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PRELIMINARY REPORT ON GROUND WATER INVESTIGATIONS AT THE GIANT INDUSTRIES, INC. BLOOMFIELD REFINERY BLOOMFIELD, NEW MEXICO

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1.0 EXECUTIVE SUMMARY

At the request of Montgomery and Andrews, P.A., Geoscience Consultants, Ltd. (GCL) is performing site investigations at the Giant Bloomfield Refinery (GBR). To date, two localized plumes of ground water degradation on the refinery site and a regional plume resulting from past waste disposal practices at the Lee Acres Landfill have been identified. The on-site sources are the "Diesel Spill Area" and the "Southern Refinery Area," each of which exhibited floating product in certain observation wells. The Lee Acres Landfill source has generated a contamination plume that underlies the entire arroyo from the landfill site, through the refinery and extending south to the Lee Acres subdivision. This plume exists under a large part of the refinery property as well as much of the Lee Acres Subdivision. This plume definition is supported by analytical results of water well samples which show contaminants which are characteristic of the Lee Acres Landfill plume and have not been generated by refinery sources.

A total of 33 boreholes have been drilled on refinery property to explore the extent of each on-site plume and most of these boreholes were completed as monitor wells. Five recovery wells (3 in the Diesel Spill area and 2 in the Southern Refinery area) have been drilled and 4 pilot-scale recovery pumps (1 in the Southern Refinery area, three in the Diesel Spill Area) have been installed. Exploratory wells were drilled in order to gain additional needed information about the depth, lateral extent, and chemical quality of the plumes. Data from this most recent drilling phase have not yet been evaluated and are not presented in this report.

A terrain electromagnetic conductivity survey performed by the New Mexico Environmental Improvement Division (NMEID) identified two anomalous electromagnetic responses: one at the Lee Acres Landfill and one in the refinery area. Consultants to the Bureau of Land Management - Farmington Resource Area (BLM) (AEPCO) have suggested that these "conductive plumes" are indicative of potential sources of ground water contamination. The conductive plume in the vicinity of the Lee Acres Landfill is probably

indicative of ground water contamination; however, the explanation for the high conductivity area on the refinery site is more likely to be associated with an arroyo channel which has been subsequently covered with earthen fill during refinery construction. Natural ground water in small arroyo channels in the San Juan Basin are generally saline. The localized influx of this saline ground water would result in a conductivity "plume" as revealed by the electromagnetic survey. An alternate explanation is a conductivity anomaly associated with the El Paso Natural Gas Company pipeline which is located in this area.

No sources of chlorinated solvents have been identified on the refinery property. Based upon a detailed survey of the materials used on-site and an evaluation of presently available water quality data, it is improbable that any activities at the refinery are responsible for the elevated levels of chlorinated solvents in residential wells in the Lee Acres Subdivision.

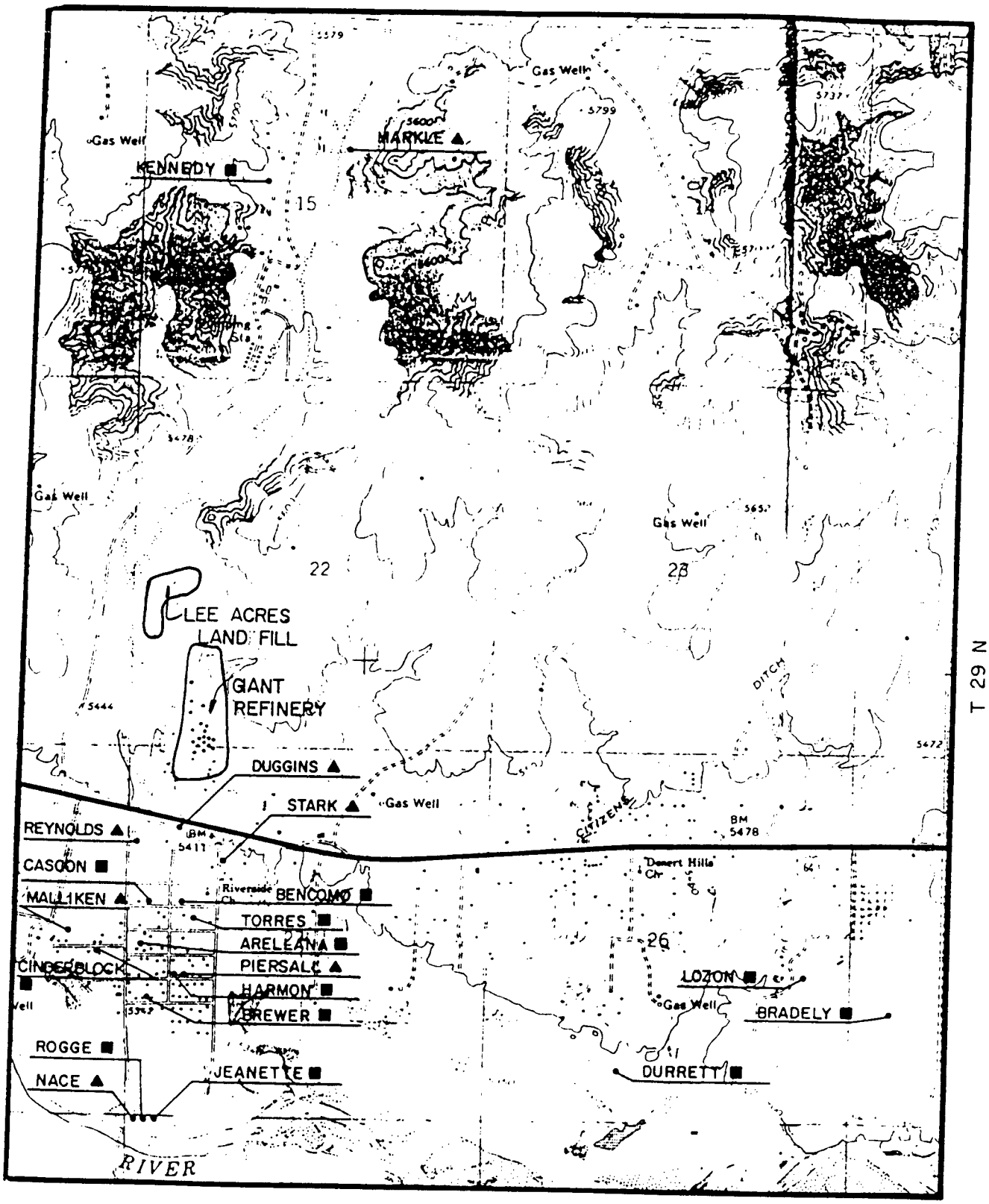
Giant Refining Company took immediate action when localized contamination was discovered on its property and is continuing to take remedial action to reduce the effects of any of its discharges. Nothing has been done, however, to remove the gross contamination emanating from the Lee Acres Landfill. Until steps are taken to do so, the remedial actions undertaken by Giant will have little effect on the quality of the local ground water. The Lee Acres Landfill plume greatly overshadows any contribution from the refinery and should, therefore, be the major focus of attention in eliminating ground water contamination in the area.

2.0 STATEMENT OF THE PROBLEM

The Giant Bloomfield Refinery (GBR) is located along hydrologic flow lines extending between the Lee Acres Landfill and the Lee Acres Subdivision, where detectable levels of chlorinated solvents have been observed in at least two domestic water wells. The Lee Acres Landfill has been identified as the most likely source of the domestic well contamination. Because the refinery lies between the landfill and the subdivision, the contamination from the landfill has affected a large portion of the refinery property.

The precise location of the GBR is NW 1/4, Section 27, and SW 1/4, Section 22, T.29 N., R.12 W. in San Juan County, New Mexico, approximately 5 miles west of the town of Bloomfield. Figure 2-1 is a location map which shows the site with the locations of the landfill, the refinery and several domestic water wells in the vicinity.

The Lee Acres Landfill has been used as a modified sanitary landfill by San Juan County and is administered by the County Department of Public Works under a lease from the owner of the property (Bureau of Land Management-Farmington Resource Area (BLM)). In addition to sanitary wastes, industrial liquid wastes from various unknown sources were also dumped into the liquid waste pits at the landfill. In April 1985, during a severe rain storm, one dike of the landfill liquid-waste pits was breached and mixed industrial/domestic wastes entered the arroyo, posing a possible threat to the San Juan River. During the same period, several releases of toxic H_2S gas from the liquid waste pits caused 15 people, including some on-site remedial workers, to experience difficulty in breathing, severe headaches, skin rashes, and other symptoms. Also during that time, the Governor called in the National Guard to secure the perimeter of the landfill. The New Mexico Environmental Improvement Division (NMEID) ordered that the landfill be closed for liquid wastes, and a private contractor was hired by NMEID to treat the pit contents with ferric chloride to control the pH and prevent further releases of H_2S gas.



■ WELL LOCATIONS FROM STATE ENGINEERS DRILL LOGS
LITHOLOGIC DESCRIPTIONS AVAILABLE

▲ WELL LOCATIONS FROM NMEID
WATER CHEMISTRY DATA AVAILABLE

WELL LOCATIONS ARE APPROXIMATE

SCALE
0 2000
FEET

NORTH

FIGURE 2-1 Location Map

Analyses of solid-phase waste samples collected from the Lee Acres Landfill by NMEID personnel and others indicated that the wastes contained elevated concentrations of highly volatile and mobile organic compounds. Some of these are toxic and/or carcinogenic, including toluene, benzene, trichloromethane, 1,1,1-trichloroethane, trichloroethylene, dichloromethane, ethylbenzene, and all three isomers of xylene. High concentrations of sulfide and strontium and trace amounts of naphthalene, phenanthrene, and 2-methyl naphthalene were also detected in the solid medium of the wastes. Compounds detected in the aqueous phase of the wastes were quite similar to those in the solid phase. The aqueous phase also contained 2,4-dimethylphenol, phenol, and 2- and 4-methylphenol. These findings indicated that the wastes in the liquid waste pits were slightly corrosive, highly volatile, slightly flammable, and potentially toxic. The chemical analyses of lagoon water samples from the landfill are shown in Appendix A.

Complaints related to odor and taste of drinking water from wells in the Lee Acres area have been registered by local residents. Residential well water samples collected downgradient from the landfill contained low but detectable concentrations of benzene, tetrachloroethene, trichloroethylene, 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethene, 1,1,1-trichloroethylene, and dichlorobromomethane. These results are included in Appendix A. The investigations that followed indicated that contamination of at least two private wells in the Lee Acres subdivision could be linked to leachate from the landfill. (Water Quality Investigations at the Lee Acres Landfill and Vicinity, San Juan County, NM; Environmental Improvement Division, Santa Fe, NM 87504.)

Because the Giant Refinery had discharged wastewater to impoundments on its premises, its potential role in the observed ground-water contamination was questioned by regulatory authorities. Surface sampling and subsurface investigations on the refinery property revealed discrete locations of both soil and ground water contamination. Steps were immediately taken to assess the extent of the contamination and to begin remedial action. The on-site investigations conducted by GCL revealed

that the Lee Acres Landfill contaminant plume is also present under the refinery property, complicating the delineation, containment and removal of contaminants.

3.0 PREVIOUS WORK

Ground water investigations have revealed two localized areas of ground water degradation due to past refinery activities and one large aerially-extensive plume associated with the Lee Acres Landfill. One area at the refinery of ground water degradation is in the southwest corner where floating product was found in three wells and a seep was found in the abandoned burn pit area. The other area of ground water degradation at the refinery is north of the truck dispatching office, where a recent (1985) line leak released an unknown quantity of diesel fuel. Monitor wells in the diesel spill area have detected free-floating product in four wells; however, other wells within 100 feet show only trace amounts of free hydrocarbons. Based upon presently available borehole data, degradation of ground water in both areas appears to be localized. Test pumping in the diesel spill area has documented a very low hydraulic conductivity of the water-bearing zone which demonstrates that any potentially degraded ground water should not migrate rapidly from its source.

To date, Giant has removed over 4500 cubic yards of contaminated soil from several isolated locations as part of its remedial action program. The soil is being stored in bermed areas which are underlain by shale bedrock and where shallow ground water does not exist. The soil has been tested and results of these chemical analyses were presented in a report submitted to NMOCD on May 23,1986. Samples of the soil which is presently being stored in the bermed area showed that concentration levels of organic compounds were below 10 mg/kg and, in most samples, organic constituent concentrations were below detection limits. Soils presently stored in the bermed area were taken from tank drain pits (see samples TD #2 and NTD Pit of the May Report), the burn pit area (GBR-1, GBR-2) and the same soil near on excavated underground tank. These sites will be employed for biodegradation of hydrocarbons in the soil by the addition of nutrients and water. The biodegradation sites are environmentally sound areas for storage and treatment due to the depth to ground water, the low permeability of the underlying shale and minimal risk of storm-water run-on or run-off in these areas. Water from ground water recovery wells may be used in the treatment process.

Chlorinated solvents associated with the Lee Acres Landfill ground water contamination plume are widespread throughout the nearby arroyo's alluvial sediments and extends well under the refinery property. The plume has been identified by the characteristic signature of contaminants (chlorinated solvents and BTEX) found in wastewater at the landfill site. These contaminants have been found in wells located south of the refinery property and between the refinery and the landfill, upgradient from the refinery.

Previous work done at the landfill site under the direction of the NMEID has included treatment of the liquid waste pits with ferric chloride to reduce hydrogen sulfide generation and closure of the site to liquid waste disposal, followed by subsequent complete closure of the landfill for disposal of any wastes.

Two reconnaissance studies have been conducted to assess the effects of the landfill contamination and to make recommendations for further action. Both of these studies, one by NMEID (Water Quality Investigations at the Lee Acres Landfill and Vicinity, San Juan County, NM; Environmental Improvement Division, Santa Fe, NM 87504, February 1986) and the other under contract by BLM (Site Investigation Report for Lee Acres Site, Farmington, San Juan Co., NM; AEPCO, Inc., under contract to BLM, Washington DC, 20240, May 1986), have resulted in useful reports which should be the basis for a comprehensive remedial action plan.

3.1 GROUND WATER INVESTIGATIONS

A total of 33 boreholes have been drilled at the GBR to characterize the general ground water regime, and to investigate the nature and extent of potential ground water contamination. Of these 33 boreholes, 27 were completed as wells. Table 3-1 lists all of the boreholes which have been drilled to date and their completion information. Two entries are shown for GBR-21 and GBR-24 because they were completed with two casings screened at different depths to permit discrete sampling of ground water below documented free product.

TABLE 3-1

DESCRIPTION OF WELLS DRILLED AT THE
GIANT BLOOMFIELD REFINERY

GBR WELL NO.	LOCATION	MATERIAL	DIAM.	DEPTH	SCREEN
1	BURN PIT	-	-	20'	NOT COMPLETED
2	BURN PIT	-	-	25'	NOT COMPLETED
3	BURN PIT	-	-	11'	NOT COMPLETED
4	BURN PIT	-	-	25'	NOT COMPLETED
5	SOUTHERN	PVC	2"	55'	32' - 52'
6	SOUTHERN	PVC	6"	65'	20' - 60'
7	SOUTHERN	PVC,SS	2"	48'	31.6'- 41.6'
8	SOUTHERN	PVC,SS	2"	58'	38' - 53'
9	SOUTHERN	PVC,SS	2"	65'	50' - 60'
10	SOUTHERN	PVC,SS	2"	45'	29' - 39'
11	SOUTHERN	GALV.	2"	55'	40' - 50'
12	SOUTHERN	-	-	42'	NOT COMPLETED
13	SOUTHERN	PVC	2"	48'	32' - 42'
14	DIESEL SPILL	PVC	6"	65'	20' - 60'
15	DIESEL SPILL	PVC,SS	2"	60'	45' - 55'
16	BURN PIT	PVC	2"	25'	REMOVED
17	ARROYO	PVC, SS	2"	68'	31' - 51'
18	NORTHERN	GALV.	2"	50'	35' - 45'
19	SOUTHERN	PVC,SS	2"	51'	31' - 46'
20	SOUTHERN	PVC	2"	48'	27' - 37'
21S	DIESEL SPILL	PVC	2"	40'	17' - 32'
21D	DIESEL SPILL	PVC	2"	41'	33' - 38'
22	DIESEL SPILL	PVC	2"	48'	32' - 42'
23	DIESEL SPILL	PVC	2"	48'	24' - 34'
24S	DIESEL SPILL	PVC	2"	41'	23' - 33'
24D	DIESEL SPILL	PVC	2"	46'	33' - 43'
25	DIESEL SPILL	PVC	2"	48'	33' - 43'
26	DIESEL SPILL	PVC	2"	42'	25' - 35'
27	DIESEL SPILL	PVC	5"	67'	22' - 62'
28	DIESEL SPILL	PVC	6"	69'	24' - 64'
29	SOUTHERN	PVC	6"	72'	25' - 65'
30	DIESEL SPILL	PVC,SS	2"	49'	25' - 40'
31	DIESEL SPILL	PVC,SS	2"	45'	24.6' - 39.6'

GALV = Galvanized Steel
SS = Stainless Steel
PVC = Polyvinyl Chloride

TABLE 3-1 (Cont.)

GBR WELL NO.	WELL ELEVATION AT BASE (IN FEET)	WELL COORDINATES (REFER TO PLATE 1) NORTH	EAST
1	-	-	-
2	-	-	-
3	-	-	-
4	-	-	-
5	5393	10248	11696
6	5394	10230	11670
7	5393	10240	11680
8	5388	10147	11495
9	5388	10150	11475
10	5388	10154	11458
11	5388	10160	11448
12	-	-	-
13	5390	10355	11465
14	5395	10980	11388
15	5394	10942	11411
16	-	-	-
17	5401	11240	11142
18	5420	12022	11528
19	5392	10478	11340
20	5392	10255	11601
21S	5398	10946	11493
21D	5398	10946	11493
22	5394	10751	11459
23	5401	11014	11563
24S	5394	11084	11447
24D	5394	11084	11447
25	5395	10854	11476
26	5394	10950	11422
27	5396	10937	11484
28	5395	10869	11419
29	5388	10135	11550
30	5396	11015	11380
31	5393	10790	11350

GBR-1 through GBR-4 were boreholes advanced in the burn pit area to define the nature and extent of the pit. These borings did not encounter ground water and were not completed as wells. They were plugged with bentonite and abandoned. GBR-16, also in the burn pit area, was completed as a 2 inch PVC monitor well but was removed during the excavation of the pit. GBR-12 was to be completed as a well but auger refusal above the water table precluded the installation of a well. GBR-27 (5 inch) and GBR-28 (6 inch) are PVC recovery wells in the diesel spill area, and GBR-6 and GBR-29 are 6" PVC recovery wells in the Southern Refinery Area. Logs of borings are included in Appendix B, and locations are shown in Plate 1.

Based upon documented past and present operations, chlorinated solvents from on-site sources would not be expected in the soil or ground water at the Bloomfield Refinery (see Montgomery and Andrews response to NMEID Administrative Order 1003). Chlorinated solvents are present in ground water along the western edge of the refinery and also have been found in one well, GBR-17 which is outside of the influence of any potential contamination from the refinery and is directly downgradient from the Lee Acres Landfill. Benzene, toluene and xylenes were detected in another monitor well, GBR-18 which is located both downgradient from the Lee Acres Landfill and upgradient from the Refinery area.

Chlorinated solvents, which are present in the ground water at the refinery and at the Lee Acres Subdivision can reasonably be assumed to have emanated from the Lee Acres Landfill because the solvents detected in the ground water in this area match the waste profile detected in the Lee Acres Landfill. Benzene, toluene and xylenes are also present in landfill wastes, in monitor wells upgradient from the refinery, downgradient from the Lee Acres Landfill and in domestic wells in the Lee Acres Subdivision.

No other wells, except those installed by Giant, have been drilled in the area of ground water degradation. Therefore, the extent of the Lee Acres Landfill plume in areas other than the refinery site is not fully known.

However, a terrain conductivity study was performed by NMEID (Water Quality Investigations at the Lee Acres Landfill and Vicinity, op. cit.) and the results were used to demonstrate a highly conductive plume, presumably contamination, extending from the landfill site (Site Investigation Report for Lee Acres Site, op. cit.). The conductivity study also revealed a conductive zone within the refinery, presumably due to the influence of a buried arroyo which now serves as a conduit for ground water flow.

3.2 PRODUCT RECOVERY INVESTIGATIONS

A pilot-scale recovery system was operated using GBR-27 as a recovery well in the diesel-spill area. The product recovery pump was designed to primarily remove the product that accumulates on top of the water. The low transmissivity of the aquifer precluded the use of a two-pump recovery system.

Analysis of data collected during the field testing of the recovery system provided information to design and install in the diesel spill area, full-scale hydrocarbon recovery system using GBR-27, GBR-28 and the recently constructed GBR-14.

A similar pilot-scale pump has been installed in GBR-29 to test the recovery of floating product in the Southern Refinery Area prior to the installation of a full-scale recovery system for that portion of the refinery. All hydrocarbons and water produced to date are being stored in above ground storage tanks.

4.0 SITE HYDROGEOLOGY

The refinery site is located on weathered outcrops of sandstone and siltstone which comprise part of the Nacimiento Formation (Cretaceous-Tertiary). Immediately to the west of the refinery lies a large unnamed arroyo which is underlain by 30 to 60 feet of Quaternary alluvial sediments. Older Quaternary terrace deposits of cobbles and boulders are also observed on the interfluvial ridges adjacent to the arroyo. These materials have been used locally as fill on the refinery site.

The San Juan River Valley is located south of the site (see Figure 2-1). This valley contains up to several hundred feet of alluvial fill. The alluvial material in the San Juan River Valley hosts the aquifer utilized for many water supply wells. In the side canyons, bedrock aquifers are typically employed for small domestic water supply wells.

The uppermost zone of ground water in the refinery area is an unconfined to partially confined water-table unit which is hosted by the weathered, locally porous sandstones and shales of the Nacimiento Formation and arroyo alluvium. These units merge hydrologically with the San Juan River alluvium to the south. Figure 4-1 is a generalized east-west cross section across the refinery site showing the relationship of the arroyo-fill to bedrock. Major hydrogeologic relationships are:

- An interconnected water-table aquifer, hosted by both valley and arroyo fill and the upper parts of the Nacimiento sandstone
- Ground water at a depth of 25 to 35 feet beneath the land surface
- An upper water-table surface generally conforming to topography; ground water slopes and flows from north to south (towards the San Juan River) in the refinery area
- Flow rates from 10 to 100 times greater in the highly transmissive alluvium than in the less permeable sandstones
- Minor, local zones of perched ground water, lying 5 to 30 feet above the water table

FIGURE 4-1

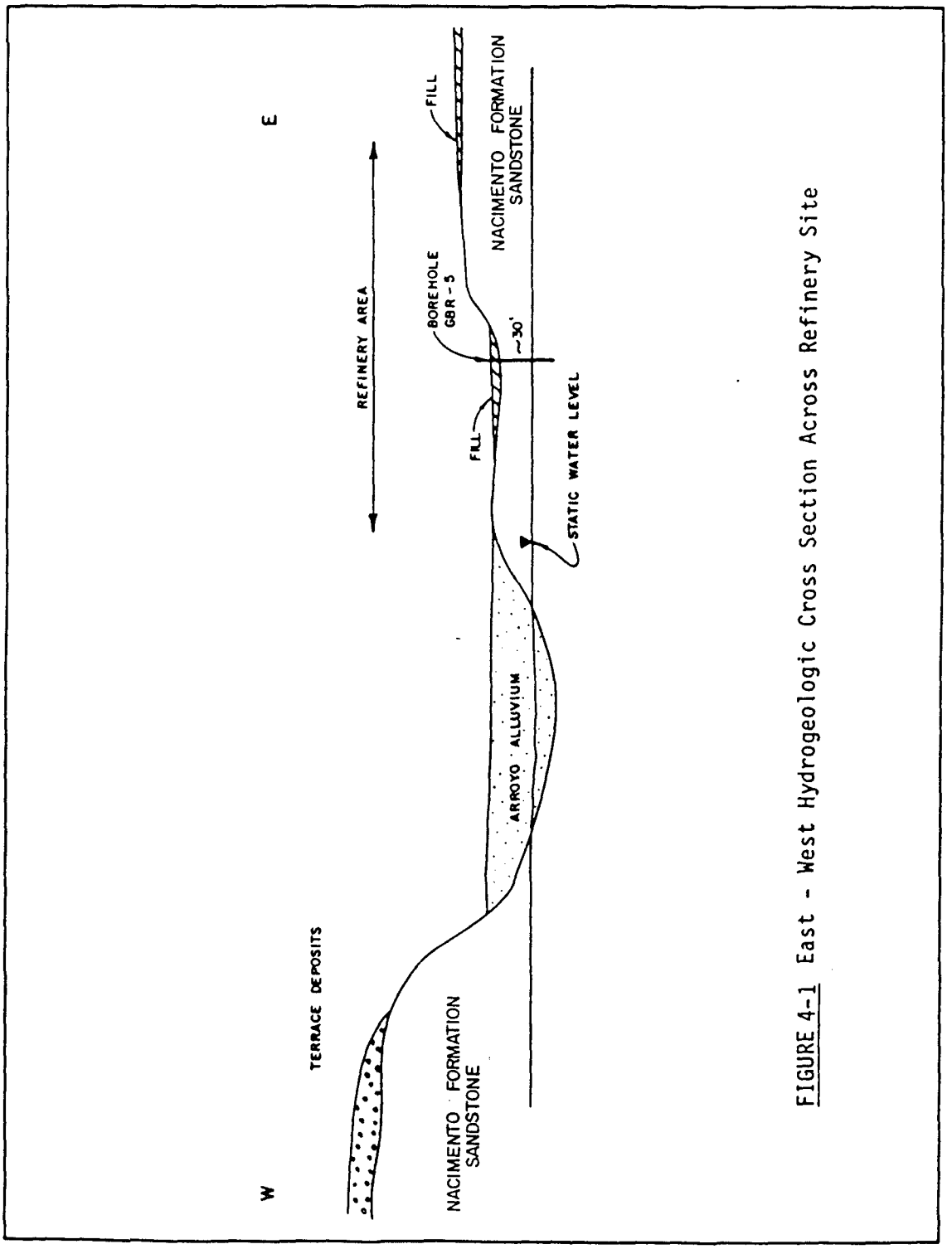


FIGURE 4-1 East - West Hydrogeologic Cross Section Across Refinery Site

Figure 2-1 shows the locations of domestic wells in relation to the refinery site, and Plate 1 shows an overall view of the site. Plate 2 presents hydrogeologic cross sections of the refinery site, and the borings used to construct them. The three specific locations of the cross sections on the refinery site are shown on Plate 3.

4.1 GROUND WATER QUALITY

Table 4-1 is a chronological record of static water levels and floating product thicknesses in all of the wells at the site, and Tables 4-2 through 4-5 summarize the results of physical and chemical analyses performed to date by GCL and NMOCD. The results of these analyses indicate an inorganic ground water chemistry of the aquifer typical of waters found in Cretaceous rocks of the San Juan Basin. Table 4-5 shows the extent of dissolved-phase contamination associated with various potential and proven sources. Chlorinated solvents detected in GBR-11, GBR-13, GBR-17, GBR-20, GBR-27, and GBR-29 indicate the presence of a plume emanating from the Lee Acres Landfill since these compounds are found in GBR-17, which is located upgradient from all refinery activities and directly downgradient from the Lee Acres Landfill. Ground water contamination on the refinery site from aromatic organic compounds including benzene, toluene, ethylbenzene and xylene (BTEX) is associated with refinery product releases, with some potential contribution from the Lee Acres Landfill (as evidenced by contamination in upgradient wells-GBR-17, GBR-18). This BTEX contamination is coincident with the location of the major product plumes in the diesel spill area (GBR-20, GBR-22, GBR-23, GBR-24, GBR-27 and GBR-28), and in the southern refinery area (GBR-5, GBR-11, GBR-13, GBR-29).

4.2 HYDROCARBON PLUME CHARACTERISTICS

Transport of spilled petroleum products in the ground occurs as a multi-phase flow, with volatile, soluble, and free-floating transport all having importance. Volatile components primarily migrate as vapor through pore spaces within the vadose zone, soluble components migrate as dissolved contaminants within ground water and the free-floating components migrate directly above the ground water. This free-floating

TABLE 4-1

CHRONOLOGY OF STATIC WATER LEVELS AND PETROLEUM PRODUCT THICKNESSES IN FEET
WELLS 5-16

DATE	WELL NO.-	GBR 5		GBR 6		GBR 7		GBR 8		GBR 9		GBR 10		GBR 11		GBR 13		GBR 14		GBR 15		GBR 16	
		W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.
4/3		-	-											5349.95	0	5354.75	0					-	-
4/15		5343.1	-											5349.91	0	5352.75	0					-	-
4/16		-	-											-	-	-	-					-	-
4/23		5341.2	0											5349.83	0	5352.68	0					5393.1	-
4/30		5342.54	0											5349.85	0	5352.79	0					5396.6	-
5/2		-	0											-	0	-	0					-	0
5/9		-	-											5349.83	-	5352.75	-					-	-
5/28		-	0											-	0	-	0					-	-
5/29		5358.21	1.375											-	0	5350.08	0					-	-
5/30		-	0.083											-	0	-	0					-	-
7/1		-	6.75											-	0	-	0					-	-
7/15		-	>4.00											5349.75	0.4	5351.77	0.56					-	-
7/31		5351.93	11.04											-	-	5350.71	0.83					-	-
8/12		5351.632	11.49											5348.66	0.17	5350.388	1.417					-	-
10/7		5362.31	1.0	5359.5	-	-	-	-	-	-	-	-	-	-	-	5351.5	0.75	5365.83	0	5364.62	0	-	-
10/8		5362.81	0.83	5359.54	0	5363	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/8 (After Pumping GBR-7)		5362.89	0.75	5358.58	0	5353.3	0							-	-	-	-			-	-		
10/9		-	-	-	-	-	-	5348.42	0	5348.5	0	5345.5	2.33	5348.87	0.75	-	-	-	-	-	-	-	-
10/9 (After Pumping GBR-31)		-	-	-	-	-	-	5348.33	0	-	-	5345.62	2.38	-	-	-	-	5365.75	0	5364.5	0	-	-
10/16		-	-	5360	-	5362.8	0	5348.38	0	5348.54	0	-	-	-	-	-	-	-	-	5357.58	0	-	-
10/17 (after purging)								5348.42	0	5347.92	0	-	-	-	-	-	-	5365.5	0	5363.46	0	-	-
11/4		5363.1	0.71	5360.17	0.04	5362.5	0	5348.46	0.04	5348.71	0	5348.17	2.04	5348.32	1.5	5351.79	0.38	-	-	-	-	-	-
11/5 (After Pumping GBR-29)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5366.46	0	5365.12	0	-	-

W.L. = WATER LEVEL
P.T. = PRODUCT THICKNESS
- = NO MEASUREMENT
0 = ZERO MEASUREMENT

TABLE 4-1 CONTINUED

CHRONOLOGY OF STATIC WATER LEVELS AND PETROLEUM PRODUCT THICKNESSES IN FEET CONT.
WELLS 17-25

DATE	WELL NO.-	GBR 17		GBR 18		GBR 19		GBR 20		GBR 21(S)		GBR 21(D)		GBR 22		GBR 23		GBR 24(S)		GBR 24(D)		GBR 25	
		W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L	P.T	W.L.	P.T.	W.L	P.T.	W.L	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.
4/3		-	-	-	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/15		-	-	-	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/16		-	-	-	-			-	-	5379.62	-	5372.92	-	5361.33	-	-	-	-	-	-	-	-	-
4/23		-	-	5407.15	-			5364.35	-	5377.7	-	5366.55	-	5361	-	5377.15	-	5370.7	-	5370.1	-	5367.65	-
4/30		-	-	5407.5	-			5354	-	5366.67	-	5370.94	-	5361.21	-	5378.5		5368.79		5368.62		5367.08	
5/2		-	-	-	0			-	0	5377.5	1.92	5370.54	0	4761.11	0	5378.71	0.01	5368.79	0.08	5368.17	0	5366.17	0
5/9		-	-	12.250	-			5354.08	-	5289.67	-	5368.42	-	5361.17	-	5379.12	-	5368.83	-	5368.33	-	5367.21	-
5/28		-	-	-	0			-	0	-	-	-	0	-	0	-	-	-	-	-	0	-	0
5/29		5367.75	0	-	0			5352.17	0	5375.29	-	5369.67	0	5357.58	0	5375.71	-	5369.54	-	5365.12	0	5365.29	0
5/30		-	0	-	0			-	0	-	1.06	-	0	-	0	-	0.01	-	0.08	-	0	-	0
7/1		-	0	-	0			-	0	-	-	-	0	-	0	-	-	-	-	-	0	-	0
7/15		5367.78	0	5407.23	0			5353.18	0	5368.83	1.04	5371.58	0	5361.07	0	5377.45	0.02	5368.07	0.008	5368.7	0	5367.55	0
7/31		5368.31	0	5411.46	0			5354.2	0	5378.12	0.8	5371.54	0	5360.96	0	5379.23	0.04	5369.57	0	5369.32	0	5367.74	0.04
												5372.248	0	5361.11	0								
8/12		5367.89	0	5410.78	0			5354.203	0	5379.04	0.417					5379.218	0.0333	5369.717	0.0333	5369.075	0	5367.805	0
10/7		-	-	-	-	-	-	-	-	5379.37	0.5	5370.71	0	5361.84	0	5379.69	0	5369.87	0.04	5369.16	0	5365.9	0
10/8						-	-					-	-	-	-	-	-	-	-	-	-	-	-
10/9		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/9																							
(After Pumping GBR-31		-	-	-	-	5355	0	-	-	-	-			5361.75	0	5379.69	0	5369.91	0.04	5369.08	0	5367.86	0
10/16		5369.06	0	5408.52	0	5355	0	5354.66	0	-	-	5363.58	0	5361.46	0	-	-	-	-	5366.62	0	5366.28	0
10/17		5369.06	0	5402.72	0	5355	0	5354.5	0	-	-	5360.79	0	5361.38	0	-	-	-	-	5368.2	0	5367.03	0
(after purging)																							
11/4		-	-	-	-	-	-	5354.87	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11/5																							
(After Pumping GBR-29)		5369.31	0	5408.56	0	5355.42	0	-	-	5379.71	0.5	5369.71	0	-	-	5379.98	0.02	5370.53	0.04	5369.58	0	5368.03	0

W.L. = WATER LEVEL
P.T. = PRODUCT THICKNESS
- = NO MEASUREMENT
0 = ZERO MEASUREMENT

TABLE 4-1 CONTINUED

CHRONOLOGY OF STATIC WATER LEVELS AND PETROLEUM PRODUCT THICKNESSES IN FEET CONT.
WELLS 26-31

DATE	WELL NO.-	GBR 26		GBR 27		GBR 28		GBR 29		GBR 30		GBR 31		STEEL WELL	
		W.L.	P.T.	W.L.	P.T.	W.L	P.T	W.L.	P.T.	W.L.	P.T.	W.L.	P.T.	W.L	P.T.
4/3		-	-	-	-	-	-	-	-					-	-
4/15		-	-	-	-	-	-	-	-					5363.17	-
4/16		-	-	-	-	-	-	-	-					5363.08	-
4/23		5362.65	-	-	-	-	-	-	-					5362.8	-
4/30		5362.92		5357.04	-	-	-	-	-					-	-
5/2		5362.85	0	5360.16	7.17	-	-	-	-					5363.12	0
5/9		5362.75	-	-	-	-	-	-	-					5362.92	-
5/28		-	0	-	8.08	-	-	-	-					-	0
5/29		5361.29	0	5357.67	8.67	5359.87	0.17	5345	0					5363.04	0
5/30		-	0	-	8.98	-	0.13	-	0					-	0
7/1		-	0	-	9.000	-	-	-	1.6					-	0
7/15		5362.62	0	-	-	5361.95	0.5	5342.85	4.5					5362.96	0
7/31		5362.93	0	5364.75 (after being pumped)	2.91	5360.59	0.58	5341.02	7.34					-	-
8/12		5362.305	0	-	-	5360.427	1.223	5341.607	6.4997					-	-
10/7		5363.72	0	5367.25	0.42	5362.18	0	5342.27	6.25	5366	0	5362.3	0	5363.71	0
10/8		-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/9		-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/9 (After Pumping GBR-31)		5363.56	0.04	5367.08	0.38	5361.47	0	-	-	5365.92	0	5362.21	0	5363.56	0
10/16		5363.35	0	-	-	5358.43	-	-	-	5365.79	0	5362	0	5362.79	0
10/17 (after purging)		5361.26	0	-	-	-	-	-	-	5365.83	0	5362	0	5363.04	0
11/4		-	-	-	-	-	-	5343.02	5.58	-	-	-	-	-	-
11/5 (After Pumping GBR-29)		5364.93	0.08	5368.08	0.29	5362.26	0.02	5345.94	2.04	5367	0.25	5362.42	0	5364.21	0

W.L. = WATER LEVEL
P.T. = PRODUCT THICKNESS
- = NO MEASUREMENT
0 = ZERO MEASUREMENT

TABLE 4-2
ORGANIC CHEMICAL ANALYSIS
GROUND WATER SOURCES
GIANT INDUSTRIES BLOOMFIELD REFINERY

PHYSICAL PARAMETERS

WELL NO.	SAMPLE NO.	ANALYTICAL LAB	pH	(uMHOS) CONDUCTIVITY	(CELSIUS) TEMP
GBR-05	8608051745	OCD	7	3700	25
GBR-11	8606051705	OCD	7	7200	25
GBR-13	8606051900	OCD	7	7800	18.5
GBR-17	8606051230	OCD	7	5500	18.5
GBR-18	8606051435	OCD	7	4100	17
GBR-20	8606051730	OCD	7	3400	21
GBR-24	8606052040	OCD	7	NA	NA
GBR-27	8606052000	OCD	7	7200	21
	& SPLIT			7200	21
GBR-29 EAST	8606051525	OCD	7		
BURN PIT SEEP	8606051905	OCD	7	1600	21.5

NA - not analyzed for this parameter

TABLE 4-3

GROUND WATER SOURCES
GIANT INDUSTRIES BLOOMFIELD REFINERY
CHEMICAL ANALYSES
INORGANIC PARAMETERS

CHEMICAL CONCENTRATIONS IN MG/L

WELL NO.	SAMPLE NO.	ANALYTICAL LAB	HCO3	Ca	Cl-	CO3	K	Mg	Na	SO4	TDS
GBR-05	8608051745	OCD	837	320	464	0	6.79	97.6	588.8	491	2865
GBR-11	8606051705	OCD	474	1030	2200	0	5.85	68	782	314	7593
GBR-13	8606051900	OCD	470	1464	3070	0	2.73	70.8	377.2	1332	10553
GBR-17	8606051230	OCD	376	712	1105	0	1.17	63.4	616.4	1202	4355
GBR-18	8606051435	OCD	122	420	262	0	6.13	29.3	432	3141	4935
GBR-20	8606051730	OCD	428	420	290	0	10.1	14.6	248.4	1776	3473
GBR-24	8606052040	OCD	NA	NA	NA	NA	NA	NA	NA	NA	NA
GBR-27	8606052000	OCD	350	1100	2816	0	1.17	141.1	526.7	1530	9023
	* SPLIT		350	1100	2816	0	1.17	141.1	526.7	1530	9023
GBR-29	8606051525	OCD	106	800	1513	0	0	63	349	1113	7538
EAST BURN PIT SEEP	8606051905	OCD	100	100	134	0	0	14.6	4.6	70	1293
SEEP	8510241435	GCL			98					9	1258

NA - not analyzed for this parameter

TABLE 4-4

GROUND WATER SOURCES
GIANT INDUSTRIES BLOOMFIELD REFINERY
METALS ANALYSIS
CHEMICAL CONCENTRATIONS IN MG/L

WELL NO.	SAMPLE NO.	ANALYTICAL LAB	Ag	Al	As	B	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	Hg	Mg	Mn	Mo	Ni	Pb	Se	Si	Sn	Sr	V	In
GBR-05	8608051745	OCD																								
GBR-11	8606051705	OCD	<0.1	<0.1	0.014	0.3	0.5	<0.1	970	<0.1	<0.1	<0.1	<0.1	6.9	<0.0005	100	7.1	<0.1	0.2	<0.1	0	7.86	<0.1	19	<0.1	7.3
GBR-11	8606051705	GCL										<0.05		<0.3						<0.05						
GBR-13	8606051900	OCD																								
GBR-17	8606051230	OCD	<0.1	<0.1	0.007	0.3	<0.1	<0.1	730	<0.1	<0.1	<0.1	<0.1	<0.1	<0.0005	60	<0.05	<0.1	<0.1	<0.1	0	5.9	<0.1	12	<0.1	<0.1
GBR-18	8606051435	OCD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GBR-20	8606051730	OCD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GBR-24	8606052040	OCD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GBR-27	8606052000	OCD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	& SPLIT		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GBR-27	8606052000	GCL										<0.05		<0.3						<0.05						
GBR-29	8606051525	OCD	<0.1	<0.1	0.008	0.4	<0.1	<0.1	814	<0.1	<0.1	<0.1	<0.1	<0.1	<0.0005	83	5.8	<0.1	<0.1	<0.1	<0.1	9	<0.1	15	<0.1	<0.1
GBR-29	8606051525	GCL										<0.05		<0.3						<0.05						
EAST BURN PIT SEEP	8606051905	OCD	<0.1																							
EAST BURN PIT SEEP	8606051905	GCL										<0.05		<0.3						<0.05						
SEEP	8510241435	GCL	<0.05		<0.05		<1.0			<0.01		<0.05	<0.01	32	<0.002		1.19			<0.05	<0.01					

NA - not analyzed for this parameter

TABLE 4-5

GROUND WATER SOURCES
GIANT INDUSTRIES BLOOMFIELD REFINERY
ORGANIC ANALYSIS

CONCENTRATIONS LISTED IN PARTS PER BILLION

WELL NO.	SAMPLE NO.	ANALYTICAL LAB	DIBROMO-METHANE	DICHLORO-METHANE	1,2-DCA	1.1-DCA	1,1-DCE	1,2-DCE	CCL4	CHCL3	PCE	PHENOLS	TCA	TCE	NAPH	1-METHYL NAPH	2-METHYL NAPH	BENZO(a) PYRENE	BENZENE	TOLUENE	PARA	XYLENES META	ORTHO	ETHYL BENZENE
GBR-05	8601231410	GCL																	830	638		2204		229
GBR-05	8605300815	GCL																	NA	NA		NA		NA
GBR-05	8608051745	OCD		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	530	200	1000	2300	300	1000
GBR-11	8604010845	GCL																	9.7	14.1		14.2		2.7
GBR-11	8605291615	GCL																	9025	3088		6981		NA
GBR-11	8606051705	OCD			140										NA	NA	NA	NA	4600	3100	250	410	71	960
GBR-13	8604151545	GCL																	42	25		99		11
GBR-13	8605091550	GCL																	129	32		105		3
GBR-13	8606051900	OCD		25	58	25		10			<10		23	<10	NA	NA	NA	NA	1300	12				130
GBR-17	8605290830	GCL																	ND	ND		ND		NA
GBR-17	8606051230	OCD		15		20		1			1		14	1	NA	NA	NA	NA	<2					
GBR-18	8605090955	GCL																	ND	ND		ND		ND
GBR-18	8606051435	OCD		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	50	11	ND	4	ND	ND
GBR-20	8605091040	GCL																	ND	ND		ND		ND
GBR-20	8606051730	OCD			20										NA	NA	NA	NA	4					<5
GBR-21	8605091700	GCL																	ND	22		234		2
GBR-22	8605091350	GCL																	ND	ND		ND		ND
GBR-23	8604181800	GCL																	1513	823		2092		NA
GBR-24	8605091625	GCL																	1154	803		1020		147
GBR-24	8606052040	OCD	<10		<10						<10			<10	NA	NA	NA	NA	680	690	290	410	190	140
GBR-25	8605091210	GCL																	ND	ND		ND		ND
GBR-26	8605091515	GCL																	ND	ND		ND		ND
GBR-27	8605181400	GCL																	ND	ND		ND		ND
GBR-27	8606052000	OCD			<50										NA	NA	NA	NA	410	120	96	240	170	ND
	+ SPLIT				6										400	1100	2400	<10	50	74	77	240	140	12
GBR-27	8510241435	GCL			(0.001	(0.001					0.4			(0.001										
GBR-28	8605291600	GCL																	2419	819		4019		NA
GBR-29	8606051525	OCD			36	30		30					<10	<10	NA	NA	NA	NA	2600	3000	700	1500	670	600
GBR-29	8606051525	GCL																	3818	3338		5210		
GBR-29	8605300945	GCL																	388	643		2000		NA
STEEL WELL	8605091140	GCL																	ND	ND		ND		ND
EAST BURN PIT SEEP	8606051905	OCD			49					50					NA	NA	NA	NA	28000	18000	2200	5500	3000	1200
EAST BURN PIT SEEP	8606051905	GCL																	15500	11900		1100		
EAST BURN PIT SEEP	8604011435	GCL																	511000	103		1518		48
EAST BURN PIT SEEP	8510241413	GCL																	5230	ND		3250		3160

NA - not analyzed for this parameter

product movement represents the primary means of transport for most of the components of a hydrocarbon spill.

Floating-product movement in a hydrocarbon spill generally occurs downward and downgradient until the material reaches the top of the ground water, where it spreads horizontally until it reaches a critical thickness determined by density, viscosity and surface tension. At this point it typically becomes immobile. The lighter fractions, however can still become dissolved in and be transported by the ground water.

The thickness of a hydrocarbon layer on ground water is usually greatly overestimated by measuring the amount of product which collects in a borehole. This results in an overestimation of the recoverable volume since free-product depth in a well can be typically four times greater than the hydrocarbon thickness in the surrounding ground water-soil matrix. This is expressed by the following equation:

$$\frac{H}{h} = \frac{P_{wo}}{P_{wa}} \times \frac{g(d_o - d_a)}{g(d_w - d_o)} = 4$$

Where: H = depth of oil in borehole

h = depth of oil in soil

P_{wa} & P_{wo} = capillary pressure difference between water and air and between water and oil

d = respective densities

It should be noted that the floating product thicknesses presented in this report are uncorrected figures and may represent 4 times the actual expected thicknesses in the surrounding ground. (Cooper, I.A. and Sprague, R.T., Gasoline Spill Ground Water Remedial technology, Conference Proceedings, Haztech International, August 11-15, 1986, Denver, p. 137.)

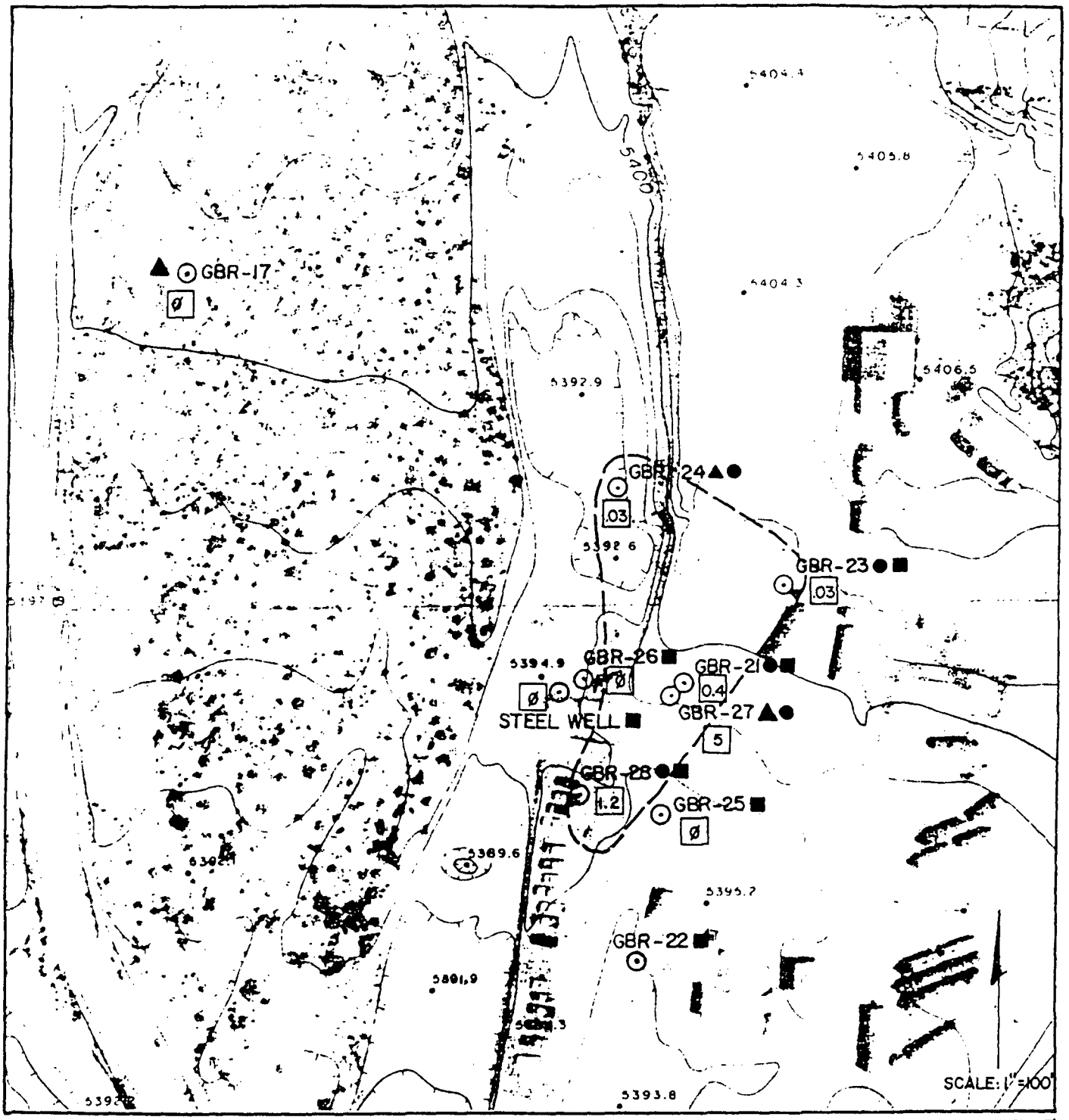
4.3 DIESEL SPILL AREA PLUME

Information from the existing wells has provided an estimate of the extent of the product and dissolved contamination plumes at the refinery site. Analysis of the data has resulted in the predicted product-plume boundary shown in Figure 4-2. This map is based on the measured floating-product thicknesses and ground water sample analyses from all the wells in the area as of August 12, 1986. Floating product was found in GBR-27 (9 feet), GBR-21 (1 feet), GBR-23 (1 inch), GBR-24 (1 inch) and GBR-28 (1 foot). These thicknesses represent about 4 times the actual undisturbed amounts in the ground (see Section 4.2). Other nearby downgradient wells (GBR-17, GBR-26 and GBR-22) have not shown any floating product, which indicates that the plume is localized.

Because of the low hydraulic conductivity of the aquifer, the dissolved-phase plume associated with the floating product probably has not migrated significantly and can be removed before becoming too extensive. Dissolved-phase products which are related to petroleum hydrocarbons (benzene, toluene, xylenes and ethylbenzene) have generally been found only in the wells which have floating product. None are found in nearby GBR-26, GBR-22 and the old "steel well". Some have been detected in GBR-25, which did not show any floating product because it is screened below the static water level. If screened at the water table, it would no doubt also contain floating product. This association indicates that the dissolved-product plume closely coincides with the floating-product plume and both can be characterized by similar methods.

4.4 SOUTHERN REFINERY AREA

The contamination plume in the Southern Refinery Area has not yet been fully defined but it may extend south of the existing ground water monitoring network. Floating product was found in GBR-5 (11 feet), GBR-29 (7 feet), GBR-11 (5 inches) and GBR-13 (1 foot), but none was found in GBR-20 which is also located in the area. These floating- product thicknesses represent about 4 times the actual undisturbed amounts in the ground (see Section 4.2).



LEGEND

- APPROXIMATE EXTENT OF PRODUCT PLUME
- ● – DISSOLVED BTEX DETECTED IN WELL
- ■ – NOT ANALYZED FOR HYDROGENATED HYDROCARBONS
- Ø – UNCORRECTED BOREHOLE PRODUCT THICKNESS (FT.) (measured 8/12/86)
- ▲ – HALOGENATED HYDROCARBONS PRESENT IN WELL

FLOATING PRODUCT THICKNESSES AND PRESENCE OF DISSOLVED PHASE PRODUCTS IN WELLS

DIESEL SPILL AREA
GIANT - BLOOMFIELD

FIGURE 4-2

Although the total extent of the plume is not yet known, it is expected that continued pumping of GBR-29 may contain the product contamination within the refinery site. Fortunately, the tightness of the formation acts to prevent the rapid spread of contamination. It was observed during the drilling of GBR-5 and GBR-29 that floating product was not apparent in the wells immediately after drilling, but accumulated over time until the present levels were reached. This indicates that the floating product is essentially trapped in the soil and moves slowly in response to disturbances.

4.5 LEE ACRES LANDFILL PLUME

An investigation of the ground water contamination caused by the Lee Acres Landfill was conducted under the direction of the Bureau of Land Management (Site Investigation Report for Lee Acres Site, op. cit., and Water Quality Investigations at the Lee Acres Landfill and Vicinity, op. cit.). This investigation found that the soils in the area are highly susceptible to contamination by the hazardous liquid and solid wastes dumped in liquid waste pits in the landfill. Some of the soils or bottom materials in the arroyo near the site may have been contaminated by uncontrolled releases of wastes from the liquid waste pits. Two domestic water wells were documented to be contaminated in the Lee Acres Subdivision located downgradient from the landfill. The shallow ground water in the subdivision was found to contain low levels of benzene, tetrachloroethene, trichloroethene or trichlorethylene, 1,1-dichloroethene, 1,2-dichloroethene, and 1,1,1-trichloroethane, most of which are also present at elevated concentrations in the surface water/liquid waste samples taken from the landfill.

A terrain electromagnetic conductivity survey, conducted by the NMEID, identified two ground water zones with high terrain conductivity anomalies. The first zone is believed to be a leachate plume originating from the liquid waste pits at the landfill. The second zone appears to be near or in the Giant Refining Company's property and is probably associated with flow of ground water along an arroyo channel which was buried during refinery construction. Both zones flow southward toward the Lee

Acres Subdivision and appear to overlap in an area approximately 1500 feet north of the Bloomfield highway (Route 64) between the arroyo and Giant Refining Company. Terrain conductivity decreased away from these two areas and resumed normal background values near the Lee Acres Subdivision, immediately south of the Bloomfield highway.

The 40 to 50 feet of unconsolidated fluvial sediments which fill the present arroyo course is a significant geologic feature which strongly influences the direction of ground water flow in the area. Based on this and on detection of landfill contaminants in certain wells, the extent of the Lee Acres Landfill plume has been estimated and is shown in Figure 4-3.

Giant Refining Company has identified the foregoing localized contamination sources on its property and is currently taking steps to reduce the effects of any contamination that may have occurred. This is complicated, however, by the continuing influx of the Lee Acres Landfill leachate plume, the removal of which must be accomplished by the responsible parties. Therefore, it is recommended that the BLM and other responsible parties undertake a remedial action to reduce all sources of contamination.

4.6 OIL AND GAS PRODUCTION ACTIVITIES

AMOCO has operated a natural gas well on the refinery property since prior to the time Giant purchased the refinery site, and it continues in operation. Prior to 1985 all produced waters at the AMOCO well site (produced water and dehydration water) were discharged to unlined pits. The produced water pit was replaced sometime in 1985 with a fiberglass tank. Quantities of produced waters that were discharged to the pits prior to lining are unknown at this time. This site remains a potential source of ground water degradation as a result of past practices. Therefore, it is recommended that further investigations be conducted to determine the contribution from this location.

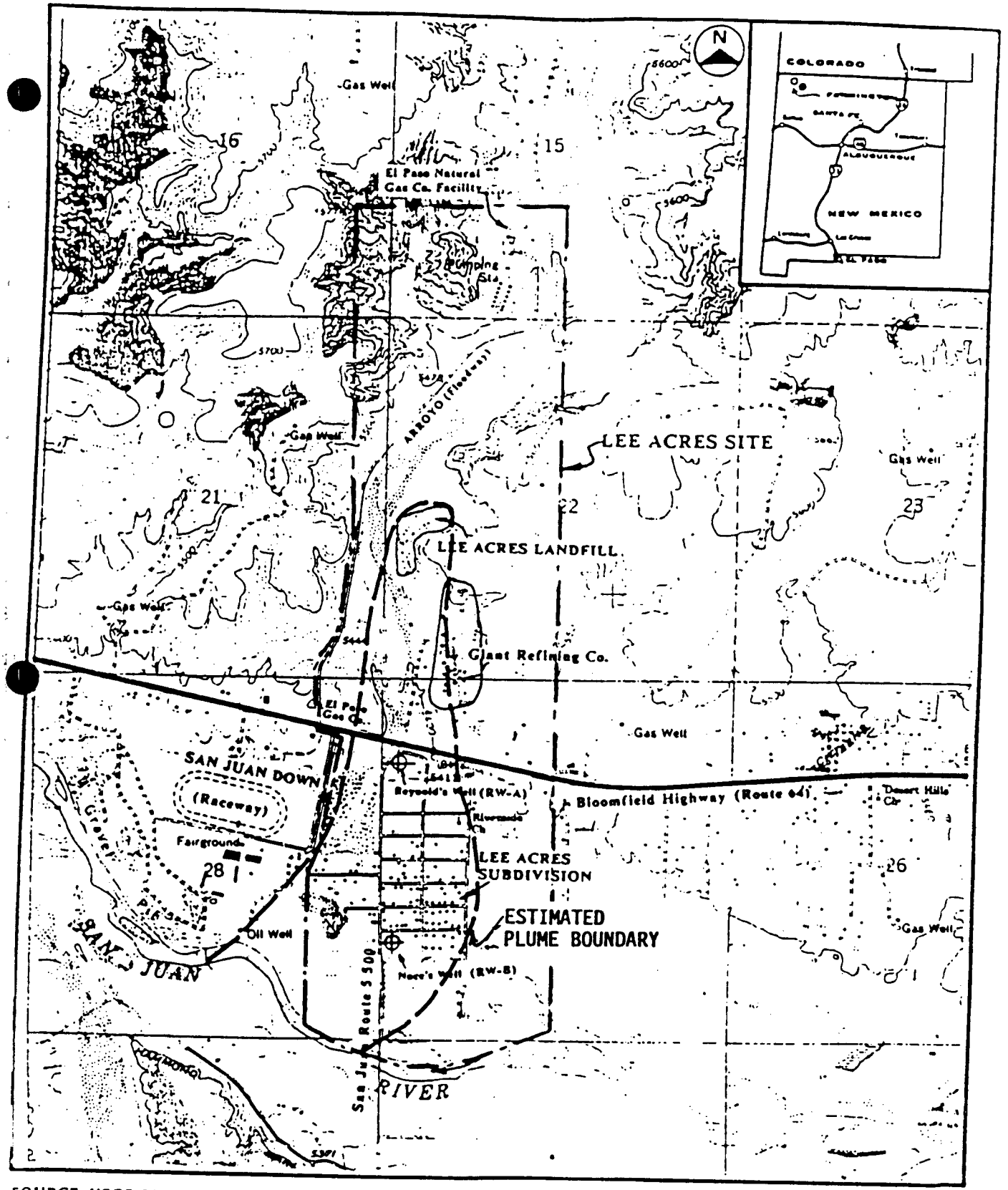


FIGURE 4-3
ESTIMATED EXTENT OF LEE ACRES
LANDFILL LEACHATE PLUME

Throughout the area of the refinery, oil and gas production operations are present. The discharge of water produced in concert with the production and transmission of gas and oil can be a potential source of ground water contamination. Prior to 1985, most of this water in the area of the GBR was discharged to unlined pits. Leakage from these pits has the potential of causing elevated levels of hydrocarbons (eg. BTEX) in ground water.

Casing leaks associated with oil and gas wells are also a possible source of dissolved phase hydrocarbon contamination. Oil and gas are generally produced under considerable pressure and a small leak in the well casing can result in significant volumes of hydrocarbons escaping into the ground water system. Improperly sealed exploratory boreholes and/or abandoned wells could also be conduits for the introduction of hydrocarbons from pressurized reservoirs into the shallow ground water system.

Therefore, it is recommended that future investigations be conducted to determine the location of oil and gas wells and exploratory borings and determine their potential contribution to ground water degradation in the region.

5.0 RESULTS OF SITE INVESTIGATION AND PRELIMINARY REMEDIAL ACTIONS

On-site remedial activities at the GBR must be accompanied by remedial activities for the overriding regional problem. Unless and until the Lee Acres Landfill plume is attenuated, the clean-up activities of Giant will have little effect on regional ground water contamination. Giant is presently removing product contamination from the ground water system. However, the volume of water which could be affected by the floating product is insignificant when compared to the total volume of water which appears to have been degraded as a result of the activities at the Lee Acres Landfill. Total removal and remediation of the floating hydrocarbon contamination at the refinery site will be of little benefit to the environment or to the residents of the Lee Acres Subdivision if ground water contaminated by chlorinated solvents, benzene, toluene and xylene is permitted to migrate from other documented sources of contamination.

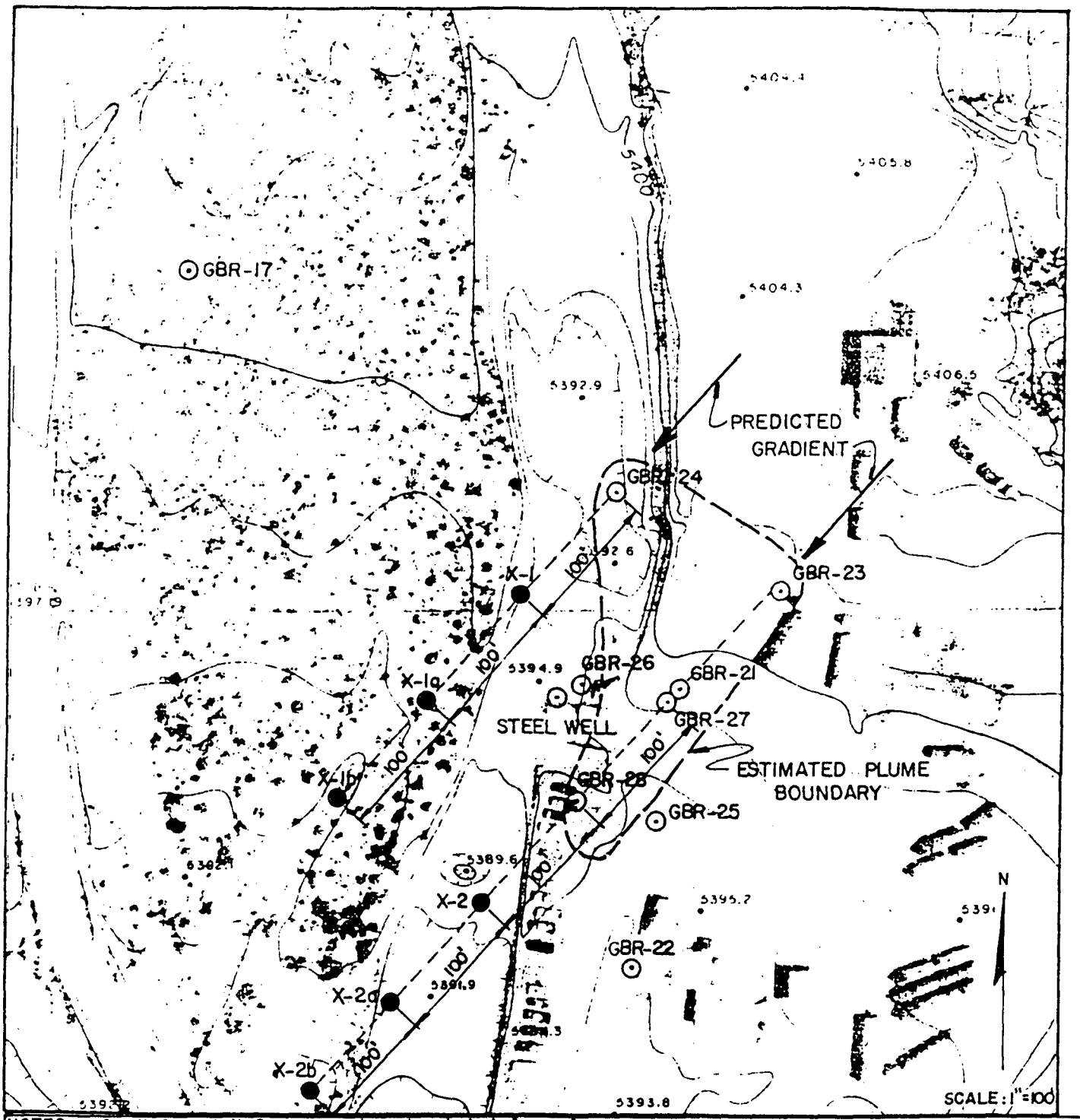
5.1 PRODUCT AND DISSOLVED CONTAMINANT PLUME DEFINITION

Giant Refining Company will continue to assess the effects of all potential contamination sources on its site according to the plan outlined below. Much of this plan has already been implemented. Several exploratory wells are completed as is the hydrocarbon recovery system in the Diesel Spill Area. The plan is presented to provide a better understanding of the activities at the GBR.

5.1.1 Diesel Spill Area Plan

Two exploratory wells have recently been drilled in the Diesel Spill Area in order to identify the actual extent of the plume, and an additional recovery well has been installed in order to cover the contamination plume. Also, a multiple piezometer has been installed in the plume to establish and monitor the water quality at selected levels.

One exploratory well (GBR-30) has been installed 100 feet southwest (downgradient) of GBR-24 and the other (GBR-31), 100 feet southwest of GBR-28 at the locations shown in Figure 5-1 as X-1 and X-2. The other proposed exploratory wells shown in Figure 5-1 are not required.



NOTES:
1. X-1 and X-2 are to be the initial exploratory wells. If product is found in X-1 then X-1a will be drilled. If product is found in X-1a then X-b will be drilled. The process will be repeated until the plume boundary is located.
2. The same procedure is to be used for Well X-2 to locate the plume boundary in that area.
3. The ground water gradient is predicted to coincide with a line connecting GBR-27 and GBR-28.

LEGEND

⊙ — EXISTING MONITORING WELLS

● — EXPLORATORY WELLS

PROPOSED EXPLORATORY WELLS

DIESEL SPILL AREA
GIANT - BLOOMFIELD

FIGURE 5-1

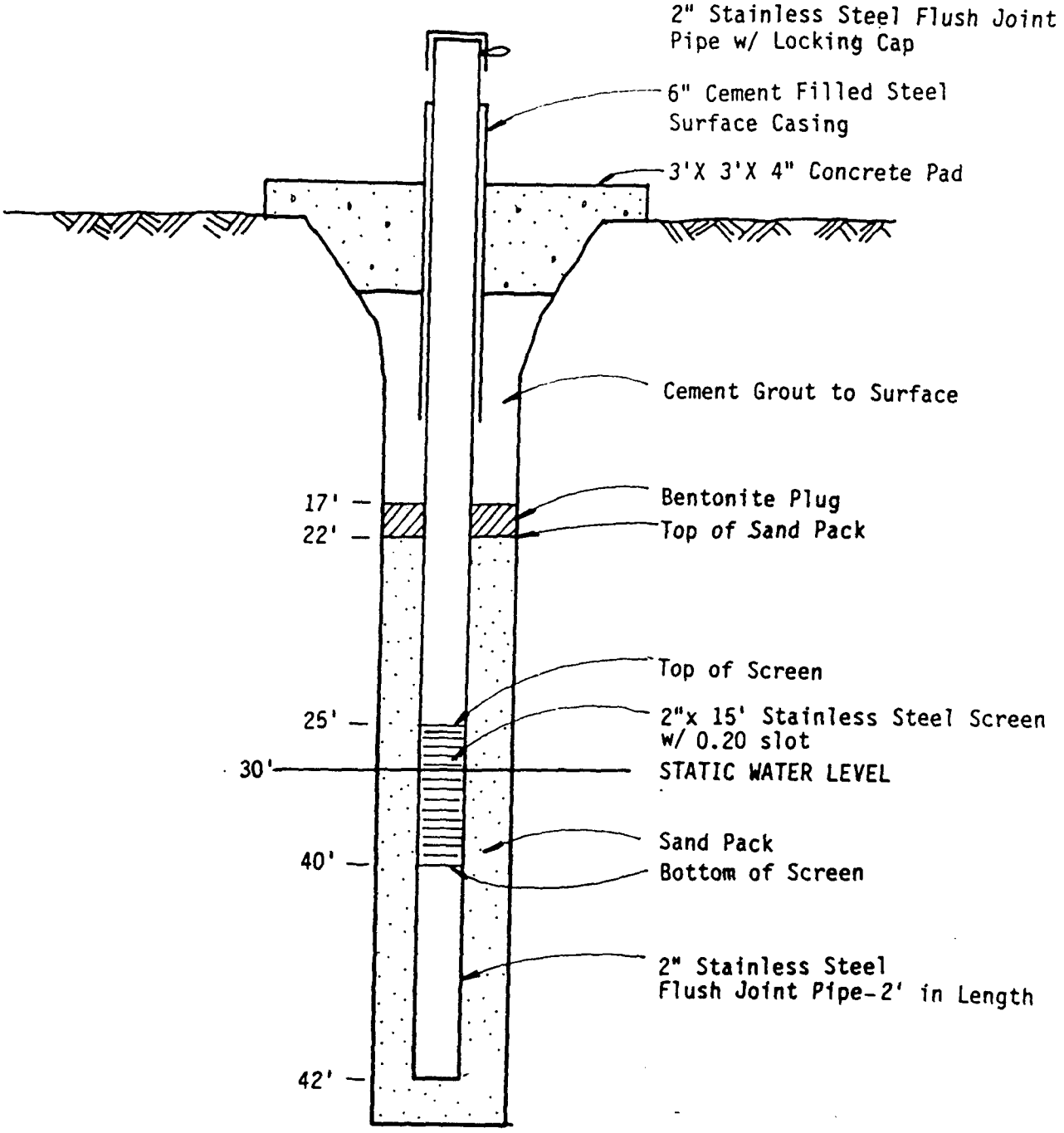
A 3-level piezometer has been installed inside the contaminated area, using two existing wells and one new well, to provide precise monitoring of ground water quality at discrete depths. The piezometer nest monitors the effects of the preliminary remedial action and will provide guidance in selecting the proper pumping level by discretely identifying contaminated zones by depth. The piezometer nest utilizes the existing "steel well" and GBR-26. A third well has been installed between these two existing wells and is constructed as a typical stainless steel monitor well as shown in Figure 5-2. The new well (GBR-15) is screened from 45 to 55 feet, GBR-26 is screened from 25 to 35 feet and the steel well is completed as a piezometer open at 40 feet.

Three recovery wells are in place, GBR-27 (5 inches), GBR-28 (6 inches) and GBR-14 (6 inches). They have been spaced so that their cones of influence intersect each other and cover the estimated down-gradient edge of the plume (Figure 5-3). These wells are constructed of 6 inch PVC casing as shown in Figure 5-4.

5.1.2 Southern Refinery Area Plan

Before a final recovery plan can be prepared for the Southern Refinery Area, more information is needed about the aquifer characteristics. A pump test similar to that which was done previously at GBR-27 has been completed in GBR-29 and is currently being analyzed. The observation wells for this pump test were GBR-8, GBR-9, GBR-10 and GBR-11 (Plate 1). The results of the pumping test will indicate the amount of water which can be pumped from a well and the cone of influence of the well.

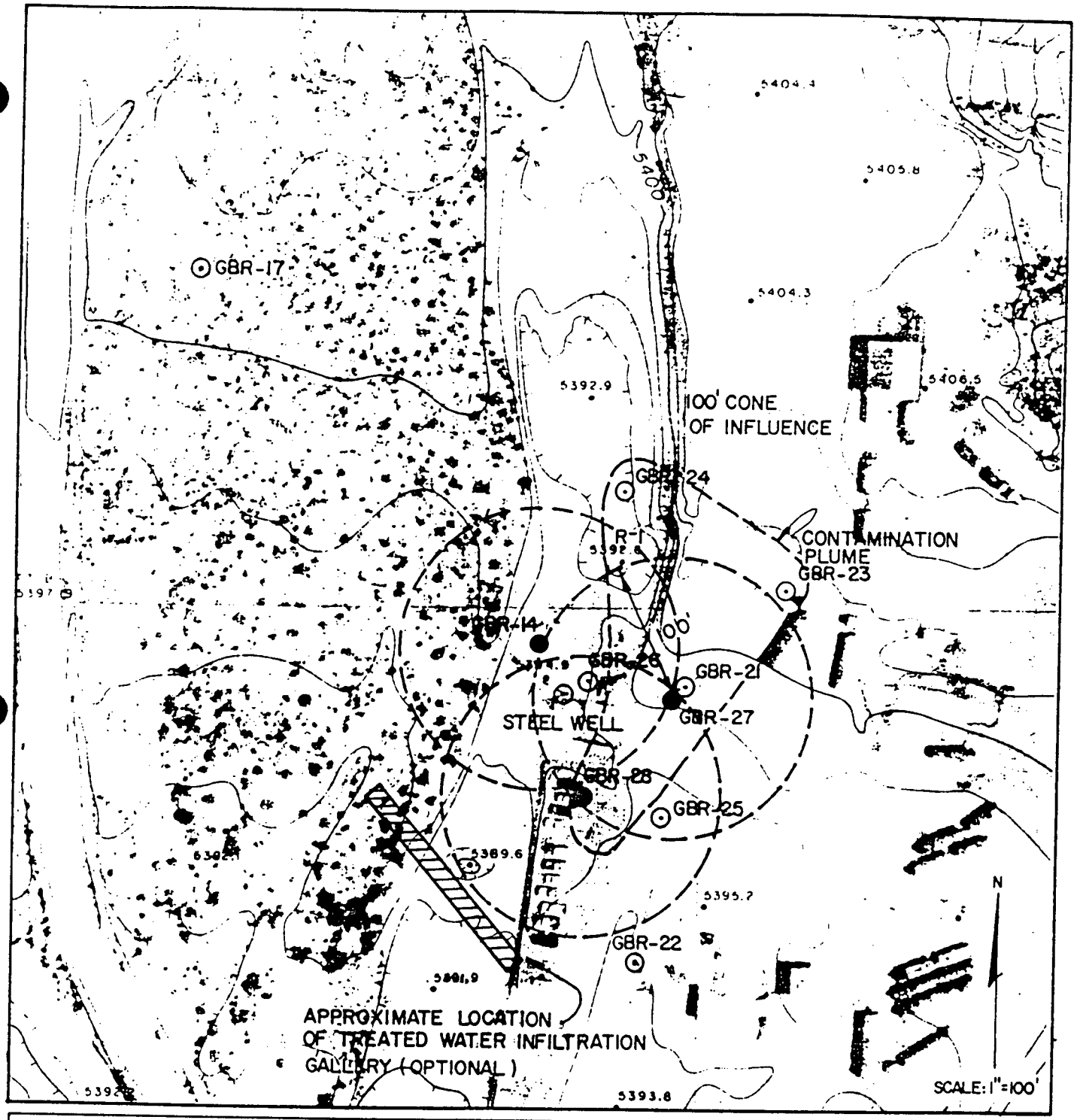
A 3-level piezometer has been installed utilizing GBR-11 as one level and 2 new adjacent 2 inch wells for the other levels (GBR-9, GBR-10). GBR-11 is screened from 40 to 50 feet, GBR-10 is screened from 29 to 30 feet and GBR-9 is screened from 50 to 60 feet. The piezometer construction is similar to that described for the diesel spill area.



NOTE: Dimensions shown are estimates. The actual values will be determined during construction. Exploratory wells are similar in construction but are made of 2" Flush Joint PVC.

TYPICAL MONITOR WELL

FIGURE 5-2



NOTES:
1. GBR-27 and GBR-28 are existing recovery wells.
2. R-1 is the estimated location of another recovery well to be drilled.
3. Additional wells may be needed if indicated by field observations.

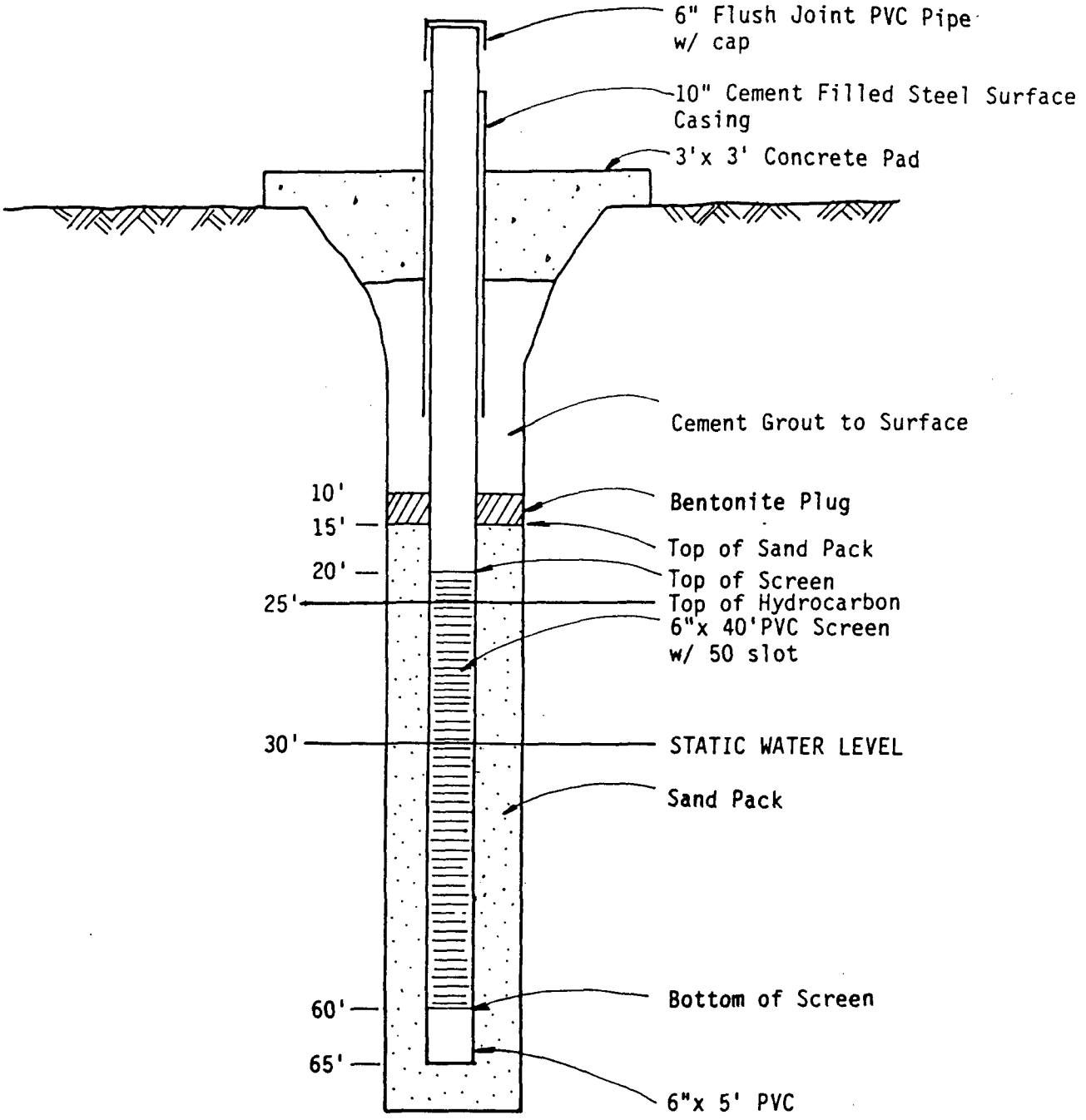
LEGEND

⊙ - MONITORING WELLS

● - EXISTING RECOVERY WELLS

PROPOSED RECOVERY WELLS
DIESEL SPILL AREA
GIANT - BLOOMFIELD

FIGURE 5-3



NOTE: The dimensions shown are estimates. The actual values will be determined during well construction.

TYPICAL RECOVERY WELL

FIGURE 5-4

An additional product recovery well (GBR-6) has already been installed near GBR-5 to facilitate floating-product recovery.

5.2 FLOATING HYDROCARBON RECOVERY AT THE REFINERY

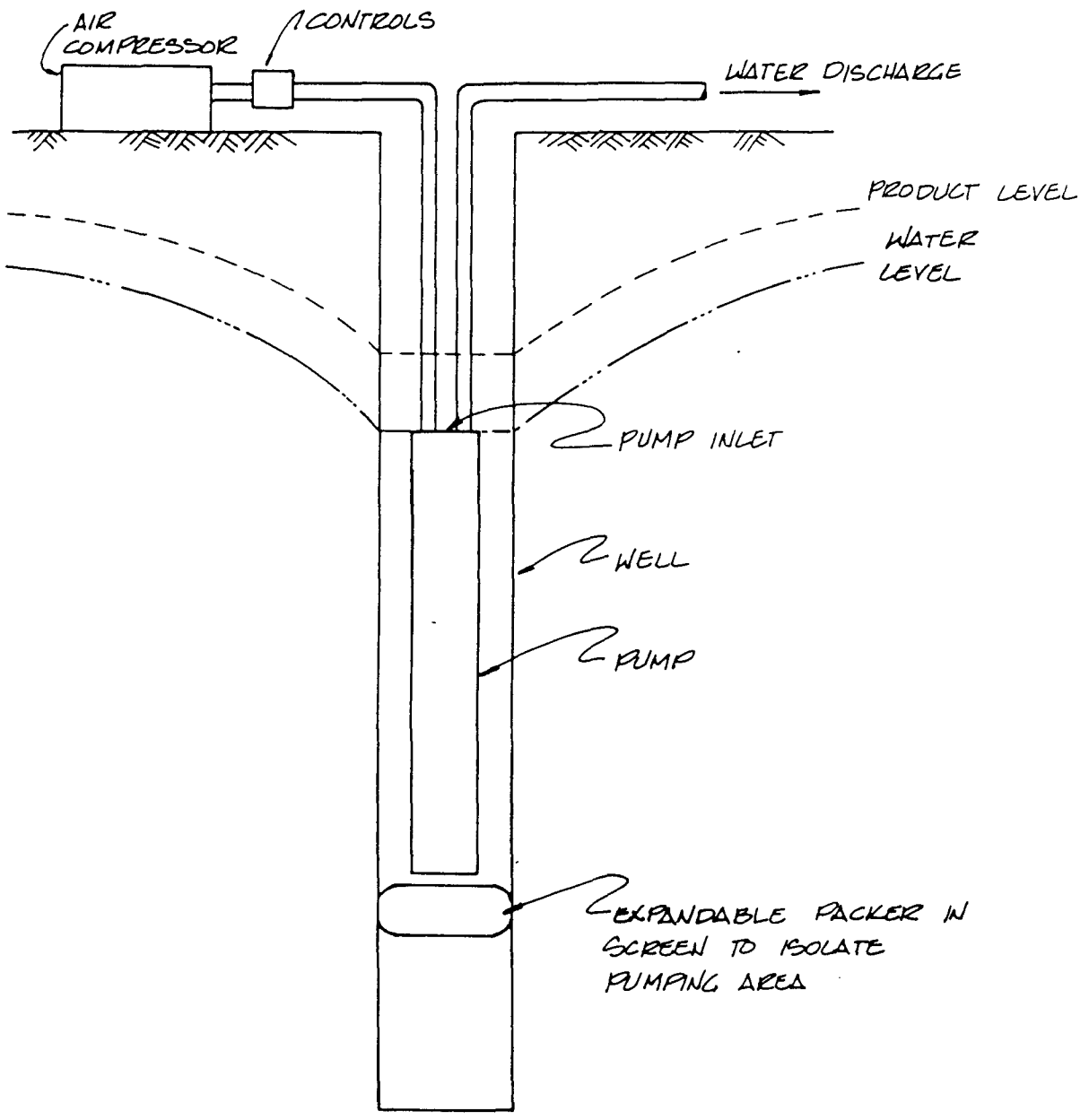
Long-term pumping of the recovery wells may be necessary in order to remove free hydrocarbons, and special equipment has been installed because of the flammable products involved and the low pumping rates which must be used. An air-lift pump specially designed for this application is utilized in each recovery well.

The pumps are top filling to assure that floating product is removed as it accumulates in the wells. The pumps are set to remove both floating product and some associated contaminated water while maintaining constant water levels at the pump inlets. A schematic diagram of a typical recovery well and pump installation is shown in Figure 5-5 and a schematic of the entire collection and treatment system is shown in Figure 5-6.

The discharge from the pumps flows into two intermediate tanks in the vicinity of the wells, one in the Diesel Spill Area and one in the Southern Refinery Area. These tanks serve the following purposes:

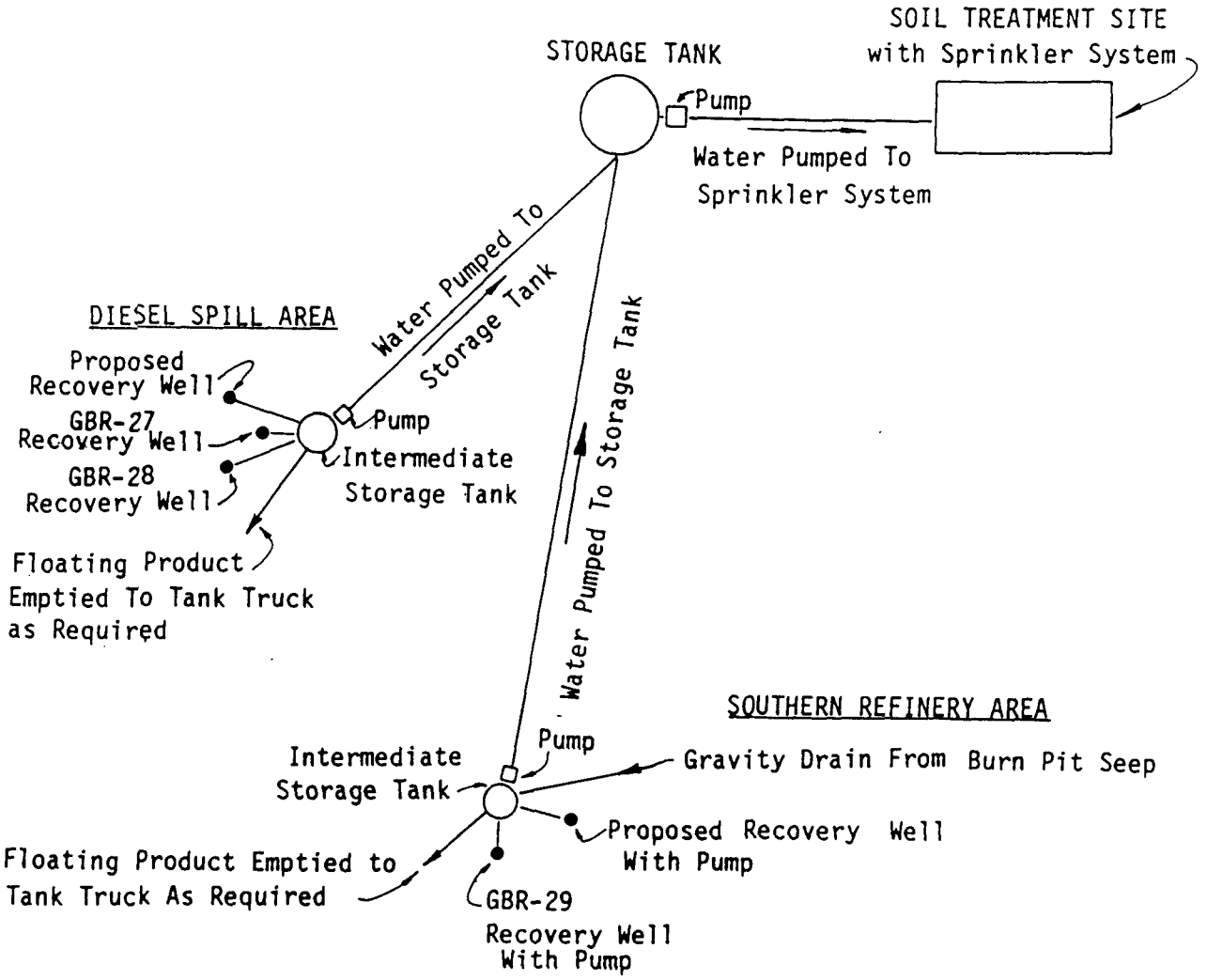
- Observation tank - the pumped fluid can be observed and sampled
- Oil separator - oil which is mixed with the water will float to the top and can be readily removed before the water is pumped to the treatment facility
- Sump - the accumulated water can be efficiently pumped to the treatment facility when a sufficient amount is collected in the tank.

A tank truck is used to transfer the settled water with the dissolved contaminants from the intermediate tanks to unused storage tanks on the site.



TYPICAL RECOVERY WELL AND PUMP INSTALLATION

FIGURE 5-5



SCHEMATIC DIAGRAM OF PROPOSED PRODUCT RECOVERY, WATER TREATMENT AND SOIL TREATMENT SYSTEM FOR THE GIANT BLOOMFIELD REFINERY

FIGURE 5-6

5.3 BURN PIT SEEP

Ground water is seeping into the excavation from which contaminated soils were removed, flowing through dark oil-stained sand and gravels from a perched zone of ground water. The bedrock under the perched zone is a clay-rich siltstone of very low permeability and ground water quality in lower stratigraphic units is not endangered by continued flow into the excavation. It is an unsightly situation, however, and removal of the seepage is desirable. This will be accomplished by installing a 4 inch perforated PVC pipe surrounded by coarse gravel in the seep area, and draining the area by gravity to the west with the drain pipe exiting near GBR-5. The drainage from the seep will be collected and stored in the tanks described above.

5.4 WATER TREATMENT AND DISPOSAL

5.4.1 Recommended Treatment and Disposal

An opportunity exists to utilize the water pumped from the recovery wells to assist in the treatment of contaminated soil. This soil has been removed from specific locations on the site as discussed in Section 3.0. The soil has already been deposited at an appropriate treatment site and samples have been taken for baseline chemical analyses. The soil will be spread into a layer approximately 1 foot thick and water added to enhance the natural biodegradation of the contaminants. The optimum amount of water will be applied to the soil through a sprinkler system fed by the storage tanks. Care will be taken not to exceed the optimum amount so that excess water will be prevented from running off or seeping into the subsurface.

Because of the high evaporation rates and the low flow rates of water pumped from the recovery wells, it should be possible to dispose of all of the water onto the soil treatment area. Studies have shown that sprinkling of water through the air with standard irrigation nozzles and subsequent evapotranspiration in the soil will effectively remove volatile organic compounds from water, and that the remainder of hydrocarbon contaminants will be biodegraded in the soil. A pilot test will

be conducted to assure that this will be accomplished under site conditions (see Cleanup of Hazardous Spill Achieves 99% Removal of Ground Water Contaminants, the Hazardous Waste Consultant, Sept./Oct. 1983, p. 6.)

A water-balance analysis shows that the average application allowed on the treatment site, based on potential evapotranspiration rates, is 17,000 gallons per day, which varies greatly according to the time of year. This will require storage of water in excess of that which will be applied to the soil during the months of November through February. This water can be subsequently discharged when evapotranspiration permits. Table 5-1 presents the Potential Evapotranspiration of the area and the Schedule for Application of Water to the Soil Treatment Site. The water will be distributed intermittently over the 3.1 acre soil treatment site through an automatic sprinkler system.

5.5 REGIONAL REMEDIAL ACTION

A regional remedial action must be implemented in order to provide any significant benefit to the environment or to the residents of the Lee Acres subdivision. Any regional remedial action must involve all of the potentially responsible parties (PRP), including but not limited to :

- The Bureau of Land Management
- San Juan County

The 4 steps outlined in the next paragraph are not intended to be a comprehensive list of work elements for a regional study. Each PRP will need to preform an investigation which is appropriate for the particular site conditions. Giant Industries is completing an investigation on the refinery property and is defining the nature of the localized degradation on-site. A regional investigation should be conducted by the PRPs who are known to have effected the regional ground water system.

TABLE 5-1

POTENTIAL EVAPOTRANSPIRATION (PET),
FARMINGTON, NEW MEXICO
AND
SCHEDULE FOR THE APPLICATION OF WATER TO
THE SOIL TREATMENT SITE

	PET/MO (CM)	PET/MO (IN)	PET IN/DAY	APPLICATION RATE (IN/MIN)	APPLICATION TIMES MIN/DAY	APPLICATION TIMES MIN/WEEK
MAR	4.1	1.6	.05	.01	5	35*
APR	23.1	9.1	.30	.01	30	210
MAY	28.5	11.2	.37	.01	37	259
JUN	38.6	15.2	.51	.01	51	357
JUL	34.0	13.4	.45	.01	45	315
AUG	30.3	11.9	.40	.01	40	280
SEP	17.9	7.1	.23	.01	23	161
OCT	12.7	5.0	.17	.01	17	119

* during the month of March, a weekly application schedule will be used

Reference: Consumptive Use and Yields of Crops in New Mexico, New Mexico Water Resources Research Institute, WRRI Report No. 115, 1979

Based upon presently available information from pumping tests, the results of chemical analyses, and observations, regional investigations should include:

1. Drilling exploratory wells to determine the full extent of dissolved contamination

2. Installation of monitor wells beyond the established contamination area

3. Installation of additional multiple piezometers inside the contamination area

4. Implementation of a remedial action to address the dissolved-phase contamination observed in the domestic water supply wells

The clean-up activities presently being conducted at the refinery are designed to contain and remove any floating hydrocarbon product which has entered the ground water system. Giant will continue these actions to remove any source of potential contamination for which it may be responsible. Any extensive remedial action which results in the pumping, treatment and monitoring of dissolved-phase ground water contamination should not be implemented if the regional contamination is not also addressed.

APPENDIX A

RESULTS OF CHEMICAL ANALYSES OF WATER AND WASTEWATER - LEE ACRES LANDFILL

APPENDIX A - Results of Chemical Analyses of

Water and Wastewater -

Lee Acres Landfill

All concentrations are mg/L except for pH units. If no entry is made for the trace elements (aluminum through zinc) then the element was not detected with the detection limit of 0.1 mg/L.

Abbreviations Used in Appendix A and in the text

CH_2Cl_2	Methylene Chloride
1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethylene
1,2-DCE	1,2-Dichloroethylene
PCE	Tetrachloroethylene
R	Reported Well Depth
1,1,1-TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene
TD	Total (Well) Depth
TDS	Total Dissolved Solids (if filtered through 0.45 um membrane) or Total Solids (if not filtered through 0.45 um membrane)
Tr	Trace (<0.001 mg/L)
VOCs	Volatile Organic Compounds

Source of Appendix A: "Water Quality Investigations at the Lee Acres Landfill and Vicinity, San Juan County, NM", Environmental Improvement Division, State of New Mexico, Santa Fe, NM, 87504

Lagoon Water		W. Side	E. Side	S. Side*
Sampling Date	1/11/85	2/27/85	2/27/85	5/2/85
Calcium	204./170.	267/230.	234./200.	224./240.
Magnesium	26.8/19.	18.7/19.	18.5/16.	36.6/25.
Sodium	1,507.	1,833.	1,263.	1790.
Potassium	885.	848.	548.	390.
Bicarbonate	--	417.	625.	476.
Sulfate	430.	1,881.	1,086.	40.2
Chloride	2,759.	3,577.	2,251.	4,474.
Phosphate	--	--	--	0.92
Nitrate-N	--	--	--	< 0.01
Ammonia-N	--	--	--	6.8
TKN	--	--	--	11.1
Aluminum	2.3	1.8	1.5	0.30
Arsenic	0.022	--	--	0.009
Barium	0.74	0.60	0.37	0.5
Beryllium	<0.10	<0.10	<0.10	<0.1
Boron	0.61	0.58	0.48	1.6
Cadmium	<0.10	<0.10	<0.10	<0.10
Chromium	0.28	0.23	0.15	<0.10
Cobalt	<0.10	<0.10	<0.10	<0.10
Copper	<0.10	<0.10	<0.10	<0.10
Iron	6.9	7.8	6.8	75.
Lead	<0.10	0.21	0.10	<0.10
Manganese	1.5	0.83	0.80	2.1
Mercury	--	--	--	--
Molybdenum	<0.10	<0.10	<0.10	<0.10
Nickel	<0.10	<0.10	<0.10	<0.10
Selenium	0.026	--	--	0.025
Silicon	1.2	2.0	2.0	14.0
Silver	<0.10	<0.10	<0.10	<0.10
Strontium	4.4	6.0	4.5	7.3
Tin	<0.10	<0.10	<0.10	<0.10
Vanadium	<0.10	<0.10	<0.10	<0.10
Yttrium	<0.10	<0.10	<0.10	<0.10
Zinc	0.29	0.24	0.54	<0.10
TDS	6,308.	7,695.	5,268.	9018.
pH	7.14	8.08	7.64	6.14
Benzene	0.44	1.03	0.89	0.120
Toluene	0.95	1.98	1.94	0.330
Ethylbenzene	0.1	0.16	0.17	0.025
Xylenes	0.71	1.21	1.34	0.205
CH_2C1_2	2.0	0.18	0.21	--
1,1,1-TCA	0.4	0.19	0.23	0.010
TCE	0.004	--	--	--
PCE	--	0.016	0.007	--
Acetone	--	--	--	--
2-Propanol	--	--	--	--

* After the addition of $FeCl_3$

Baldwin Well	TD = 50'-60'R
Sampling Date	5/2/85
Calcium	360./400.
Magnesium	46.4/47.
Sodium	311.
Potassium	55.4
Bicarbonate	148.8
Sulfate	1464.
Chloride	69.0
Nitrate-N	<0.01
Ammonia-N	0.02
TKN	0.19
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.24
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	18.
Lead	
Manganese	0.77
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	9.0
Silver	
Strontium	6.3
Tin	
Vanadium	
Yttrium	
Zinc	0.15
TDS	2345.
pH	7.11
Filtration (0.45 um)	No
VOCs	ND

Chacon Well	TD = 55'R
Sampling Date	**5/1/85**
Calcium	352./410.
Magnesium	51.4/39.
Sodium	506.0
Potassium	3.9
Bicarbonate	127.6
Sulfate	2073.
Chloride	53.2
Nitrate-N	0.04
Ammonia-N	0.15
TKN	0.31
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.32
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	26.
Lead	
Manganese	0.63
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	6.6
Silver	
Strontium	7.1
Tin	
Vanadium	
Yttrium	
Zinc	0.80
TDS	3118.
pH	6.66
Filtration (0.45 um)	No
VOCs	
1,1,1-TCA	0.001
TCE	0.001

Duggins Well

Sampling Date	4/30/85
Calcium	448./430.
Magnesium	43.9/24.
Sodium	610.
Potassium	5.46
Bicarbonate	125.2
Sulfate	2452.
Chloride	40.2
Nitrate-N	1.39
Ammonia-N	0.32
TKN	0.39
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.30
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	0.19
Lead	
Manganese	0.30
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	7.4
Silver	
Strontium	8.8
Tin	
Vanadium	
Yttrium	
Zinc	0.40
TDS	3773.
pH	7.04
Filtration (0.45 um)	No
VOCs	ND

Duncan Well	TD = 40'R
Sampling Date	4/22/85
Calcium	413./430.
Magnesium	69.3/51.
Sodium	508.
Potassium	5.46
Bicarbonate	119.0
Sulfate	2041.
Chloride	81.7
Nitrate-N	<0.01
Ammonia-N	
TKN	
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.42
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	15.
Lead	
Manganese	0.45
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	7.7
Silver	
Strontium	7.7
Tin	
Vanadium	
Yttrium	
Zinc	
TDS	3250.
pH	7.59
Filtration (0.45 um)	No
VOCs	ND

Haines "Cinderblock" Well

Sampling Date	4/30/85
Calcium	117./110.
Magnesium	22.0/24.
Sodium	273.7
Potassium	3.12
Bicarbonate	69.9
Sulfate	871.9
Chloride	20.2
Nitrate-N	0.00
Ammonia-N	0.12
TKN	0.36
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.17
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	16.
Lead	
Manganese	0.15
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	1.7
Silver	
Strontium	3.6
Tin	
Vanadium	
Yttrium	
Zinc	
TDS	1398.
pH	7.02
Filtration (0.45 um)	No
VOCs	ND

Mulliken Well

Sampling Date	4/30/85
Calcium	378./450.
Magnesium	42.5/48.
Sodium	345.
Potassium	3.12
Bicarbonate	155.7
Sulfate	1759.
Chloride	34.1
Nitrate-N	0.08
Ammonia-N	0.01
TKN	<0.1
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.26
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	0.58
Lead	
Manganese	0.43
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	12.
Silver	
Strontium	7.4
Tin	
Vanadium	
Yttrium	
Zinc	
TDS	2278.
pH	7.21
Filtration (0.45 um)	No
VOCs	ND

Nace Well	TD = 13.5'R
Sampling Date	5/1/85
Calcium	148./130.
Magnesium	14.
Sodium	101.2
Potassium	2.73
Bicarbonate	151.4
Sulfate	471.9
Chloride	13.2
Nitrate-N	<0.01
Ammonia-N	0.07
TKN	<0.1
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	<0.1
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	0.44
Lead	
Manganese	2.1
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	6.7
Silver	
Strontium	2.0
Tin	
Vanadium	
Yttrium	
Zinc	0.13
TDS	855.
pH	6.60
Filtration (0.45 um)	No
VOCs	0.001 PCE

Piersall Well

Sampling Date	4/29/85
Calcium	224./280.
Magnesium	46.4/32.
Sodium	145.
Potassium	2.73
Bicarbonate	169.
Sulfate	814.7
Chloride	37.7
Nitrate-N	<0.01
Ammonia-N	0.12
TKN	<0.1
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.18
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	1.7
Lead	
Manganese	0.90
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	10.
Silver	
Strontium	4.3
Tin	
Vanadium	
Yttrium	
Zinc	0.13
TDS	1428.
pH	6.93
Filtration (0.45 um)	No
VOCs	ND

Reynolds Well TD = 50'R

Sampling Date	4/22/85	4/26/85	10/23/85	10/24/85	10/24/85
Calcium	677.	710.		816.8/810.	762.4/810.
Magnesium	73.0	53.		120.5/61.	86.4/61.
Sodium	393.			418.6	414.0
Potassium	2.34			1.17	1.56
Bicarbonate	171.6			228.9	218.7
Sulfate	1231.			1262.	1212.
Chloride	1002.9			1221.8	1320.8
Nitrate-N	3.06			2.31	2.38
Ammonia-N				<0.10	<0.10
TKN				0.62	<0.10
Aluminum	----Not Analyzed----		----Not Analyzed----		
Arsenic					
Barium					
Beryllium					
Boron		0.19		0.2	0.2
Cadmium					
Chromium					
Cobalt					
Copper					
Iron		<0.10		0.2	<0.10
Lead					
Manganese		<0.05		<0.05	<0.05
Mercury					
Molybdenum					
Nickel					
Selenium					
Silicon		6.6		6.3	6.2
Silver					
Strontium		13.		14.	14.
Tin					
Vanadium					
Yttrium					
Zinc		1.1		0.7	0.7
TDS	4313.			4343.	4308.
pH	6.85			6.38	6.38
Filtration (0.45 um)	No	No	No	No	Yes
VOCs					
Benzene	0.008	Tr			
1,1-DCA	0.006	0.002			
1,1,1-TCA	0.022	0.02			
vinylchloride	--	--		?	
1,1-DCE	0.001	Tr	0.002		
1,2-DCE	0.001	Tr	0.011	0.01	
TCE	0.002	0.002	0.0015	Tr	
PCE	0.01	0.004	0.001	0.001	

Stark Well	TD = 55'R
Sampling Date	4/30/85
Calcium	140./180.
Magnesium	24.4/26.
Sodium	80.5
Potassium	3.9
Bicarbonate	121.4
Sulfate	441.6
Chloride	19.2
Nitrate-N	0.05
Ammonia-N	0.03
TKN	<0.1
Aluminum	
Arsenic	
Barium	
Beryllium	
Boron	0.10
Cadmium	
Chromium	
Cobalt	
Copper	
Iron	4.2
Lead	
Manganese	4.9
Mercury	
Molybdenum	
Nickel	
Selenium	
Silicon	8.2
Silver	
Strontium	2.7
Tin	
Vanadium	
Yttrium	
Zinc	0.15
TDS	828.
pH	6.69
Filtration (0.45 um)	No
VOCs	ND

APPENDIX B

MONITOR WELL LITHOLOGIC LOGS
AND COMPLETION DIAGRAMS

GBR 7-10 AND 15 WERE ORIGINALLY
PROPOSED BUT MAY NOT BE DRILLED

GBR 16 WAS REMOVED DURING
EXCAVATION OF BURN PIT

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR-1

___ ¼ NE ¼ NW ¼ NW ¼ S 27 T 29 R 12 State New Mexico

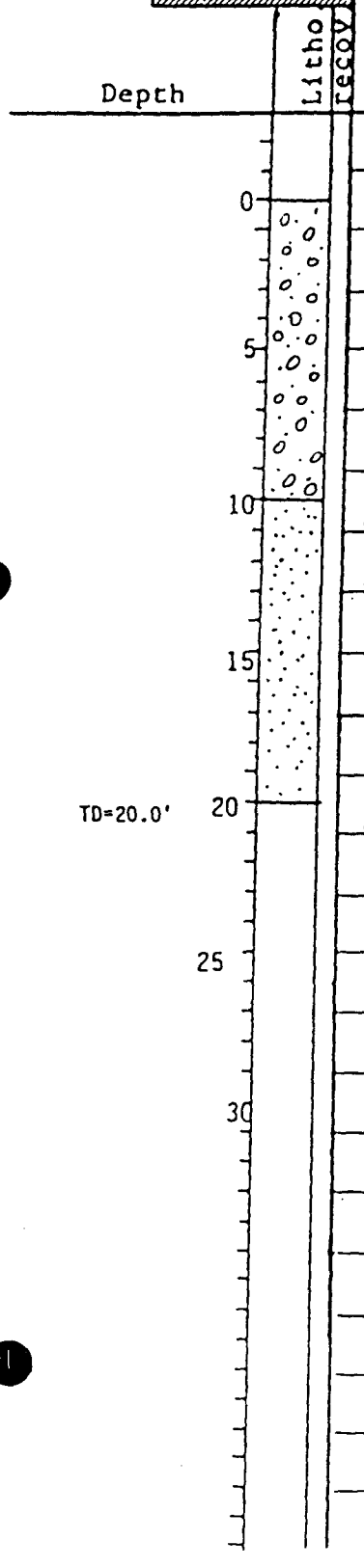
County San Juan Contractor Western Technology

Spud Date 12/20/85 Completion Date 12/20/85

Logs Run Lithology from cuttings Logged By J.C. Hunter

Elevation 5414' topo Spud In (Fm.) Fill and/or Animas Fm.

Remarks Drilled With Hollow-Stem Auger (CME-55)



Samples/Footage	Lithology/Remarks
	0.0-10.0 (10.0') FILL: very coarse cobbles and small boulders of quartzite w/sand and gravel; dark gray; dark hydrocarbon stain and odor below 2.5'; damp.
8512200850/10.0'	10.0-20.0' (20.0') SANDSTONE : yellow-gray brown; silty and poorly sorted; fine-med grained; damp' faint hydrocarbon odor 10.0-15.0'
8512200900/15.0'	dryer with no odor 15.0'-20.0'.
8512200916/20.0'	Borehole located on N side of old burn pit; 90.0' 165° to south fire hydrant' borehole backfilled w/cuttings and bentonite plug
85122000850	: 1 VOA, cuttings
8512200900	: 1 VOA, 1 Whirlpack, split spoon
8512200916	: 1 VOA, 1 Whirlpack, split spoon

Geoscience Consultants, Ltd

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR-2

____ ¼ NE ¼ NW ¼ NW ¼ S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technology

Spud Date 12/20/85 Completion Date 12/20/85

Logs Run Lithology from cuttings Logged By J.C. Hunter

Elevation 5414' topo Spud In (Fm.) Fill and/or Animas Fm.

Remarks Drilled with Hollow-Stem Auger (CME_55)

Depth	Litho	Recov.	Samples/Footage	Lithology/Remarks
0				0.0'-15.0' (15.0') FILL: very coarse cobbles and small boulders of quartyite w/sand and gravel; faint hydrocarbon odor 5.0'-10.0'; strong hydrocarbon odor 10.0'-15.0'; free water level encountered @ 10.0'; Hydrocarbon stains 5.0'-15.0'.
5				
10			8512201046/12.5'	
15				15.0'-25.0' (10.0') SANDSTONE : grades from medium gray (15.0 17.5') to yellow gray (17.5'-25.0'); strong hydrocarbon odor and some stains 15.0'-17.5'; faint odor and no stain 17.5'-25.0'; sand is fine-med grained, poorly sorted, silty; wet to 25.0'.
20				
TD=25.0 ' 25				
30				Borehole located in center of old burn pit; 73.0', 148° to south hydrant; borehole backfilled with cuttings and bentonite plug @ bottom and @ top of water.
				8512201046 : 1 VOA, 1 whirlpack, cuttings

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR-3

___ ¼ NE ¼ NW ¼ NW ¼ S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technolgy

Spud Date 12/20/85 Completion Date 12/20/85

Logs Run Lithology from cuttings Logged By J.C. Hunter

Elevation 5414' topo Spud In (Fm.) Fill and/or Animas Fm.

Remarks Drilled with Hollow- Stem Auger (CME-55)

Depth	Litho	Recov	Samples/footage	Lithology/remarks
0				0.0'-5.0' (5.0') FILL: very coarse cobbles and small boulder of quartyite; some sand and gravel; gray-gray brown; dry; faint hydrocarbon odor.
5				5.0'-7.5' (2.5') SANDY FILL: sand & gravel with some cobbles and boulders; browish gray; damp; faint hydrocarbon odor.
10				7.5'-12.5' (5.0') SANDSTONE: yellow-brown; fine grained; poorly sorted and silty; damp; very faint hydrocarbon odor; no stain.
TD=12.5' (Refused auger)				
15				Borehole located 51.0', 136° to south hydrant; backfilled w/ cuttings and bentonite plug @ bottom. Probably at or near south edge of burn pit.
20				
25				
30				

Geoscience Consultants, Ltd

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR-4

___ ¼ NE ¼ NW ¼ NW ¼ S 27 T 29 R 12 State New Mexico

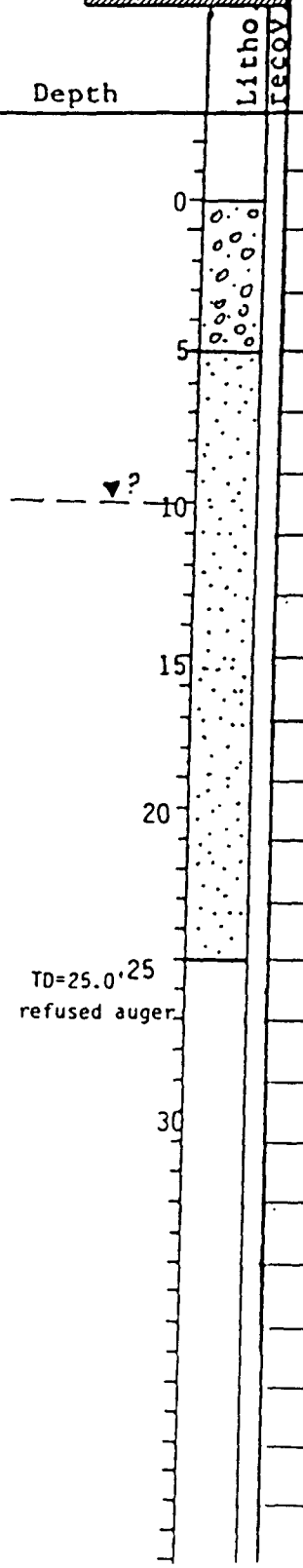
County San Juan Contractor Western Technology

Spud Date 12/20/85 Completion Date 12/20/85

Logs Run Lithology from cuttings Logged By J C Hunter

Elevation 5414' topo Spud In (Fm.) Fill and/or Animas Fm.

Remarks Drilled with Hollow-Stem Auger (CME-55)



Samples/footage	Lithology/remarks
	0.0'-5.0' (5.0') FILL: Very coarse cobbles and small boulde brown-gray; dry, faint hydrocarbon odor; no stain.
	5.0'-25.0' (20.0') SAND and STONE : gray-brown; soft and loose 5.0'-13.0', becomes harder and cosolidated 13.0'-25.0'; damp fron 5.0'-10.0'; saturated 10.0'-25.0'; hydrocarbon odor and some stain 5.0' - 25.0'; water level poorly defined, about 10.0'.
	Located 97.0', 138° to south hydrant; backfilled with cuttings and bentonite plug @ bottom.

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR-5

____ ¼ ____ ¼ ____ ¼ ____ ¼ S____ T____ R____ State New Mexico

County San Juan Contractor Western Technology

Spud Date 12/20/85 Completion Date 12/20/85

Logs Run Lithology from cuttings Logged By J.C. Hunter

Elevation 5390'topo Spud In (Fm.) Fill and/or Animas Fm.

Remarks Drilled with Hollow-Stem Auger (CME-55)

Depth	Litho	recov	Samples/footage	Lithology/remarks
0				0.0'-5.0' (5.0') FILL: Very coarse cobbles and small boulders of quartyite; minor sand and gravel; dark gray with strong oily hydrocarbon stain and odor, dry-moist.
10				
20			8512201240/20.0'	5.0'-55.0' (50') SANDSTONE: dark gray-yellow gray; fine grained; poorly sorted; silty; strong hydrocarbon stain and odor 5.0'-25.0'; faint stain and some odor 25.5'- 55.0' ; water level at approximately 33.0', odor persists in saturated sand to total depth.
30				
5/30/86 33'				
40				
50			8512201410/55.0'	
TD=55.0' refused auger				Borehole covered and left open for later ground water sampling. Located below SW corner of south pad.
60				8512201240 : 1VOA, 1 whirlpack, cuttings
				8512201410 : 1VOA, 1 whirlpack, cuttings
				TD 53'6" TOC, screened from 31'6" to 51'6"
				gravel to 26'8", 50 lb. Bentonite @ 26'8"
				Backfill to surface

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Page _____ of _____

Client Montgomery & Andrews Well Number GBR-6

___ ¼ ___ ¼ ___ ¼ ___ ¼ S 27 T 29 R 12 State New Mexico

County San Juan Contractor Beeman Bros. Drilling Co.

Spud Date 9-9-86 Completion Date 9-9-86

Logs Run ~~Lith from cuttings~~ Logged By Martin

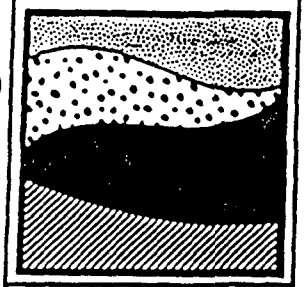
Elevation _____ Spud In (Fm.) _____

Remarks Drilled With Air Rotary

Depth	Litho	recov	
0'			0' - Very course cobbles; sand and gravel; dark brown with hydrocarbon smell.
10'			10' - Course sand and gravel with some cobbles; dark brown with hydrocarbon smell.
20'			20' - Fine sand; well sorted; medium brown with hydrocarbon smell.
30'			30' - Fine sand; well sorted; dark brown-black; strong hydrocarbon smell.
			35' - Sandstone; mixed gray-green/yellow-brown with hydrocarbon smell.
40'			40' - Sandstone; course grained well sorted; yellow-brown; faint hydorcarbon smell.
			45' - Sandstone; course grained poorly sorted; yellow-brown with some clay.
50'			50' - Fine grained poorly sorted; gray yellow/brown; water present
			55' - Shale; fine grained poorly sorted; gray
60'			60' - Shale; medium grained poorly sorted w/some gravel; dark gray
65'			65' - Shale; course grained poorly sorted; dark brown

TD of 65'4" from surface, screened from 60'4" to 20'4" gravel to 12', bentonite to 6'5", cement grout w/5% bentonite to surface. Completed as 6" pvc reconvery well with identical casing of 1" pvc attached to outside.

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 7

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date Completion Date 9-24-86

Logs Run Lithology Logged By Martin

Elevation Spud In (Fm.)

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
						0-5'	COBBLES AND SAND, 1/8"-5" in diam w/minor sand; fn-co gr; mod ylsh brn 10YR5/4
5						5-7.5'	SAND AND GRAVEL, dusky hlsh brn 10YR2/2; med-co gr sand
						7.5-10'	SAND AND GRAVEL, as above; at 10' hit hydrocarbon-stained sand; brnsh blck 5YR2/5
10						10-12.5'	SAND, w/1-2% small gravel; 1/2"-1" in diam; olive gry 5Y4/1; fn-co gr; hydrocarbon odor and stain
						12.5-15'	SAND, w/some gravels; 2-3% gravel, 1/4"-1 1/2" diam; sand olive gry 5Y4/1 and fn-co gr
15						15-16'	SAND, lt olive gry 5Y5/2; v fn-fn gr; slight hydrocarbon odor
						16-17'	SILTY SAND, olive gry 5Y4/1; v fn gr; hydrocarbon odor
20						17-17.5'	SAND, olive gry 5Y4/1; v fn gr hydrocarbon odor
						17.5-18.0	SAND, lt olive gry 5Y5/2; v fn gr; slight hydrocarbon odor
						18-22.5'	SAND, v fn gr w/some silt; lt olive gry 5Y5/2; slight hydrocarbon odor
25						22.5-25.0'	SAND, as above, slight hydrocarbon odor
						25-27'	GRAVEL AND SAND, hydrocarbon-stained
						27-30'	SAND, hydrocarbon-stained; grades from olive blck 5Y2/1 to blck N1; 1/4"-1/2" diam cobbles; fn fr sand
30						33-35'	SANDSTONE, weathered lt olive brn 5Y5/6; fn-med gr w/some silt; no hydrocarbon odor, no moisture
35						35-36'	CLAY, olive gry 5Y3/2; hydrocarbon odor; moist; minor sand
						36-40'	SAND AND SOME SILT, fn gr dusky yel 5Y6/4
40						40-41'	SAND, w/some silt, fn gr dk yelsh orng 10YR6/6, some gravel and quartzite at 40'
						41-43.5'	SAND, w/some silt, fn gr minor gravels, quartzite
						43.5-46'	SAND, grades from med-co gr sand to fn silty sand, dk yelsh orng
45							

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 7

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date Completion Date 9-24-86

Logs Run Lithology Logged By Martin

Elevation Spud In (Fm.)

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							46-47.5' SILTY SANDSTONE, lt gry to lt olive gry N7 to 5Y6/1
50							TD to 48' from surface, screened from 41'7.5" to 31'7.5", 6' blank on bottom, gravel pack to 24'10", bentonite plug to 19'8", cement grout w/5% bentonite to surface. Completed well with 2" PVC.
55							
60							
65							
70							
75							
80							
85							
90							

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number (P-4) GBR 8

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date Completion Date 10-1-86

Logs Run Lithology Logged By Martin

Elevation Spud In (Fm.)

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
							0-5' SILTY SAND, w/some cobbles, fn-med gr dk yelsh brn color 10YR4/2
5							5-10' SAND, med-co gr; dk yelsh brn color 10YR4/2
10							10-25' COARSE-GRAINED SAND, dk yelsh brn color 10YR4/2
15							
20							
25							25-30' CLAYEY SAND, fn-med gr; dk yelsh brn color 10YR4/2
30							30-35' SANDY CLAY, v fn-med gr, dk yelsh brn color 10YR4/2
35							35-38' SANDY CLAY, fn-med gr olive gry color 5Y4/1; strong hydrocarbon odor
40							38-38.33' SANDY CLAY, fn-med gr mixed color of mod yelsh brn 10YR5/4 and olive gry 5Y4/1; strong hydrocarbon odor 38.33-39.17' SILTY SAND, fn-med gr olive gry color 5Y4/1 strong hydrocarbon odor 39.17-39.5' SAND, co gr olive gry color 5Y4/1, strong hydrocarbon odor
45							

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number (P-4) GBR 8

___1/4___1/4___1/4___1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 10-1-86

Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							TD to 58' from surface. Screened from 53' to 38', 5'
							blank on bottom. Gravel pack to 30', bentonite plug
50							to 25', cement grout to surface. Completed with 2" PVC.
55							
60							
65							
70							
75							
80							
85							
90							

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 9

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date 9-29-86 Completion Date 9-30-86

Logs Run Lithology Logged By Martin/Kaszuba

Elevation Spud In (Fm.)

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
						0-2.5'	SAND, med-fn gr w/rare pebbles; mod yelsh brn 10YR5/4
						2.5-5'	SAND, med-fn gr w/rare pebbles; mod yelsh brn 10YR5/4
5						5-7.5'	SAND, med-fn gr w/rare pebbles; mod yelsh brn 10YR5/4
						7.5-10'	CLAYEY SAND, med-fn gr; mod yelsh brn 10YR5/4
						10-12.5'	CLAYEY SAND, co gr w/1-2% gravels; mod yelsh brn 10YR5/4
10							
						12.5-15'	CLAYEY SAND, med-fn gr; mod yelsh brn 10YR5/4
15						15-17.5'	same as above
						17.5-20'	SAND, med gr; mod yelsh brn 10YR5/4
20						20-22.5'	SAND, med gr, w/occasional pebbles; mod yelsh brn 10YR5/4
25						22.5-25'	same as above
						25-27.5'	SAND, med gr, w/occasional pebbles; mod yelsh brn 10YR5/4
						27.5-30'	SANDY CLAY, med gr sand; dk yelsh brn 10YR4/2, faint HC odor
30						30-32.5'	CLAYEY SAND, fn-med gr; dk yelsh brn 10YR4/2, faint HC odor
						32.5-40'	SANDY CLAY, fn-med gr; olive gry 5Y4/1, strong HC odor
35							
						40-45'	CLAY AND SAND, fn gr sand, dk yelsh orng 10YR6/6; clay is lt olive gry 5Y5/2
40							
						45-47.5'	SANDY CLAY/CLAYEY SAND, dusky yel 5Y6/4
45							

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 9

__1/4__1/4__1/4__1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date 9-29-86 Completion Date 9-30-86

Logs Run Lithology Logged By Martin/Kaszuba

Elevation _____ Spud In (Fm.) _____

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							47.5-52.5' SANDY CLAY, med gr sand; lt olive gry 5Y5/2
50							52.5-52.9' SILT, olive gry 5Y4/1
							52.9-57.5' SHALE, grnsh gry 5GY6/1
55							
							57.5-62.5' SILT, grnsh gry 5GY6/1
60							TD of 65' from TOC. Completed with 2" PVC/ss flush joint. Sand pack to 37', bentonite to 18 1/2' (1.5 bags) cement grout w/5% bentonite to surface. Screened from 50-60', ss up to 35', PVC from 35' to TOC.
65							
70							
75							
80							
85							
90							

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number (P-2) GBR 10

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-29-86

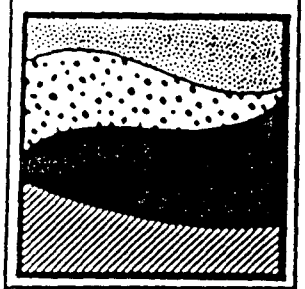
Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
							0-10' SAND, med gr poorly sorted w/some cobbles; mod yelsh brn color 10YR5/4
5							
10							10-15' SAND, co-med gr mod yelsh brn color 10YR5/4 poorly sorted
15							15-20' SAND, co-med gr poorly sorted; dk yelsh brn color 10YR4/2
20							20-30' SAND, w/5% gravel co-med gr, poorly sorted; dk yelsh brn color 10YR4/2, faint HC smell
25							
30							30-33' SANDY CLAY, fn-med gr dk yelsh brn color 10YR4/2, faint HC odor
							33-33.33' SILTY SAND, fn-med gr; olive gry color 5Y4/1 well sorted, strong HC color
35							33.33-33.75' SAND, fn-med gr well sorted; lt olive gry 5Y5/2, strong HC odor
							33.75-34.67' SILTY SAND, fn-med gr olive gry color 5Y4/1; well sorted; strong HC odor
							38-38.92' CLAYEY SAND, fn-med gr olive gry color 5Y4/1; strong HC odor
40							38.92-39' SAND, fn-med gr grysh blck color N2; strong HC odor
							39-39.67' CLAYEY SAND, fn-med gr olive gry color 5Y4/1, strong HC odor
45							39.67-39.83' CLAYEY SAND, co-med gr dusky yel color 5Y6/4; faint HC odor

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number (P-2) GBR 10

___1/4 ___1/4 ___1/4 ___1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-29-86

Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							TD to 45' from surface. Screened from 39' to 29' 5' blank on bottom. Gravel pack to 23' bentonite plug to 18.5'; cement grout to surface. Completed with 2" PVC.
50							
55							
60							
65							
70							
75							
80							
85							
90							

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR-11

¼ SW ¼ NW ¼ NW ¼ S 27 T 29N R 12W State New Mexico

County San Juan Contractor Western Technologies

Spud Date 4/1/86 Completion Date 4/1/86

Logs Run lithology from cuttings Logged By J.C. Hunter

Elevation 5388' (topo) Spud In (Fm.) Nacimiento (Tertiary)

Remarks Drilled w/HSA, completed as galv. steel piezometer (2.0") 80.7', 245 to N end of "GIANT" sign

Depth	Litho	Recov	
5'			0'-10' (10') SILTY SAND : mod. yellow-brown(10yr 5/4); fine to med grained,poorly sorted. rounded to subrounded, no stain or odor.
10			
15			10'-40' (30') SAND: med brown (5yr 4/4); med to coarse grained, med. sorted, subround to angular, no stain or odor.
20			
25			
30			25'-35': Quartzite and granite pebbles, subrounded, 1/8" -1".
35			
W.L. 39.75 4/2/86 40			40'-50' (10') SAND: Light olive gray (5y 6/1) to olive gray (5y 4/1) med grained, subangular, med sorted; distinct hydrocarbon stain and odor
46			
50			50'-55' (5') CLAYEY SAND: Dark yellow brown (10yr 4/2); med grained sand with streaks of blackish red (5r 2/2) to med gray (NG) sticky wet clay; med hydrocarbon odor.
TD@ 55 55			

Completed as 2.0" galv steel piezometer
TD=57.2 from top of pipe, stickup=2.7
Screen from 40'-50', 5' blank on bottom
Screen packed w/washed sand, bentonite plug (½sack) @30-35'

50'7"
10' 1½' H20

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 12

____ ¼ ____ ¼ ____ ¼ ____ ¼ S____ T____ R____ State New Mexico

County San Juan Contractor Western Technologies

Spud Date 4/2/86 Completion Date 4/3/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation _____ Spud In (Fm.) _____

Remarks

Auger Refused @ 42"

Depth	Litho	recov	
0			0-5' GRAVEL: ¼" -12" cobbles predominately qaurtzite . poorly sorted, subrounded to sub-angular.
5			
10			
15			5'-15' SILTY SAND: moderate yellowish brown, (10yr 5/4), fine to med grained, moderately well sorted.
20			
25			15'-25',CLAYED SILTY SAND: light olive gray, (5y6/1), fine to med. grained, moderately well sorted.
30			
35			25'-35' SILTY CLAY: dark yellowish brown, (10yr 4/2)
40			
TD=42'			No cuttings would come up hole after 35' Auger Refused at 42'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Page____ of____

Client Montgomery & Andrews Well Number GBR 13

____ ¼ ____ ¼ ____ ¼ ____ ¼ S____ T____ R____ State New Mexico

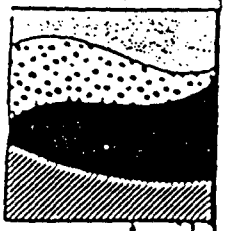
County San Juan Contractor Western Technologies

Spud Date____ Completion Date____

Logs Run Lith. from cuttings and cores Logged By J. Hunter

Elevation 5392' topo Spud In (Fm.) Nacimiento

Remarks NW corner, South parking area



Depth	Litho	Recov	
0			
5			0-20' sand: moderate yellowish brn, med to fine grained
10			
15			20-25' clayey sand: mod brown, very fine sand with stringers of yellowish gray clay
20			
25			25-30' sand: mod brown to yellowish brown, fine-med gr., poorly sorted, locally clayey
30			
35			30-35' oil-stained (?) sand: mod gray to yel gray, fine gr., faint HC odor, stain increases w/depth
37'2" ▼			
40			
45			35-48' sand/sandstone: mod yel brn to yel brn, very fine gr; poorly sorted, silty
TD=48'			
50			

Completed as 2.0" PVC piezometer, screen 32'-42'.

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Page ____ of ____

Client Montgomery & Andrews Well Number GBR-14

____ ¼ ____ ¼ ____ ¼ ____ ¼ S 27 T 29 R 12 State New Mexico

County San Juan Contractor Beeman Bros. Drilling Co.

Spud Date 9-10-86 Completion Date 9-10-86

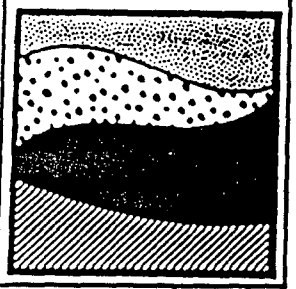
Logs Run Lith. from cuttings Logged By Martin

Elevation ____ Spud In (Fm.) ____

Remarks Drilled With Air Rotary

Depth	Litho recov	
0'		0' - Course grained poorly sorted sandy material; medium brown
10'		10' - Course grained well sorted clayey sand; mixed medium brown/dark gray-black; stained; strong hydrocarbon smell.
20'		20' - Course grained poorly sorted clayey sand; light gray brown no hydrocarbon smell.
30'		30' - Course grained well sorted clayey sand; medium to dark gray; faint hydrocarbon smell.
		35' - Poorly sorted clayey sand and gravel; medium brown
40'		40' - Poorly sorted sandy gravel; dark brown
		45' - Poorly sorted clayey sand and gravel; gray-brown
50'		50' - Poorly sorted gravel; light gray
		55' - Well sorted clayey gravel; medium gray
		60' - Well sorted course gravel; medium gray-brown
60'		65' - Poorly sorted sand and gravel; dark gray
65'		TD to 65' from surface, screened from 60' to 20', gravel pack 10'10", bentonite plug to 4'4", cement grout w/5% bentonite to surface completed as 6" pvc recovery well with identical 1" pvc casing attached to side.

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number (P-1) GBR 15

__1/4__1/4__1/4__1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-28-86

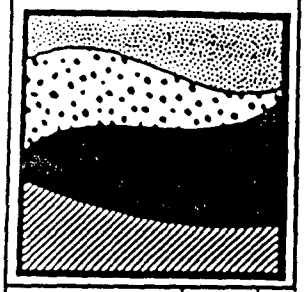
Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
							0-5' SAND, med gr; mod brn color 5YR4/4
							5-7' SAND, med gr; mod brn color 5YR4/4, HC stain
5							
							7-10' SAND, med gr; blck N1; strong HC odor and stain
							10-15' CLAYEY SAND, med gr, olive gry color 5Y4/1; HC odor
10							
							15-20' CLAYEY SAND, med gr w/2-5% gravels; olive gry color 5Y4/1, HC odor
15							
							20-25' SILTY SAND, med gr olive gry color 5Y4/1 faint HC odor
20							
25							
							30-35' SANDY CLAY, fn-med gr olive gry 5Y3/2; HC odor
30							
Bedrock and water at 36.0'							
35							35-40' CLAYEY, SILTY SAND, fn gr lt olive gry color 5Y5/2; HC odor
							40-45' CLAYEY SAND, fn-med gr; grysh olive color 10Y4/2; faint HC odor
40							
							45-60' SANDY CLAY, fn-med gr; grnsh gry color 5GY6/1; HC odor
45							

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 15

__1/4__1/4__1/4__1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-28-86

Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							TD to 60' from surface. Screened from 55' to 45', 5' blank on bottom. Gravel pack to 35', bentonite plug to 30', cement grout to surface. Completed with 2" PVC.
50							
55							
60							
65							
70							
75							
80							
85							
90							

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Page ____ of ____

Client Montgomery & Andrews Well Number GBR 16

____ ¼ ____ ¼ ____ ¼ ____ ¼ S____ T____ R____ State New Mexico

County San Juan Contractor Western Technologies

Spud Date ____ Completion Date ____

Logs Run Lith. from cuttings and cores Logged By ____

Elevation 5414 topo Spud In (Fm.) Fill

Remarks w end of burn pit

Depth	Litho	recov	
0			0-12' Fill: Gray to brn gry, very coarse boulders, cobbles and sand, local HC stain & odor
5			
10			
12.25' ▼			12-25' Sandstone: mod yel brn, fine gr, very poor sorted, subrounded, mod HC odor
15			
20			
25			Completed as 2.0" PVC piezometer, screen 10-20'.

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 17

___ ¼ ___ ¼ ___ ¼ ___ ¼ S 27 T 29 R 12 State New Mexico

County San Juan Contractor Beeman Bros. Drilling Co.

Spud Date 5/28/86 Completion Date 5/28/86

Logs Run Lith. from cuttings Logged By NICHOLAS

Elevation _____ Spud In (Fm.) _____

Remarks Drilled With Air Rotary , completed as a 2" flush joint PVC and SS Well

Depth	Litho	recov	
			0-5' (5') sand, mod yellowish brn (10YR 5/4), very fine to coarse grained sand
5			
10			5-10' (5') clayey sand, dk yellowish brn (10YR 4/2) fine to coarse grained sand
15			with clay stringers
20			10-20' (10') clayey sand, mod yellowish brn (10YR 5/4) fine to med grained sand
25			with clay stringers
30			20-45' (25') silty sand, mod yellowish brn, (10YR 5/4) fine to med grained sand
33'-6"-5-29-86			
35			grades coarser at 45'
40			45-60' (15') sand, mod yellowish brn (10yr 5/4) to lt olive grey (5Y 5/2), fine to
45			coarse grained sand with some cobbles
50			60-68' (8') silty sand, greenish grey (5GY 6/1), fine to coarse grained sand
55			w/some cobbles (1/2"-3"), 10-15%.
60			TD 68' to TOC, screened from 31'-51' ss screen, ss blanks on bottom,
65			PVC risers. Gravel packed to 28', 100 lb bag Bentonite @ 28', Backfill
			to surface

Geoscience Consultants, Ltd

WELL LOGGING FORM

Page____ of ____

Client Montgomery & Andrews Well Number GBR 18

___ ¼ ___ ¼ ___ ¼ ___ ¼ S___ T___ R___ State New Mexico

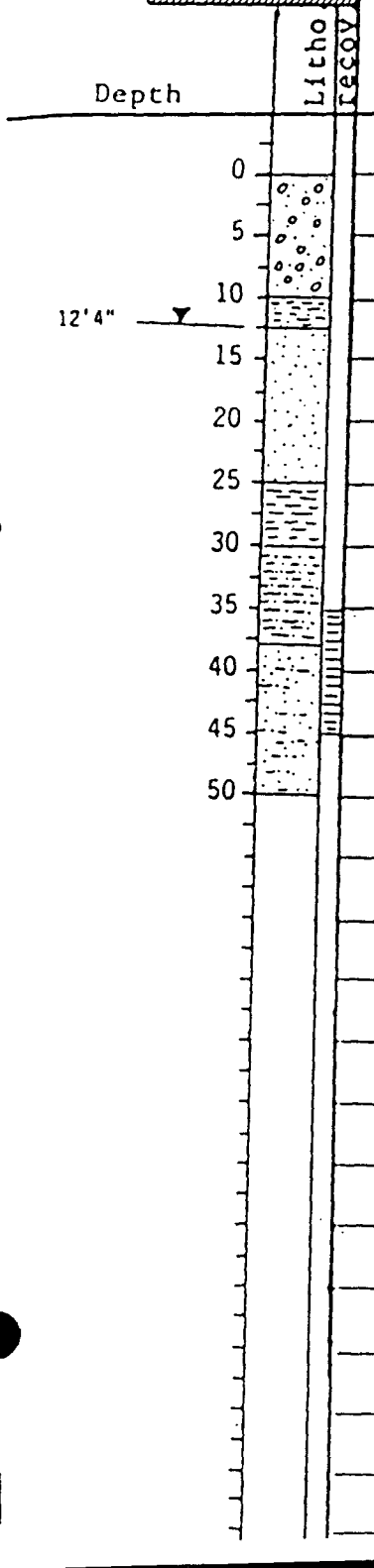
County San Juan Contractor Western Technologies

Spud Date____ Completion Date____

Logs Run Lith from cuttings and cores Logged By____

Elevation____ Spud In (Fm.)____

Remarks drilled w/ HSA



0-10' (10') fill: very coarse cobbles, some sand and gravel

10'-12.5' (2.5') sandy shale, yellowish brn

12.5-25' (12.5') sandstone: yellowish brn, med to fine grained poorly sorted

25'-30' shale: brn gry to rd brn, fissile, clayey, damp

30-38' siltstone: gry brn to brn gry; clayey, same thin, irregular sand stringers 1/4"-1/2"; moist

38-50' silty sandstone: yel brn to yel gry, very fine grained, poorly sorted, locally clayey

Completed as 2.0" galv. steel piezometer, screen 35'-45'.

GCL

WELL LOGGING FORM

Client Montgomery & Andrews Well Number (Obs W2) GBR 19

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 10-1-86

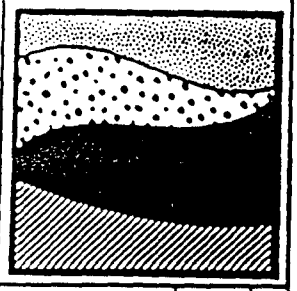
Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
							0-5' SAND, fn-med gr, mod yelsh brn color 10YR5/4
5							5-10' SAND, med-co gr; mod yelsh brn color 10YR5/4
10							10-20' CLAYEY SAND, med-co gr; mod yelsh brn color 10YR5/4
15							
20							20-25' SAND, med gr; mod yelsh brn color 10YR5/4
25							25-30' SANDY CLAY, v med-co gr; dk yelsh brn color 10YR4/2
30							30-33' CLAY, fn gr; dk yelsh brn color 10YR4/2
							33-35' SILTY SAND, fn gr lt olive gry color 5Y5/2; HC odor
35							35-35.83' SILTY SAND, fn gr dk grnsh gry color 5GY4/1
							35.83-36.17' SAND, med gr blck N1; wet w/HC strong HC odor
							36.17-36.5' SAND, med gr lt olive gry color 5Y5/2; faint HC odor
40							36.83-38' SAND, co gr mod yelsh brn color 10YR5/4; no HC odor
							38-41.33' SANDY CLAY, fn gr dk yelsh brn color 10YR4/2
							41.33-41.67' SAND, fn-med gr; dk yelsh brn color 10YR4/2
45							41.67-42.33' CLAYEY SAND, v fn-med gr w/some cobbles and gravels; dk yelsh brn color 10YR4/2

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 19

__1/4__1/4__1/4__1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 10-1-86

Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							42.92-43' SAND, co gr yelsh gry color 5Y7/2
							43-48' CLAY, fn gr; olive gry color 5Y4/1; faint HC odor
50							
							TD to 51' from surface. Screened from 46' to 31', 5' blank on bottom. Gravel pack to 25', bentonite plug to 20' cement grout to surface. Completed with 2" PVC.
55							
60							
65							
70							
75							
80							
85							
90							

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 20

NW ¼ SE ¼ NW ¼ NW ¼ S 27 T 29N R 12W State New Mexico

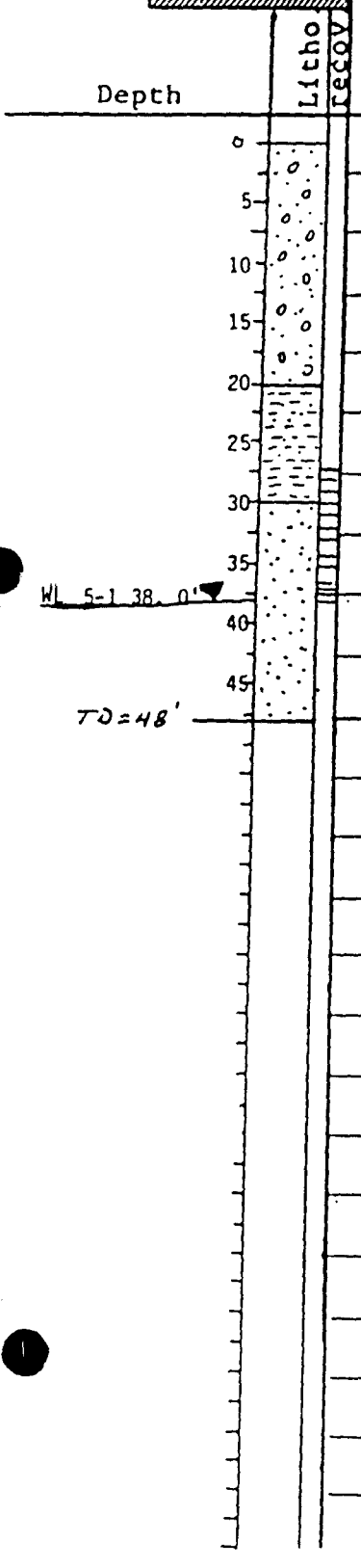
County San Juan Contractor WesternTechnologies

Spud Date 4/18/86 Completion Date 4/18/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation 5394'(topo) Spud In (Fm.) Nacimiento

Remarks Drilled with HSA, no continous sampler used.



0-20' (20') SAND & GRAVEL : Moderate yellowish brown (10yr 5/4), med to coarse grained sand with 5%-30% gravel (¼"-2"), No HC Odor.

20-30' (10') SILTY CLAY: Med light gray (N6) to med dark grey (N4), fine to med grained with some silt, hard drilling at 34', no HC ODOR.

30-48.5' (18.5') SANDSTONE: Med lt grey (N6) to med dk grey (N4), fine to med grained with some silt, hard drilling at 34', No HC odor.

Completed as 2" PVC Piezometer
Stickup 1' 10" TD 43'10" from top of casing
Screened interval 27'-37'
Sand to 25', Bentonite 2/3 Bag @ 25'
Backfill to 6', Bentonite 1/3 Bag @ 6'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 21

NE ¼ NW ¼ NW ¼ NW ¼ S 27 T 29N R 12W State New Mexico

County San Juan Contractor Western Technologies

Spud Date 4/15/86 Completion Date 4/16/86

Logs Run Lithology from cuttings Logged By B Nicholas

Elevation 5398'(topo) Spud In (Fm.) Nacimiento

Remarks Drille with HSA, completed as 2' PVC Piezometer

Depth	Litho recov	
0		0'-5' (5') SAND: Brown, fine to med grained
5		
10		5'-20' (15') SILTY SAND : Brown, med to coarse grained with minor small cobbles.
15		
18'3"		
20		
25		20'-38' (18') SANDY SHALE: Brown, fine grained, grades to yellowish brown at 25'. HC ODOR.
30		
35		
40		38'-46' (8') SANDSTONE : Med. bluish gray (5B5/1), med to coarse grained with local small cobbles (½"-1½") HC ODOR and sheen in sampler.
45		
50		
55		Dual Completion as 2" PVC Piezometer Stickup 3'3" TD 40'3" and 41'3" from top of casing Screened intervals 17-32' and 33-38' Caved in snad to 6', Bentonite (3/4 Bag) @ 6' Bentonite (½Bag)@ 2'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 22

NE ¼ NW ¼ NW ¼ NW ¼ S ___ T ___ R ___ State New Mexico

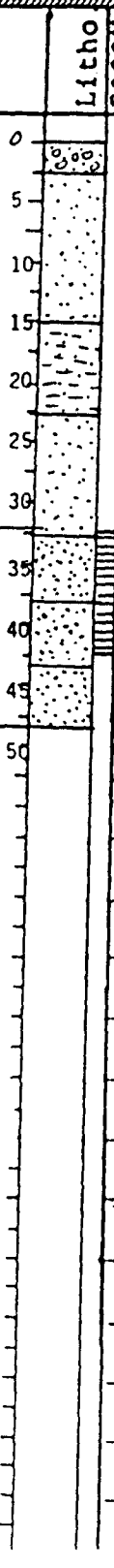
County San Juan Contractor Western Technologies

Spud Date 4/15/86 Completion Date 4/16/86

Logs Run Lithology from cuttings Logged By Hicks/Nicholas

Elevation 5394.5"(topo) Spud In (Fm.) Nacimiento

Remarks Drilled with HSA, continous sampler and spit spoon used completed as 2' PVC Piezometer



0-2.5' (2.5') SAND & GRAVEL FILL: Brown, some HC odor from surface spills

2.5'-15.0' (12.5') SAND: Mod yellowish brown (10yr5/4) (2.5'-12.5') grades to Lt. brown at 12.5'(5yr5/6), med grained, well sorted contains gravels (12/5'-15.0') HC Odor

15.0-22.5' (7.5) CLAYEY SAND: Brown, grades to dark brown at 17.5', some clay balls increasing with depth, HC odor.

22.5'-32.5' (10') SAND : Brown, fine to med grained, well sorted, clean , some clay from (22.5'-27.5'), black stained sand at 30', HC Odor.

32.5'-38.0' (5.5') SANDSTONE: Green to yellow green, consolidated grades to yellow brown at 36.5'.

38'-43' (5') No Returns.

43'-48' SANDSTONE: gray, med to coarse grained, no HC odor

Completed as 2' PVC Piezometer
Stickup 3'5" TD 49.5' from top of casing
Screen from 32'-42', 4' blank on bottom
Sand to 32', Backfill to 26', 3/4 Bag Bentonite @ 26'
Backfill to 2', 1/4 Bag Bentonite @2'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 23

SW ¼ NE ¼ NW ¼ NW ¼ S 27 T 29N R 12W State New Mexico

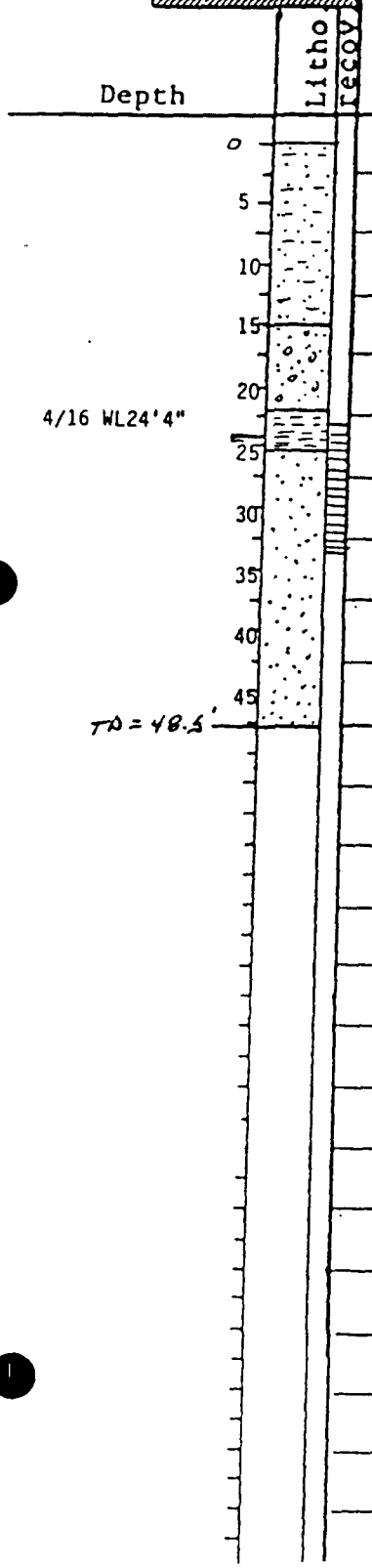
County San Juan Contractor Western Technologies

Spud Date 4/16/86 Completion Date 4/16/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation 5401'(topo) Spud In (Fm.) Nacimiento

Remarks Drilled With Hsa, continous sampler used 22'-48.5'



0-15' (15') SILTY SAND: mod yellowish brown (10yr5/4), very fine grained, with small amounts of cobbles (½"-1") , grades coarser at 10', HC Odor.

15'-22' (7') SAND & GRAVEL: Mod yellowish brown(10yr 5/4) to pale brown (5yr 5/2), med to coarse grained sand :with cobbles (¼"-3") , HC Odor

22'-26' (4') SHALE: Grayish Brown (5yr 3/2) to yellowish grey (5y7/2), localized sand lenses, some weathering in shale, no HC Odor.

26'-48.5' (22.5) SANDSTONE: Weathered, light olive gray (5y5/2) from 26-27', med lt gray (N6) to med gray (N5) , fine to med grained, slight HC odor(?) from 26'-27'.

Completed as 2" PVC Piezometer
Stickup 3' TD 41'10" from top of casing
Screen from 23'10" to 33'10" 5' Blank on Bottom
Sand to 23', 2/3 Bag Bentonite @ 23', Backfill to 5', 1/3 Bag Bentonite at5'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 24

NW ¼ NW ¼ NW ¼ NW ¼ S 27 T 29N R 12 W State New Mexico

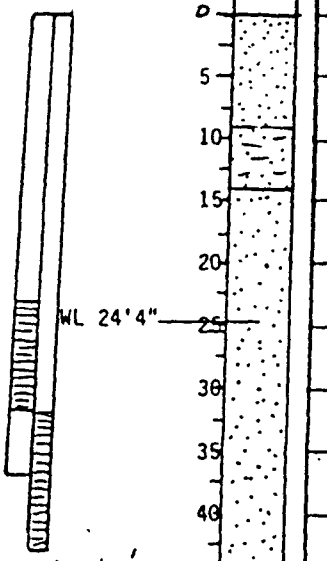
County San Juan Contractor Western Technologies

Spud Date 4/17/86 Completion Date 4/17/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation 5395'(topo) Spud In (Fm.) Nacimiento

Remarks Drilled with HSA, continous sampler used from 9'-49'



0'-9' (9') SAND : Moderate yellowish brown, (10yr5/4), med to coarse grained, No HC Odo

9'-14' (5') SILTY SANDSTONE: Moderate yellowish brown (10yr 5/4) to olive gray (5y4/1) weathered, very fine to fine grained, No HC Odor.

14'-49' (35') SANDSTONE: lt olive grey (5y 6/1), fine grained, contains minor gravels . 28' (1"-1½"), HC Odor at 29'

Dual Completion as 2' PVC Piezometer
Stickup 3'3" TD41'3" and 46'3" from top of casing
Screened intervals 23-33' and 33'-43'
Caved to 33', sand to 22', Bentonite 2/3 Bag @22', Backfill to 6', Bentonite 1/3 Bag @ 6'.

Geoscience Consultants, Ltd

WELL LOGGING FORM

Client Montgomery & Andrews Well Number CBR 25

NE ¼ NW ¼ NW ¼ NW ¼ S 27 T 29N R 12W State New Mexico

County San Juan Contractor Western Technologies

Spud Date 4/17/86 Completion Date 4/18/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation 5395'(topo) Spud In (Fm.) Nacimiento

Remarks Drilled with HSA, used continous sampler from 17'-48'

Depth	Litho	recov	
5			0'-17' (17') SAND: Mod yellowish brown (10yr5/4) , med to coarse grained with some small cobbles from 5'-17', HC Odor
10			
15			
20			17'-24' (7') SHALE: Dark yellowish brown, (10yr4/2), with pale yellowish orange stringers (10yr8/6) from 23'-24', soft . slight HC Odor
25			
WL 32' 30			24'-28' SANDSTONE: Moderate yellowish brown (10yr5/4) with streaks of dark yellowish orange (10yr 6/6), fine to med grained, weathered, NO HC odor.
35			
40			28'-48' SANDSTONE: Ranges in color from lt gray (N7), to moderate yellowish brown (10yr5/4) from 28-33', greenish gray (5G6/1) to dark yellowish orange (10yr6/6) from 33'-43', med to coarse grained, grades coarser at 38', grades to lt gray (N7) at 43',contains small cobbles from 28-43', shale stringers from 43-48', no HC odor
45 TD = 48'			

Completed as 2" PVC Piezometer
Stickup 2' 0" TD 50' to top of casing
Screened interval 33-43', caved to 35', sand to 23'
Bentonite 2/3 Bag @ 23', Backfill to 6'
Bentonite 1/3 Bag at 6'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 26

NE ¼ NW ¼ NW ¼ NW ¼ S 27 T 29N R 12 W State New Mexico

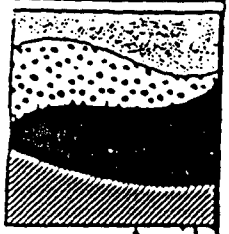
County San Juan Contractor PSI Western Technologies

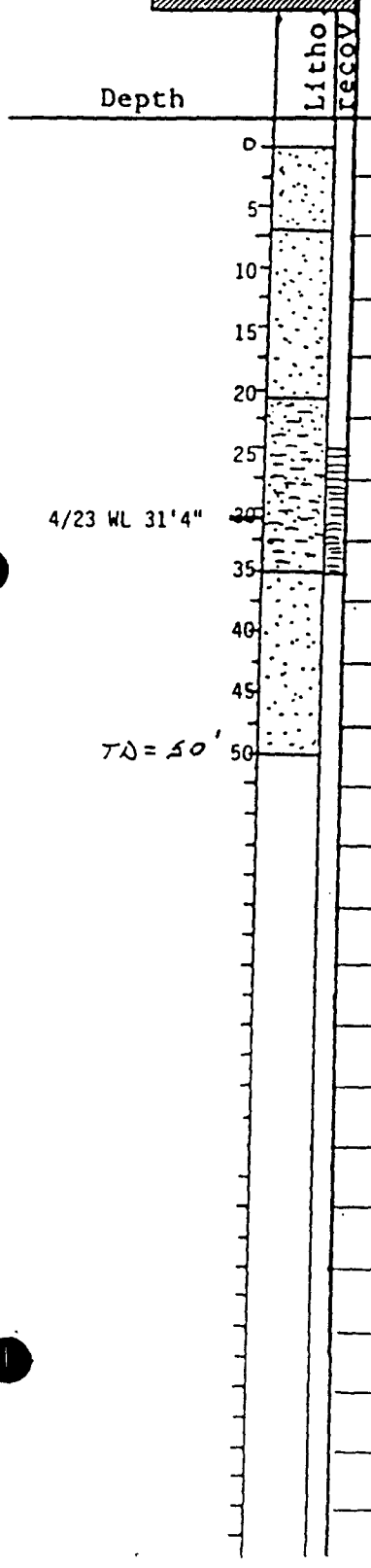
Spud Date 4/18/86 Completion Date 4/18/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation 5396' (topo) Spud In (Fm.) Nacimiento

Remarks Drilled with HSA, continous sampler was not used.





0-7' (7') SAND : moderate yellowish brown (10yr5/4), med to fine grained, well sorted, no HC odor

7'-21' (14') SAND: HC stained, ranges from med dark gray (N4), grayish black (N2), to med gray (N5), fine to med grained, contains cobbles at 15', clay lenses from 12'-15' strong HC odor

21'-35' (14') CLAYEY SAND: HC stained, ranges in color from med gray (N5) to grayish black (N2), very fine to fine grained, moist, HC odor.

35'-50' (15') SANDSTONE: med dark gray (N4), fine to med grained with some clay, wet HC odor.

Completed as 2" PVC Piezometer
Stickup 1'6" TD 41'6" from top of casing
Screened interval 25-35', caved to 26',
Sand to 23', Bentonite @23 2/3 Bag, Backfill to
5', Bentonite 1/3 Bag at 5'

Geoscience Consultants, Ltd

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 27

NE ¼ NW ¼ NW ¼ NW ¼ S 27 T 29N R12W State New Mexico

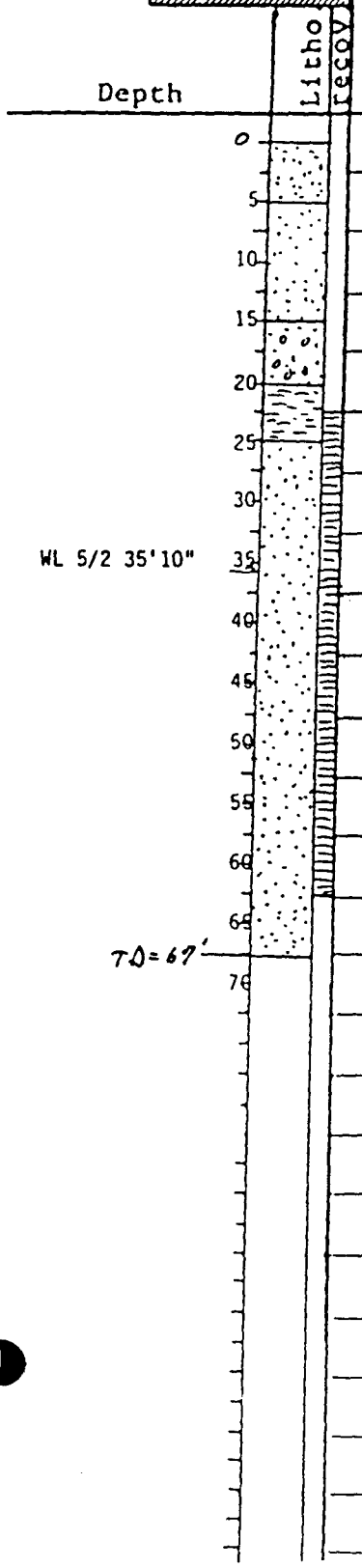
County San Juan Contractor Beeman Brothers

Spud Date 4/23/86 Completion Date 4/23/86

Logs Run Lithology from cuttings Logged By Nicholas

Elevation 5397'(topo) Spud In (Fm.) Nacimiento

Remarks Drilled with Air Rotary, completed as 5" PVC Well



0-5' (5') SAND: Grayish orange (10yr7/4); fine to coarse grained, no HC odor

5-15' (10') SAND: Mod yellowish brown (10yr5/4); fine to med grained with some silt, contains some cobbles at 13', (2-3%)

15-20' (5') SAND & GRAVEL : Mod yellowish brown (10yr5/4) ; fine to med grained with some silt, contains 30% gravels

20-25' (5') SHALE: Dusky yellow (5y6/4)

25-67' (42') SANDSTONE: Lt gray (N7), very fine to med grained, grades to mod yellowish brown (10yr5/4) from 32'-34'

Completed as 5" PVC well
Stickup 1'4" TD 68'4" from top of casing
Screen from 22-62' , 5' Blank on Bottom
Sand to 18', Bentonite (1sack) 1 18'

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 28

___ ¼ ___ ¼ ___ ¼ ___ ¼ S 27 T 29 R 12 State New Mexico

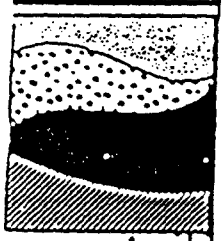
County San Juan Contractor Beeman Bros. Drilling Co.

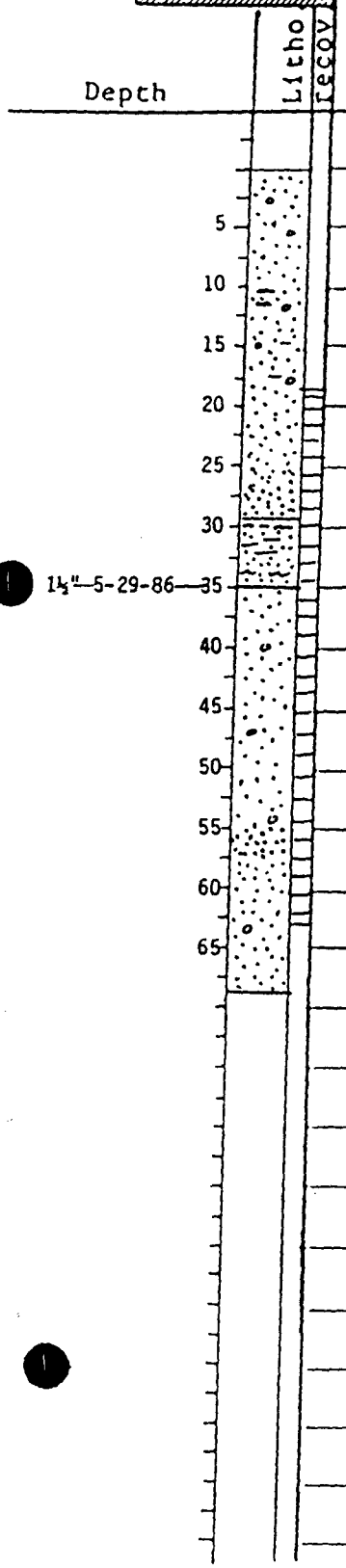
Spud Date 5/27/86 Completion Date 5/27/86

Logs Run Lith from cuttings Logged By NICHOLAS

Elevation _____ Spud In (Fm.) _____

Remarks Drilled With Air Rotary, completed as 6" PVC recovery well





Depth	
0-10' (10')	sand, mod. yelish brn (10YR 5/4), med to coarse grained w/some cobbles.
10-20' (10')	sand, mod. yelish brn (10YR 5/4), coarse to med grained with some cobbles and lt brn clay stringers
20-29' (9')	sand, mod. yelish brn (10YR 5/4), fine to coarse grained, grades coarser at 27'
29-30' (1')	silty clay, brown
30-32' (2')	sandy clay, brown, med. to fine grained sand.
32-35' (3')	Silty Sand, greyish black, HC ODOR, fine to med. grained sand w/brn clay stringers.
35-38' (3')	sandstone, lt olive grey (5Y 5/2)
38-69' (31')	sandstone, med. lt grey (N8), graded to dk greenish grey (5GY 4/1) at 58', grades to dk grey (N3) at 63', fine to coarse grained sandstone with some cobbles, grading coarser from 55-57'
TD 68' 6"	stickup 2', screened from 23'6" to 63'6", Bentonite @ 16' (100 lb bag), gravel packed to 16', TD from TOC 70'6"

Geoscience Consultants, Ltd.

WELL LOGGING FORM

Client Montgomery & Andrews Well Number GBR 29

___ ¼ ___ ¼ ___ ¼ ___ ¼ S 27 T 29 R 12 State New Mexico

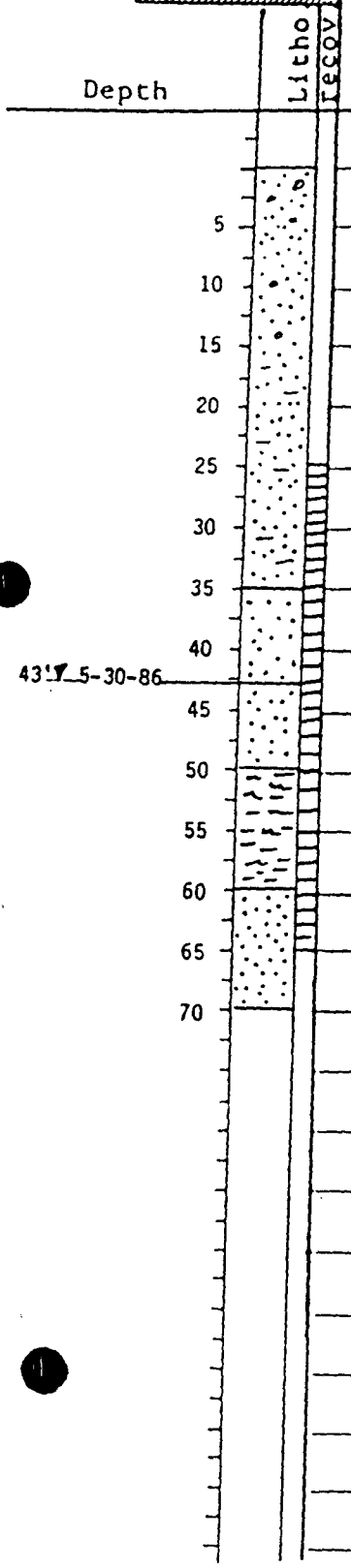
County San Juan Contractor Beeman Bros. Drilling Co.

Spud Date 5/29/86 Completion Date 5/30/86

Logs Run Lith. from cuttings Logged By NICHOLAS

Elevation _____ Spud In (Fm.) _____

Remarks Drilled With Air Rotary, completed as a 6" PVC recovery well



0-5' (5') sand and gravel, pale yellowish brn (10YR 6/2), gravels (1/4"-1'), sand; fine to coarse grained

5-15' (10') sand, greyish orange (10YR 7/4), med. to coarse grained w/some cobbles

15-35' (20') clayey sand, dk yellowish brn (10YR 4/2), fine to coarse grained sand with increasing clay content from 30-35'

35-40' (5') sandstone, greenish grey (5GY 6/1), H.C. ODOR, fine to coarse grained with some silt.

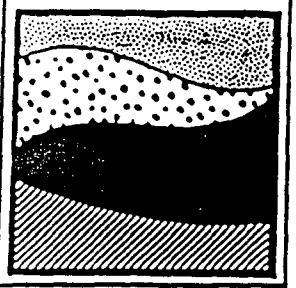
40-50' (10') sandstone, mod. yellowish brn (10YR 5/4), fine to coarse grained sand, grades med. to coarse at 45'

50-60' (10') silty clay, lt olive grey (5Y 6/1) from 50-55', brownish grey (5YR 4/1) from 55-60, increasing clay content at 55'

60-70' (10') sandstone, greenish grey (5 GY 6/1) to med. lt grey (N6), fine to med. grained

TD 72' from TOC, screened interval from 25'-65', gravel packed to 15', 100 lb bag Bentonite @ 15', backfill to the surface

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number (X-1) GBR 30

__1/4 __1/4 __1/4 __1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-24-86

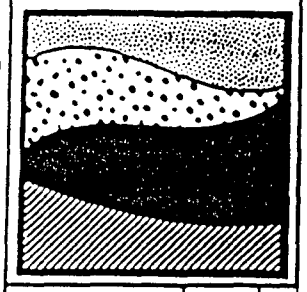
Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
						0-5'	SAND, med gr mod yelsh brn 10YR5/4
5						5-10'	SAND, med-co gr mod yelsh brn 10YR5/4
10						10-15'	SAND, w/1-2% gravels; med-co gr mod yelsh brn 10YR5/4
15						15-20'	SILTY SAND, fn-med gr olive blck 5Y2/1; strong HC odor and stain
20						20-25'	SILTY SAND, med gr, dk grnsh bry 5GY4/1; strong HC odor and stain
25						25-30'	CLAYEY SAND, med-gr, olive blck 5Y2/1, strong HC odor and stain
30						30-33'	SANDY CLAY, fn-med gr, olive gry 5Y4/1; faint HC odor; wet
						33-45'	SANDY CLAY, fn-med gr, lt olive gry 5Y5/2; faint HC odor; wet
35							
40							
45							TD to 49'. Screened from 40' to 25', sand pack to 19'2"

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number (X-1) GBR 30

__1/4__1/4__1/4__1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-24-86

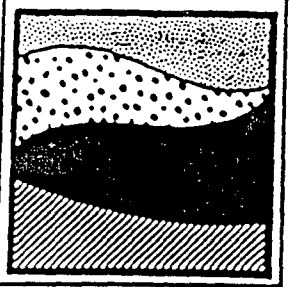
Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
45							
							5' blank on bottom, bentonite plug to 13'11", cement grout
							w/5% bentonite to surface. Completed with 2" PVC.
50							
55							
60							
65							
70							
75							
80							
85							
90							

GCL



WELL LOGGING FORM

Client Montgomery & Andrews Well Number (X-2) GBR 31

1/4 1/4 1/4 1/4 S 27 T 29 R 12 State New Mexico

County San Juan Contractor Western Technologies

Spud Date _____ Completion Date 9-25-86

Logs Run Lithology Logged By Martin

Elevation _____ Spud In (Fm.) _____

Remarks Drilled with Hollow Stem Auger

DEPTH	LITHO.	RECOV.	RUN	FROM	TO	SAMPLE DEPTH	REMARKS
0							
							0-5' SAND, med gr, mod yelsh brn 10YR5/4
5							5-10' CLAYEY SAND, med-co gr, dk yelsh brn 10YR4/2
10							10-20' SILTY SAND, med-co gr, dk yelsh brn 10YR4/2
15							
20							20-25' CLAYEY SAND, med-co gr, dk yelsh brn 10YR4/2 HC odor (?), v v faint
25							25-30' CLAY, fn gr, dk yelsh brn 10YR4/2
30							30-33' SANDY CLAY, fn-med gr, lt olive gry 5Y5/2
Water level @ 33'							33-37' GRAVEL LAYER
35							37-45' SANDY CLAY, fn-med gr lt olive gry 5Y5/2
Bedrock @ 37'							
40							TD to 45', screened from 39'7" to 24'7", 5' blank on bottom, sand pack to 19.33', bentonite plug to 13'4" cement grout w/5% bentonite to surface. Completed with 2" PVC.
45							