However, if spilled into waters of the United States, it may be reportable under 40 CFR Part 153 if it produces a sheen.

DOT PROPER SHIPPING NAME: Crude Oil, Petroleum, Flammable Liquid, UN1267 or Crude Oil, Petroleum, Combustible Liquid, UN1267

OSHA HAZARD COMMUNICATION STANDARD: Flammable liquid. Irritant. Carcinogen. Contains hazardous components. See the Toxicological Information section for health hazards that the OSHA standard attributes to this product.

RCRA STATUS:
This product is not subject to the 40 CFR Part 268.30 land ban on the disposal of certain hazardous wastes.

SARA STATUS:
This product is regulated under the following section(s) of SARA Title III, 42 USC 9601. Spills or releases of the product may be reportable as determined by the information given below:

SECTION 302 OF SARA AND 40 CFR PART 355:
This product contains the following substance, which is on the Extremely Hazardous Substances List (Appendix A of 40 CFR Part 355):

COMPONENT/CAS NUMBER	THRESHOLD PLANNING QUANTITY (TPQ)	REPORTABLE QUANTITY (RQ
Hydrogen sulfide (7783-06-4)	10,000 lbs.	2,000 lbs.

SECTIONS 311 AND 312 OF SARA AND 40 CFR PART 370:
This product is defined as hazardous by OSHA under 29 CFR Part 1910.1200(d).

SECTION 313 OF SARA AND 40 CFR PART 372:
This product contains the following substance, which is on the Toxic Chemicals List in 40 CFR Part 372:

COMPONENT/CAS NUMBER	WEIGHT PERCENT
Benzene (71-43-2)	1

TSCA STATUS: All of the components of this product are listed on the TSCA Inventory.

ISSUE INFORMATION

BY:

R G Farmer

R. G. Farmer, Director,
Product Safety & Toxicology

ISSUED: June 26, 1990
SUPERSEDES: June 13, 1990

This material safety data sheet and the information it contains is offered to you in good faith as accurate. We have reviewed any information contained in this data sheet which we received from sources outside our company. We believe that information to be correct but cannot guarantee its accuracy or completeness. Health and safety precautions in this data sheet may not be adequate for all individuals and/or situations. It is the user's obligation to evaluate and use this product safely and to comply with all applicable laws and regulations. No statement made in this data sheet shall be construed as a permission or recommendation for the use of any product in a manner that might infringe existing patents. No warranty is made, either express or implied.

8.0 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

8.1 SAMPLING PROCEDURES

A strict Quality Assurance Plan was incorporated throughout all phases of the drilling and sampling operations. The sampling and drilling equipment was decontaminated by a high-pressure steam cleaner before the start of sampling operations and between the borings. The soil samples were collected with decontaminated stainless steel sampling trowels. The sampling equipment was cleaned between sample collections to eliminate the potential of cross-contamination between sampling stations. Groundwater samples were obtained with new disposable bailers after each monitor well was purged.

The soil and water samples were placed in glass jars and sample vials with teflon-lined lids and preserved at 4°C with zero head space in accordance with EPA requirements (EPA 600/4-82-029). A chain-of-custody (COC) that documents sample collection times and delivery times to the laboratory was completed for each set of samples. The COCs are included with the analytical results in the Appendices. Analyses were performed using EPA-recommended analytical methods on all samples.

CURA maintains the highest quality assurance standards with direct supervision of operations (sample handling and storage). Drilling operations were conducted using a New Mexico licensed water well driller. CURA provides management oversight for laboratory procedures and analytical results and uses laboratories that maintain strict quality control, i.e., equipment calibration and standardization, EPA-recommended analytical methods, preparing spiked samples, and complete chains-of-custody.

8.2 LABORATORY PROTOCOL

STANDARD OPERATING PROCEDURE
ALLOCATION, PREPARATION, AND STORAGE
OF
BTEX CHEMICAL STANDARDS

I. Allocation, storage, and preparation of BTEX chemical standards used for initial instrument calibration.

A. Allocation and storage of initial calibration standard

1. The initial BTEX calibration standard will be purchased in a methanolic medium at a concentration of 0.200 μg/ml (concentrate) through Supelco, Incorporated. These standards will be stored at 4°C in a refrigerator, purchased specifically for chemical standards.

B. Preparation of the initial calibration standard

1. Place approximately 24.8 ml of methanol into five 25.0 ml volumetric flasks (previously rinsed with acetone and oven dried).

2. Allow the flasks to stand unstoppered about 10 minutes or until all alcohol wetted surfaces have dried.

3. To each flask, add the following volumes from a freshly opened ampul of the initial calibration standard (rapidly inject the standard into the expanded portion of the flask):

a. Flask 1 - 20 μl
b. Flask 2 - 40 μl
c. Flask 3 - 60 μl
d. Flask 4 - 80 μl
e. Flask 5 - 100 μl

4. Dilute to volume, stopper, then mix by inverting three times.

C. Introduction of the initial calibration to the Tekmar ALS 2016 for Purge and Trap Gas Chromatography Analysis (PATGC)

1. Once the calibration standard has been prepared (at a minimum of five concentration units), the volume occupying the neck of each volumetric flask is discarded and all flasks are restoppered.

2. Five clean, dry 5,000 μl Hamilton syringes (with plungers removed) are overfilled with each of the calibration standards and reduced to volume by plunger with addition.

3. To each of the 5,000 μl Hamilton syringes containing the initial calibration standards add 1.0 μl of TFT (internal standard at approximately 400 μg/l) by using a clean 10.0 μl syringe and injecting through the syringe bore of the 5,000 μl Hamilton syringe.

> NOTE: the 10.0 μl Hamilton syringe should be cleaned by acetone rinse before each addition of internal standard.

STANDARD OPERATING PROCEDURE
ALLOCATION, PREPARATION, AND STORAGE
OF
INTERNAL STANDARDS FOR AROMATIC VOLATILE ORGANIC ANALYSIS
(BTEX)

I. Allocation, Preparation, and Storage of Internal Chemical Standards

A. Alpha, alpha, alpha triflurotoluene (TFT) will be used as the internal standard due to similar analytical behavior to the aromatic compounds of interest [benzene, toluene, ethylbenzene, o, m, p-xylenes (BTEX)].

1. The internal standard is purchased through Aldrich Chemical Company.

2. The analyst must demonstrate that measurement of the internal standard is not affected by method or matrix interferences.

a. The measurement of TFT will therefore be carried out under the following conditions at similar concentrations:

1) Aqueous environment
2) Methanolic/aqueous environment (1:50 ratio)

3. Internal standard preparation.

a. To a previously cleaned and oven dried 50.0 ml volumetric flask is added approximately 49.8 ml of Methonol.

b. The volumetric flask is allowed to stand, unstoppered for approximately 10 minutes to allow residual methanol to dry from the walls of volumetric flask.

c. Weigh the flask to the nearest 0.1 mg.

d. Using a 100 μl syringe, immediately add (by dropping) concentrated TFT to the flask, then reweigh. The drops should fall directly into the alcohol without contacting the neck of the flask.

e. Dilute to volume, stopper, then mix by inverting the flask three times.

f. Transfer the solution to a dated and labeled screw cap vial equipped with a teflon-lined Mininert valve. Use a vial which minimizes head space.

g. Calculate the concentration in micrograms per microliter from the net gain in weight.

4. Internal standard storage

a. Internal standards will be stored at 4°C in a refrigerator for storage of all standards.

b. The internal standard can be stored for a period not to exceed eight weeks.

STANDARD OPERATING PROCEDURE
INSTRUMENT CALIBRATION
FOR
GAS CHROMATOGRAPHIC ANALYSIS
(BTEX)

I. Internal Standard Calibration Procedure (Initial Calibration)

A. To use this approach, each analyst will use alpha, alpha, alpha - Triflurotoluene (Internal Standard) due to similar analytical behavior to analytes of interest.

B. Calibration standards at a minimum of five concentration levels for each analyte of interest will be prepared by adding volumes of a BTEX stock standard to a volumetric flask. To each calibration standard, add a known constant amount of internal standard and dilute to volume with methanol.

C. Inject each calibration standard using the same introduction technique (Purge-And-Trap). Tabulate the area responses against the concentration of each compound and the internal standard. Calculate response factors (RF) for each compound as follows:

$$RF = (A_s C_{is})/(A_{is} C_s)$$

WHERE:

A_s = Response area for Analyte to be measured (eg. Benzene, Toluene, Ethylbenzene, m,p - Xylenes, or o-Xylene)

A_{is} = Response area of internal standard (eg. Alpha, Alpha, Alpha Triflurotoluene)

C_{is} = Concentration of the internal standard, $\mu g/l$.

C_s = Concentration of the analyte to be measured, $\mu g/l$.

D. The RF over the working range must be constant (<20 % relative standard deviation) for each constituent of interest, therefore the RF can be assumed to be invariant, and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_{is} versus RF.

E. The working calibration curve or RF will be verified on each working day by the measurement of a calibration standard (purchased independently than that used in Section 1 part C). Due to the insensitivity of the Flame ionization detector, the response for each analyte may vary by ± 25% from the predicted response; however, if the response for any analyte varies from the predicted response to a value > ± 25%, a new calibration curve must be prepared.

F. This calibration procedure will be carried out on a monthly basis regardless of calibration verification by each analyst, and all calculations will be checked by the laboratory supervisor for accuracy.

G. All chromatograms and calculations will be kept in a file and provide the analyst name, date and time of analysis and length of time that calibration was effective.

STANDARD OPERATING PROCEDURE
SAMPLE PREPARATION AND ANALYSIS
OF
VOLATILE ORGANIC CONTAMINANTS
(BTEX)

I. Sample Preparation

A. Sediment/soil and waste samples that are insoluble in methanol.

1. Weight 4 grams (wet weight) of sample into a tared 20 ml scintillation vial. Using a top loading analytical balance, record the weight to 0.1 grams and immediately cap the vial with an appropriate screw cap equipped with a teflon liner.

2. Using a 10.0 ml volumetric pipet, transfer 10.0 ml of methanol to the scintillation vial containing the sample. Cap and shake for 2 minutes.

   NOTE: Step 2 will be performed rapidly and without interruption to avoid loss of volatile organics. These steps will be performed in a laboratory free from solvent fumes.

3. Remove the plunger from a Hamilton 5.0 ml gas-tight syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air and adjust the volume to 4.9 ml. Pull the plunger back to 5.0 ml to allow volume for the addition of the sample extract and internal standard. Add 1.0 μl of internal standard solution followed by the volume of methanol extract determined from Table 2 per EPA Method 5030, and a volume of methanol solvent to total 100 μl (excluding methanol standards).

B. Water Samples

1. Remove the plunger from a Hamilton 5.0 ml gas-tight syringe and attached a closed syringe valve. The 40.0 ml sample vial containing the water sample is allowed to thermally stabilize to ambient temperature, opened and carefully poured into the syringe to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve to vent any residual air while adjusting the sample to a volume of 5.0 ml.

2. Using a Hamilton 10.0 μl syringe inject 1.0 μl of internal standard into the sample through the syringe bore. Care should be taken to prevent air from leaking into the syringe. The following procedure is appropriate for diluting purgeable samples. All steps must be performed without delays until the diluted sample in a Hamilton 5.0 ml gas-tight syringe.

   a. Diluting will be made in volumetric flasks (10 ml - 100 ml) selected to allow for necessary dilutions of highly contaminated samples. Intermediate dilutions will be necessary for extremely large dilutions.

   b. The analyst will calculate the approximate volume of reagent water to be added to the volumetric flask selected and should add slightly less than the calculated volume

c. Inject the proper aliquot of sample from the sample vial into the volumetric flask (aliquots of less than 1 ml are not valid). Dilute the sample to volume with reagent water. Cap the flask and invert three times for proper mixing. Repeat this procedure for additional dilutions.

d. Fill a Hamilton 5.0 ml gas-tight syringe with the diluted sample as outlined in Section I, Part B.

C. Water-Miscible Liquids

1. Water-miscible liquids are analyzed as water samples after first diluting them at least 50-fold with reagent water.

2. Dilutions are prepared directly in a Hamilton 5.0 ml gas-tight syringe filled with reagent water by adding at least 20 μl, but no more than 100 μl of liquid sample. At this point, 1.0 μl if internal standard is added to the sample through the syringe bore.

3. Attach the syringe-syringe valve assembly to the syringe valve on the Tekmar purge and trap. Open the syringe valve and inject the water/methanol sample into the purge chamber (sparger).

II. Sample Analysis

A. Samples are analyzed in a set referred to as an analytical sequence.

1. Sequence begins with a water blank and calibration standard.

2. One to twenty samples (never more than twenty) are injected.

3. Sequence ends with injection of duplicate, spikes, and method blank.

B. Identification of each analyte occurs when a peak from a sample extract falls within the daily retention time window.

1. Establish daily retention time windows for each analyte as follows:

a. The absolute retention time for each analyte is determined by the analysis of three BTEX standards at equal concentrations over a 72 hour period. Calculate the standard deviation for each analyte as well as the average retention time.

b. The absolute retention time for each analyte is used as the midpoint. The daily retention time equals the midpoint ± three times the standard deviation determined from Section II, Part B, Subpart 1a.

C. Calculations for each analyte of interest is calculated as follows:

1. Non-Aqueous Samples

a. Concentration (μg/kg) = $[(A_s(C_{is})(D)\ (V_s]/[(A_{is})(RF)(W_s)]$

Where:

A_s = Response of the analyte being measured, units are in area counts.

C_{is} = Amount of internal standard added to extract, ng.

D = Dilution factor, if a dilution was made on the sample prior to analysis. If no dilution was made, $D=1$ (dimensionless).

A_{is} = Response of the internal standard, units same as A_s.

RF = Response factor for analyte, as determined per specific SOP

W_s = Weight of sample extracted.

V_s = Final extract volume

2. Aqueous Samples

a. Concentration ($\mu g/l$) = $[(A_x)(C_{is})(D)]/[(A_{is})(RF)(V_s)]$

Where:

A_x = Response of the analyte being measured, units are in area counts.

C_{is} = Amount of internal standard added to extract, ng.

D = Dilution factor, if a dilution was made on the sample prior to analysis. If no dilution was made, $D=1$ (dimensionless).

A_{is} = Response of the internal standard, units same as A_x.

RF = Response factor for analyte, as determined per specific SOP

V_s = Volume of water purged

STANDARD OPERATING PROCEDURE
MEASUREMENT OF
VOLATILE ORGANIC CONTAMINANTS (BTEX)
BY
PURGE AND TRAP GAS CHROMATOGRAPHY (PATGC)

INSTRUMENT OPERATING PARAMETERS

I. Gas Chromatograph Equipped With Flame Ionization Detector

A. Flow Rates

1. Hydrogen (H_2) - 40.0 ml ± 1.0 ml/minute
2. Compressed Air - 300.0 ml ± 1.0 ml/minute
3. Nitrogen (N_2 Carrier Gas)
    a. Column Flow - 10.0 ml ± 1.0 ml/minute
    b. Makeup Flow - 20.0 ml ± 1.0 ml/minute

B. Temperature Settings

1. Flame Ionization Detector - 300°Celsius
2. Injector Temperature - 300°Celsius
3. Column Temperature - Temperature Programmed
    a. Initial Column Temperature - 40°Celsius
    b. Initial Column Hold Time - 5.5 Minutes
    c. Final Column Temperature - 170°Celsius
    d. Final Column Hold Time - 10.5 Minutes
    e. Temperature Rate - 6°Celsius/Minute

C. Detector Settings

1. Attenuation - 128
2. Range - 10^{-11}
3. Auto Zero - On

II. Liquid Sample Concentrator (Purge and Trap)

A. Flow Rates (Nitrogen)

1. Purge Gas - 40.0 ml ± 1.0 ml/minute
2. Backflush inert Gas - 20-60 ml/minute

B. Purge Time and Temperature

1. Purge Time - 12.0 minute
2. Purge Temperature - Ambient

C. Desorb Time and Temperature

  1. Desorb Time - 4.0 minute
  2. Desorb Temperature - 180° Celsius

D. Trap Bake Temperature and Time

  1. Trap temperature during daily bake mode - 180° Celsius
  2. Bake Time - 10.0 minutes

E. Transfer Line Temperature - 100° Celsius

III. Integrator Settings

A. Chart Speed - 1.0 cm/minute
B. Attenuation - 1024
C. Peak Threshold - 100
D. Peak Area - 1,000
E. Dialog Mode

  1. File Name - BTEX
  2. Integrate Inhibit (II)

    a. Time on (1) 24.0 minutes

  3. End Run (ER) 29.66 minutes

V. Standard Operating Procedures for Analysis of

Total Petroleum Hydrocarbons (TPH)

STANDARD OPERATING PROCEDURE
MEASUREMENT OF
PETROLEUM HYDROCARBONS, TOTAL RECOVERABLE

Method 418.1 (Spectrophotometric, Infrared)

1. Scope and Application

1.1 This method is for measurement of fluorocarbon-113 extractable petroleum hydrocarbons from surface and saline waters, industrial and domestic wastes.

1.2 The method is applicable to measurement of light fuels, although loss of about half of any gasoline present during the extraction manipulations can be expected.

1.3 The method is sensitive to levels of 1 mg/l and less, and may be extended to ambient monitoring.

2. Summary of Method

2.1 The sample is acidified to a low pH (<2) and serially extracted with fluorocarbon-113 in a separatory funnel. Interferences are removed with silica gel adsorbent. Infrared analysis of the extract is performed by direct comparison with standards.

3. Definitions

3.1 As in the case of Oil and Grease, the parameter of Petroleum Hydrocarbons is defined by the method. The measurement may be subject to interferences and the results should be evaluated accordingly.

3.2 Oil and Grease is a measure of biodegradable animal greases and vegetable oils along with the relative non-biodegradable mineral oils. Petroleum hydrocarbons is the measure of only the mineral oils. Maximum information may be obtained using both methods to measure and characterize oil and grease of all sources.

4. Sampling and Storage

4.1 A representative sample of 1 liter volume should be collected in a glass bottle. Because losses of grease will occur on sampling equipment, the collection of a composite sample is impractical. The entire sample is consumed by this test; no other analyses may be performed using aliquots of the sample.

4.2 A delay between sampling and analysis of greater than 4 hours requires sample preservation by the addition of 5 ml HCI (6.1). A delay of greater than 48 hours also requires refrigeration for sample preservation.

5. Apparatus

5.1 Separatory funnel, 2000 ml, with Teflon stopcock.

5.2 Filter paper, Whatman No. 40,11 cm.

5.3 Infrared spectophotometer, fixed wavelenth, for measurement around 2950 cm.

5.4 Cells, 10 mm, 50 mm, and 100 mm pathlength, sodium chloride or infrared grade glass.

5.5 Magnetic stirrer, with Teflon coated stirring bars.

6. Reagents

6.1 Hydrochloric acid, 1:1. Mix equal volumes of conc HCI and distilled water.

6.2 Fluorocarbon-113, (1,1,2-trichloro-1,202-triflourethane), b.p. 48°C.

6.3 Sodium sulfate, anhydrous crystal.

6.4 Silica gel, 60-200 mesh. Davidson Grade 950 or equivalent. Should contain 1-2% water as defined by residue test at 130°C. Adjust by overnight equilibration if needed.

6.5 Calibration mixtures:

6.5.1 Reference oil: Pipet 15.0 ml n-hexadecane, 15.0 ml isooctane, and 10.0 ml chlorobenzene into a 50 ml glass stoppered bottle. Maintain the integrity of the mixture by keeping stoppered except when withdrawing aliquots.

6.5.2 Stock standard: Pipet 1.0 ml reference oil (6.5.1) into a tared 200 ml volumetric flask and immediately stopper. Weigh and dilute to volume with fluorocarbon-113.

6.5.3 Working standards: Pipet appropriate volumes of stock standard (6.5.2) into 100 ml volumetric flasks according to the cell pathlength to be used. Dilute to volume with fluorocarbon-113. Calculate concentration of standards from the stock standard.

7. Procedure

7.1 Mark the sample bottle at the water meniscus for later determination of sample volume. If the sample was not acidified at time of collection, add 5 ml hydrochloric acid (6.1) to the sample bottle. After mixing the sample, check the pH by touching pH-sensitive paper to the cap to insure that the pH is 2 or lower. Add more acid if necessary.

7.2 Pour the sample into a separatory funnel.

7.3 Add 30 ml fluorocarbon-113 (6.2) to the sample bottle and rotate the bottle to rinse the sides. Transfer the solvent into the separatory funnel. Extract by shaking vigorously for 2 minutes. A Allow the layers to separate.

7.4 Filter the solvent layer through a funnel containing solvent-moistened filter paper into a 100 ml volumetric flask.

NOTE 1: An emulsion that fails to dissipate can be broken by pouring about 1 g sodium sulfate (6.3) into the filter paper cone and slowly draining the emulsion through the salt. Additional 1 g portions can be added to the cone as required.

7.5 Repeat (7.3 and 7.4) twice more with 30 ml portions of fresh solvent, combining all solvent into the volumetric flask.

7.6 Rinse the tip of the separatory funnel, filter paper, and the funnel with a total of 5-10 ml solvent and collect the rinsings in the flask. Dilute the extract to 100 ml. If the extract is known to contain greater than 100 mg of non-hydrocarbon organic material, piper an appropriate portion of the sample to a 100 ml volumetric and dilute to volume.

7.7 Discard about 5-10 ml solution from the volumetric flask. Add 3 silica gel (6.4) and a stirring bar; stopper the volumetric flask, and stir the solution for a minimum of 5 min on a magnetic stirrer.

7.8 Select appropriate working standards and cell pathlength according to the following table of approximate working ranges:

Pathlength	Range
10 mm	2-40 mg
50 mm	0.5-8 mg
100 mm	0.1-4 mg

calibrate the instrument for the appropriate cells using a series of working standards (6.5.3). Is not necessary to add silica gel to the standards. Determine absorbance directly for each solution at the absorbance maximum at about 2930 cm. Prepare a calibration plot of absorbance vs. mg petroleum hydrocarbons per 100 ml solution.

7.9 After the silica gel has settled in the sample extract, fill a clean cell with solution and determine the absorbance of the extract. If the absorbance exceeds 0.8 prepare an appropriate dilution. NOTE 2: The possibility that the absorptive capacity of the silica gel has been exceeded can be tested at this point by adding another 3.0 g silica gel to the extract and repeating the treatment and determination.

7.10 Determine the concentration of petroleum hydrocarbons in the extract by comparing the response against the calibration plot.

8. Calculations

8.1 Calculate the petroleum hydrocarbons in the sample using the formula:

$$\text{mg/1 Petroleum Hydrocarbons} = \frac{RxD}{V}$$

where:

R = mg of Petroleum Hydrocarbons as determined from the calibration plot (7.10).
D = extract dilution factor, if used.
V = volume of sample, in liters.

STANDARD OPERATING PROCEDURE

TPH CHEMICAL STANDARDS FOR GC ALLOCATION, PREPARATION AND STORAGE

1. Allocation, preparation and storage of TPH chemical standards used for initial/daily calibration.

   A. Allocation and storage of qualitative calibration standard.

      1. The TPH qualitative calibration standards is purchased from Supelco, Inc. These standards will be stored at 4°C in a refrigerator purchased specifically for chemical standards.

      2. The TPH calibration standard was chosen due to similar analytical behavior of its components to those found in petroleum hydrocarbons. The components of volume/volume percentages are as follows:

2-methylbutate	10.5	p-xylene	14.0
n-pentane	8.1	n-propylbenzene	4.7
2-methylpentane	5.8	n-decane	3.5
n-haxane	5.8	n-butylbenzene	3.5
2,4-dimethylpentane	5.8	n-dodecane	3.5
n-heptane	10.5	n-tridecane	2.3
toluene	11.6	n-tetradecane	2.3
N-octane	5.8	n-pentadecane	2.3

   B. Preparation of the initial calibration standard.

      1. Place approximately 49.8 ml of 1, 1,2-trichlorotrifluoroethane (freon 113) into five 50.0 ml volumetric flasks (labeled #1-5 and previously rinsed with acetone and oven dried.

      2. Allow the flasks to stand unstoppered until all freon wetted surfaces have dried.

      3. To each flask, add the following volumes from a freshly opened ampule of the TPH qualitative calibration standard. (Rapidly inject the standard into the expanded portion of the flask):

         a. flask 1 - 1.0 microliters
         b. flask 2 - 2.0 microliters
         c. flask 3 - 3.0 microliters
         d. flask 4 - 6.0 microliters
         e. flask 5 - 10.0 microliters

      4. Dilute to volume, stopper, then mix by inverting three times.

      5. Once the initial calibration standards have been prepared (at a minimum of five concentration units), the volume occupying the neck of each flask is discarded and each standard is transferred to a labeled 20 microliter vial equipped with a Mininert valve.

6. Introduction of each initial calibration standard into the Varian gas chromatograph is carried out by injecting 0.2 microliters of each standard into the injector port on the split/splitless injector.

   NOTE: The Hamilton 10.0 microliter syringe used for all injections into the gas chromatograph should be cleaned thoroughly with acetone following each injection.

7. Statistical analysis of the initial calibration data is outlined in the SOP for **"INSTRUMENT CALIBRATION"**.

C. Preparation of daily calibration standard

1. Place approximately 49.8 ml of 1, 1,2-trichlorotrifluoroethane into a 50.0 ml volumetric flask (previously rinsed with acetone and oven dried).

2. Allow the flask to stand unstoppered until all freon wetted surfaces have dried.

3. Transfer the flask to a top loading balance and tare the flask. Transfer approximately 15-20 mg of TPH qualitative calibration standard to the flask with a clean Hamilton 500 microliter syringe and record the weight to 0.1 mg. Dilute to volume, stopper, and invert three times to allow proper mixing.

4. Once the daily calibration standard has been prepared, the volume occupying the neck of the flask should be discarded and the remaining mixture transferred to a labeled 20 ml vial equipped with a mininert valve. The standard is then stored at 4°C in a refrigerator specifically purchased for chemical standards.

STANDARD OPERATING PROCEDURE
DIRECT INJECTION GAS CHROMATOGRAPHY
OF
TOTAL PETROLEUM HYDROCARBONS
INSTRUMENT CALIBRATION

A. To use this approach, each analyst will use the qualitative calibration standard purchased through Supelco, Inc. (catalog no. D-8884). This standard was chosen due to similar analytical behavior to Total Petroleum Hydrocarbon (long chain hydrocarbons).

B. Calibration standards at a minimum of five concentration levels will be prepared by adding volumes of the Total Petroleum Hydrocarbon (TPH) standard to a volumetric flask. Dilute to volume with 1,1,2-Trichlorotrifluoroethane (Freon 113).

C. Inject each calibration standard using the same introduction technique (direct injection). Tabulate the area of response (over the entire integration area of interest) against the total concentration of all analytes present in the standard mixture.

D. The results (Section 1, part C.) are then used to plot a calibration curve to check linearity of the gas chromatographic measurement for each TPH calibration standard. Once linearity is established, measurement of real samples can be carried out.

E. The working calibration curve will be verified on each working day by the measurement of a calibration standard. Due to the insensitivity of the flame ionization detector, the measurement of the analyte (TPH) may vary by ± 10% from the predicted measurement; however, if the measurement of the analyte varies from the predicted response to a value greater than ± 10%, a new calibration curve must be prepared.

F. This calibration procedure will be carried out on a monthly basis regardless of calibration verification by each analyst, and all calculations will be checked for accuracy by the laboratory supervisor.

G. All chromatograms and calculations will be kept in a file and provide the analyst name, date and time of analysis and length of time that calibration was effective.

STANDARD OPERATING PROCEDURE
SAMPLE PREPARATION AND ANALYSIS
TOTAL PETROLEUM HYDROCARBONS
(TPH)

I. Sample Preparation

A. Sediment/Soil Samples

1. Weigh 2 grams (wet weight) of the sample into a tared 20 ml scintillation vial. Using a top loading analytical balance, record the weight to 0.1 grams and immediately add approximately 2 grams of anhydrous sodium sulfate (Na_2So_4) and mix well with a spatula. Cap the vial with an appropriate screw cap equipped with a teflon liner.

2. Using a 10.0 ml volumetric pipet, transfer 10.0 ml of 1,1,2-Trichlorotrifluoroethane to the scintillation vial containing the sample.

3. The sample is then extracted by sonication for 2.0 minutes. Filtered through Pyrex wool and collected for analysis in a labeled screw cap scintillation vial equipped with a teflon liner.

   a. All samples collected for analysis will be analyzed the day of extraction or stored at 4°C in a refrigerator specifically purchased for storage of liquid samples.

4. The sample is then introduced into the gas chromatograph by a 0.2 μl injection into the split/splitless injector of gas chromatograph.

B. Water Samples

1. Water samples are first allowed to thermally stabilize to ambient temperature. Once thermally stable, the 1 liter amber vessel containing the water sample is opened and the sample is transferred to a 2,000 ml separatory funnel (previously rinsed with acetone and oven dried) for the purpose of isolating the organic compounds from the aqueous medium through a separatory liquid-liquid extraction.

2. Measure 60 ml of 1,1,2-trichlorotrifluoroethane with a graduated cylinder and add it to the separatory funnel.

3. Seal and shake the separatory funnel vigorously for 1 to 2 minutes with periodic venting to release excess pressure.

   NOTE: 1,1,2-trichlorotrifluoroethane creates excessive pressure very rapidly; therefore, initial venting should be done immediately after the separatory funnel has been sealed and shaken once.

4. Allow the organic layer to separate from the aqueous phase for a minimum of ten minutes. If an emulsion layer exists between layers, the analyst must employ mechanical techniques to complete the phase separation. This may include stirring, filtration of the emulsion through Pyrex wool, or other physical methods. Collect the solvent extract in an appropriate vessel (eg. beaker or Erlenmeyer flask).

5. Repeat the extraction two additional times using fresh portions of solvent and combine the three solvent extracts.

6. The extract obtained is dried by passing it through a drying column containing about 10 cm of anhydrous sodium sulfate (Na_2So_4) and collected for analysis in a labeled 20.0 ml screw cap scintillation vial equipped with a teflon liner.

    a. All samples collected for analysis will be analyzed the day of extraction or stored at 4°C in a refrigerator specifically purchased for storage of liquid samples.

7. The sample is then introduced into the gas chromatograph by a 0.2 μl injection into the split/splitless injector of gas chromatograph.

II. Sample Analysis

A. Samples are analyzed in a set referred to as an analytical sequence.

1. Sequence begins with a water blank and calibration standard.

2. One to twenty samples (never more than twenty) are injected.

3. Sequence ends with injection of duplicate, spikes, and method blank

B. Identification of the analyte (TPH) occurs through peak detection in the calibrated integration window.

C. Calculations for the analyte (TPH) are based on the assumption of a One-to-One response between the calibration standard and total petroleum hydrocarbons.

1. Calculations are as follows:

$$TPH_{(ppm)} = [(A_x)(C_s(D))]/[A_s]$$

Where:

A_x = Response of the analyte being measured, units are in area counts.

C_s = Concentration of TPH standard analyzed, units are in mg/l.

D = Dilution factor, if a dilution was made on the sample prior to analysis. If no dilution was made, D=1 (dimensionless).

A_s = Area of the TPH standard being measured, units same as A_x.

STANDARD OPERATING PROCEDURE
MEASUREMENT OF
TOTAL PETROLEUM HYDROCARBON (TPH)
BY
DIRECT INJECTION
GAS CHROMATOGRAPHY

INSTRUMENT OPERATING PARAMETERS

I. Gas Chromatograph Equipped With Flame Ionization Detector.

A. Flow Rates

1. Hydrogen (H_2) - 40.0 ml ± 1.0 ml/minute
2. Compressed Air - 300.0 ml ± 1.0 ml/minute
3. Nitrogen (N_2 Carrier Gas)
   - a. Column Flow - 10.0 ml ± 1.0 ml/minute
   - b. Makeup Flow - 20.0 ml ± 1.0 ml/minute
   - c. Vent Flow (Splitless Mode) - 100.0 ml ± 1.0 ml/minute

B. Temperature Settings

1. Flame Ionization Detector - 300° Celsius
2. Injector Temperature - 300° Celsius
3. Column Temperature (Programmed)
   - a. Initial Column Temperature - 40°Celsius
   - b. Initial Column Hold Time - 1.0 Minutes
   - c. Final Column Temperature - 200° Celsius

   - d. Final Column Hold Time - 10.0 Minutes
   - e. Temperature Rate - 9.0° Celsius/Minute

C. Detector Settings

1. Attenuation - 128
2. Range - 10^{-11}
3. Auto Zero - On

D. Relays

1. Initial - -1 for 1.5 minutes
2. Final - +1

II. Integrator Settings

A. Chart Speed - 1.0 cm/minute
B. Attenuation - 16.0
C. Peak Threshold - 12
D. Dialog Mode

1. File Name - TPH
2. Integrate Inhibit (II)
   - a. Initial (Time 0) - II = 1 (ON)
   - b. Final (Time 2.5 Minutes) - II = 0 (OFF)
3. End Run (ER) 28.67 Minutes

9.0 SITE SAFETY PLAN

The sampling operations were performed at level D personal protection. All CURA personnel involved in on-site activities have completed the Hazardous Waste Field Operation training course (OSHA 29 CFR 1910.120) and have obtained safety training for hydrogen sulfide environments. Applicable safety equipment was available on site to CURA personnel. A site safety meeting for this Preliminary Subsurface Investigation was conducted by Amoco Pipeline Company prior to commencement of work activities. A contractor safety manual was supplied to all on site personnel by Amoco Pipeline Company (Appendix F). A Hydrogen Sulfide (H_2S) Safety manual is included in Appendix H.

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9.01 GENERAL SITE SAFETY PLAN

Site Name: **Amoco Artesia Station**
Address: **Section 10, T18S, R27E, Eddy County, New Mexico**
Site Owner: **Amoco Oil Company**
Contacts: **Raymond L. Banks - Environmental Coordinator**

Work Description: Environmental site assessment activities: soil borings, soil sampling, and site mapping.

Proposed Date of Work: May 17, 1993

Work Team:
Team Leader - Raymond L. Banks (Amoco Oil Company)
Site Safety Officer - Gilbert J. Van Deventer (CURA, Inc.)
Team Member - Barry Simmons (Hi-Plains Drilling Company)
Team Member - Freddie Tovar (Hi-Plains Drilling Company)
Team Member - Billy D. Smith (CURA, Inc.)

Plan prepared by: Gilbert J. Van Deventer, R.E.M.
Reviewed by: Richard Wilson, Ph.D.

9.02 SITE BACKGROUND

Facility Description: The facility is a crude oil pipeline pump station operated by Amoco Pipeline Company. Subsurface pipelines, aboveground storage tank(s), and sump(s) containing crude oil are located on site.

Unusual Features: None

Status of the Site: Active pump station.

9.03 CHEMICAL/WASTE CHARACTERISTICS

Chemical/Waste Physical Type: Crude Oil
Chemical Characteristics: Crude oil contains a wide variation of light to heavy chain hydrocarbons and aromatic hydrocarbons (refer to Material Safety Data Sheet in Appendix H). Hydrogen sulfide (H_2S) gas and small concentrations of benzene may also be present. Characteristics of crude oil are: low vapor pressure, flammable (flashpoint varies widely - 45°F to over 200 °), insolvable in water, vapors heavier than air. See attached safety manual for hydrogen sulfide (H_2S) gas characteristics (Appendix G).

9.04 HAZARD EVALUATION

Chemical Hazards: Crude oil vapors are flammable, meaning, the vapors can ignite at ambient temperatures if an ignition source is present. Crude oil liquid and vapors also present a poisoning hazard, if exposure is excessive. The American Conference of Governmental Industrial Hygenists (ACGIH) have adopted a eight-hour time-weighted average Threshold Limit Value (TLV) of 10 ppm for hydrogen sulfide (H_2S) with a ceiling concentration not to exceed 15 ppm. The ACGIH eight-hour time-weighted average TLV for benzene is 10 ppm. The OSHA Permissible Exposure Limit (PEL) for benzene is 1 ppm (eight-hour time-weighted average. The inhalation and dermal routes of exposure are the greatest concerns related to personal exposure.

Physical Hazards of the Site: Drilling operations could present physical threats normally associated with such operations. These include hazards typically associated with operation of heavy equipment. All equipment should be placed no closer than 15-feet from any overhead electric line. All construction on site should adhere to CURA's policy as stated in the CURA Safety Manual as well as 29 CFR 1926. Another physical hazard associated with drilling and sampling operations is injury due to vehicular traffic around the site. In addition, proper work procedures, should be observed with regard to hot and cold weather conditions.

9.05 SPECIAL WORK PROCEDURES

All field work will comply with CURA's Corporate Health and Safety Plan and Safe Procedures for Field Operations.

Drilling will be accomplished using procedures generally recognized as safe and prudent for operations involving petroleum hydrocarbons. Prudent sampling techniques shall be utilized to achieve both safe and representative sampling of the soil materials present at the site. Items utilized shall include all appropriate PPE, scoops, augers, spatulas and approved sampling containers for each sampled material.

Prudent safety measures should be used during well purging (bailing) and well sampling operations to minimize exposure to liquids and hydrocarbon vapors. Items utilized should include splash apron, gloves (hydrocarbon resistant), and boot covers. Generally, hydrocarbon vapor concentrations in the breathing zone do not exceed regulatory (OSHA) limits, however, the person sampling the well should stand upwind of the well and if air circulation around the well is restricted for some reason, use a monitoring instrument (H_2S monitor or DVA) to check hydrocarbon vapor levels.

Use lockout/tagout procedures during O&M of remediation systems. These are required by OSHA General Duty Clause and ANSI Standards. Keep protective covers on electrical equipment and guards on belts and fans.

All activities may be initially accomplished utilizing the Level D PPE ensemble. The protection level shall be upgraded if the environmental monitoring indicates the need for an increase in the level of protection (see Action Levels page 7).

9.06 SITE OPERATIONS

Monitoring equipment available:

Equipment Name

OVA (Organic Vapor Analyzer - FID)
H_2S monitor (electrochemical alarm type)

All monitoring equipment will be calibrated on the day preceding the field operations. Field calibrations and/or field checks will be performed and recorded at the time the equipment is used.

Operating Procedures and Methods of Surveillance: Frequent air quality monitoring with an OVA and H_2S monitor, and visual surveys for presence of free crude oil. This is a field decision.

Perimeter Establishment: The decontamination area, if required, will be marked with caution tape. During drilling, establish separate exclusion zones around each drilling location, leaving an open area for rapid evacuation.

During well purging (bailing) and sampling, use orange cones to warn drivers in the area and exercise extreme caution i.e., don't depend on a driver to see the cones and avoid you.

9.07 PERSONAL PROTECTION

Respiratory and Dermal Requirements:

Level D - Tyvek coveralls (or splash apron during well development) latex boot covers, surgical and nitrile gloves, hard hat

Level C - Tyvek coveralls, latex boot covers, surgical and nitrile gloves, hard hat, APR with cartridge (organic vapor).

Selection Criteria: Purging (bailing), sampling, drilling, and disposal activities will begin at Level D. Based on general air quality monitoring data, if organic vapor readings are greater than 100 ppm above ambient background, PPE will be upgraded to Level C. If H_2S monitor readings are above 15 ppm, PPE will be upgraded to Level A (SCBA) if work is to be continued in the area.

Modifications for PPE:

Action Levels (breathing zone)

H_2S monitor - <10 ppm as normal; >15 ppm leave the area

Oxygen meter - 19.5 to 23.5 work as normal; <19.5 or >23.5 leave the area.

RAM IV - 0 - 0.1 mR/hr work as normal; >0.1 mR/hr leave the area, note location and call CURA.

OVA - 0 - 100 ppm Level D; 100 - 1,000 ppm Level C; >1,000 ppm leave area (action levels are based on PEL for gasoline and appropriate protection levels for specific hydrocarbon constituents).

Explosimeter - 0 - 15% work as normal, 15 - 25% continuous monitoring, 25% leave area, note location and call CURA.

9.08 DECONTAMINATION PROCEDURES

Establish exclusion zone, contamination reduction zone, and support zone for each drilling/sampling location. Mark zones with barrier tape and keep exclusion zone as small as possible.

Line the contamination reduction zone (decon) with plastic sheeting and collect all spillage and run off from equipment. Use Alconox detergent, water rinse, and distilled water rinse on equipment such as augers, coring equipment, trowels, and bailers. PPE is disposable, except for APR's.

Disposal Procedures: Temporarily store purged water and crude oil in 55-gallon drums.

9.09 EMERGENCY PROCEDURES

Emergency Responsibilities:

Name	Responsibility	Action
Gil	First Aid	Travel with injured to hospital
Ray	Site Control	Remain at site
Gil	Driver	Drive injured to hospital
Barry	Driver	Drive injured to hospital

Emergency Procedures:

For first aid and treatment of exposure, see attached chemical information. For injuries apply first aid and remove the victim from the exclusion zone. If necessary, transport the victim to the hospital.

For fire or explosion potential, leave the area and call CURA and maybe the local fire department. Should a fire occur on site call the fire department.

If radiation is discovered on site, leave the area and call CURA.

If it rains, site work will be halted unless it can be determined that the rain (no lightning) will not effect the sampling.

9.10 EMERGENCY INFORMATION

Site Name:	Amoco Artesia Station
Site Address:	9 miles southeast of Artesia in Eddy County, New Mexico
Site Owner:	Amoco Pipeline Company

Telephone Numbers:

Ambulance Service:	911
Hospital:	Artesia General Hospital - 505-748-3333
Poison Control Center:	1-800-432-6866
Police:	911
Fire Department:	911

Emergency Contacts

Company Health and Safety Officer: Dr. Richard Wilson
Work: (214) 620-7117
Home: (214) 241-5803

Project Manager: Greg C. Walterscheid, R.E.M.

Work:	1-915-570-8408
Mobile Phone:	1-915-559-5224
Pager:	1-915-560-2537
Home:	1-915-682-5029

9.11 PRE-SITE MEETING

The Pre-Site Meeting will be conducted on site, before work begins. Persons attending will be CURA field personnel, subcontractors, Amoco Oil Company representatives.

TOPICS DISCUSSED:

Description of work to be done
Chemical/waste types and review of chemical and physical characteristics
Chemical and physical hazards most likely to be encountered
Special work procedures
Site monitoring operations
Personal Protective Equipment on-hand
Emergency procedures

SIGNATURES OF PERSONS ATTENDING THE MEETING:

10.0 REFERENCES

Amoco Pipeline Company, 1992. Contractor Safety Manual.

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11.0 LIMITATIONS

It should be noted that all subsurface investigations are inherently limited in the sense that conclusions are drawn and recommendations are developed from test borings and observation wells which depict subsurface conditions at representative locations over relatively short periods of time. Subsurface conditions elsewhere may differ from those at the sampling locations. In addition, subsurface conditions at sampling locations may vary over longer periods of time than can be observed in a study of this type.