Ultramar

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92 APR 17 PM 2:50

April 10, 1992

Ms. Pamela Evans
Hazardous Materials Program
Department of Environmental Health
Alameda County Health Care Services
80 Swan Way, Room 200
Oakland, CA 94612

SUBJECT: BEACON STATION NO. 721, 44 LEWELLING BLVD., SAN LORENZO, CALIFORNIA

Dear Ms. Evans:

Enclosed is a copy of the Interim Groundwater Remediation Plan for the above-referenced Ultramar facility. After the plan is approved the remediation system will be installed and operation will begin. Once the system begins operation it will be evaluated periodically to determine the need to expand the system.

Ultramar Inc. (Ultramar) is anxious to begin work to install this system and your quick review of the plan would be greatly appreciated. Ultramar understands that the County has an extensive work load a may not always be able to formally respond. Therefore, if written response to the plan is not received by June 1, 1992, Ultramar will assume that the plan meets with your approval and will proceed with the installation.

Please call if you have any questions regarding the information included in this report.

Sincerely,

ULTRAMAR INC.

Terrence A. Fox

Terrence A. Fox
Senior Project Manager
Marketing Environmental Department

Enclosures

cc w/encl: Mr. Steven Ritchie, San Francisco Bay Region, RWQCB

INTERIM GROUNDWATER REMEDIATION PLAN

FOR

BEACON GAS STATION NO. 721
44 LEWELLING BOULEVARD
SAN LORENZO, CALIFORNIA

Mar 1992

Project No. 3-30092-41
March 26, 1992

RESNA
42501 Albrae Street
Fremont, California 94538
(510) 440-3300

RESNA
Working to Restore Nature

42501 Albrae Street
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Phone: (510) 651-1906
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March 26, 1992
Project No. 3-30092-41

Ultramar Inc.
525 West Third Street
Hanford, CA 93232-0466

Attention: Mr. Terrence A. Fox

Subject: Interim Groundwater Remediation Plan
Beacon Service Station No. 721
44 Lewelling Boulevard, San Lorenzo, California

Dear Mr. Fox:

RESNA Industries Inc. has completed an interim groundwater remediation plan for the subject site. This plan addresses portions of the on-site groundwater plume which appear to contain the highest levels of gasoline hydrocarbons. RESNA recommends installation of a vapor extraction system and groundwater pump-and-treat system to begin free-product removal, groundwater migration control, and remediation of the dissolved contaminant plume near the tank complex. Results of recent a groundwater pump test and vapor extraction test are included as appendices to this report.

If you have any questions regarding this report, please call.

Sincerely,
RESNA Industries Inc.

Walid Naouchi
Project Engineer

John H. Turney, P.E.
Senior Program Engineer

Bruce T. Maeda, P.E.
Project Engineer

Dan Wynne, C.E.G. 1569
Senior Program Geologist

REGISTERED GEOLOGIST
DANIEL B. WYNNE
6/92
STATE OF CALIFORNIA

WN/JHT/BTM/sr
Attachment

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INTERIM GROUNDWATER REMEDIATION PLAN

FOR

BEACON SERVICE STATION NO. 721
44 LEWELLING BOULEVARD
SAN LORENZO, CALIFORNIA

1.0 INTRODUCTION

At the request of Ultramar Inc., RESNA Industries Inc. has prepared this interim groundwater remediation plan for Beacon Service Station No. 721 located at 44 Lewelling Boulevard in San Lorenzo, California (see Site Location Map - Figure 1). This report presents the results of the previous site investigations conducted by several firms as well as the results of a groundwater pump test and soil vapor extraction test performed in RESNA. The report concludes by presenting interim remedial measures for impacted groundwater at the site.

1.1 Site Background

Beacon Service Station No. 721 is located about 200 feet east of the intersection of Lewelling Boulevard and Via Granada (Figure 1). Residential dwellings are located south and east of the site. A fast-food restaurant is located west of the site. Lewelling Boulevard borders the site to the north. The site elevation is approximately 40 feet above mean sea level. San Lorenzo Creek flows westward approximately 1/4-mile south of the site. This creek flows westward and discharges to San Francisco Bay, located approximately 3 miles west of the site.

On April 28, 1987, two 10,000-gallon tanks and one 7,500-gallon tank were excavated and removed from the western portion of the site. Volatile hydrocarbons were identified in soil samples collected from the bottom of the tank pit at the 16-foot depth. Three new 10,000-gallon underground storage tanks were installed in the original excavation. Subsequent to the underground tank replacement, Applied GeoSystems (AGS) installed three 2-inch diameter groundwater monitoring wells (MW-1, MW-2, and MW-3) near the underground fuel tanks (see Site Plan - Figure 2). Hydrocarbon-impacted soil and water were encountered in the three borings/monitoring wells. The results of this investigation are described in an AGS report prepared for the Kayo Oil Company, dated June 23, 1987 [Reference 1].

In December 1988, DuPont Environmental Services (DuPont) installed four additional monitoring wells (MW-4 through MW-7), and drilled one soil boring (B-1) to a depth of 37 feet. In September 1989, DuPont installed two additional monitoring wells (MW-8 and MW-9), south and west of the site. In the boreholes drilled by DuPont, only boring B-1 contained hydrocarbons in soil above the water table. This boring was located approximately 20 feet southwest of the tank pit. Results of the subsurface investigations are summarized in a Problem Assessment Report prepared by DuPont for Conoco, Inc., dated November 22, 1989 [Reference 2].

Quarterly groundwater monitoring and sampling were performed by AGS and DuPont from May 29, 1987 to December 18, 1990. Results of their work are summarized in the quarterly report dated January 25, 1991 prepared by DuPont for Ultramar Inc. [Reference 3].

In October 1991, RESNA installed two off-site monitoring wells (MW-10 and MW-11) and a 6-inch recovery well (RW-1) near the underground tank complex. The results of this investigation will be summarized in the groundwater monitoring and sampling report prepared by RESNA for Ultramar Inc., currently awaiting completion [Reference 4].

1.2 Regional Geology and Hydrogeologic Setting

The site is underlain by unconsolidated stream deposits of San Lorenzo Creek and neighboring streams. These sediments generally consist of interfingering gravel, sand, silt, and clay. The inferred regional groundwater flow direction is toward west-southwest based on local topography and surface drainage patterns. Surface and subsurface waters in the vicinity of the site drain toward San Lorenzo Creek and San Francisco Bay [Reference 5].

1.3 Local Geologic and Hydrogeologic Conditions

The station is underlain by complexly interbedded alluvial sediments which consist of variable amounts of clay, silt, silty sand, sand, and gravel. Sandy silt is predominant to the depths of approximately 11 to 14 feet. It is underlain by a sequence of interbedded clays and silty sands. The aquifer encountered at a depth of approximately 20 feet consists primarily of poorly graded sands and gravels. For additional details, refer to boring logs presented in References 1 - 4.

Groundwater beneath the study area is unconfined and generally flows southwest at a gradient of 0.0024 foot per foot, as calculated from measurements taken on November 13, 1991. Groundwater elevation data are presented in Table 1. The most recent groundwater elevation contour map is presented in Figure 3.

1.4 Extent of Soil and Groundwater Contamination

Chemical analyses from previous soil investigations by AGS, DuPont, and RESNA are summarized in Table 2. Gasoline hydrocarbons have been identified in soils near the former / existing tank complex and wells MW-1 and MW-3. Free-product has recently been identified in groundwater monitoring well MW-3, indicating that separate-phase gasoline hydrocarbons are present in the capillary fringe soils. These results suggest that hydrocarbons in both soil and groundwater are likely concentrated around the tank complex area.

Groundwater sampling data from previous investigations is summarized in Table 3. Total Petroleum Hydrocarbons as Gasoline have recently been identified in monitoring wells MW-1, MW-2, MW-3 (free-product), MW-4, MW-6, MW-7, MW-8, MW-10, MW-11 and RW-1. Benzene has recently been identified in wells MW-1, MW-7, MW-10 and RW-1. The groundwater plume map for benzene is presented in Figure 4, based upon the most recent data.

The benzene plume appears to be defined in all directions except to the northwest, where a sample from well MW-7 recently contained 16 ppb benzene.

2.0 FIELD TESTING

To assist in the evaluation of interim remedial alternatives for groundwater, RESNA conducted two field tests at the site:

- Groundwater Pumping Test
- Vapor Extraction Test

2.1 Groundwater Pumping Test

The groundwater pump test was performed by pumping recovery well RW-1 to determine well yields, optimum pumping rates, and an estimated groundwater capture zone. The pump test report is presented in Appendix A.

Based upon the pump test, an optimum pumping rate of 1.1 GPM was established for recovery well RW-1. At a flowrate of 1.1 GPM, a maximum 10 feet of drawdown was observed in well RW-1.

The computer model used to estimate the zone of capture calculated a radius of approximately 15 feet. However, the model assumes a horizontal and vertical homogeneous aquifer system. This is not the case at this site. The aquifer system beneath the site appears to be vertically stratified. Thus, with long term pumping, a larger zone of capture would be expected.

2.2 Pilot Vapor Extraction Test

The vapor extraction test was performed to evaluate the feasibility of vapor extraction to expedite the groundwater remediation process. Two wells (RW-1 and MW-1) were tested to determine airflow / vacuum relationships, vapor stream concentrations, well efficiencies, and an estimated radius of influence. The vapor extraction test report is presented in Appendix B.

The pilot test demonstrated that vapor extraction can remove gasoline hydrocarbons from the vadose zone soils near the underground storage tank complex. Relatively large vapor flow rates (40 to 60 SCFM) could be extracted from the wells using moderate well-head vacuums (8 to 40 inches W.C.). Vapor concentrations from the wells ranged from 7,100 to 31,000 µg/liter TPHG, corresponding to hydrocarbon removal rates of 1.1 to 5.8 lbs/hr TPHG.

3.0 INTERIM GROUNDWATER REMEDIATION PLAN

The interim groundwater remediation plan has three primary goals:

(1) Establish control over free-floating gasoline product near the tank complex;
(2) Begin the removal of free-product from the water table;
(3) Begin migration control / remediation of the on-site dissolved hydrocarbon plume;

This plan addresses portions of the on-site groundwater plume which appear to contain the highest levels of gasoline hydrocarbons (i.e. areas near the underground tank complex). Implementation of this interim plan will initiate migration control in a timely manner and provide a basis for future remediation work by utilizing system operation data.

3.1 Evaluation of Remedial Options

Free-Product Removal Options

The presence of free-product in monitoring well MW-3 suggests that separate-phase gasoline product exists at the water table near the underground storage tank complex. Removal of this product is typically accomplished by one of the following methods:

- Free-product skimming;
- Total fluids pumping;
- Vapor extraction.

<u>Skimmer Pumps</u>

Hydrocarbon skimmer pumps selectively recover free-product from the water surface within a well using floating devices which draw product from above the product / water interface. These pumps often utilize hydrophobic (water-repelling) screen materials which only allow similar hydrophobic compounds (i.e. hydrocarbons) to enter. The advantage of skimmer pumps is that they can selectively recover floating hydrocarbons from the water surface without recovering large amounts of groundwater. The disadvantages of skimmer pumps are: (1) they generally require large amounts of free-product to work effectively; (2) they do not depress the groundwater surface and, as a result, are not as effective in controlling the migration of free-product hydrocarbons; and (3) they do not enhance the release of free-product entrapped within the capillary fringe.

The thickness of free-product in monitoring well MW-3 was measured at 0.17 feet [2 inches] on January 17, 1992. This relatively small product thickness indicates that skimmer pump operation may not be efficient in product recovery.

<u>Total Fluids Pumps</u>

Total fluids pumps recover both free-product and water phases from groundwater wells using groundwater depression pumps. Top filling pneumatic pumps, low-speed submersible pumps, or low-speed above-ground centrifugal pumps are often used to extract groundwater and depress the potentiometric water surface. Since a combined free-product / water stream is being extracted, additional treatment through oil / water separators is required to isolate the two phases. By creating a cone of depression in the potentiometric water surface, both free product and groundwater which may contain dissolved product are encouraged to flow towards the well, resulting in plume migration control. The disadvantages of total fluids pump systems are: (1) an oil / water separator is necessary to isolate the free and dissolved hydrocarbon phases; (2) expensive pneumatic pumps (which require an air-compressor) are often required to prevent emulsion formation; and (3) treatment of the combined product / water stream may subject the groundwater treatment process to State of California Department of Health Services permit-by-rule criteria, resulting in added permit costs.

Vapor Extraction

Vapor extraction is a remediation technology which removes volatile hydrocarbons from the subsurface soils by volatilizing them with a flow of air. Airflow is induced by applying a vacuum to the end of a vapor extraction well. Air enters through the surrounding surface soils or nearby air-induction wells, and is swept through the soil to volatilize contaminants. The contaminated vapors exit the system through the extraction wells and are then treated to meet regional air quality management district criteria before discharge. Activated carbon, catalytic oxidizers, thermal oxidizers, or internal combustion engines are commonly used methods of air treatment.

Though typically used for the remediation of vadose zone soils, vapor extraction has also been used for removal of free-floating gasoline product from groundwater wells [Reference 6]. To produce airflow over the capillary fringe soils and potentiometric water surface, the well must contain a perforated interval above the free-product / water level. Vapor extraction has the added advantage of reducing vadose zone and capillary fringe hydrocarbons in soil which can act as a source of groundwater contamination.

Field tests conducted with wells RW-1 and MW-1 demonstrated that vapor extraction can remove gasoline hydrocarbons from the vadose zone soils near the underground storage tank complex (see Appendix A). At vapor extraction flowrates of 40 to 60 SCFM, vapor concentrations from the wells ranged from 7,100 to 31,000 μg/liter TPHG, corresponding to hydrocarbon removal rates of 1.1 to 5.8 lbs/hr TPHG. These air flowrates and corresponding hydrocarbon removal rates suggest that vapor extraction is feasible through the soils near the tank complex.

Dissolved Contaminant Plume Control Options

Migration control of dissolved contaminant plumes can be achieved using groundwater depression pumps followed by treatment to remove contaminants prior to discharge. These pump and treat systems create a cone of depression in the potentiometric water surface and encourage the dissolved plume to migrate towards the well. However, unlike total fluids systems, only groundwater which may contain dissolved product is removed. Removal of free product is discouraged by always maintaining the pump inlet below the product / water interface. This control can be accomplished using conductivity-based level controls. The advantages of groundwater-only pump and treat systems are: (1) depression of the groundwater surface is initiated, thereby providing a mechanism to affect the migration of both free-product and groundwater which may contain dissolved hydrocarbons; (2) an oil / water separator is not required since free-product is not recovered; (3) less expensive submersible pumps can be utilized since the potential for product / water emulsions is minimized; and (4) treatment of the water stream is less likely to be subject to Department of Health Services permit-by-rule criteria.

3.2 Proposed Interim Groundwater Remediation Plan

The proposed interim groundwater remediation system will utilize vapor extraction for free-product removal and a pump-and-treat system to begin migration control / remediation of the on-site dissolved contaminant plume.

Interim Groundwater Pump and Treat System

The pump and treat system will utilize a groundwater depression pump installed in recovery well RW-1 to depress the water surface in the well and create a cone of depression surrounding the well. Both free and dissolved hydrocarbon plumes should then be hydraulically drawn toward the well. The proposed remediation would involve three stages: (1) a groundwater extraction stage; (2) water treatment stage; and (3) a water discharge stage.

Groundwater Extraction Stage

The estimated radius of capture was calculated at 15 feet based upon data from a 24-hour pump test at 1.1 GPM. This theoretical capture zone does not encompass the entire on-site or off-site plume. It does address the portion of the dissolved plume located near the tank complex, where hydrocarbon concentrations appear to be highest. The capture zone is based upon a limited duration test (24 hours) and is only estimated. The need for additional groundwater extraction wells will be evaluated once the system is operational. A submersible pump will be used to extract groundwater at a design flowrate of 1.0 GPM.

Water Treatment Stage

Before discharge to the sanitary sewer, recovered groundwater will be treated to meet East Bay Municipal Utility District (EBMUD) permit requirements before discharge to the sanitary sewer. According to EBMUD, treated groundwater is restricted to 3 parts per billion (ppb) for benzene, 31 ppb for toluene, 5 ppb for ethylbenzene, and 42 ppb for total xylenes. The Lower Explosive Limit is restricted to 25%.

Water Discharge Stage

After the extracted water is treated to EBMUD guidelines, the effluent would be discharged to the sanitary sewer. The discharge stage will include a sampling port and piping to the proposed discharge point. The sampling port is required for periodic monitoring of discharged water.

Vapor Extraction System

The proposed vapor extraction system will recover free-product drawn into well RW-1 as a result of the groundwater depression pump. Due to the relatively small radius of influence generated in the soils during the vapor extraction test (approx. 12 feet), RESNA recommends utilizing groundwater wells RW-1 and MW-3 for the vapor extraction system. A blower and air-treatment unit will be used to extract and treat vapors from the wells. Treated vapors will be discharged to the atmosphere under a Bay Area Air Quality Management District (BAAQMD) air discharge permit.

In addition to free-product removal from well RW-1, some remediation of the vadose zone soils in the immediate vicinity of the tank complex is also expected to occur. As the water table is depressed, previously saturated soils should become exposed to airflow. The removal of hydrocarbons from newly exposed capillary fringe soils should assist in the groundwater remediation process. For added flexibility, RESNA also recommends manifolding groundwater monitoring well MW-1 to the vapor extraction system. This well can also be used to draw vapor through the tank complex soils.

3.3 Interim System Permit Requirements

Construction and operation of the proposed interim groundwater treatment system will likely require permits from the following agencies:

Wastewater Discharge Permit: An EBMUD discharge permit will be required to discharge the treated groundwater to the sanitary sewer.

Air Discharge Permit: A BAAQMD air discharge permit will be required to allow discharge of treated gasoline vapors to the atmosphere.

Building Permit: A building permit will be necessary to construct the system on the site. City planning department approvals will also be necessary. These approvals should be obtained from the Alameda County Building and Planning Department.

Fire Department: Fire department approvals will be required prior to construction and operation of the groundwater treatment and vapor extraction system.

Permit By Rule: Owners or operators of facilities which treat hazardous waste [as defined in Title 22 of the California Code of Regulations] are required to obtain a treatment facility variance or permit from the California Department of Toxic Substances Control (DTSC). For fuel-leak sites with contaminated groundwater that is classified as a hazardous waste, these requirements can often be addressed through the DTSC's recent Permit by Rule regulations. If the groundwater is not classified as hazardous waste, no permit is required for the groundwater treatment system. No Permit by Rule regulations have yet been established for vapor extraction operations. However, these requirements are subject to change in the near future.

4.0 LIMITATIONS

The discussion and recommendations presented in this report are based on the following.

1. Exploratory test borings drilled at the site.
2. Observations of field personnel.
3. Data obtained from the pump test performed by RESNA.
4. Referenced documents.
5. Our understanding of the regulations of the State of California, County of Alameda, and the City of San Lorenzo.

It is possible that variations in the soil or groundwater conditions could exist beyond the points explored in this investigation. Also, changes in the groundwater conditions could occur at some time in the future because of variations in rainfall, temperature, regional water usage, or other factors.

The service performed by RESNA has been conducted in a manner consistent with the level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions in the Alameda County area. No other warranty, expressed or implied, is made.

5.0 REFERENCES

[1] Applied GeoSystems, "Subsurface Environmental Investigation: Soil Boring and Monitoring Well Installation at the Econo Gasoline Station, 44 Lewelling Boulevard, San Lorenzo, California," June 23, 1987.

[2] Dupont Environmental Services, "Problem Assessment Report, Jet Gas Station, 44 Lewelling Boulevard, San Lorenzo, California," November 22, 1989.

[3] Groundwater Technology, Inc., "Work Plan, Continuing Subsurface Environmental Investigation at Beacon Station No. 721, 44 Lewelling Boulevard, San Lorenzo, California," March 13, 1991.

[4] RESNA Industries, Inc., "Groundwater Monitoring and Sampling Report, Fourth Quarter 1991 at Beacon Gas Station No. 721, 44 Lewelling Boulevard, San Lorenzo, California," March 17, 1992 [draft].

[5] United States Geological Survey Professional Paper No. 943, "Flatland Deposits - Their Geology and Engineering Properties and Their Importance to Comprehensive Planning, Selected Examples from the San Francisco Bay Region, California," 1979.

[6] Terra Vac, "Soil Remediation and Free Product Removal Using In-Situ Vacuum Extraction with Catalytic Oxidation," Proceedings of Hazmacon 1990, April 17 - 19, 1990.

TABLE 1

SUMMARY OF GROUNDWATER ELEVATION DATA

Well Number	Top of Well Casing (famsl)	Date Sampled	Depth to Water (feet)	Groundwater Surface Elevation (famsl)	Elevation Change Since Previous Measurement (feet)
MW-1	43.67	03/10/88	17.12	26.55	---
		06/14/88	18.05	25.62	-0.93
		12/05/88	19.48	24.19	-1.43
		03/08/89	18.07	25.60	1.41
		06/22/89	18.60	25.07	-0.53
		09/27/89	19.98	23.69	-1.38
		12/29/89	20.45	23.22	-0.47
		03/29/90	19.31	24.36	1.14
		06/21/90	19.69	23.98	-0.38
		09/25/90*	21.88	22.51	-1.47
		12/18/90*	20.89	23.12	0.61
		03/28/91	17.77	25.90	2.78
		06/25/91	18.60	25.07	-0.83
		09/17/91	20.14	23.53	-1.54
		11/05/91	20.40	23.27	-0.26
		02/18/92	16.42	27.25	3.98
MW-2	43.09	03/10/88	16.43	26.66	---
		06/14/88	17.35	25.74	-0.92
		12/05/88	18.79	24.30	-1.44
		03/08/89	17.31	25.78	1.48
		06/22/89	17.92	25.17	-0.61
		09/27/89	19.27	23.82	-1.35
		12/29/89	19.75	23.34	-0.48
		03/29/90	18.62	24.47	1.13
		06/21/90	19.12	23.97	-0.50
		09/25/90	20.54	22.55	-1.42
		12/18/90	20.30	22.79	0.24
		03/28/91	16.94	26.15	3.36
		06/25/91	17.95	25.14	-1.01
		09/17/91	19.50	23.59	-1.55
		11/05/91	19.73	23.36	-0.23
		02/18/92	16.65	26.44	3.08
MW-3	43.10	03/10/88	16.68	26.42	---
		06/14/88	17.59	25.51	-0.91
		12/05/88	18.96	24.14	-1.37
		03/08/89	17.60	25.50	1.36
		06/22/89	18.11	24.99	-0.51

TABLE 1

SUMMARY OF GROUNDWATER ELEVATION DATA

Well Number	Top of Well Casing (famsl)	Date Sampled	Depth to Water (feet)	Groundwater Surface Elevation (famsl)	Elevation Change Since Previous Measurement (feet)
MW-3		09/27/89	19.47	23.63	-1.36
Cont'd		12/29/89*	19.97	23.13	-0.50
		3/29/90*	17.60	25.53	2.40
		06/21/90	19.35	23.75	-1.78
		9/25/90*	20.72	22.41	-1.34
		12/18/90*	21.42	22.00	-0.41
		03/28/91	17.45	25.85	3.85
		06/25/91	18.12	25.01	-0.84
		9/17/91*	19.55	23.55	-1.46
		11/05/91	19.98	23.12	-0.43
		02/18/92	16.89	26.21	3.09
MW-4	44.66	12/05/88	20.47	24.19	---
		03/08/89	19.03	25.63	1.44
		06/22/89	19.57	25.09	-0.54
		09/27/89	20.98	23.68	-1.41
		12/29/89	21.43	23.23	-0.45
		03/29/90	20.29	24.37	1.14
		06/21/90	20.78	23.88	-0.49
		09/25/90	22.24	22.42	-1.46
		12/18/90	22.18	22.48	0.06
		03/28/91	18.79	25.87	3.39
		06/25/91	19.59	25.07	-0.80
		09/17/91	21.15	23.51	-1.56
		11/05/91	21.41	23.25	-0.26
		02/18/92	18.51	26.15	2.90
MW-5	43.79	12/05/88	19.48	24.31	---
		03/08/89	18.00	25.79	1.48
		06/22/89	18.60	25.19	-0.60
		09/27/89	20.00	23.79	-1.40
		12/29/89	20.43	23.36	-0.43
		03/29/90	19.24	24.55	1.19
		06/21/90	19.82	23.97	-0.58
		09/25/90	21.23	22.56	-1.41
		12/18/90	21.04	22.75	0.19
		03/28/91	17.69	26.10	3.35
		06/25/91	18.62	25.17	-0.93
		09/17/91	20.23	23.56	-1.61
		11/05/91	20.43	23.36	-0.20
		02/18/92	17.37	26.42	3.06

TABLE 1

SUMMARY OF GROUNDWATER ELEVATION DATA

Well Number	Top of Well Casing (famsl)	Date Sampled	Depth to Water (feet)	Groundwater Surface Elevation (famsl)	Elevation Change Since Previous Measurement (feet)
MW-6	42.47	12/05/88	17.99	24.48	---
		03/08/89	16.75	25.72	-1.24
		06/22/89	17.30	25.17	-0.55
		09/27/89	18.64	23.83	-1.34
		12/29/89	19.16	23.31	-0.52
		03/29/90	18.04	24.43	1.12
		06/21/90	18.53	23.94	-0.49
		09/25/90	19.91	22.56	-1.38
		12/18/90	20.61	21.86	-0.70
		03/28/91	16.29	26.18	4.32
		06/25/91	17.36	25.11	-1.07
		09/17/91	18.89	23.58	-1.53
		11/05/91	19.07	23.40	-0.18
		02/18/92	15.87	26.60	3.20
MW-7	41.54	12/05/88	17.61	23.93	---
		03/08/89	16.27	25.27	1.34
		06/22/89	16.72	24.82	-0.45
		09/27/89	17.99	23.55	-1.27
		12/29/89	18.54	23.00	-0.55
		03/29/90	17.43	24.11	1.11
		06/21/90	17.88	23.66	-0.45
		09/25/90	19.12	22.42	-1.24
		12/18/90	19.16	22.38	-0.04
		03/28/91	16.04	25.50	3.12
		06/25/91	16.66	24.88	-0.62
		09/17/91	17.99	23.55	-1.33
		11/05/91	18.33	23.21	-0.34
		02/18/92	15.51	26.03	2.82
MW-8	42.26	09/27/89	18.89	23.37	---
		12/29/89	19.45	22.81	-0.56
		03/29/90	18.39	23.87	1.06
		06/21/90	18.80	23.46	-0.41
		09/25/90	20.10	22.16	-1.30
		12/18/90	20.13	22.13	-0.03
		03/28/91	17.14	25.12	2.99
		06/25/91	17.45	24.81	-0.31
		09/17/91	18.81	23.45	-1.36
		11/05/91	19.14	23.12	-0.33
		02/18/92	16.57	25.69	2.57

TABLE 1

SUMMARY OF GROUNDWATER ELEVATION DATA

Well Number	Top of Well Casing (famsl)	Date Sampled	Depth to Water (feet)	Groundwater Surface Elevation (famsl)	Elevation Change Since Previous Measurement (feet)
MW-9	44.94	09/27/89	21.38	23.56	---
		12/29/89	21.76	23.18	-0.38
		03/29/90	20.58	24.36	1.18
		06/21/90	21.11	23.83	-0.53
		09/25/90	22.60	22.34	-1.49
		12/18/90	22.56	22.38	0.04
		03/28/91	19.13	25.81	3.43
		06/25/91	19.90	25.04	-0.77
		09/17/91	21.49	23.45	-1.59
		11/05/91	21.75	23.19	-0.26
		02/18/92	18.87	26.07	2.88
MW-10	42.34	11/05/91	19.28	23.06	---
		02/18/92	16.63	25.71	2.65
MW-11	45.00	11/05/91	22.11	22.89	---
		02/18/92	17.00	26.17	3.28

NOTE: All available water elevation data were recalculated to present wellhead elevations as reported by Ronald R. Archer, Surveryor, on November 6, 1991

1. famsl = feet above mean sea level
2. * = groundwater elevations for these quarters were corrected for the presence of floating gasoline product using the equation: GWE = WE -[DTW-(PT x 0.8)]

Where:
GWE = Groundwater elevation in feet above mean sea level
WE = Well elevation at top of casing
DTW = Depth to water from top of casing in feet
PT = Product thickness in feet
0.8 = Assumed difference in specific gravities between water and gasoline

TABLE 2

SUMMARY OF SOIL ANALYTICAL RESULTS

Sample I.D.	Date Sampled	Depth (feet)	Benzene (mg/kg)	Ethyl-benzene (mg/kg)	Toluene (mg/kg)	Xylenes (mg/kg)	TPHG (mg/kg)	TVH (mg/kg)	Comments	Consultant
B-1	12/02/88	11.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
B-1	12/02/88	16.0	ND(2.0)	7.8	ND(3.0)	39.0	250.0		No Odor	DE
B-1	12/02/88	21.5	0.55	0.25	0.1	0.9	7.1		Slight Odor	DE
B-1	12/02/88	33.0	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
B-10	10/17/91	6	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)	ND (1.0)		Monitoring Well MW-10	R
B-10	10/17/91	11	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)	ND(1.0)		Monitoring Well MW-10	R
B-10	10/17/91	16	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)	ND(1.0)		Monitoring Well MW-10	R
B-11	10/17/91	6	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)	ND(1.0)		Monitoring Well MW-11	R
B-11	10/17/91	11	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)	ND(1.0)		Monitoring Well MW-11	R
B-11	10/17/91	16	ND(0.005)	ND(0.005)	ND(0.005)	ND(0.005)	ND(1.0)		Monitoring Well MW-11	R
MW-4	12/01/88	11.5	ND(0.09)	ND(0.2)	ND(0.2)	ND(0.7)	ND(0.5)		No Odor	DE
MW-4	12/01/88	21.0	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-4	12/01/88	26.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	0.64		No Odor	DE
MW-5	12/01/88	11.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-5	12/01/88	21.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-5	12/01/88	26.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-6	12/01/88	11.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-6	12/01/88	21.0	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	5.5		No Odor	DE
MW-6	12/01/88	26.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-7	12/02/88	11.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-7	12/02/88	21.5	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-7	12/02/88	26.0	ND(0.09)	ND(0.2)	ND(0.1)	ND(0.7)	ND(0.5)		No Odor	DE
MW-8C	09/05/88	15.0	ND(0.01)	ND(0.02)	ND(0.02)	ND(0.06)	ND(0.5)		No Odor	DE
MW-8D	09/05/88	20.0	ND(0.01)	0.16	0.84	ND(0.06)	43.0		Slight Odor	DE

TABLE 2

SUMMARY OF SOIL ANALYTICAL RESULTS

Sample I.D.	Date Sampled	Depth (feet)	Benzene (mg/kg)	Ethyl-benzene (mg/kg)	Toluene (mg/kg)	Xylenes (mg/kg)	TPHG (mg/kg)	TVH (mg/kg)	Comments	Consultant
MW-9C	09/05/88	15.0	ND(0.01)	ND(0.02)	ND(0.04)	ND(0.06)	ND(0.5)		No Odor	DE
MW-9E	09/05/88	19.0	ND(0.01)	ND(0.02)	ND(0.01)	ND(0.06)	ND(0.5)		No Odor	DE
RW-1	10/17/91	5	0.005	0.005	0.005	0.005	ND		Recovery Well RW-1	R
RW-1	10/17/91	10	0.009	0.025	0.018	0.11	1.5		Recovery Well RW-1	R
RW-1	10/17/91	15	7.9	29	28	160	1,900		Recovery Well RW-1	R
S-1	04/28/87	14.0	12.0	14.0	2.0	63.0		329.0	Tank Pit Sample	AGS
S-2	04/28/87	14.0	22.0	26.0	136.0	179.0		663.0	Tank Pit Sample	AGS
S-3	04/28/87	14.0	52.0	43.0	158.0	288.0		1136.0	Tank Pit Sample*	AGS
S-4	04/28/87	14.0	16.0	19.0	8.0	116.0		510.0	Tank Pit Sample	AGS
S-5	04/28/87	14.0	ND(0.05)	ND(0.05	ND(0.05)	ND(0.05)		1.64	Tank Pit Sample	AGS
S-6	04/28/87	14.0	0.41	0.21	0.08	0.31		4.22	Tank Pit Sample	AGS
S-17NW	04/30/87	17.0	1.37	0.40	1.06	1.18		6.98	Tank Pit Sample	AGS
S-20B1	05/26/87	20.0	NA	NA	NA	NA		904.0	Monitoring Well MW-1	AGS
S-20B2	05/26/87	20.0	NA	NA	NA	NA		0.62	Monitoring Well MW-2	AGS
S-15B3	05/27/87	15.0	NA	NA	NA	NA		101.39	Monitoring Well MW-3	AGS
S-20B3	05/27/87	20.0	NA	NA	NA	NA		9.40	Monitoring Well MW-3	AGS

*Additional soil excavation performed in this area. For post-excavation sample, refer to sample S-17-NW. [Reference 1].

mg/kg parts per million
TVH Total Volatile Hydrocarbons
ND Not detected; detection limits are shown in parentheses
NA Not Analyzed
TPHG Total Petroleum Hydrocarbons as Gasoline

DE = Dupont Environmental Services
R = RESNA Industries, Inc.
AGS = Applied Geosystems, Inc.

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

Well No.	Date Sampled	Benzene (ppb)	Toluene (ppb)	Ethyl Benzene (ppb)	Xylenes (ppb)	TPHG (ppb)	Comments
MW-1	05/29/87	490	150	930	3,790	18,050	
	07/14/87	560	120	950	3,270	14,750	
	08/17/87	630	40	320	1,130	12,860	
	09/01/87	558	84	562	1,942	14,269	
	12/10/87	200	138	273	777	14,000	
	03/10/88	70	40	340	940	7,300	
	06/14/88	290	ND	330	790	34,000	
	12/05/88	100	16	140	310	4,000	
	03/08/89	670	20	580	1,200	9,100	Sheen
	06/22/89	1,000	20	1,200	2,200	12,000	Sheen
	09/27/89	960	9	260	360	6,800	
	12/29/89	210	33	1,200	250	4,800	
	03/29/90	1,100	42	510	1,800	14,000	
	06/21/90	1,400	ND	160	130	7,900	
	09/25/90	NS	NS	NS	NS	NS	0.9 ft free-product
	12/18/90	NS	NS	NS	NS	NS	0.4 ft free-product
	03/28/91	230	75	570	2,000	26,000	Sheen
	06/25/91	970	35	300	610	22,000	
	09/17/91	490	150	250	370	16,000	
	11/05/91	420	45	410	780	35,000	
	02/18/92	NS	NS	NS	NS	NS	Sheen
MW-2	05/29/87	113	14	46	58	4,870	
	07/14/87	103	25	34	48	2,207	
	08/17/87	37.6	10.9	8.2	11.1	756	
	09/01/87	75.3	14.2	16.4	27.6	1,482	
	12/10/87	28	40.6	38.1	100.3	1,800	
	03/10/88	9.2	3.1	7.3	2.6	1,200	
	06/14/88	ND	ND	2.2	5.7	500	
	12/05/88	ND	1.3	5.6	3.6	500	
	03/08/89	ND	1.3	3.5	3.7	730	
	06/22/89	ND	ND	ND	ND	570	
	09/27/89	3.8	0.64	2.9	54	420	
	12/29/89	6.7	2	5.7	2.9	270	
	03/29/90	10	0.88	10	3.3	420	
	06/21/90	ND	ND	4	ND	650	
	09/25/90	ND	1.5	3.5	1.5	680	
	12/18/90	ND	1.7	2.2	0.6	500	

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

Well No.	Date Sampled	Benzene (ppb)	Toluene (ppb)	Ethyl Benzene (ppb)	Xylenes (ppb)	TPHG (ppb)	Comments
MW-2	03/28/91	ND	2.2	2.7	1.1	730	
(cont)	06/25/91	ND	ND	ND	1.2	610	
	09/17/91	ND	ND	2.5	1.2	820	
	11/05/91	ND	ND	1.1	ND	700	
	02/18/92	ND	ND	1.9	ND	1600	
MW-3	05/29/87	5,400	3,900	1,700	5,200	40,300	
	07/14/87	6,880	7,080	1,580	4,770	30,320	
	08/17/87	5,930	4,180	1,240	3,370	25,620	
	09/01/87	8,540	6,660	1,020	3,740	38,210	
	12/10/87	4,240	2,350	890	1,860	25,000	
	03/10/88	3,210	950	940	950	13,400	
	06/14/88	5,900	7,600	450	4,600	54,000	
	12/05/88	4,200	2,400	1,000	3,100	19,000	
	03/08/89	11,000	9,400	2,300	9,900	53,000	Sheen
	06/22/89	16,000	5,900	2,100	6,600	60,000	Sheen
	09/27/89	8,100	2,800	1,200	4,300	34,000	
	12/29/89	NS	NS	NS	NS	NS	0.02 ft free-product
	03/29/90	NS	NS	NS	NS	NS	0.04 ft free-product
	06/21/90	19,000	22,000	22,000	120,000	2,100,000	
	09/25/90	NS	NS	NS	NS	NS	0.04 ft free-product
	12/18/90	NS	NS	NS	NS	NS	0.42 ft free-product
	03/28/91	NS	NS	NS	NS	NS	0.25 ft free-product
	06/25/91	NS	NS	NS	NS	NS	0.02 ft free-product
	09/17/91	NS	NS	NS	NS	NS	0.44 ft free-product
	11/05/91	NS	NS	NS	NS	NS	Sheen
	02/18/92	NS	NS	NS	NS	NS	Sheen
MW-4	12/05/88	ND	ND	2.3	6.5	4,500	
	03/08/89	ND	ND	ND	ND	3,900	
	06/22/89	ND	ND	ND	ND	1,500	
	09/27/89	11	ND	ND	ND	1,200	
	12/29/89	ND	2.1	2.3	ND	920	
	03/29/90	ND	ND	8	ND	870	
	06/21/90	ND	ND	ND	ND	1,500	
	09/25/90	ND	11	4.6	6	3,100	
	12/18/90	ND	4.4	15	6.3	3,600	
	03/28/91	8.9	4.4	4.4	2.2	2,000	
	06/25/91	ND	5.4	1.7	ND	2,000	

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

Well No.	Date Sampled	Benzene (ppb)	Toluene (ppb)	Ethyl Benzene (ppb)	Xylenes (ppb)	TPHG (ppb)	Comments
MW-4	09/17/91	ND	ND	0.8	ND	2,300	
(Con't)	11/05/91	ND	ND	3.2	1.1	3,500	
	02/18/92	ND	ND	12	21	5,100	
MW-5	12/05/88	ND	0.78	0.23	0.92	3.9	
	03/08/89	2.7	6.7	2.7	15	58	
	06/22/89	0.91	ND	ND	ND	5	
	09/27/89	1.3	ND	ND	ND	5.3	
	12/29/89	ND	ND	ND	ND	ND	
	03/29/90	ND	ND	ND	ND	ND	
	06/21/90	ND	ND	ND	ND	12	
	09/25/90	ND	ND	ND	ND	ND	
	12/18/90	ND	ND	ND	ND	ND	
	03/28/91	ND	ND	ND	ND	ND	
	06/25/91	ND	ND	ND	ND	ND	
	09/17/91	ND	ND	ND	ND	ND	
	11/05/91	ND	ND	ND	ND	ND	
	02/18/92	ND	ND	ND	ND	ND	
MW-6	12/05/88	4	1.3	0.63	1.3	190	
	03/08/89	2.2	ND	ND	1.1	23	
	06/22/89	0.82	2.6	0.18	1.2	57	
	09/27/89	0.2	0.24	ND	ND	2.1	
	12/29/89	ND	ND	ND	ND	ND	
	03/29/90	2.1	ND	ND	ND	12	
	06/21/90	ND	ND	ND	ND	ND	
	09/25/90	1.4	ND	ND	ND	98	
	12/18/90	2.2	ND	ND	ND	200	
	03/28/91	3.5	ND	ND	ND	140	
	06/25/91	ND	ND	ND	ND	95	
	09/17/91	ND	ND	ND	ND	ND	
	11/05/91	ND	ND	ND	ND	130	
	02/18/92	4.8	ND	ND	ND	370	
MW-7	12/05/88	140	150	40	370	1,500	
	03/08/89	730	72	180	370	2,400	
	06/22/89	570	43	180	220	2,000	
	09/27/89	420	5.9	140	28	1,400	
	12/29/89	87	3.5	18	15	150	

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

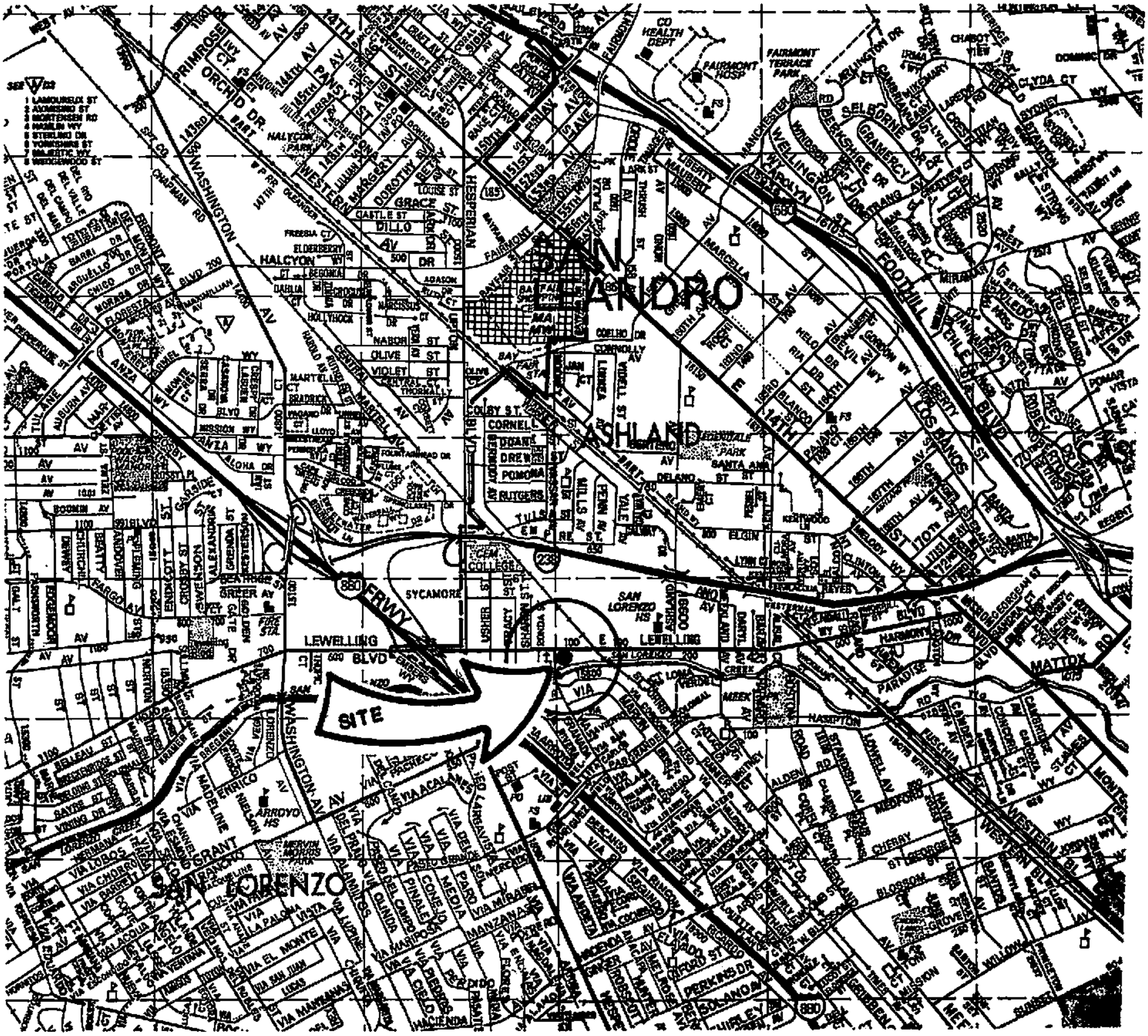
Well No.	Date Sampled	Benzene (ppb)	Toluene (ppb)	Ethyl Benzene (ppb)	Xylenes (ppb)	TPHG (ppb)	Comments
MW-7	03/29/90	110	40	53	150	530	
(con't)	06/21/90	620	34	290	400	4,100	
	09/25/90	49	2.4	30	42	750	
	12/18/90	74	4.5	25	69	510	
	03/28/91	53	0.8	24	24	500	
	06/25/91	23	ND	32	37	570	
	09/17/91	79	1	89	100	1,400	
	11/05/91	52	ND	76	58	1,100	
	02/18/92	16	ND	10	16	670	
MW-8	09/27/89	ND	ND	16	ND	4,200	
	12/29/89	ND	3.2	18	ND	2,800	
	03/29/90	ND	ND	19	ND	2,600	
	06/21/90	ND	ND	13	ND	4,600	
	09/25/90	2.3	22	16	26	4,500	
	12/18/90	0.7	6	9.7	2.3	1,100	
	03/28/91	2.6	4.6	3.2	3.1	1,600	
	06/25/91	ND	ND	2.5	1.3	760	
	09/17/91	ND	ND	13	3.9	1,900	
	11/05/91	ND	ND	15	ND	1,400	
	02/18/92	ND	ND	9.5	ND	1,200	
MW-9	09/27/89	ND	ND	ND	ND	25	
	12/29/89	ND	ND	ND	2.5	11	
	03/29/90	ND	ND	ND	ND	ND	
	06/21/90	ND	ND	ND	ND	ND	
	09/25/90	ND	ND	ND	ND	ND	
	12/18/90	ND	ND	ND	ND	100	
	03/28/91	ND	ND	ND	ND	ND	
	06/25/91	ND	ND	ND	ND	ND	
	09/17/91	ND	ND	ND	ND	ND	
	11/05/91	ND	ND	ND	ND	ND	
	02/18/92	ND	ND	ND	ND	ND	
MW-10	11/05/91	29	140	500	320	27,000	
	02/18/92	110	57	440	63	18,000	

TABLE 3

SUMMARY OF GROUNDWATER ANALYTICAL RESULTS

Well No.	Date Sampled	Benzene (ppb)	Toluene (ppb)	Ethyl Benzene (ppb)	Xylenes (ppb)	TPHG (ppb)	Comments
MW-11	11/05/91	ND	ND	ND	ND	890	
	02/18/92	ND	ND	ND	ND	2,400	
RW-1	11/13/91	74	68	7	99	1,600	

1. TPHG Total petroleum hydrocarbons as gasoline
2. ND - Not detected
3. NS - Not sampled
4. Samples prior to December 1988 collected by Applied GeoSystems
5. Sample from December 1988 through December 1990 collected by DuPont Environmental
6. Sample from March 1991 through September 1991 collected by Groundwater Technology



BASE MAP: THOMAS BROS. GUIDE ALAMEDA CO. 1991

LEGEND

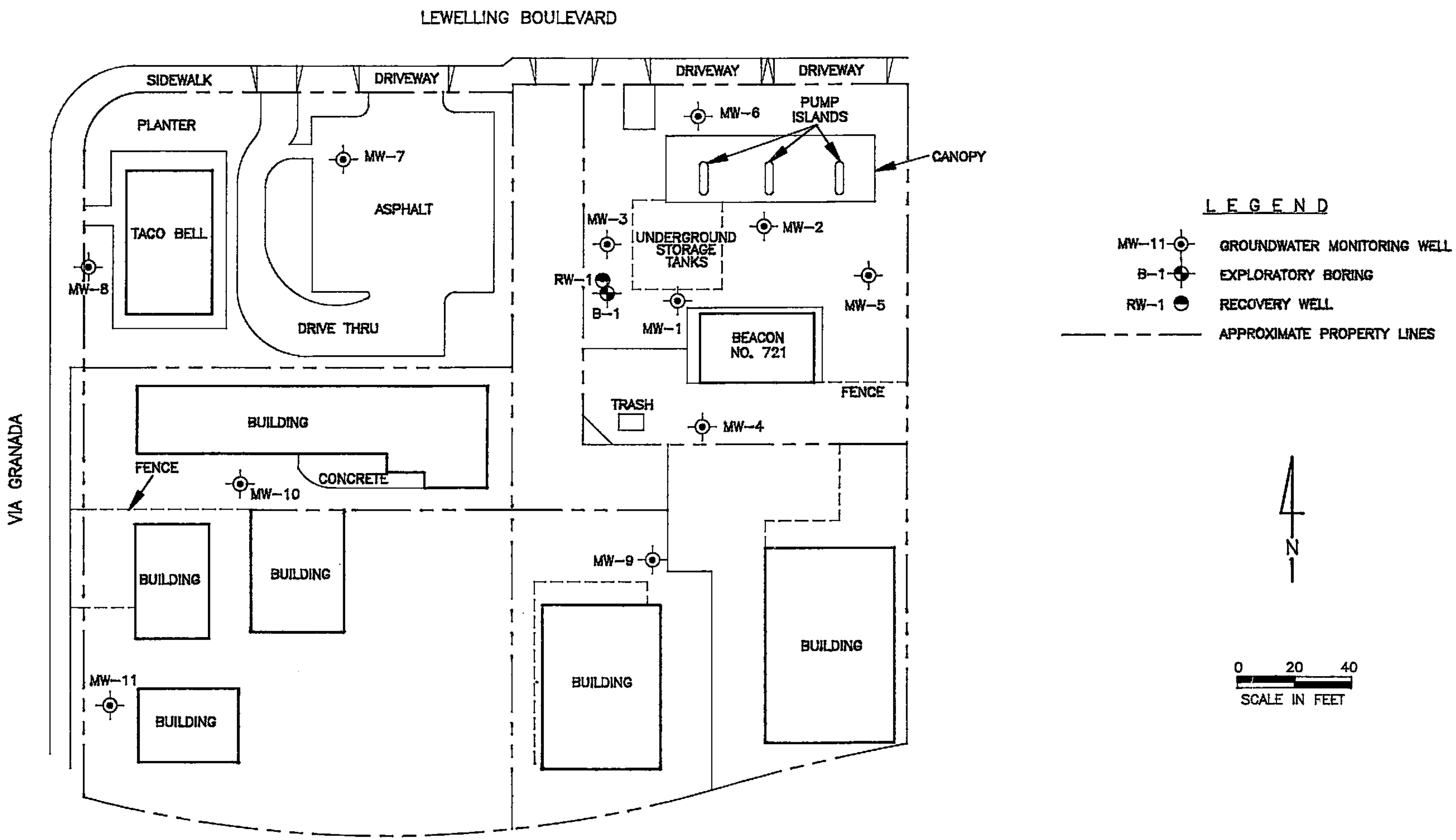
SITE LOCATION

0 1100 2200

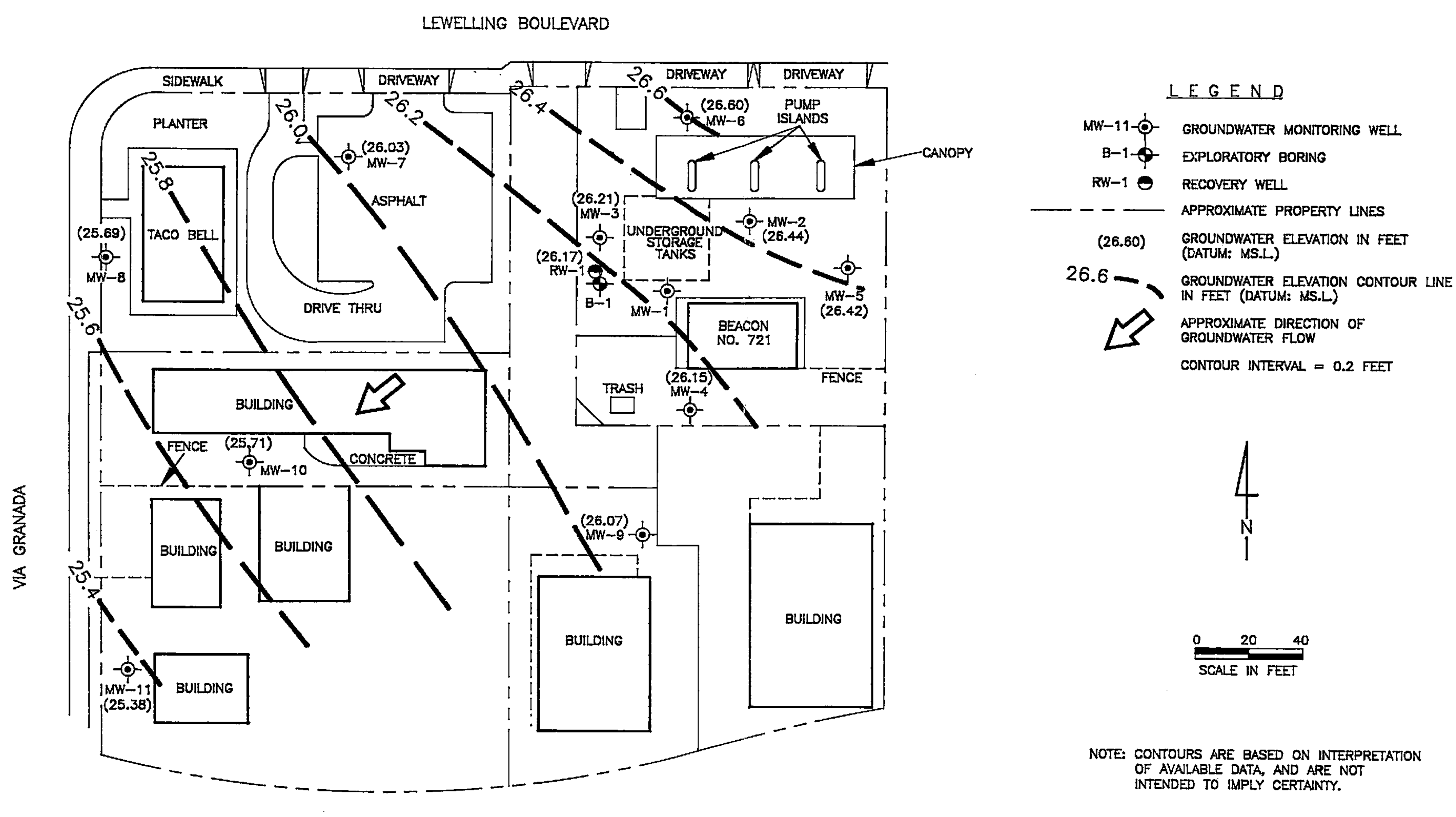
SCALE IN FEET

N

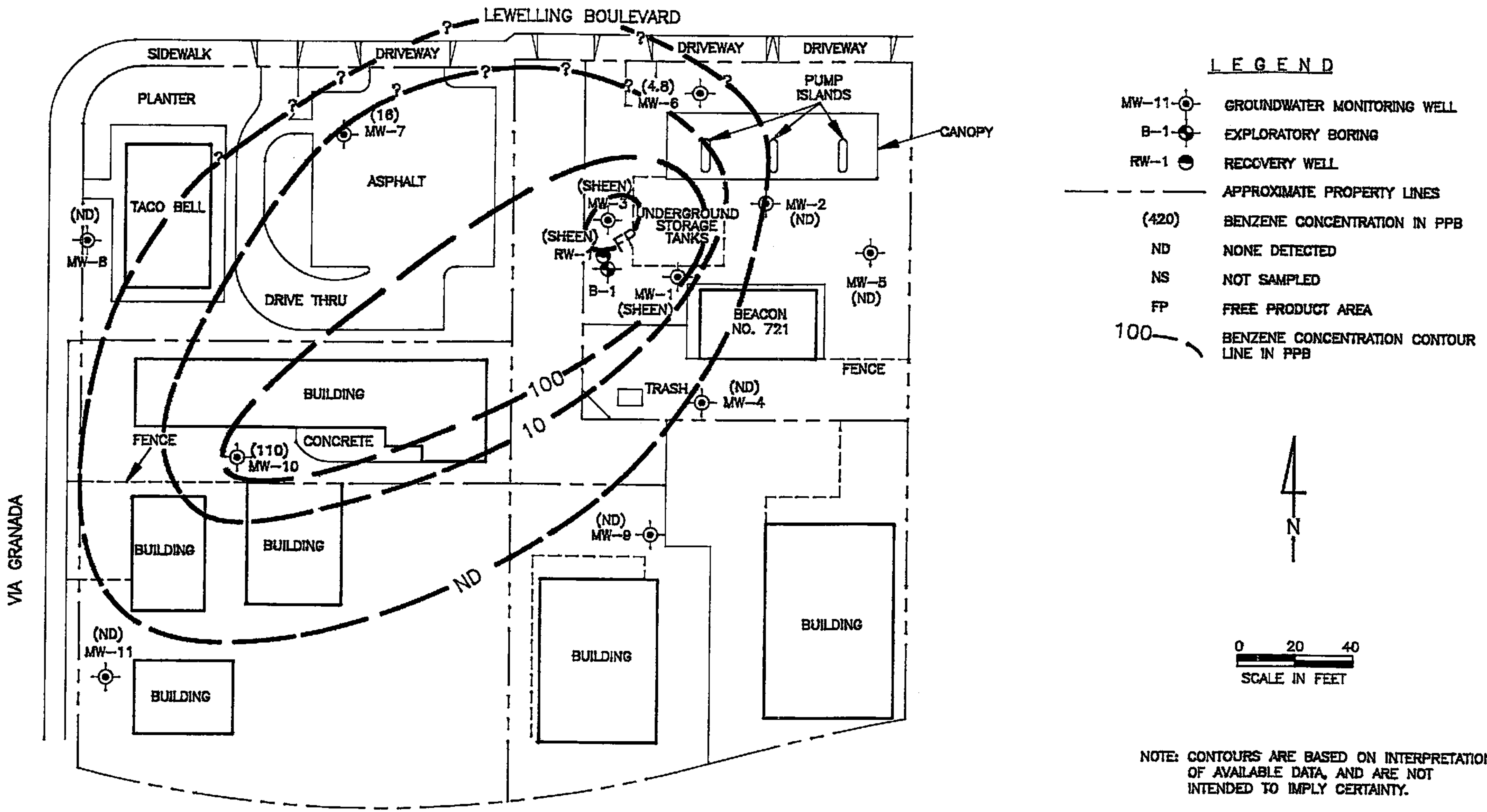
REVIEWED BY:	SITE LOCATION MAP	RESNA	
	ULTRAMAR BEACON STATION NO. 721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 330092-32	DRAWN BY: J.D.S.
	SAN LORENZO, CALIFORNIA	DATE: 1/8/92	DRAWING #: FIG. 1



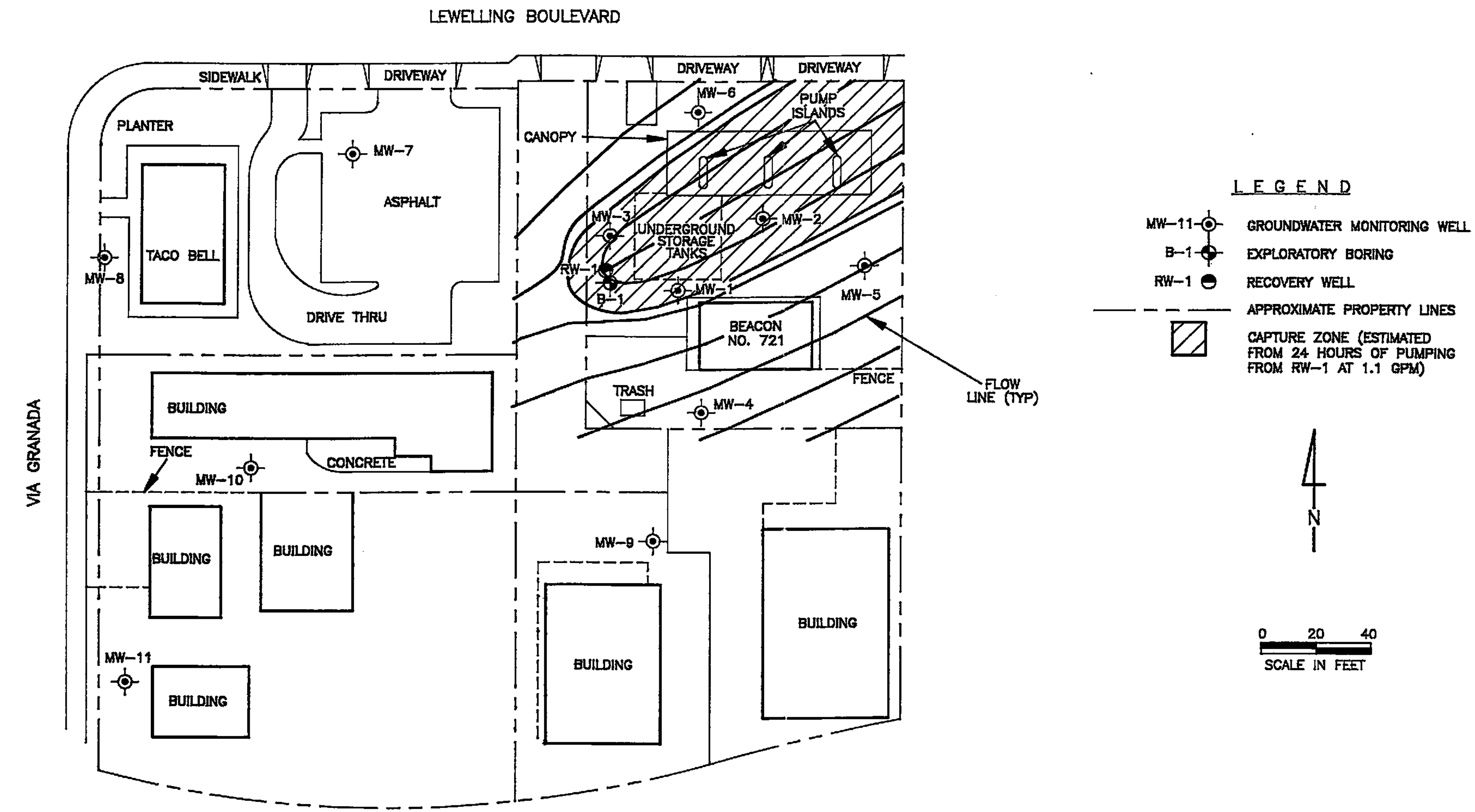
REVIEWED BY:	SITE PLAN	RESNA
	ULTRAMAR/BEACON STATION NO. 721	
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32 / DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 1/9/92 / DRAWING #: FIG. 2



REVIEWED BY: [signature]	GROUNDWATER ELEVATION CONTOUR MAP (2-18-92)	RESNA
	ULTRAMAR/BEACON STATION NO. 721	
APPROVED BY: [signature]	44 LEWELLING BOULEVARD	JOB #: 3-30092-32 / DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 3/9/92 / DRAWING #: FIG. 3



REVIEWED BY:	BENZENE CONCENTRATION MAP (2/18/92)	RESNA	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 3/18/92	DRAWING #: FIG. 4



REVIEWED BY:	COMPUTER GENERATED CAPTURE ZONE DIAGRAM BASED ON 24-HR PUMPTEST	RESNA	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY: PBW	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 3/18/92	DRAWING #: FIG. 5

APPENDIX A

PUMP TEST REPORT

1.0 Introduction / Purpose

RESNA Industries Inc., has conducted a shallow groundwater pump test at the subject site at the request of Ultramar, Inc. to determine aquifer parameter data for design and implementation of an interim groundwater treatment system. The test was conducted in a attempt to determine the following:

(1) Shallow aquifer characteristics;
(2) Feasibility of achieving hydraulic control beneath the site;
(3) Feasibility of using a recovery well to remove free product and groundwater;
(4) Delineating the zone of capture.

2.0 Background Data

To verify the validity of groundwater level changes recorded during the pump test, it was necessary to correlate those changes with the natural cycle of groundwater level fluctuations as measured over a period of time.

RESNA measured background fluctuations of groundwater levels from November 4 through November 11, 1991 by installing a pressure transducer in well RW-1. This sensor was linked with a Terrascience Systems, Ltd., Terra 8 Datalogger that recorded groundwater depths at regular time intervals. The transducer measured the pressure of the overlying water, which was converted by the Datalogger into feet of pressure head. Data stored in the Datalogger was downloaded into a portable, IBM-compatible computer on-site. The computer was also used to start, stop, and modify the Datalogger program. The background data is presented in Appendix A1.

A graph of the background fluctuation data is shown on Figure 2. The maximum 24-hour background fluctuation observed during the period in which the background data were collected was approximately 0.16 feet.

2.1 Equipment Setup

A Grundfos SP-1-9 submersible electric purge pump was installed in well RW-1. Electric power was supplied by a 230-volt AC, gasoline-driven generator. For the constant discharge test, five transducers were installed in wells RW-1, MW-1, MW-3, MW-4, and MW-5 to record groundwater depths at regular intervals. Discharged groundwater was carried from the pump by a plastic hose and run in series through a control valve and a 0 to 5 gallon per minute (gpm) flow meter. The extracted groundwater was then run to a portable 6,500-gallon closed-top, poly tank for storage. All equipment was cleaned prior to and following the pump tests.

2.2 Step/Drawdown Test

RESNA performed a step/drawdown test on November 21, 1991 in order to estimate the maximum sustainable discharge rate and acceptable drawdown for well RW-1. Pumping was started at an initial flow rate of 0.5 gpm and was increased to 1.5 gpm. At this rate the recovery well began to dewater. The results of this test indicated that the optimum discharge rate for recovery well RW-1 was approximately 1.1 gpm. The step-drawdown data is presented in Figure 3 and the data record for the step test is presented in Appendix A2.

2.3 Constant Discharge Pump Test/Recovery Test

Commencing on November 13, 1991, the pump was run at a constant discharge rate of 1.1 gpm and pumping was halted on November 14, 1991 after 24 hours. Monitoring of the recovery phase of the test was performed for 1.2 hours. Groundwater level data were acquired during the recovery phase until groundwater levels reached 90% recovery. Groundwater depths for all wells were also manually measured at 1-hour intervals with electronic sounders as a back-up measure against failure of the datalogger.

3.0 Analysis of Constant Duration Pump Test

Data obtained during the constant duration pump test from those wells with transducers (RW-1, MW-1, MW-3 MW-4, and MW-5) were downloaded from the Datalogger. The data were then processed using the Terrascience Systems, Ltd., Terra 8 software, and compiled into a data report (Appendix A3) using software from Golden Software, Inc. (Golden), on an IBM-PC-compatible computer. Data collected by manual electronic sounding from wells without transducers were tabulated by hand and compiled into data files using the Golden software. Drawdown data obtained from extraction well RW-1 was modified to eliminate casing storage effects associated with the pumping of unconfined aquifer systems. Groundwater contour maps were prepared from the files. An effective maximum radius of influence of approximately 30 feet around the extraction well was inferred from data taken at 23.8 hours into the test.

Data obtained from the pump test were analyzed using the Graphical Well Analysis Package by Groundwater Graphics on an IBM-PC-compatible computer. This software package calculates aquifer characteristics by using the Theis Nonequilibrium Well Equation. To apply this equation to the aquifer characteristics of this site, the Neuman (1975) modification of the Theis equation for water-table aquifers was used. This analysis makes the following generalized assumptions about the aquifer:

1. The aquifer is unconfined.
2. The aquifer is level and infinite in horizontal extent.
3. The aquifer is homogeneous and isotropic.
4. The pumping well fully penetrates the aquifer.
5. Discharge from the well is at a constant rate.
6. There is no storage within the well itself.
7. The aquifer response to drawdown is elastic (early response).

The Theis equation for elastic response of water-table aquifers is as follows:

$$T = Q/(4\pi s W(U_A, B))$$

Where: $U_A = (r^2 S_s)/(4Tt)$

$B = r^2/b^2$

T = transmissivity
Q = pumping rate
s = drawdown
W = well function
r = radial distance from pumping well
S_s = storativity coefficient
t = time since pumping started
b = initial standard thickness of aquifer

Sources: Dansby and Price (1987), p. B.7, eqs. B.7, B.8; Fetter (1988), p. 192, eqs. 6-48, 6-49

Hydraulic conductivity is calculated by:

$$K = T/b$$

Where: K = hydraulic conductivity
T = transmissivity
b = initial saturated thickness of aquifer

Figures 4 through 6 show Theis curve plots and values for transmissivity, aquifer thickness, hydraulic conductivity, and storativity for wells RW-1, MW-1 and MW-3. Test data for the other wells were not usable because of the short duration of the test. A summary of these results is given in Table 2.

Transmissivities were calculated from the data from observation well data and ranged from 5,250 gallons per day per foot (gpd/ft) in MW-1 to 6,320 gpd/ft in well MW-3. Hydraulic conductivity varied from 525 gpd/ft^2 for MW-1 to 486 gpd/ft^2 for MW-3.

The saturated aquifer thickness was approximately 10 feet for each well. Storativity coefficients varied from 0.01 for MW-3 to 0.04 for MW-1. These values are compiled in Table 2.

3.1 Analysis of Recovery Test

During the recovery phase of the test, water levels were measured by the Datalogger in wells that contained transducers. The Datalogger measured water levels beginning with approximately 1-second intervals, gradually lengthening to 40-minute intervals.

The data were plotted as residual drawdown (s') vs. the log of the ratio t/t" (where t = time since start of pumping and t" = time since pumping stopped). This is a modification of the Jacob Straight-Line Method (Driscoll, 1986, pp. 256-257). Transmissivity is calculated by the equation:

$$T = \frac{264\,Q}{\Delta s'}$$

Where:

- T = transmissivity in gpd/ft
- Q = pumping rate in gpm
- $\Delta s'$ = change in drawdown over one log cycle in feet
- 264 = conversion factor for gpm to gpd

The graph, calculations, and transmissivity from the recovery data for well RW-1 are shown in Figure 7 and the data is presented in Appendix A4. The transmissivity calculated from the recovery test data was 29.9 gpd/ft, which compares with 105 gpd/ft as calculated from the pumping test data (Figure 8). The values are within acceptable accuracy considering differences in measurement technique, data analysis, and change in aquifer storativity due to delayed yield of aquifer material following dewatering and recovery and site stratigraphy.

3.2 Capture Zone Analysis

Calculation of the capture zone was performed using the RESSQ semi-analytical contaminant transport model (Javandel, et al., 1987). The model uses a series of injection well points to (1) create point sources for flow lines and (2) generate a regional flow equivalent to the groundwater gradient observed beneath the site. The program then uses extraction well points to represent groundwater recovery wells using pumping rates determined from the pump tests. The model combines the equations for complex velocity potential, uniform flow, number of point sources, and point sinks to calculate the symmetry of the capture zone. The analysis makes the following assumptions about the aquifer: (1) the aquifer is of uniform thickness; and (2) a steady state flow (gradient and direction) exists beneath the site.

The capture zone configuration model was run using a pumping rate of 1.1 gpm. Figure 9 is a graphical representation of the flow lines and capture zone resulting from the simulated pumping of existing extraction well RW-1 at 1.1 gpm. The capture zone includes all on-site wells except monitoring wells MW-4, MW-5 and MW-6. Data used to generate the capture zone model are presented in Appendix A5.

4.0 Discussion and Conclusions

Results of the pump test indicate that the aquifer materials at the site are heterogeneous and anisotropic. The radius of influence for recovery well RW-1 has been determined by the analytical model to be approximately 15 feet. This radius appears to encompass the storage tank area. In RESNA's experience, a more reasonable radius of capture for this type of geology and area should be approximately 30 feet. Upon installation of the interim recovery system, long term monitoring will be performed to accurately determine the zone of capture and determine if further modifications will be necessary.

5.0 References

Dansby, D.A. and C.A. Price, 1987, Graphical Well Analysis Package, Version 2.0 - User Manual, Groundwater Graphics, Oceanside, CA., pp. B3 - B8.

Driscoll, G., 1986, Groundwater and Wells, Second Edition, Johnson Division, St. Paul, MN, pp. 256-260.

Fetter, C.W., 1988, Applied Hydrogeology, Second Edition, Merrill Publishing Company, Columbus, OH., p. 105, 192.

Javandel, I., C. Doughty, and C.E. Tsang, 1987, Groundwater Transport: Handbook of Mathematical Models, American Geophysical Union Water Resources Monograph No. 10, pp. 228.

Neuman, S.P., 1975, Analysis of pumping test data from unconfined aquifers considering delayed gravity response, Water Resources Res., 11, pp. 329-342.

TABLE 1

GROUNDWATER ELEVATION DATA

Pre-Pump Test
November 12, 1991

Well No.	Groundwater Elevation (Ft — Datum MSL)
MW-1	23.17
MW-2	23.26
MW-3	23.04
MW-4	23.15
MW-5	23.26
MW-6	23.28
MW-7	23.09
MW-8	22.94
MW-9	23.10
MW-10	22.95
MW-11	23.18
RW-1	23.12

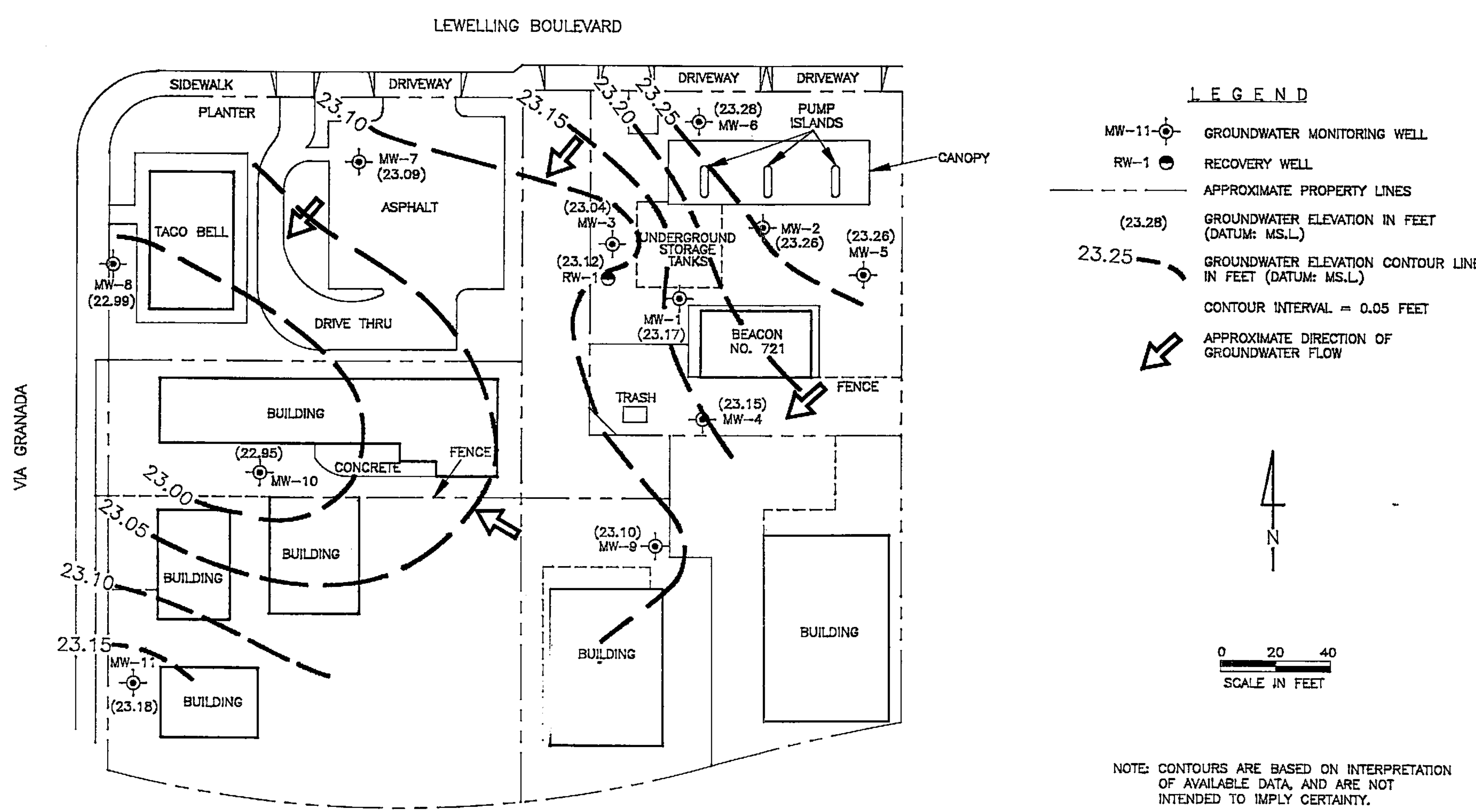
MSL = Mea sea level

TABLE 2

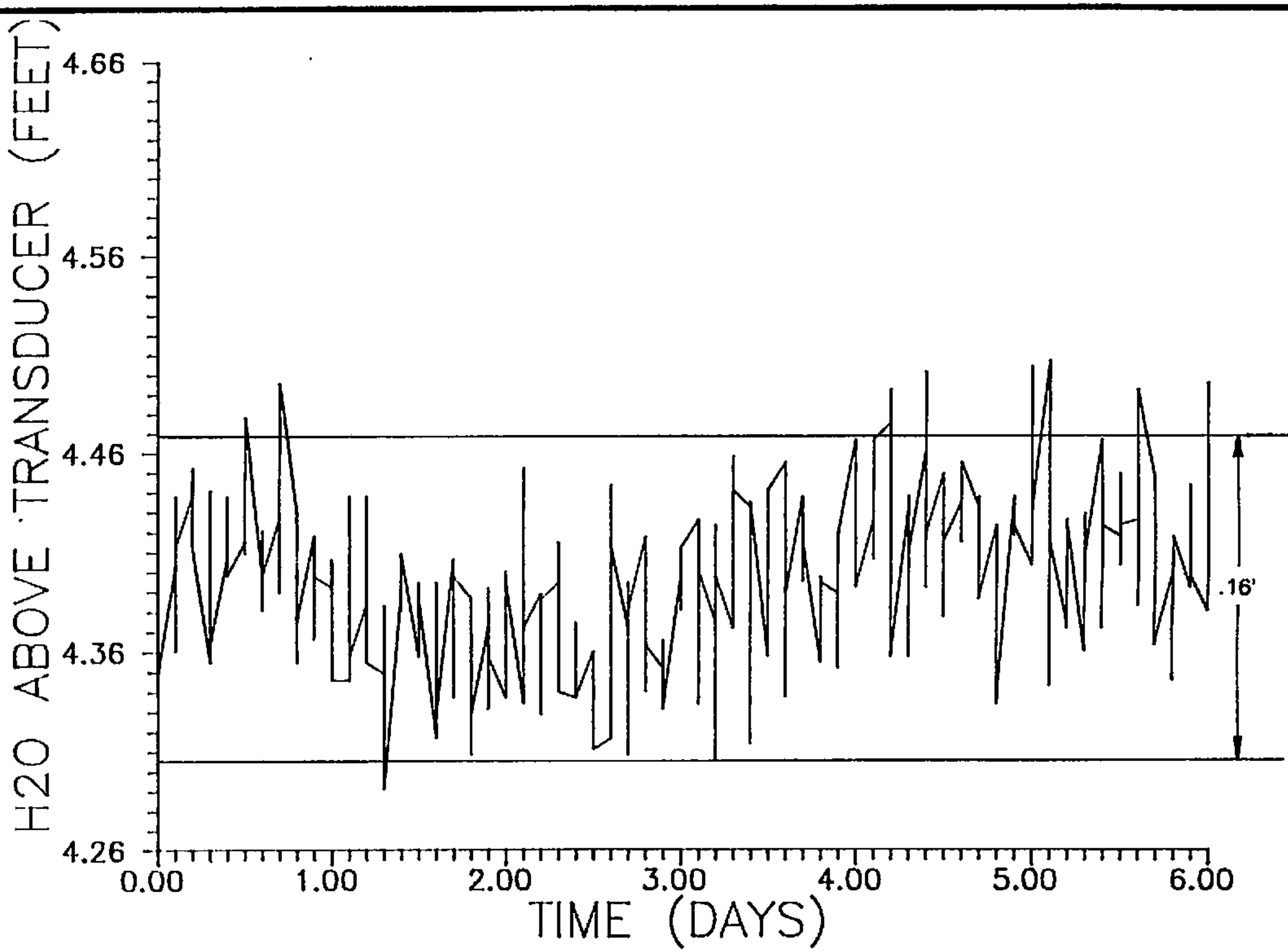
AQUIFER CHARACTERISTICS

Constant Discharge Pump Test Analysis

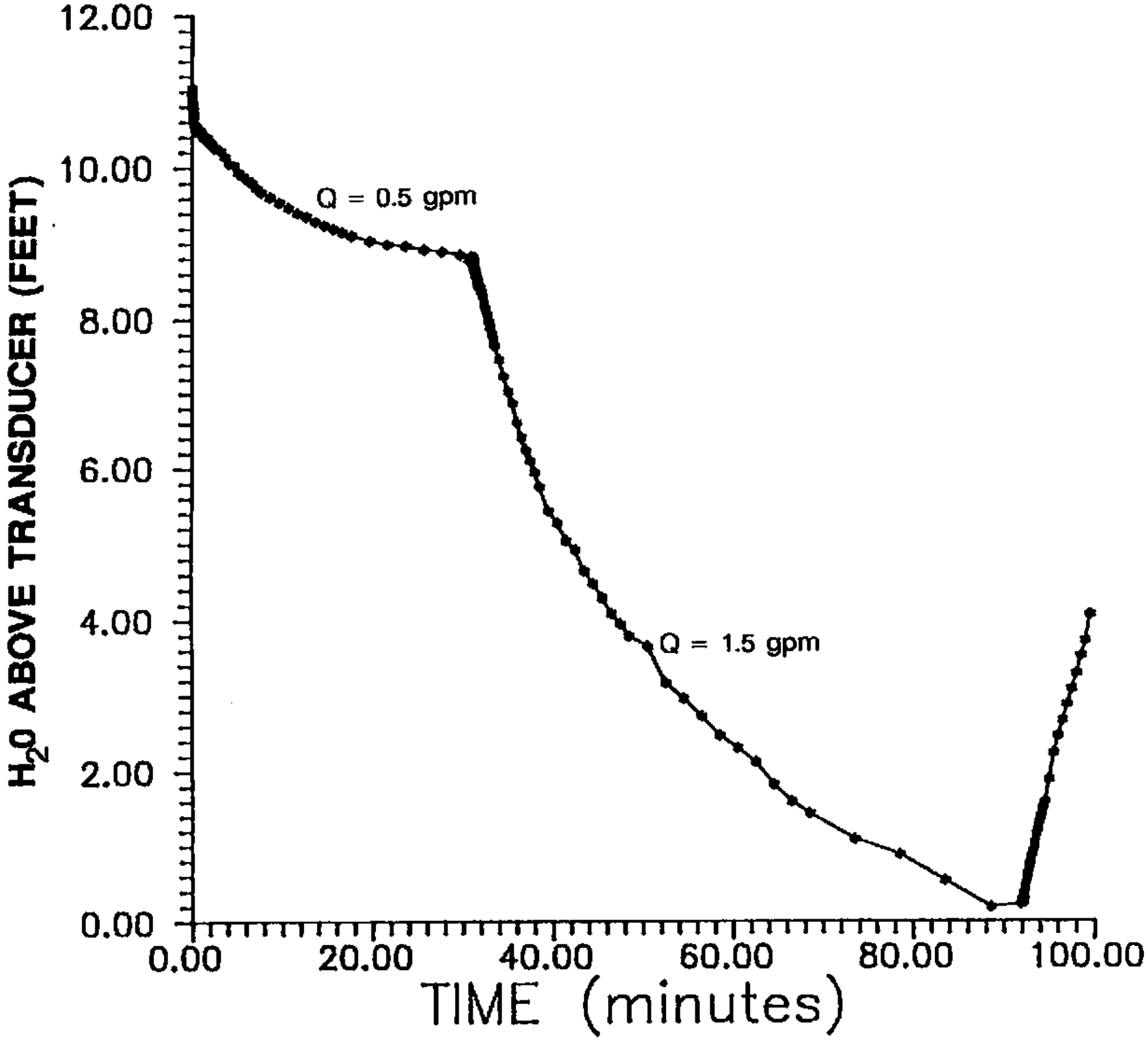
Well No.	Transmissivity (gpd/ft)	Saturated Aquifer Thickness (ft)	Hydraulic Conductivity (gpd/ft^2)	Storativity Coefficient
RW-1	105	15.0	7.0	0.02
MW-1	5,250	13.0	525.0	0.04
MW-3	6,320	13.0	486.0	0.02



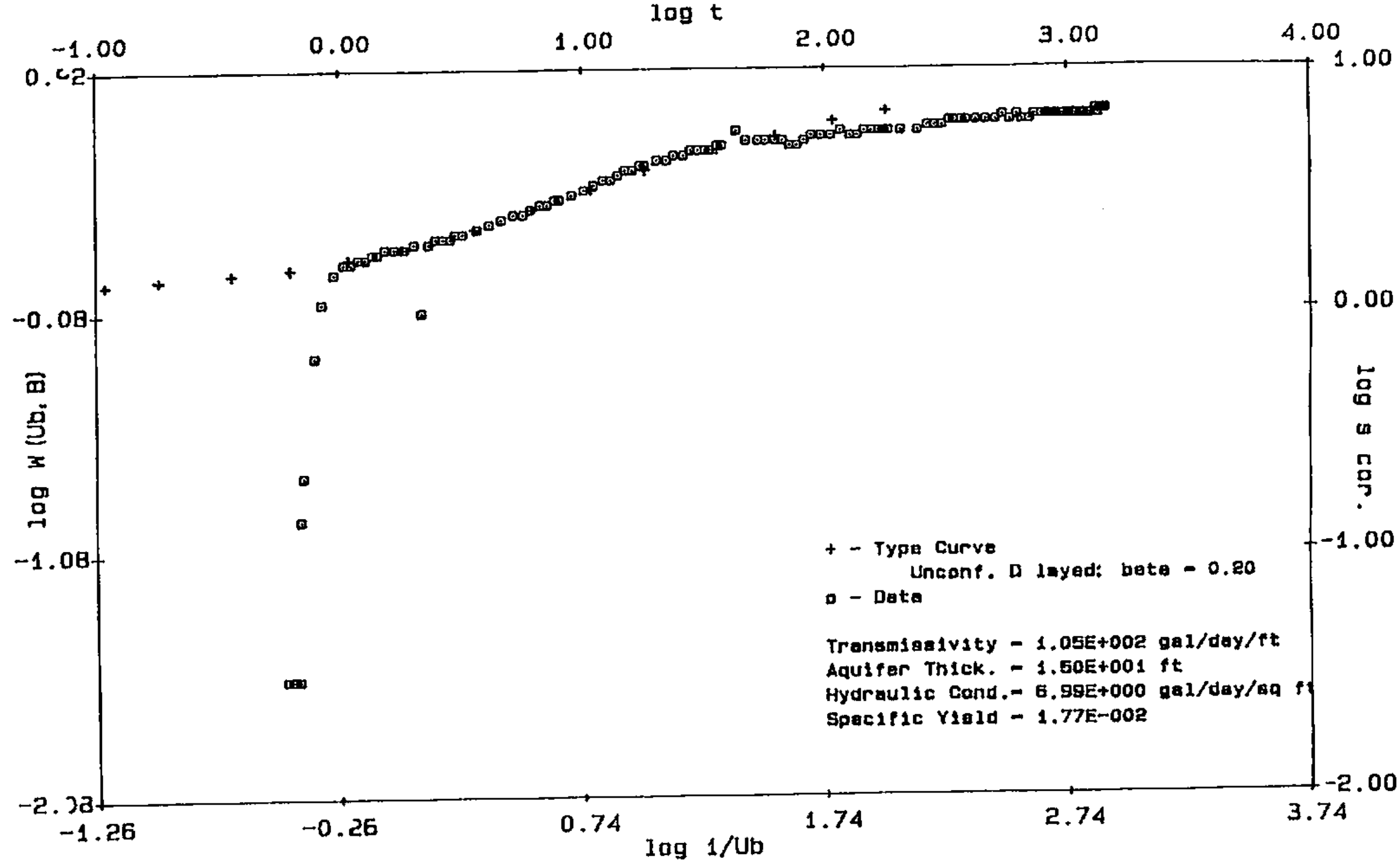
REVIEWED BY:	PRE-PUMPTEST CONTOUR LINES (11/12/91)	RESNA	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/19/92	DRAWING #: FIG. 1



REVIEWED BY:	**BACKGROUND RECOVERY WELL RW-1**	RESNA
	ULTRAMAR/BEACON STATION NO. 721	
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32 / DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/11/92 / DRAWING #: FIG. 2



REVIEWED BY:	RECOVERY WELL RW-1, STEP TEST DATA	RESNA	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/11/92	DRAWING #: FIG. 3



REVIEWED BY:	**PUMPTEST ANALYSIS RW-1**	RESNA
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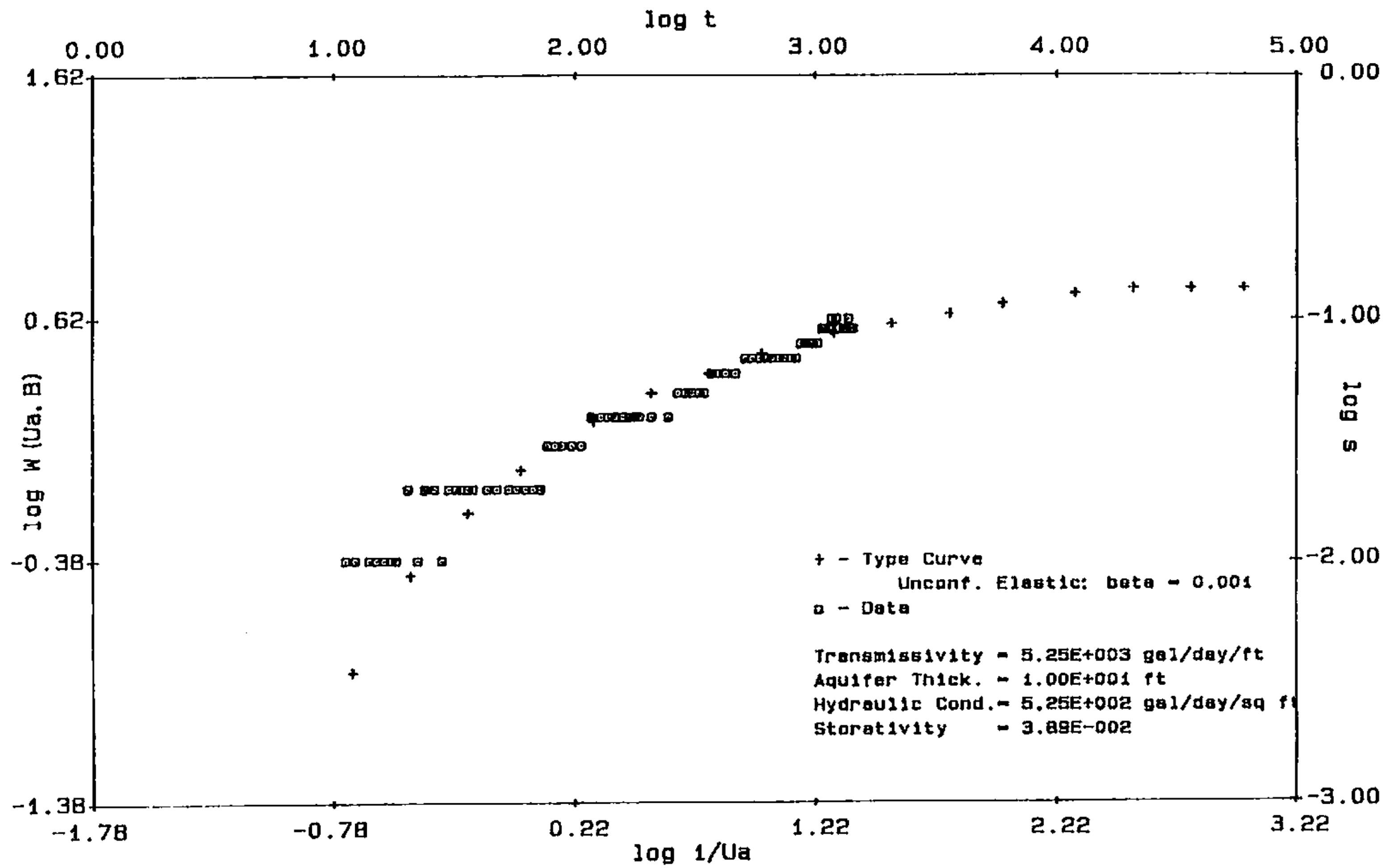
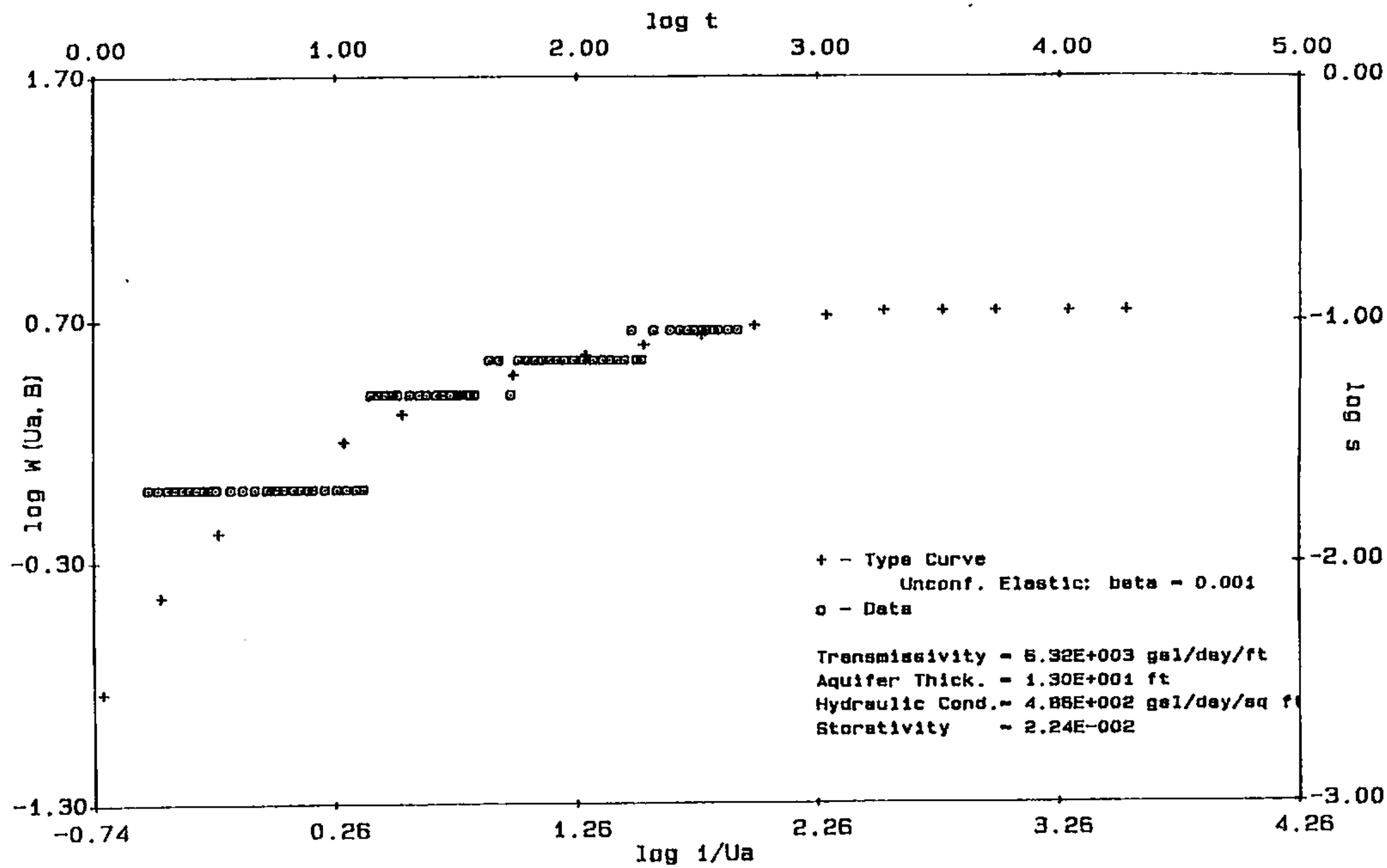
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32 — DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/11/92 — DRAWING #: FIG. 4



REVIEWED BY:	PUMPTEST ANALYSIS MW-1	RESNA	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/11/92	DRAWING #: FIG. 5



REVIEWED BY:

APPROVED BY:

PUMPTEST ANALYSIS MW-3

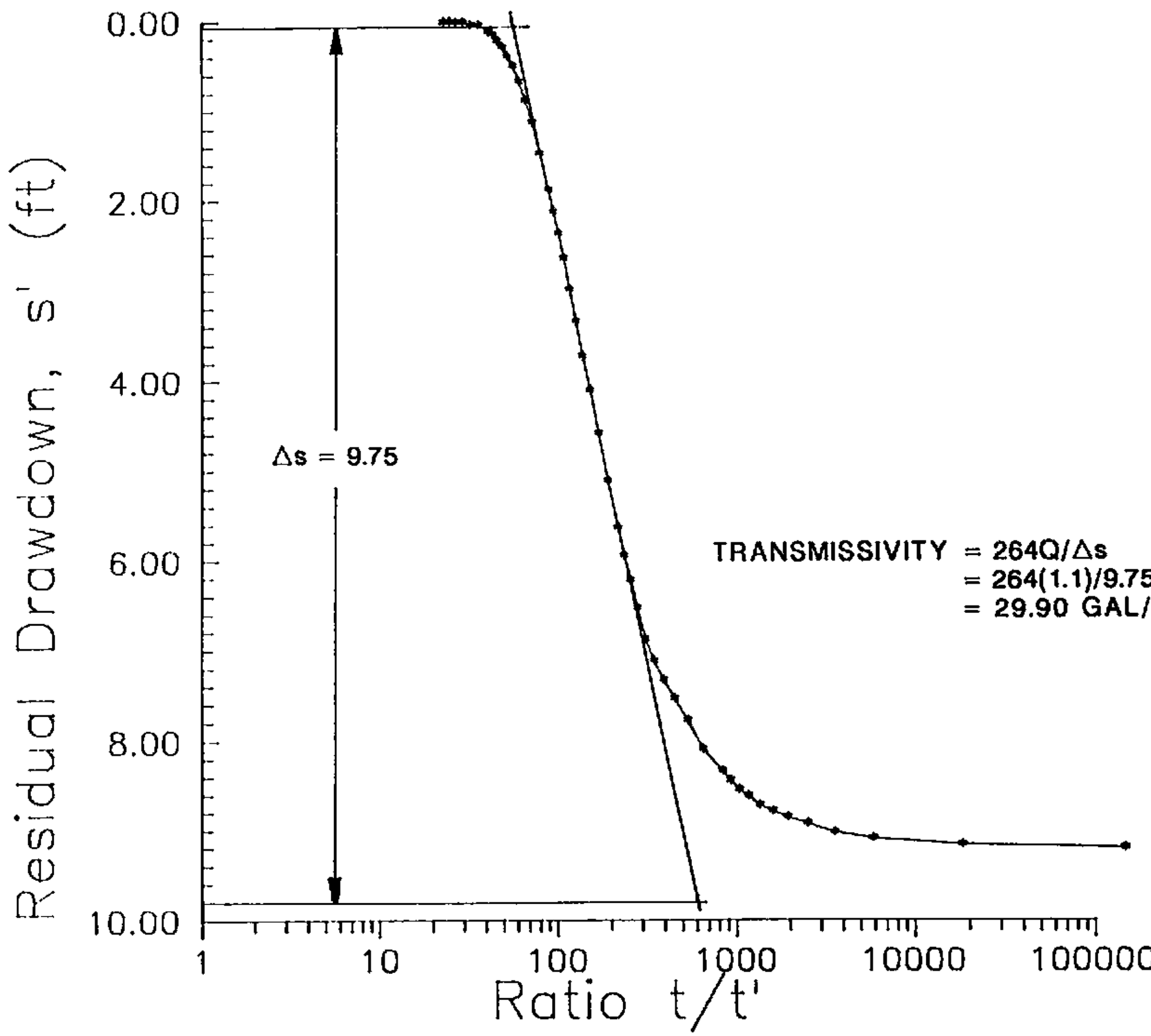
ULTRAMAR/BEACON STATION NO. 721

44 LEWELLING BOULEVARD

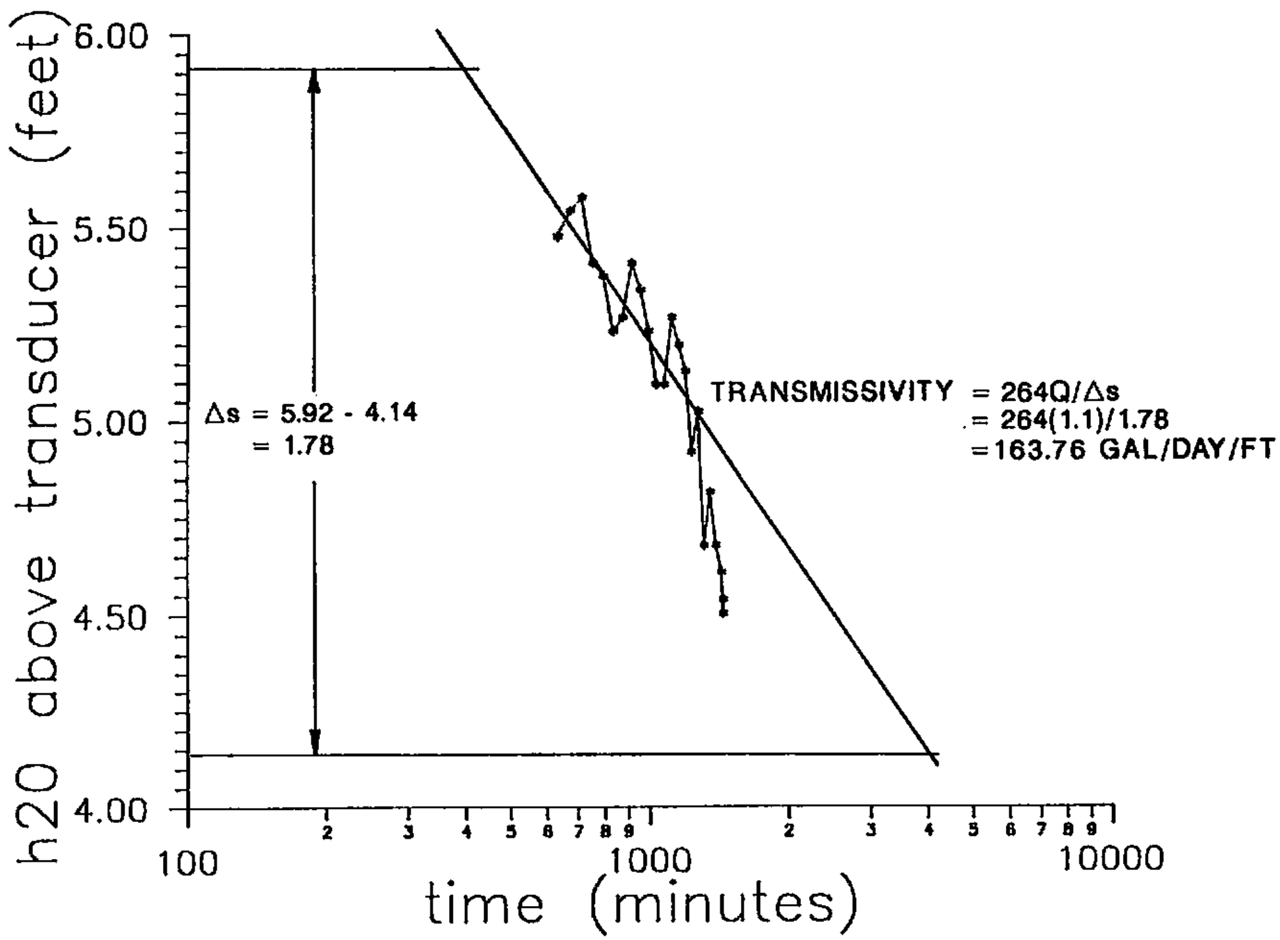
SAN LORENZO, CALIFORNIA

RESNA

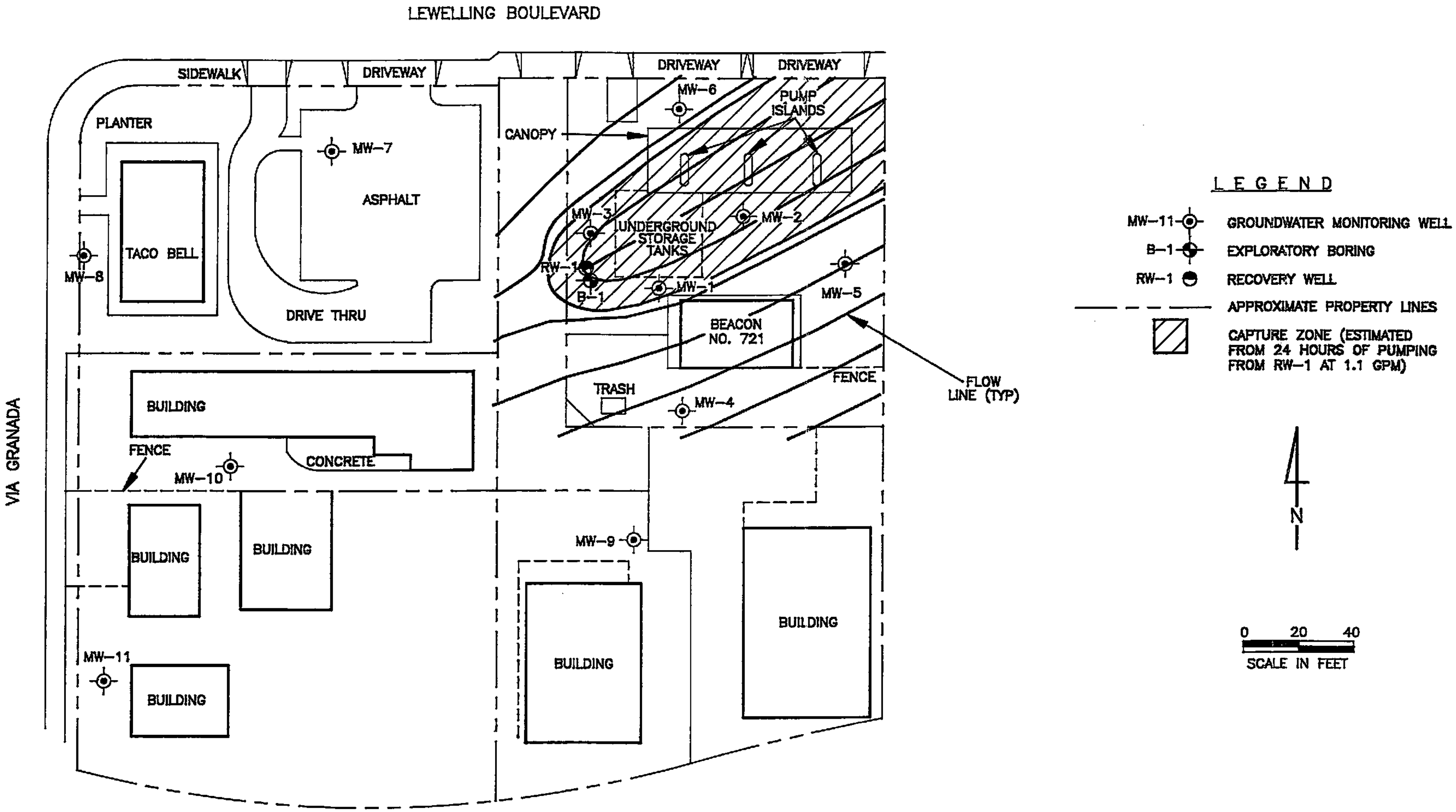
JOB #: 3-30092-32	DRAWN BY: E.C.
DATE: 2/11/92	DRAWING #: FIG. 6



REVIEWED BY:	**RECOVERY WELL RW-1**	RESNA
	ULTRAMAR/BEACON STATION NO. 721	
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32 / DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/11/92 / DRAWING #: FIG. 7



REVIEWED BY:	**PUMPTEST AFTER CASING STORAGE REMOVED**	**RESNA**	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 2/11/92	DRAWING #: FIG. 8



REVIEWED BY:	COMPUTER GENERATED CAPTURE ZONE DIAGRAM BASED ON 24-HR PUMPTEST	RESNA	
	ULTRAMAR/BEACON STATION NO. 721		
APPROVED BY: DM	44 LEWELLING BOULEVARD	JOB #: 3-30092-32	DRAWN BY: E.C.
	SAN LORENZO, CALIFORNIA	DATE: 3/18/92	DRAWING #: FIG. 9

APPENDIX A1

PUMP TEST
GROUNDWATER FLUCTUATION
DATA

BACKGROUND DATA WELL RW-1

*

1:	*0.000000E+000	4.3948
2:	0.000000E+000	4.337
3:	0.000000E+000	4.3486
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5:	1.015630E-001	4.4381
6:	1.015630E-001	4.3601
7:	1.015630E-001	4.3832
8:	1.015630E-001	4.4121
9:	1.992190E-001	4.4381
10:	1.992190E-001	4.4525
11:	1.992190E-001	4.4179
12:	1.992190E-001	4.4439
13:	1.992190E-001	4.4121
14:	3.007810E-001	4.3543
15:	3.007810E-001	4.4294
16:	3.007810E-001	4.441
17:	3.007810E-001	4.4005
18:	3.007810E-001	4.363
19:	3.984380E-001	4.4063
20:	3.984380E-001	4.415
21:	3.984380E-001	4.3977
22:	3.984380E-001	4.4381
23:	3.984380E-001	4.3977
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29:	6.015630E-001	4.3803
30:	6.015630E-001	4.3919
31:	6.015630E-001	4.4208
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34:	6.992190E-001	4.3919
35:	6.992190E-001	4.389
36:	6.992190E-001	4.4381
37:	6.992190E-001	4.4958
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283: 5.89844 4.3919
284: 5.89844 4.4265
285: 5.89844 4.4034
286: 5.89844 4.4439
287: 5.89844 4.3977
288: 6 4.3803
289: 6 4.441
290: 6 4.4092
291: 6 4.4958

APPENDIX A2

PUMP TEST
STEP & DRAWDOWN DATA

STEP DRAWDOWN DATA WELL RW-1

```
*
"                  Terra8 Data Collection Report"

"Firmware Version                        6.1/87"
"Number of Bytes in Data Dump             2052"
"User Supplied Comment                  STEPTEST ULTRAMAR 721        "
"Time Header Block Loaded               11/11  22:47:04.30  "
"Time Data File Dumped                  11/12  23:03:58.50  "
"Remaining Memory                        63484"
"Number of Logs                            193"
"Type of Data Memory                    Memory Board"
"Logs/Timestamp                           1"
"Power was OK During Data Collection Period"


"                        Terra8 Channel Setup:"
"Number of Declared Analog Channels =  1"
"_____________________________________________________________________________"
"Ch#___Description_______Units___Delay______M__________B____"
" 1 RW-1............... FEET....    100      4.620      0.000"
"_____________________________________________________________________________"

"                        Terra8 Channel Setup:"

"Number of Declared Digital Channels =  0"
"_____________________________________________________________________________"
"Ch#___Description_______Units___Delay______M__________B____"
"_____________________________________________________________________________"

"*Initial Scan at "11 11 22 47 4 10
"*Next Scan at    "11 11 22 47 4 10

"      Time                "" Analog#01"
```

0.00	11.042
1.30	10.996
2.30	10.949
3.30	10.903
4.70	10.834
5.20	10.811
6.30	10.788
7.30	10.741
8.30	10.695
9.30	10.695
10.30	10.672
15.30	10.557
20.30	10.534
25.30	10.534
30.30	10.534
35.30	10.510
40.30	10.487
45.30	10.487
50.30	10.464
55.30	10.464
60.30	10.464
70.30	10.418
80.30	10.395
90.30	10.395
100.30	10.372
110.30	10.349
120.30	10.326

[illegible]	1[illegible]	10.[illegible]
64:	140.30	10.279
65:	150.30	10.256
66:	160.30	10.256
67:	190.30	10.210
68:	220.30	10.141
69:	250.30	10.048
70:	280.30	10.025
71:	310.30	9.933
72:	340.30	9.887
73:	370.30	9.841
74:	400.30	9.794
75:	430.30	9.725
76:	460.30	9.679
77:	520.30	9.610
78:	580.30	9.540
79:	640.30	9.471
80:	700.30	9.402
81:	760.30	9.355
82:	820.30	9.286
83:	880.30	9.240
84:	940.30	9.194
85:	1000.30	9.148
86:	1060.30	9.101
87:	1180.30	9.032
88:	1300.30	8.986
89:	1420.30	8.963
90:	1540.30	8.917
91:	1660.30	8.893
92:	1780.30	8.847
93:	1851.00	8.824
94:	1852.30	8.824
95:	1853.30	8.824
96:	1854.30	8.824
97:	1855.30	8.801
98:	1856.30	8.801
99:	1857.30	8.778
100:	1858.70	8.778
101:	1859.20	8.778
102:	1860.30	8.755
103:	1861.30	8.755
104:	1866.30	8.709
105:	1871.30	8.686
106:	1876.30	8.639
107:	1881.30	8.616
108:	1886.30	8.570
109:	1891.30	8.547
110:	1896.30	8.501
111:	1901.30	8.455
112:	1906.30	8.431
113:	1911.30	8.408
114:	1921.30	8.362
115:	1931.30	8.293
116:	1941.30	8.200
117:	1951.30	8.131
118:	1961.30	8.062
119:	1971.30	7.969
120:	1981.30	7.900
121:	1991.30	7.808
122:	2001.30	7.738
123:	2011.30	7.646
124:	2041.30	7.461
125:	2071.30	7.230
126:	2101.30	7.022
127:	2131.30	6.841

[illegible]	[illegible]	[illegible]
131:	2251.30	6.098
132:	2281.30	5.937
133:	2311.30	5.752
134:	2371.30	5.428
135:	2431.30	5.267
136:	2491.30	5.036
137:	2551.30	4.920
138:	2611.30	4.643
139:	2671.30	4.481
140:	2731.30	4.297
141:	2791.30	4.089
142:	2851.30	3.950
143:	2911.30	3.788
144:	3031.30	3.650
145:	3151.30	3.165
146:	3271.30	2.957
147:	3391.30	2.726
148:	3511.30	2.472
149:	3631.30	2.310
150:	3751.30	2.125
151:	3871.30	1.825
152:	3991.30	1.594
153:	4111.30	1.432
154:	4411.30	1.086
155:	4711.30	0.878
156:	5011.30	0.531
157:	5311.30	0.185
158:	5511.60	0.231
159:	5513.30	0.254
160:	5514.30	0.231
161:	5515.70	0.254
162:	5516.20	0.277
163:	5517.30	0.277
164:	5518.30	0.277
165:	5519.30	0.300
166:	5520.30	0.300
167:	5521.30	0.323
168:	5522.30	0.323
169:	5527.30	0.370
170:	5532.30	0.416
171:	5537.30	0.462
172:	5542.30	0.508
173:	5547.30	0.554
174:	5552.30	0.601
175:	5557.30	0.647
176:	5562.30	0.693
177:	5567.30	0.739
178:	5572.30	0.785
179:	5582.30	0.878
180:	5592.30	0.947
181:	5602.30	1.039
182:	5612.30	1.155
183:	5622.30	1.224
184:	5632.30	1.317
185:	5642.30	1.386
186:	5652.30	1.455
187:	5662.30	1.525
188:	5672.30	1.594
189:	5702.30	1.894
190:	5732.30	2.241
191:	5762.30	2.472
192:	5792.30	2.680
193:	5822.30	2.887
194:	5852.30	3.095

[illegible]	5882.30	[illegible]
196:	5912.30	3.534
197:	5942.30	3.742
198:	5972.30	4.089
199:	6032.30	0.000
200:	6092.30	0.000
201:	6152.30	0.000
202:	6212.30	0.000
203:	6272.30	0.000
204:	6332.30	0.000
205:	6392.30	0.000
206:	6452.30	0.000
207:	6512.30	0.000
208:	6572.30	0.000
209:	6692.30	0.000
210:	6812.30	0.000
211:	6932.30	0.000
212:	7052.30	0.000
213:	7172.30	0.000
214:	7292.30	0.000
215:	7412.30	0.000
216:	7532.30	0.000
217:	7652.30	0.000
218:	7772.30	0.000
219:	8072.30	0.000
220:	8372.30	0.000
221:	8672.30	0.000
222:	8972.30	0.000
223:	9272.30	0.000
224:	9572.30	0.000
225:	9872.30	0.000
226:	10172.30	0.000
227:	10472.30	0.000
228:	10772.30	0.000

229: "*Last Scan at "11 12 1 46 36 40

STEP DRAWDOWN RECOVERY DATA

*

```
1:*1 14.137 1.000000E-001
2: 31.7 14.172 5.283330E-001
3: 33.5 14.137 5.583330E-001
4: 34.5 14.137 5.750000E-001
5: 35.5 14.172 5.916670E-001
6: 36.5 14.137 6.083330E-001
7: 38.2 14.137 6.366670E-001
8: 38.9 14.137 6.483330E-001
9: 39.6 14.137 6.600000E-001
10: 40.3 14.137 6.716670E-001
11: 41.5 14.033 6.916670E-001
12: 42.5 13.964 7.083330E-001
13: 47.5 13.479 7.916670E-001
14: 52.5 13.028 8.750000E-001
15: 57.5 12.647 9.583330E-001
16: 62.5 12.509 1.04167
17: 67.5 12.509 1.125
18: 72.5 12.405 1.20833
19: 77.5 12.37 1.29167
20: 82.5 12.301 1.375
21: 87.5 12.301 1.45833
22: 92.5 12.266 1.54167
23: 102.5 12.231 1.70833
24: 112.5 12.197 1.875
25: 122.5 12.162 2.04167
26: 132.5 12.127 2.20833
27: 142.5 12.093 2.375
28: 152.5 12.058 2.54167
29: 162.5 12.024 2.70833
30: 172.5 11.989 2.875
31: 182.5 11.954 3.04167
32: 192.5 11.92 3.20833
33: 222.5 11.816 3.70833
34: 252.5 11.677 4.20833
35: 282.5 11.538 4.70833
36: 312.5 11.469 5.20833
37: 342.5 11.365 5.70833
38: 372.5 11.261 6.20833
39: 402.5 11.157 6.70833
40: 432.5 11.053 7.20833
41: 462.5 10.984 7.70833
42: 492.5 10.88 8.20833
43: 552.5 10.741 9.20833
44: 612.5 10.534 10.2083
45: 672.5 10.395 11.2083
46: 732.5 10.256 12.2083
47: 792.5 10.152 13.2083
48: 852.5 9.979 14.2083
49: 912.5 9.806 15.2083
50: 972.5 9.633 16.2083
51: 1032.5 9.494 17.2083
52: 1092.5 9.39 18.2083
53: 1212.5 9.182 20.2083
54: 1332.5 9.113 22.2083
55: 1452.5 9.009 24.2083
56: 1572.5 8.801 26.2083
57: 1692.5 8.662 28.2083
58: 1812.5 8.524 30.2083
59: 1932.5 8.42 32.2083
60: 2052.5 8.385 34.2083
61: 2172.5 8.351 36.2083
62: 2292.5 8.351 38.2083
```

65:	3192.5	7.727	53.2083
66:	3492.5	7.796	58.2083
67:	3792.5	7.762	63.2083
68:	4092.5	7.623	68.2083
69:	4392.5	8.073	73.2083
70:	4692.5	8.073	78.2083
71:	4992.5	7.796	83.2083
72:	5292.5	7.588	88.2083
73:	5892.5	7.519	98.2083
74:	6492.5	7.554	108.208
75:	7092.5	7.103	118.208
76:	7692.5	7.242	128.208
77:	8292.5	7.207	138.208
78:	8892.5	7.138	148.208
79:	9492.5	7.034	158.208
80:	10092.5	6.965	168.208
81:	10692.5	7.242	178.208
82:	11292.6	7.103	188.21
83:	12492.5	6.757	208.208
84:	13692.5	6.583	228.208
85:	14892.5	6.722	248.208
86:	16092.5	6.653	268.208
87:	17292.5	6.41	288.208
88:	18492.5	6.376	308.208
89:	19692.5	6.029	328.208
90:	20892.5	5.96	348.208
91:	22092.5	5.994	368.208
92:	23292.6	5.821	388.21
93:	25692.5	5.925	428.208
94:	28092.5	5.787	468.208
95:	30492.5	5.579	508.208
96:	32892.5	5.371	548.208
97:	35292.5	5.683	588.208
98:	37692.5	5.475	628.208
99:	40092.5	5.544	668.208
100:	42492.5	5.579	708.208
101:	44892.5	5.405	748.208
102:	47292.5	5.371	788.208
103:	49692.5	5.232	828.208
104:	52092.5	5.267	868.208
105:	54492.5	5.405	908.208
106:	56892.5	5.336	948.208
107:	59292.5	5.232	988.208
108:	61692.5	5.094	1028.21
109:	64092.5	5.094	1068.21
110:	66492.5	5.267	1108.21
111:	68892.5	5.197	1148.21
112:	71292.5	5.128	1188.21
113:	73692.5	4.92	1228.21
114:	76092.5	5.024	1268.21
115:	78492.5	4.678	1308.21
116:	80892.5	4.816	1348.21
117:	83292.5	4.678	1388.21
118:	85692.5	4.608	1428.21
119:	86369.6	4.504	1439.49
120:	86370.9	4.539	1439.52
121:	86371.6	4.539	1439.53
122:	86372.3	4.539	1439.54

APPENDIX A3

CONSTANT DURATION PUMP TEST DATA

WELL RW-1

1:	*31.7	7.773
2:	33.5	7.773
3:	34.5	7.773
4:	35.5	7.773
5:	36.5	7.773
6:	38.2	7.773
7:	38.9	7.773
8:	39.6	7.773
9:	40.3	7.773
10:	41.5	7.773
11:	42.5	7.773
12:	47.5	7.773
13:	52.5	7.773
14:	57.5	7.773
15:	62.5	7.773
16:	67.5	7.773
17:	72.5	7.773
18:	77.5	7.773
19:	82.5	7.773
20:	87.5	7.773
21:	92.5	7.773
22:	102.5	7.773
23:	112.5	7.773
24:	122.5	7.773
25:	132.5	7.773
26:	142.5	7.773
27:	152.5	7.773
28:	162.5	7.762
29:	172.5	7.773
30:	182.5	7.773
31:	192.5	7.773
32:	222.5	7.773
33:	252.5	7.762
34:	282.5	7.773
35:	312.5	7.773
36:	342.5	7.773
37:	372.5	7.762
38:	402.5	7.773
39:	432.5	7.773
40:	462.5	7.773
41:	492.5	7.773
42:	552.5	7.773
43:	612.5	7.773
44:	672.5	7.762
45:	732.5	7.762
46:	792.5	7.773
47:	852.5	7.762
48:	912.5	7.762
49:	972.5	7.762
50:	1032.5	7.762
51:	1092.5	7.762
52:	1212.5	7.75
53:	1332.5	7.762
54:	1452.5	7.75
55:	1572.5	7.75
56:	1692.5	7.762
57:	1812.5	7.75
58:	1932.5	7.75
59:	2052.5	7.75
60:	2172.5	7.75
61:	[illegible]	[illegible]

63:	2892.5	7.75
64:	3192.5	7.75
65:	3492.5	7.75
66:	3792.5	7.75
67:	4092.5	7.75
68:	4392.5	7.75
69:	4692.5	7.738
70:	4992.5	7.738
71:	5292.5	7.738
72:	5892.5	7.738
73:	6492.5	7.738
74:	7092.5	7.727
75:	7692.5	7.727
76:	8292.5	7.727
77:	8892.5	7.738
78:	9492.5	7.727
79:	10092.5	7.727
80:	10692.5	7.727
81:	11292.6	7.727
82:	12492.5	7.727
83:	13692.5	7.727
84:	14892.5	7.727
85:	16092.5	7.715
86:	17292.5	7.715
87:	18492.5	7.715
88:	19692.5	7.715
89:	20892.5	7.715
90:	22092.5	7.704
91:	23292.6	7.704
92:	25692.5	7.704
93:	28092.5	7.704
94:	30492.5	7.692
95:	32892.5	7.692
96:	35292.5	7.692
97:	37692.5	7.692
98:	40092.5	7.692
99:	42492.5	7.692
100:	44892.5	7.692
101:	47292.5	7.692
102:	49692.5	7.692
103:	52092.5	7.681
104:	54492.5	7.692
105:	56892.5	7.692
106:	59292.5	7.692
107:	61692.5	7.692
108:	64092.5	7.681
109:	66492.5	7.681
110:	68892.5	7.681
111:	71292.5	7.669
112:	73692.5	7.669
113:	76092.5	7.681
114:	78492.5	7.681
115:	80892.5	7.681
116:	83292.5	7.669
117:	85692.5	7.681
118:	86369.6	7.681
119:	86370.9	7.681
120:	86371.6	7.681
121:	86372.3	7.681
122:	86373.5	7.681
123:	86374.5	7.681
124:	86375.5	7.681
125:	86376.5	7.681
126:	86377.5	7.681

[illegible]	[illegible]	[illegible]
129:	86384.5	7.681
130:	86389.5	7.681
131:	86394.5	7.681
132:	86399.5	7.681
133:	86404.5	7.681
134:	86409.5	7.681
135:	86414.5	7.669
136:	86419.5	7.681
137:	86424.5	7.669
138:	86429.5	7.669
139:	86439.5	7.681
140:	86449.5	7.669
141:	86459.5	7.681
142:	86469.5	7.669
143:	86479.5	7.669
144:	86489.5	7.681
145:	86499.5	7.681
146:	86509.5	7.669
147:	86519.5	7.669
148:	86529.5	7.669
149:	86559.5	7.669
150:	86589.5	7.681
151:	86619.5	7.681
152:	86649.5	7.681
153:	86679.5	7.681
154:	86709.5	7.681
155:	86739.5	7.669
156:	86769.5	7.669
157:	86799.5	7.669
158:	86829.5	7.681
159:	86889.5	7.681
160:	86949.5	7.681
161:	87009.5	7.681
162:	87069.5	7.681
163:	87129.5	7.681
164:	87189.5	7.681
165:	87249.5	7.681
166:	87309.5	7.681
167:	87369.5	7.681
168:	87429.5	7.692
169:	87549.5	7.692
170:	87669.5	7.692
171:	87789.5	7.692
172:	87909.5	7.692
173:	88029.5	7.692
174:	88149.5	7.692
175:	88269.5	7.692
176:	88389.5	7.692
177:	88509.5	7.704
178:	88629.8	7.704
179:	88929.5	7.704
180:	89229.5	7.704
181:	89529.5	7.704
182:	89829.5	7.715
183:	90129.5	0.000000E+000
184:	90429.5	0.000000E+000

WELL MW-3

1:	*31.7	9.402
2:	33.5	9.402
3:	34.5	9.402
4:	35.5	9.402
5:	36.5	9.379
6:	38.2	9.402
7:	38.9	9.402
8:	39.6	9.379
9:	40.3	9.402
10:	41.5	9.402
11:	42.5	9.402
12:	47.5	9.402
13:	52.5	9.402
14:	57.5	9.402
15:	62.5	9.402
16:	67.5	9.402
17:	72.5	9.402
18:	77.5	9.402
19:	82.5	9.402
20:	87.5	9.402
21:	92.5	9.402
22:	102.5	9.379
23:	112.5	9.379
24:	122.5	9.379
25:	132.5	9.379
26:	142.5	9.379
27:	152.5	9.379
28:	162.5	9.379
29:	172.5	9.379
30:	182.5	9.379
31:	192.5	9.379
32:	222.5	9.379
33:	252.5	9.379
34:	282.5	9.379
35:	312.5	9.379
36:	342.5	9.379
37:	372.5	9.379
38:	402.5	9.379
39:	432.5	9.379
40:	462.5	9.379
41:	492.5	9.379
42:	552.5	9.379
43:	612.5	9.379
44:	672.5	9.379
45:	732.5	9.379
46:	792.5	9.379
47:	852.5	9.355
48:	912.5	9.355
49:	972.5	9.355
50:	1032.5	9.355
51:	1092.5	9.355
52:	1212.5	9.355
53:	1332.5	9.355
54:	1452.5	9.355
55:	1572.5	9.355
56:	1692.5	9.355
57:	1812.5	9.355
58:	1932.5	9.355
59:	2052.5	9.355
60:	2172.5	9.355
61:	2292.5	9.355
62:	2592.5	9.332
63:	2692.5	9.332

65:	3492.5	9.332
66:	3792.5	9.332
67:	4092.5	9.332
68:	4392.5	9.332
69:	4692.5	9.332
70:	4992.5	9.332
71:	5292.5	9.332
72:	5892.5	9.332
73:	6492.5	9.332
74:	7092.5	9.332
75:	7692.5	9.332
76:	8292.5	9.332
77:	8892.5	9.332
78:	9492.5	9.332
79:	10092.5	9.309
80:	10692.5	9.332
81:	11292.6	9.332
82:	12492.5	9.309
83:	13692.5	9.309
84:	14892.5	9.309
85:	16092.5	9.309
86:	17292.5	9.309
87:	18492.5	9.309
88:	19692.5	9.309
89:	20892.5	9.309
90:	22092.5	9.309
91:	23292.6	9.309
92:	25692.5	9.309
93:	28092.5	9.309
94:	30492.5	9.286
95:	32892.5	9.286
96:	35292.5	9.286
97:	37692.5	9.286
98:	40092.5	9.286
99:	42492.5	9.286
100:	44892.5	9.286
101:	47292.5	9.286
102:	49692.5	9.286
103:	52092.5	9.286
104:	54492.5	9.286
105:	56892.5	9.286
106:	59292.5	9.286
107:	61692.5	9.263
108:	64092.5	9.263
109:	66492.5	9.263
110:	68892.5	9.263
111:	71292.5	9.263
112:	73692.5	9.263
113:	76092.5	9.286
114:	78492.5	9.263
115:	80892.5	9.263
116:	83292.5	9.286
117:	85692.5	9.263
118:	86369.6	9.263
119:	86370.9	9.263
120:	86371.6	9.263
121:	86372.3	9.263
122:	86373.5	9.263
123:	86374.5	9.263
124:	86375.5	9.263
125:	86376.5	9.263
126:	86377.5	9.263
127:	86379.3	9.263
128:	86380	9.263

```
131: 86394.5 9.263
132: 86399.5 9.263
133: 86404.5 9.263
134: 86409.5 9.263
135: 86414.5 9.263
136: 86419.5 9.263
137: 86424.5 9.263
138: 86429.5 9.263
139: 86439.5 9.263
140: 86449.5 9.263
141: 86459.5 9.263
142: 86469.5 9.263
143: 86479.5 9.263
144: 86489.5 9.263
145: 86499.5 9.263
146: 86509.5 9.263
147: 86519.5 9.263
148: 86529.5 9.263
149: 86559.5 9.263
150: 86589.5 9.263
151: 86619.5 9.263
152: 86649.5 9.263
153: 86679.5 9.263
154: 86709.5 9.263
155: 86739.5 9.263
156: 86769.5 9.263
157: 86799.5 9.263
158: 86829.5 9.263
159: 86889.5 9.263
160: 86949.5 9.286
161: 87009.5 9.263
162: 87069.5 9.263
163: 87129.5 9.263
164: 87189.5 9.286
165: 87249.5 9.286
166: 87309.5 9.286
167: 87369.5 9.286
168: 87429.5 9.286
169: 87549.5 9.286
170: 87669.5 9.309
171: 87789.5 9.309
172: 87909.5 9.309
173: 88029.5 9.309
174: 88149.5 9.309
175: 88269.5 9.309
176: 88389.5 9.332
177: 88509.5 9.332
178: 88629.8 9.332
179: 88929.5 9.332
180: 89229.5 9.332
181: 89529.5 9.332
```

WELL MW-4

```
 1:*31.7 8.100000E-002
 2: 33.5 8.100000E-002
 3: 34.5 8.100000E-002
 4: 35.5 8.100000E-002
 5: 36.5 8.100000E-002
 6: 38.2 8.100000E-002
 7: 38.9 8.100000E-002
 8: 39.6 8.100000E-002
 9: 40.3 8.100000E-002
10: 41.5 8.100000E-002
11: 42.5 8.100000E-002
12: 47.5 8.100000E-002
13: 52.5 8.100000E-002
14: 57.5 8.100000E-002
15: 62.5 8.100000E-002
16: 67.5 8.100000E-002
17: 72.5 8.100000E-002
18: 77.5 8.100000E-002
19: 82.5 8.100000E-002
20: 87.5 8.100000E-002
21: 92.5 8.100000E-002
22: 102.5 8.100000E-002
23: 112.5 8.100000E-002
24: 122.5 8.100000E-002
25: 132.5 8.100000E-002
26: 142.5 8.100000E-002
27: 152.5 8.100000E-002
28: 162.5 8.100000E-002
29: 172.5 8.100000E-002
30: 182.5 8.100000E-002
31: 192.5 8.100000E-002
32: 222.5 8.100000E-002
33: 252.5 8.100000E-002
34: 282.5 8.100000E-002
35: 312.5 8.100000E-002
36: 342.5 8.100000E-002
37: 372.5 8.100000E-002
38: 402.5 8.100000E-002
39: 432.5 8.100000E-002
40: 462.5 8.100000E-002
41: 492.5 8.100000E-002
42: 552.5 8.100000E-002
43: 612.5 8.100000E-002
44: 672.5 8.100000E-002
45: 732.5 8.100000E-002
46: 792.5 8.100000E-002
47: 852.5 8.100000E-002
48: 912.5 8.100000E-002
49: 972.5 8.100000E-002
50: 1032.5 8.100000E-002
51: 1092.5 8.100000E-002
52: 1212.5 8.100000E-002
53: 1332.5 8.100000E-002
54: 1452.5 8.100000E-002
55: 1572.5 8.100000E-002
56: 1692.5 8.100000E-002
57: 1812.5 8.100000E-002
58: 1932.5 8.100000E-002
59: 2052.5 8.100000E-002
60: 2172.5 8.100000E-002
61: 2292.5 8.100000E-002
62: 2592.5 8.100000E-002
```

[illegible]:	[illegible]	8.100000E-002
63:	2892.5	8.100000E-002
64:	3192.5	8.100000E-002
65:	3492.5	8.100000E-002
66:	3792.5	8.100000E-002
67:	4092.5	8.100000E-002
68:	4392.5	8.100000E-002
69:	4692.5	8.100000E-002
70:	4992.5	8.100000E-002
71:	5292.5	8.100000E-002
72:	5892.5	8.100000E-002
73:	6492.5	8.100000E-002
74:	7092.5	8.100000E-002
75:	7692.5	8.100000E-002
76:	8292.5	8.100000E-002
77:	8892.5	8.100000E-002
78:	9492.5	8.100000E-002
79:	10092.5	8.100000E-002
80:	10692.5	8.100000E-002
81:	11292.6	8.100000E-002
82:	12492.5	8.100000E-002
83:	13692.5	8.100000E-002
84:	14892.5	8.100000E-002
85:	16092.5	8.100000E-002
86:	17292.5	9.200000E-002
87:	18492.5	8.100000E-002
88:	19692.5	8.100000E-002
89:	20892.5	8.100000E-002
90:	22092.5	9.200000E-002
91:	23292.6	8.100000E-002
92:	25692.5	9.200000E-002
93:	28092.5	9.200000E-002
94:	30492.5	9.200000E-002
95:	32892.5	8.100000E-002
96:	35292.5	9.200000E-002
97:	37692.5	8.100000E-002
98:	40092.5	9.200000E-002
99:	42492.5	9.200000E-002
100:	44892.5	9.200000E-002
101:	47292.5	9.200000E-002
102:	49692.5	9.200000E-002
103:	52092.5	9.200000E-002
104:	54492.5	9.200000E-002
105:	56892.5	8.100000E-002
106:	59292.5	9.200000E-002
107:	61692.5	8.100000E-002
108:	64092.5	9.200000E-002
109:	66492.5	9.200000E-002
110:	68892.5	9.200000E-002
111:	71292.5	9.200000E-002
112:	73692.5	8.100000E-002
113:	76092.5	8.100000E-002
114:	78492.5	8.100000E-002
115:	80892.5	9.200000E-002
116:	83292.5	8.100000E-002
117:	85692.5	9.200000E-002
118:	86369.6	8.100000E-002
119:	86370.9	8.100000E-002
120:	86371.6	8.100000E-002
121:	86372.3	8.100000E-002
122:	86373.5	8.100000E-002
123:	86374.5	9.200000E-002
124:	86375.5	9.200000E-002
125:	86376.5	9.200000E-002
126:	86377.5	9.200000E-002

```
[illegible]
130: 86389.5 8.100000E-002
131: 86394.5 8.100000E-002
132: 86399.5 8.100000E-002
133: 86404.5 8.100000E-002
134: 86409.5 8.100000E-002
135: 86414.5 8.100000E-002
136: 86419.5 8.100000E-002
137: 86424.5 8.100000E-002
138: 86429.5 8.100000E-002
139: 86439.5 8.100000E-002
140: 86449.5 8.100000E-002
141: 86459.5 8.100000E-002
142: 86469.5 8.100000E-002
143: 86479.5 8.100000E-002
144: 86489.5 8.100000E-002
145: 86499.5 8.100000E-002
146: 86509.5 8.100000E-002
147: 86519.5 8.100000E-002
148: 86529.5 8.100000E-002
149: 86559.5 8.100000E-002
150: 86589.5 8.100000E-002
151: 86619.5 8.100000E-002
152: 86649.5 8.100000E-002
153: 86679.5 8.100000E-002
154: 86709.5 8.100000E-002
155: 86739.5 8.100000E-002
156: 86769.5 8.100000E-002
157: 86799.5 8.100000E-002
158: 86829.5 8.100000E-002
159: 86889.5 8.100000E-002
160: 86949.5 8.100000E-002
161: 87009.5 8.100000E-002
162: 87069.5 8.100000E-002
163: 87129.5 8.100000E-002
164: 87189.5 8.100000E-002
165: 87249.5 8.100000E-002
166: 87309.5 8.100000E-002
167: 87369.5 8.100000E-002
168: 87429.5 8.100000E-002
169: 87549.5 8.100000E-002
170: 87669.5 8.100000E-002
171: 87789.5 8.100000E-002
172: 87909.5 8.100000E-002
173: 88029.5 8.100000E-002
174: 88149.5 8.100000E-002
175: 88269.5 0.000000E+000
176: 88389.5 0.000000E+000
177: 88509.5 0.000000E+000
178: 88629.8 0.000000E+000
179: 88929.5 0.000000E+000
180: 89229.5 0.000000E+000
181: 89529.5 0.000000E+000
182: 89829.5 0.000000E+000
183: 90129.5 0.000000E+000
184: 90429.5 0.000000E+000
*@
```

WELL MW-5

1:	*31.7	1.478
2:	33.5	1.49
3:	34.5	1.49
4:	35.5	1.49
5:	36.5	1.49
6:	38.2	1.49
7:	38.9	1.478
8:	39.6	1.49
9:	40.3	1.49
10:	41.5	1.49
11:	42.5	1.49
12:	47.5	1.49
13:	52.5	1.478
14:	57.5	1.49
15:	62.5	1.49
16:	67.5	1.478
17:	72.5	1.49
18:	77.5	1.478
19:	82.5	1.478
20:	87.5	1.49
21:	92.5	1.49
22:	102.5	1.49
23:	112.5	1.49
24:	122.5	1.49
25:	132.5	1.49
26:	142.5	1.49
27:	152.5	1.49
28:	162.5	1.49
29:	172.5	1.49
30:	182.5	1.49
31:	192.5	1.49
32:	222.5	1.49
33:	252.5	1.49
34:	282.5	1.49
35:	312.5	1.49
36:	342.5	1.49
37:	372.5	1.49
38:	402.5	1.49
39:	432.5	1.49
40:	462.5	1.478
41:	492.5	1.49
42:	552.5	1.49
43:	612.5	1.49
44:	672.5	1.49
45:	732.5	1.49
46:	792.5	1.49
47:	852.5	1.49
48:	912.5	1.49
49:	972.5	1.49
50:	1032.5	1.49
51:	1092.5	1.49
52:	1212.5	1.49
53:	1332.5	1.49
54:	1452.5	1.49
55:	1572.5	1.478
56:	1692.5	1.49
57:	1812.5	1.478
58:	1932.5	1.478
59:	2052.5	1.49
60:	2172.5	1.49
61:	2292.5	1.49
62:	2592.5	1.478
63:	2892.5	1.49

65:	3492.5	1.49
66:	3792.5	1.49
67:	4092.5	1.49
68:	4392.5	1.49
69:	4692.5	1.49
70:	4992.5	1.478
71:	5292.5	1.49
72:	5892.5	1.478
73:	6492.5	1.49
74:	7092.5	1.49
75:	7692.5	1.49
76:	8292.5	1.49
77:	8892.5	1.49
78:	9492.5	1.49
79:	10092.5	1.49
80:	10692.5	1.478
81:	11292.6	1.49
82:	12492.5	1.478
83:	13692.5	1.49
84:	14892.5	1.49
85:	16092.5	1.49
86:	17292.5	1.49
87:	18492.5	1.478
88:	19692.5	1.49
89:	20892.5	1.49
90:	22092.5	1.49
91:	23292.6	1.49
92:	25692.5	1.49
93:	28092.5	1.49
94:	30492.5	1.478
95:	32892.5	1.478
96:	35292.5	1.478
97:	37692.5	1.49
98:	40092.5	1.49
99:	42492.5	1.478
100:	44892.5	1.478
101:	47292.5	1.49
102:	49692.5	1.49
103:	52092.5	1.478
104:	54492.5	1.49
105:	56892.5	1.478
106:	59292.5	1.478
107:	61692.5	1.478
108:	64092.5	1.478
109:	66492.5	1.478
110:	68892.5	1.478
111:	71292.5	1.478
112:	73692.5	1.478
113:	76092.5	1.478
114:	78492.5	1.478
115:	80892.5	1.478
116:	83292.5	1.478
117:	85692.5	1.478
118:	86369.6	1.478
119:	86370.9	1.478
120:	86371.6	1.478
121:	86372.3	1.478
122:	86373.5	1.478
123:	86374.5	1.478
124:	86375.5	1.478
125:	86376.5	1.478
126:	86377.5	1.467
127:	86379.3	1.478
128:	86380	1.478
129:	86384.5	1.478

132:	86399.5	1.478
133:	86404.5	1.478
134:	86409.5	1.478
135:	86414.5	1.478
136:	86419.5	1.478
137:	86424.5	1.467
138:	86429.5	1.478
139:	86439.5	1.478
140:	86449.5	1.478
141:	86459.5	1.478
142:	86469.5	1.478
143:	86479.5	1.478
144:	86489.5	1.478
145:	86499.5	1.478
146:	86509.5	1.467
147:	86519.5	1.467
148:	86529.5	1.467
149:	86559.5	1.467
150:	86589.5	1.478
151:	86619.5	1.478
152:	86649.5	1.478
153:	86679.5	1.467
154:	86709.5	1.478
155:	86739.5	1.467
156:	86769.5	1.467
157:	86799.5	1.478
158:	86829.5	1.478
159:	86889.5	1.478
160:	86949.5	1.478
161:	87009.5	1.467
162:	87069.5	1.478
163:	87129.5	1.478
164:	87189.5	1.478
165:	87249.5	1.478
166:	87309.5	1.478
167:	87369.5	1.478
168:	87429.5	1.478
169:	87549.5	1.478
170:	87669.5	1.478
171:	87789.5	1.478
172:	87909.5	1.478
173:	88029.5	0.000000E+000
174:	88149.5	0.000000E+000
175:	88269.5	0.000000E+000
176:	88389.5	0.000000E+000
177:	88509.5	0.000000E+000
178:	88629.8	0.000000E+000
179:	88929.5	0.000000E+000
180:	89229.5	0.000000E+000
181:	89529.5	0.000000E+000
182:	89829.5	0.000000E+000
183:	90129.5	0.000000E+000
184:	90429.5	0.000000E+000

APPENDIX A4

PUMP TEST
TRANSMISSIVITY DATA

RECOVERY DATA WELL RW-1

1:	*86424.5	4.955	1440.41
2:	86429.5	4.99	1440.49
3:	86439.5	5.059	1440.66
4:	86449.5	5.128	1440.82
5:	86459.5	5.232	1440.99
6:	86469.5	5.301	1441.16
7:	86479.5	5.371	1441.32
8:	86489.5	5.44	1441.49
9:	86499.5	5.544	1441.66
10:	86509.5	5.613	1441.82
11:	86519.5	5.717	1441.99
12:	86529.5	5.821	1442.16
13:	86559.5	6.064	1442.66
14:	86589.5	6.376	1443.16
15:	86619.5	6.618	1443.66
16:	86649.5	6.826	1444.16
17:	86679.5	7.034	1444.66
18:	86709.5	7.276	1445.16
19:	86739.5	7.623	1445.66
20:	86769.5	7.935	1446.16
21:	86799.5	8.212	1446.66
22:	86829.5	8.524	1447.16
23:	86889.5	9.044	1448.16
24:	86949.5	9.563	1449.16
25:	87009.5	10.048	1450.16
26:	87069.5	10.43	1451.16
27:	87129.5	10.811	1452.16
28:	87189.5	11.157	1453.16
29:	87249.5	11.504	1454.16
30:	87309.5	11.781	1455.16
31:	87369.5	12.024	1456.16
32:	87429.5	12.266	1457.16
33:	87549.5	12.682	1459.16
34:	87669.5	13.028	1461.16
35:	87789.5	13.271	1463.16
36:	87909.5	13.479	1465.16
37:	88029.5	13.652	1467.16
38:	88149.5	13.756	1469.16
39:	88269.5	13.86	1471.16
40:	88389.5	13.929	1473.16
41:	88509.5	13.999	1475.16
42:	88629.8	14.033	1477.16
43:	88929.5	14.103	1482.16
44:	89229.5	14.103	1487.16
45:	89529.5	14.137	1492.16
46:	89829.5	14.137	1497.16
47:	90129.5	14.172	1502.16
48:	90429.5	14.137	1507.16
49:			
50:			
51:			
52:			
53:			
54:	90429.5	1507.16	

APPENDIX A5

PUMP TEST
CAPTURE ZONE MODEL DATA

```
 1:*3-30092-31 ULTRAMAR STATION 721 CAPTURE ZONE MODEL
 2:     21      1           0.          .01
 3:          3.28         .15         243.87      315.        .05
 4:          IW1        99.00       99.00       0.00                                    225.
 5:          IW2        99.00       70.00       0.00                                    225.
 6:          IW3        99.00       60.00       0.00                                    225.
 7:          IW4        99.00       50.00       0.00                                    225.
 8:          IW5        99.00       40.00       0.00                                    225.
 9:          IW6        99.00       30.00       0.00                                    225.
10:         IW1A        99.00       65.00       0.00                                    225.
11:         IW2A        99.00       55.00       0.00                                    225.
12:         IW3A        99.00       45.00       0.00                                    225.
13:         IW4A        99.00       35.00       0.00                                    225.
14:         IW5A        99.00       25.00       0.00                                    225.
15:          IW7        99.00       20.00       0.00                                    225.
16:          IW8        99.00       10.00       0.00                                    225.
17:         IW8B        99.00        5.00       0.00                                    225.
18:          IW9        99.00        0.00       0.00                                    225.
19:        IW15b        67.00       99.00       0.00                                    225.
20:        IW16b        73.00       99.00       0.00                                    225.
21:        IW16c        77.00       99.00       0.00                                    225.
22:        IW17B        83.00       99.00       0.00                                    225.
23:         IW16        70.00       99.00       0.00                                    225.
24:         IW17        80.00       99.00       0.00                                    225.
25:         IW18        99.00       99.00       0.00                                    225.
26:         RW-1        40.00       40.00     0.25
27:       1        5.
28:  1.5        1.0               -1
29:       0.      99.00          0.      99.00
```

APPENDIX B

VAPOR EXTRACTION TEST REPORT

APPENDIX B

VAPOR EXTRACTION TEST REPORT

1.0 Introduction / Purpose

On January 20, 1991, RESNA performed a vapor extraction test at the site using groundwater wells RW-1 and MW-1. This test was performed to evaluate the feasibility of using vapor extraction to facilitate the groundwater remediation process. The vapor extraction test had three main objectives:

(1) To determine the vapor concentrations and flowrates which can be achieved from the wells;
(2) To determine an estimated radius of influence for each extraction well;
(3) To generate a design basis for the soil vapor extraction if feasible.

An Internal Combustion (IC) engine with catalytic converter was used to apply vacuum to each well and induce airflow through the soils. The extracted hydrocarbon vapors were burned as fuel in the engine. The exhaust was discharged to the atmosphere following additional treatment through a catalytic converter. Notification was provided to the Bay Area Air Quality Management District (BAAQMD) approximately 1 week prior to the testing in accordance with BAAQMD policy (See Appendix B1).

2.0 Vapor Extraction Test Apparatus

The IC engine was individually connected to each well using 2-inch diameter PVC piping set above ground. Vacuum was provided to the wells using the IC engine's internal vacuum. An additional vacuum pump / blower could also be engaged to provide additional vacuum if needed. A schematic of the vapor extraction test set-up is shown in Figure 1.

Groundwater recovery well RW-1 is a 6-inch diameter well screened from 15 feet to 35 feet below grade. Depth to water in this well is typically 18 to 20 feet from top of casing. As a result, an estimated 3 to 5 feet of screen exists above the potentiometric water surface in clayey sand soils.

Groundwater monitoring well MW-1 is a 2-inch diameter well screened from 10 feet to 35 feet below grade. Depth to water in this well is typically 20 feet from top of casing. As a result, an estimated 10 feet of screen exists above the potentiometric water surface in clayey silt soils.

3.0 Flow Characteristic Evaluation

To evaluate vapor flow characteristics from each well, RESNA measured vapor flowrate as a function of well-head vacuum. Vacuum measurements were collected using a differential pressure gauge open to the atmosphere. Flow rate measurements were determined using a pitot tube to measure air velocity. For consistency, air flowrates were corrected to standard (70°F and 0 psig) values, expressed as Standard Cubic Feet per Minute (SCFM). Raw data is contained in Appendix B2. Flow versus vacuum data is summarized in Table 1 for wells RW-1 and MW-1.

Approximately 40 to 50 SCFM of air could be extracted from well RW-1 at well-head vacuums ranging from 8 to 14 inches Water Column [W.C.]. By engaging the vacuum pump, air flowrates as high as 65 SCFM could be produced at a well-head vacuum of 22 inches W.C.

Approximately 35 to 50 SCFM of air could be extracted from well MW-1 at well-head vacuums ranging from 7 to 20 inches W.C. By engaging the vacuum pump, air flowrates as high as 60 SCFM could be produced at a well-head vacuum of 40 inches W.C. These flow / vacuum characteristics are similar to those of well RW-1. However, more vacuum appears to be required. This effect is likely the result of one or more of the following: (1) well MW-1 is screened through less permeable clayey silt soils; and/or (2) friction losses through the 2-inch well are higher.

By plotting well-head vacuum versus air flowrate on a logarithmic scale, an apparent straight-line correlation was observed (see Figures 2 and 3). Using the Cricket-graph™ curve-fitting program a "best-fit" mathematical equation was determined for the data. The corresponding logarithmic equations are shown on the flow / vacuum graphs. The correlation coefficient (r) reflects the match between best-fit curve and actual data. This coefficient ranges from 0 (no correlation) to 1.0 (perfect correlation). For wells RW-1 and MW-1, the correlation coefficient ranged from $r = 0.93$ to $r = 0.96$ suggesting a good relationship with empirical data.

3.2 Vapor Concentrations

Vapor concentrations were qualitatively measured in the field using a portable Photo-ionization Detector (PID) and combination Oxygen / Lower Explosion Limit (0_2/LEL) meter. The PID meter was calibrated to iso-butylene. Vapor samples were collected from a sample port located on the IC engine piping using a sampling pump. PID readings from well RW-1 ranged from 540 to 780 parts per million by volume (ppm_V). PID readings for well MW-1 ranged from 480 to 530 ppm_V. LEL meter readings from both wells ranged from 60% to 128% of the LEL for gasoline. As shown later, these values did not correlate well with vapor samples collected for laboratory analysis. Raw data is contained in Appendix B2.

For quantitation, vapor samples were collected for laboratory analysis. These samples were collected in opaque Mylar™ bags using a sampling pump. The samples were transported to a certified laboratory within 72-hours and analyzed for Total Petroleum Hydrocarbons as Gasoline (TPHG) and Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX). Two vapor samples were collected from each well. An initial vapor sample was collected after 15 minutes of system operation. A final vapor sample was then collected from each well after 1 hour of operation. To facilitate future air permitting, an effluent sample was collected from the exhaust stack of the IC engine. Results are summarized in Table 2. Laboratory reports are contained in Appendix B3.

Vapor samples from wells RW-1 and MW-1 contained TPHG ranging from 7,100 to 31,000 µg/liter. These concentrations appeared to fluctuate throughout the pilot test. Assuming a molecular weight of 95 grams per mole for gasoline, these concentrations correspond to volumetric concentrations of 1,900 to 8,100 ppm_V [15% to 62% of the LEL for gasoline].

3.3 Hydrocarbon Removal Rates

Hydrocarbon removal rates from wells RW-1 and MW-1 were calculated from TPHG vapor concentrations and vapor flowrates. With vapor concentrations expressed as micrograms TPHG per liter of air (µg/liter), the mass of hydrocarbons removed was determined by multiplying vapor concentrations by air flowrates expressed in liters per unit time as shown below:

$$\text{Hydrocarbon Removal Rate [lb/hr]} = \frac{\text{TPHG conc. [µg/liter]} \times \text{Flow rate [ft3/min]} \times 28.33 \text{ liter /ft3} \times 60 \text{ min/hr}}{454{,}000{,}000 \text{ µg/lb}}$$

Vapor concentration data, vapor flowrate data, and the corresponding initial hydrocarbon removal rates are summarized in Table 3. For flowrates ranging from 40 to 50 SCFM, these concentrations result in hydrocarbon removal rates of 1.1 to 5.8 pounds per hour. Vapor-phase benzene concentrations from both wells were minimal (<10 µg/liter). These results suggest that extracted hydrocarbons are weathered gasoline.

3.4 Radius of Influence Evaluation:

The radius of influence from each vapor well was determined by drawing vapor from a single well and measuring the vacuum drawdown on adjacent monitoring wells screened through the same interval. These vacuum readings were obtained using magnehelic vacuum gauges capable of reading to 0.01 inches W.C. Raw data is summarized in Appendix B2. Vacuum drawdown data is summarized in Table 4.

Using the 6-inch diameter well RW-1, vacuum drawdown was moderately observed in well MW-3 located 12 feet away and only slightly observed in well MW-1 located 27 feet away. When applying 8 to 15 inches W.C. on the extraction well, an induced vacuum of 0.23 to 0.44 inches W.C. was observed on well MW-1 located 12 feet away.

Using the 2-inch diameter well MW-1, no significant vacuum influence was observed in either well RW-1 (located 27 feet away) or well MW-3 (located 31 feet away). These results are somewhat inconclusive as radius of influence measurements at distances less than 27 feet could not be obtained.

The radius of influence for well RW-1 was determined by plotting vacuum drawdown data from the monitoring wells as a function of distance. By normalizing vacuum drawdown data (dividing by extraction well vacuum) and plotting this data versus distance on semi-log paper, a linear correlation was observed. The corresponding plot of normalized vacuum versus distance are shown in Figure 4 for well RW-1. A radius of influence was estimated by setting a minimum vacuum drawdown at which effective clean-up of the soils is presumed to be achieved. For the purpose of this pilot test, a minimum vacuum drawdown of 0.25 inches W.C. was utilized. Based upon this analysis, a 12-foot radius of influence was estimated in the clayey sand / clayey silt soils.

3.5 Vapor Well Efficiency

Assuming that free gasoline liquid exists within the site soils, the maximum vapor concentration which can be generated in the wells is the saturated vapor concentration for liquid gasoline. For weathered gasoline, this vapor concentration is estimated at approximately 220,000 μg/liter TPHG (Reference [1], p. 38). To evaluate the efficiency of the vapor wells, well-head vapor concentrations are divided by 220,000 μg/liter to obtain a percent well efficiency. This efficiency can be used as a qualitative indicator of vapor flow through the contaminated soil zone.

A comparison of initial well-head vapor samples to the saturated vapor concentration for weathered gasoline (220,000 μg/liter) indicates the pilot vapor wells operated between 3% and 14% of saturated vapor concentrations. These efficiencies suggest that not all of the extracted air is directed through the zones of contamination and some dilution of the vapor stream occurs.

4.0 Summary

The pilot test demonstrated that vapor extraction can remove gasoline hydrocarbons from the vadose zone soils near the underground storage tank complex. Relatively large vapor flowrates (40 to 60 SCFM) could be extracted from the wells using moderate well-head vacuums (8 to 40 inches W.C.). Vapor concentrations from the wells ranged from 7,100 to 31,000 μg/liter TPHG, corresponding to hydrocarbon removal rates of 1.1 to 5.8 lbs/hr TPHG. Though these hydrocarbon removal rates will likely decrease exponentially with time (depending on hydrocarbon composition and vapor flow path), these initial gasoline removal rates should be sufficient to reduce free-product and vadose zone hydrocarbons in the immediate vicinity of the extraction wells. As a result, the groundwater remediation process should be facilitated due to this hydrocarbon removal.

5.0 References

[1] Johnson, Stanley, et. al. "A Practical Approach to the Design, Operation, and Monitoring of In-Situ Soil Venting Systems," Shell Development Company, undated.

TABLE 1

WELL VACUUM vs. AIR FLOWRATE DATA

Applied Well Vacuum (inches W.C.)	Vapor Flowrate (ACFM)	Vapr Flowrate (SCFM)
Recovery Well RW-1		
8	38	39
8.5	40	41
9	41	42
9.5	48	49
12	50	50
14	54	54
22	65	64
Monitoring Well MW-1		
7	37	38
13.5	51	52
15	53	53
20	54	53
21	54	53
40	65	61

Inches W.C. = inches Water Column
ACFM = Actual Cubic Feet per Minute (at stated vacuum and average 50°F temp.)
SCFM = Standard Cubic Feet per Minute (air flowrates corrected to 70°F and 0 psig).

TABLE 2

SUMMARY OF LABORATORY RESULTS
WELL-HEAD VAPOR SAMPLES

Vapor Well	Run Time (Min.)	TPHG Vapor Conc. (µg/liter)	Benzene Vapor Conc. (µg/liter)	Toluene Vapor Conc. (µg/liter)	Ethyl-benzene Vapor Conc. (µg/liter)	Xylenes Vapor Conc. (µg/liter)
RW-1	15	7,100	<0.3	<0.3	27	15
	120	31,000	10	110	48	110
MW-1	15	30,000	<0.3	1.8	50	4.4
	60	9,700	<0.3	8.7	51	6.8
Engine Effluent*	120	<50	<0.3	<0.3	<0.3	<0.3

* Effluent sample collected from engine exhaust stack during operation of well RW-1 at 120 minutes.

TPHG = Total Petroleum Hydrocarbons as Gasoline
µg/liter = Micrograms per liter
<0.3 = Not detected at or above stated laboratory detection limit

TABLE 3

ESTIMATED HYDROCARBON REMOVAL RATES

Vapor Well	Operation Time (Min.)	Vapor Flowrate (SCFM)	Initial TPHG Vapor Conc. (µg/liter)	Estimated Hourly TPHG Removal Rate (lbs/hr)
RW-1	15	43	7,100	1.1
	120	39	31,000	4.5
MW-1	15	52	30,000	5.8
	60	50	9,700	1.8

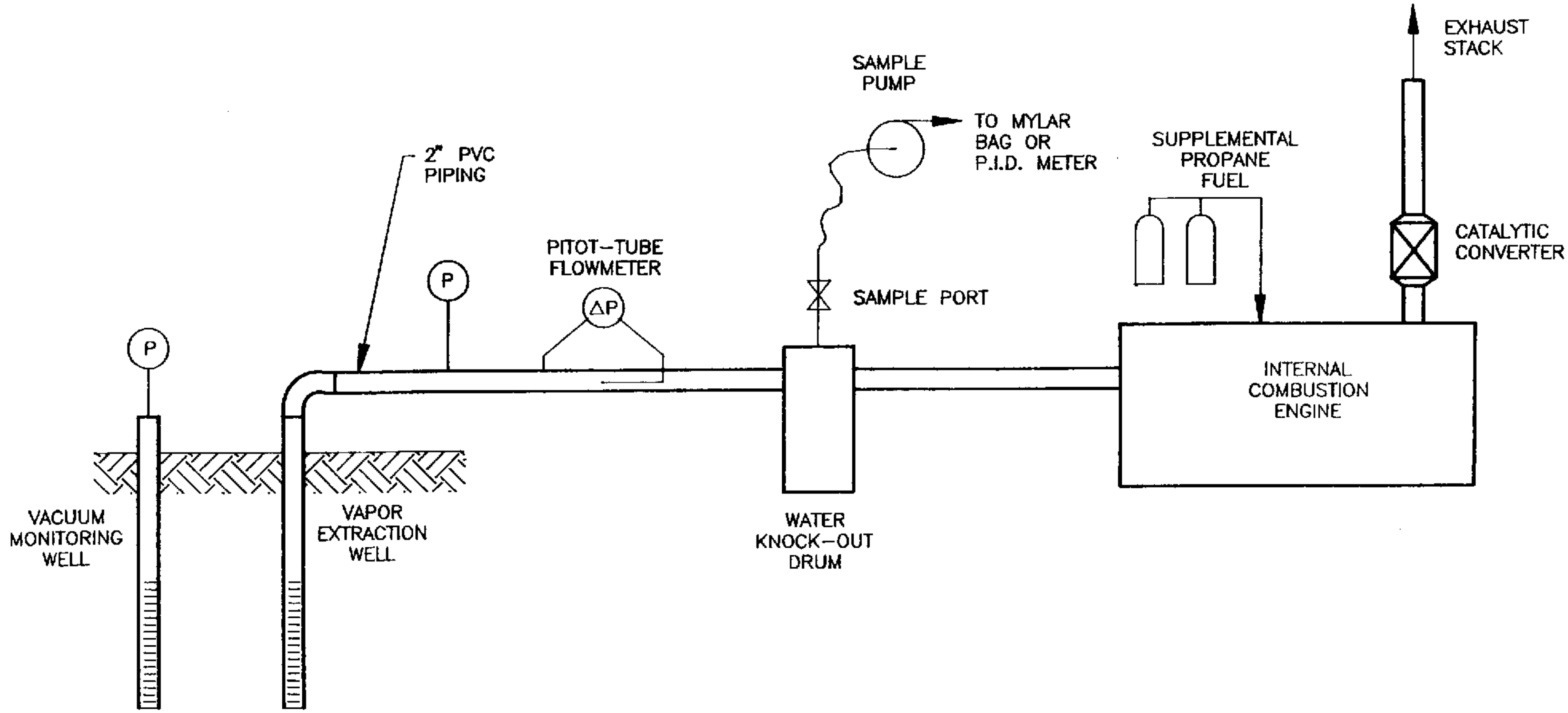
TPHG = Total Petroleum Hydrocarbons as Gasoline
µg/liter = Micrograms per liter
SCFM = Standard Cubic Feet per Minute

TABLE 4

RADIUS OF INFLUENCE DATA
GROUNDWATER RECOVERY WELL RW-1

Applied Well (Inches W.C.)	Vapor Flowrate (SCFM)	Operation Time (minutes)	Induced Vacuum MW-3 at 12 feet (inches W.C.)	Induced Vacuum MW-1 at 27 feet (inches W.C.)
8	39	60 - 120	0.23	0.02
15	54	30	0.44	0.02

Inches W.C. = Inches Water Column vacuum
SCFM = Standard Cubic Feet per Minute



LEGEND

P — PRESSURE (VACUUM) INDICATOR

ΔP — DIFFERENTIAL PRESSURE INDICATOR

REVIEWED BY: BTM	VAPOR EXTRACTION TEST APPARATUS	RESNA
	ULTRAMAR/BEACON SERVICE STATION #721	
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-30092-42 / DRAWN BY: J.D.S.
	SAN LORENZO, CALIFORNIA	DATE: 2/20/92 / DRAWING #: FIG. 1

"BEST FIT" LOGARITHMIC EQUATION

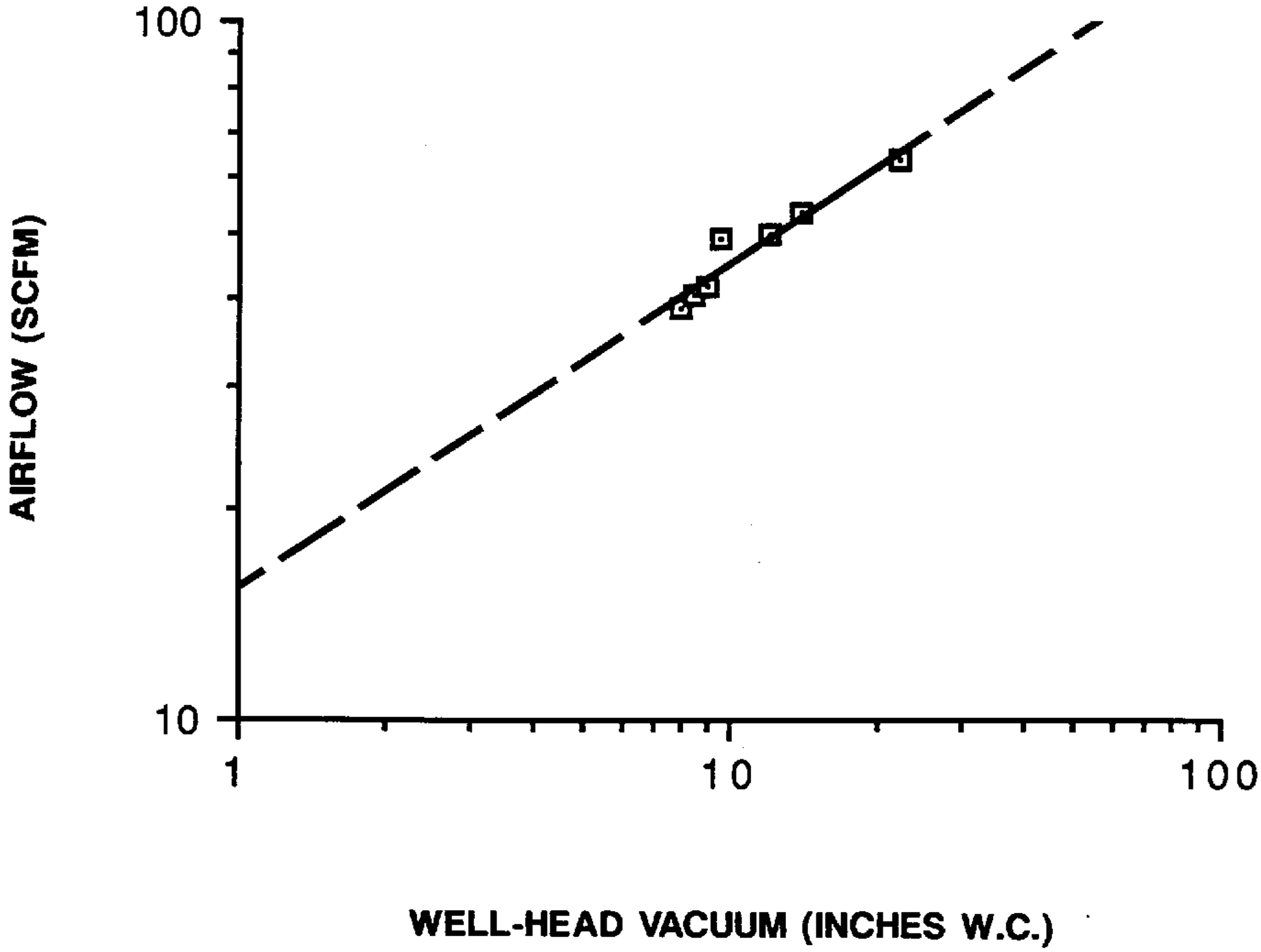
$$Q = 15 \times [\Delta P]^{0.47}$$

correlation coefficient r = 0.96

where:

Q = AIRFLOW [SCFM]

ΔP = WELL-HEAD VACUUM [inches W.C.]



LEGEND

SCFM = STANDARD CUBIC FEET PER MINUTE

INCHES W.C. = INCHES WATER COLUMN

REVIEWED BY:	**FLOW RATE VERSUS WELL-HEAD VACUUM RECOVERY WELL RW-1**	RESNA	
	ULTRAMAR/BEACON SERVICE STATION #721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-20092-42	DRAWN BY: J.D.S.
	SAN LORENZO, CALIFORINA	DATE: 2/20/92	DRAWING #: FIG. 2

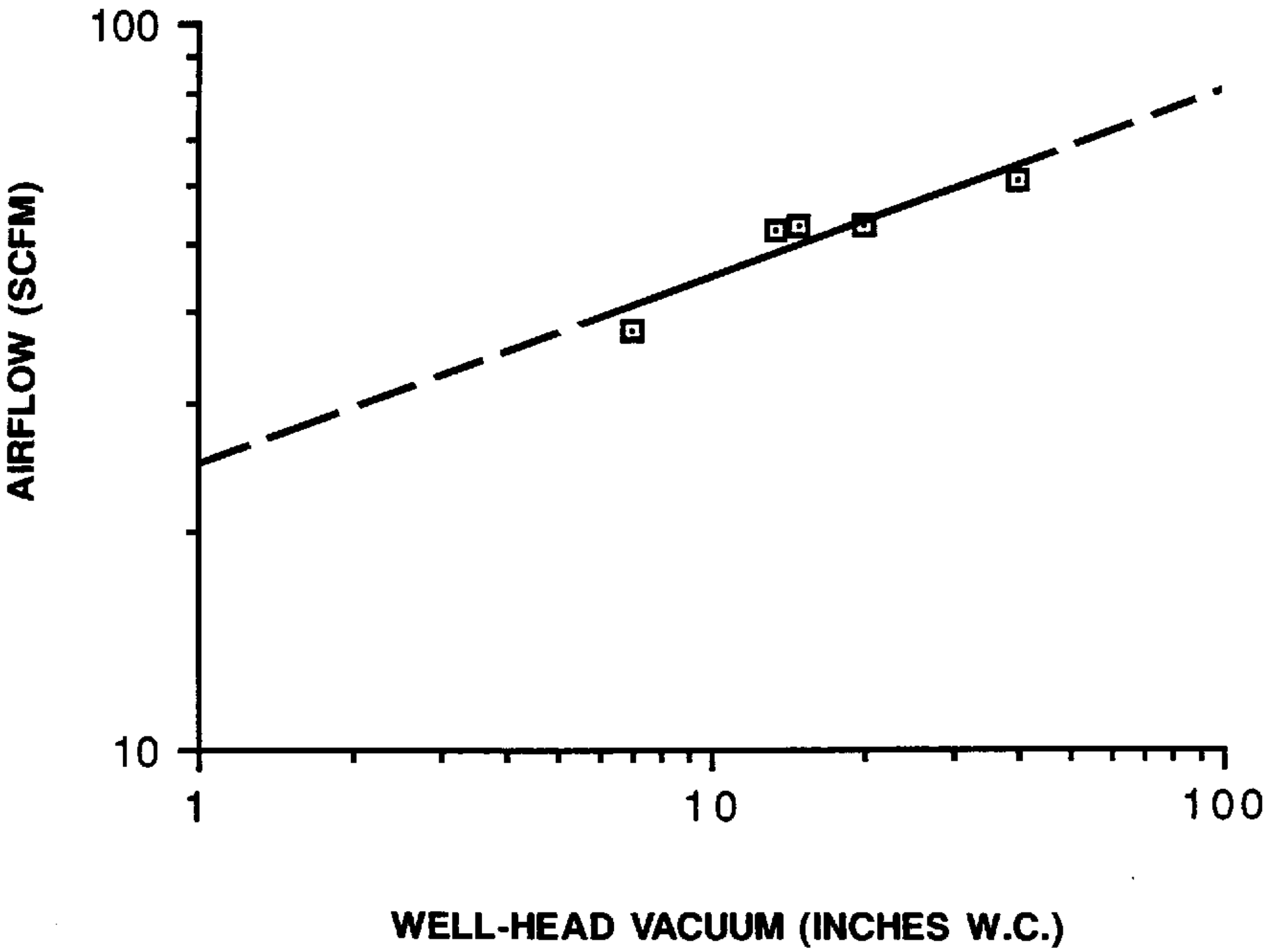
"BEST FIT" LOGARITHMIC EQUATION

$Q = 25 \times [\Delta P]^{0.26}$ correlation coefficient r = 0.93

where:

Q = AIRFLOW [SCFM]

ΔP = WELL-HEAD VACUUM [inches W.C.]



LEGEND

SCFM = STANDARD CUBIC FEET PER MINUTE

INCHES W.C. = INCHES WATER COLUMN

REVIEWED BY:	FLOWRATE VERSUS WELL-HEAD VACUUM MONITORING WELL MW-1	RESNA	
	ULTRAMAR/BEACON SERVICE STATION #721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-20092-42	DRAWN BY: J.D.S.
	SAN LORENZO, CALIFORINA	DATE: 2/20/92	DRAWING #: FIG. 3

"BEST FIT" LOGARITHMIC EQUATION

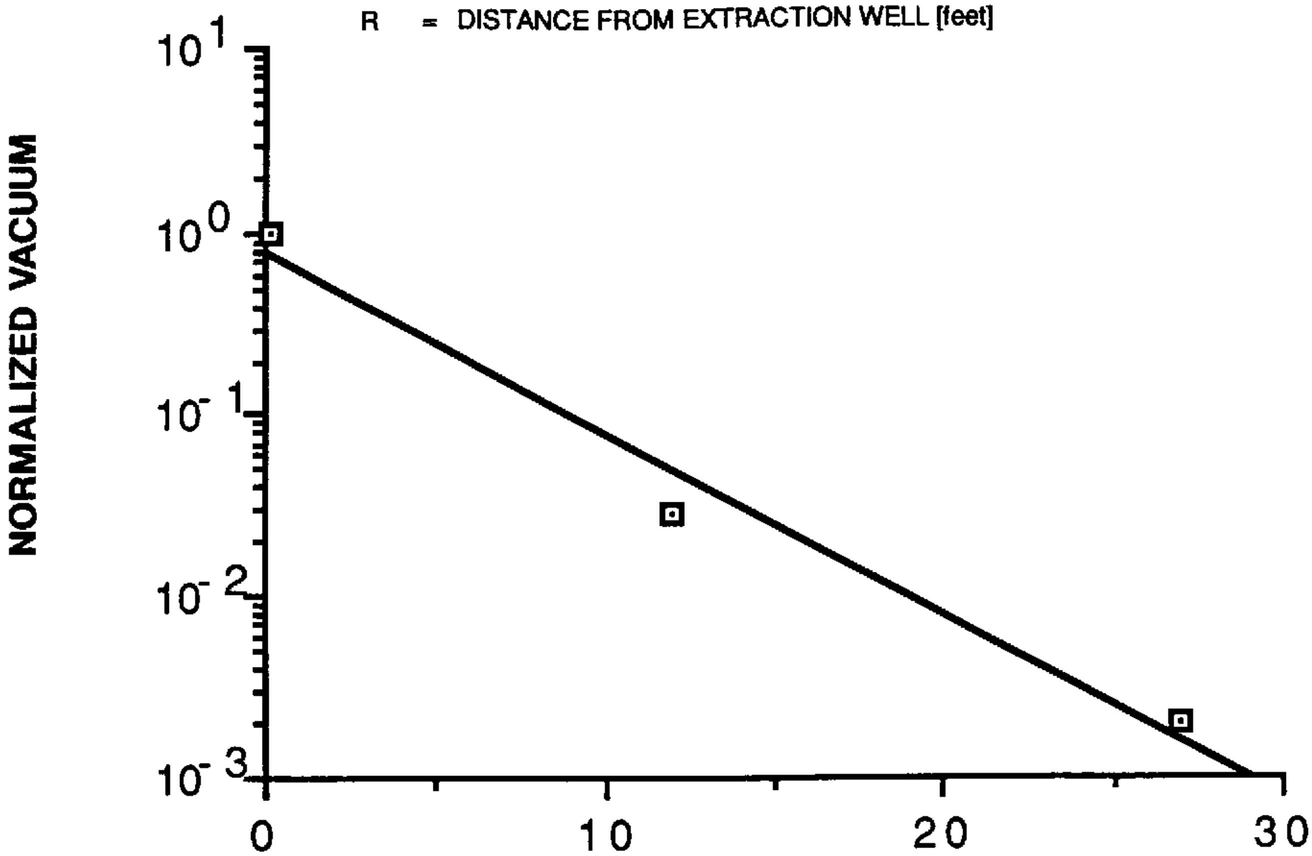
$$\Delta P' = \frac{25}{[10]^{0.099 \times [R]}}$$

correlation coefficient r = 0.99

where:

$\Delta P'$ = NORMALIZED VACUUM DRAWDOWN

R = DISTANCE FROM EXTRACTION WELL [feet]



DISTANCE FROM EXTRACTION WELL (FEET)

LEGEND

NORMALIZED WELL VACUUM = $\frac{\text{VACUUM DRAWDOWN AT MONITORING WELL}}{\text{APPLIED VACUUM AT EXTRACTION WELL}}$

REVIEWED BY:	VACUUM DRAWDOWN VERSUS DISTANCE RECOVERY WELL RW-1	RESNA	
	ULTRAMAR/BEACON SERVICE STATION #721		
APPROVED BY:	44 LEWELLING BOULEVARD	JOB #: 3-20092-42	DRAWN BY: J.D.S.
	SAN LORENZO, CALIFORINA	DATE: 2/20/92	DRAWING #: FIG. 4

APPENDIX B1

VAPOR EXTRACTION TEST
BAAQMD NOTIFICATION LETTER

RESNA
Environmental Solutions
Through Applied Science,
Engineering & Construction

41674 Christy Street
Fremont, CA 94538
Phone: (510) 659-0404
Fax: (510) 651-4677

January 10, 1992

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109-7799
FAX (415) 928-8560

Attention: Mr. Alex Saschin, Permit Engineer

Subject: Vapor Extraction Testing
Ultramar Service Station #721
44 Lewelling Boulevard, San Lorenzo, California

Dear Mr. Saschin:

RESNA, Inc. is preparing a remedial action plan for the above referenced gasoline service station. To evaluate the feasiblity of soil vapor extraction to assist in groundwater remediation, RESNA proposes to perform a 1-day soil vapor extraction test at the site. An internal combustion engine with catalytic converter will be used for vapor abatement. This unit will achieve destruction efficiencies in excess of 90%, however, destruction efficiencies of 95%+ destruction efficiencies are typical.

Based upon our understanding of BAAQMD policy and regulations (see enclosed October 27, 1987 management memo), such tests would not require a BAAQMD source permit provided: (1) the test period does not exceed 2 weeks; and (2) air emissions are abated with carbon or other equivalent control device.

RESNA is faxing this prior notification to the BAAQMD to insure that such activites are performed in compliance with applicable BAAQMD regulations (hard-copy via mail). Relevant information is summarized below:

Site Location:	44 Lewelling Boulevard, San Lorenzo, California
Testing Date:	January 17, 1991(proposed date)
Client:	Ultramar, Inc. - 525 W. Third Street, Hanford, CA 93230
Contractor:	RESNA, Inc. - 41674 Christy Street, Fremont, CA 94538-3114

If you have any questions regarding these activities please call.

Sincerely,

Bruce T. Maeda
Project Engineer

BTM
Enclosure

cc: Mr. Terry Fox, Ultramar, Inc.

October 27, 1987

TO: J SWANSON Concur, JS 10/27

FROM: S HILL

SUBJECT: GAS CHARACTERIZATION TESTS FOR IN SITU SOIL DECONTAMINATION PROJECTS

Gas samples need to be collected and analyzed in order to characterize the emissions from, and design controls for, in situ soil decontamination projects. These operations are not considered to be subject to Regulation 8-40, because it is impossible to determine the volume of soil being aerated. They are instead subject to Rule 8-2.

I recommend that operation of extraction equipment during the collection of gas samples for analysis be considered exempt from permit requirements, provided the emissions are controlled by carbon or other equivalent control device. A reasonable period for such tests would not exceed two weeks. The carbon control device should consist of two 55-gallon canisters in series, with a sample port between them. The gas between the two canisters should be monitored daily for breakthrough.

Any testing which does not provide equivalent control, or extends beyond two weeks, should be considered operation of a source without a permit.

Please indicate your concurrence.

All Permit Division Engineers:

Please follow this recommendation in evaluating any soil decontamination project.

Thanks!!!

John Swanson

APPENDIX B2

VAPOR EXTRACTION TEST RAW DATA

VAPOR EXTRACTION TEST MONITORING DATA

RESNA Project No.:	Project Manager:	Data Collected by:	Date:
3-30092-42	B. MAEDA	PETER SCHURMAN / BRUCE MAEDA	1/20/92

Client: Site: Address:	Data Checked by:	Test Unit:
ULTRAMAR #721, 44 LEWELLING BLVD, SAN LORENZO, CA	B. Maeda	RESNA PETROLANE #1

EXTRACTION WELL DATA								OBSERVATION WELL DATA				
Time (min)	Air Velocity (ft/min)	Air Flowrate (cfm)	Air Temperature (deg. F)	Vacuum (in H2O)	PID/OVA Conc. (ppm)	Engine RPM	Vapor Sample Number	MW-1 Vacuum (in H2O)	MW-2 Vacuum (in H2O)	MW-3 Vacuum (in H2O)	% OXYGEN ~~Vacuum (in H2O)~~	% LEL ~~Vacuum (in H2O)~~
0 min	1725	38	42	8.5	540	1800						
10	1950	43		8.5	540							
15						1700	PS-0120-INF1	0.01	0.03*	0.14	7.1%	89%
25	1750	38	47	12	613	1650	@ 15 min.	0.01	0.06*	0.18	17%	60%
30	2500	55		20			(engine sputtering)					
40	2200	48	44	13	725	1550		0.016	0.05*	0.28	13.6%	105%
45	2200	48		4.5			RE-SET FLOWRATE					
55	1900	41	50	9	745	1800		0.017	0.06*	0.24	15.5%	90%
65	1900	41	50	8	767	1850		0.019	0.07*	0.23	14.2%	95%
80	1800	39	57	8				0.015	0	0.23	13%	112%
95	1600	35	51	8				0.015	0	0.22	—	—
110	1700	37		8	777	1900		0.015	0	0.20	14.4%	100%
125	1750	38	52	7.5	777	1900	PS-0120-INF2	0.012	0	0.20	9%	107%
135	3,000	65	52	22		1900	@ 125 min.	ENGAGE BLOWER				
150	2400	52	53	15			PS-0120-EFF1	0.026	0.015	0.44	9.2%	128%
165	2300	50		12			@ 130 min.	0.020	0.016	0.39	6.7%	121%
	2500	55		14				0.025	0.01	0.41	—	—

Distance from Extraction Well RW-1; MW-1 (27') MW-2 (60') MW-3 (12')

NOTES: RAW DATA TRANSCRIBED FROM P. Schurman / B. MAEDA'S NOTES.

@ 135 min - ENGAGED BLOWER TO INCREASE VACUUM/FLOW.

* SUSPECT MAGNEHELIC GAUGE READINGS (METER INCREASED IN DIRECT SUNLIGHT DUE TO HEATING. READINGS WENT TO ZERO IN SHADE - COVERED METER FOR REST OF TEST.

VAPOR EXTRACTION TEST MONITORING DATA

RESNA Project No.: 3-30092-42	Project Manager: B. MAEDA	Data Collected by: PETER SCHURMAN/BRUCE MAEDA	Date: 1/20/92
Client: Site: Address: ULTRAMAR #721, 44 LEWELLING BLVD, SAN LORENZO, CA		Data Checked by: B. Maeda	Test Unit: RESNA PETROLANE #1

EXTRACTION WELL DATA								OBSERVATION WELL DATA				
Time	Air Velocity (ft/min)	Air Flowrate (cfm)	Air Temperature (deg. F)	Vacuum (in H2O)	PID/OVA Conc. (ppm)	Engine RPM	Vapor Sample Number	RW-1 Vacuum (in H2O)	MW-1 Vacuum (in H2O)	MW-2 Vacuum (in H2O)	% O_2 ~~Vacuum (in H2O)~~	% LEL ~~Vacuum (in H2O)~~
Ø	2600/2400	54	50	21"	527	1700	AS-0120-INF3 @ 10 min	0*	0	0	9.1%	126%
15	2450		51	15"	515	1750		0*	0	0.0025	11%	127%
30	2400	53		15"	570	1800		0.005	0	0.0025	12.5%	105%
45	2,350	51	52	13.5"	504	1800		0.007	0	0.0025	7.1%	108%
60	2300	51		13.5"	477	1800	AS-0120-INF4 @ 55 min	0.005	0	0.01-0.075	12.6%	90%
	1700	37		7"								
65	3000	65										
	2500	54										

Distance from Extraction Well MW-1; RW-1 (27') MW-2 (41') MW-3 (31')

NOTES: RAW DATA TRANSCRIBED FROM P. Schurman / B. Maeda's NOTES. (* USED LARGER MAGNETHELIC GAUGE)

APPENDIX B3

VAPOR EXTRACTION TEST
LABORATORY ANALYSES

Sparger Technology Scientific, Inc.
With Automation In Mind

3100 Fite Circle, Suite 108
Sacramento
California 95827
(916) 362-8947

February 11, 1992

Mr. Bruce Maeda
RESNA Industries.
42501 Ca Albrae St.
Fremont, CA 94538

Dear Mr. Maeda

Enclosed is the report for the five (5) air samples. The samples were received at Sparger Technology Analytical Lab on January 21, 1992.

The samples were received in five (5) tedlar bag. The samples were transported and received under documented chain of custody and stored at four (4) degrees C until analysis was performed.

The report consists of the following sections:

I. Sample Description
II. Analysis Request
III. Quality Control Report
IV. Analysis Results

No problems were encountered with the analysis of your samples.

If you have questions, please feel free to call.

Sincerely,

R. L. James
Principal Chemist

Sparger Technology Scientific, Inc.
With Automation In Mind

3100 Fite Circle, Suite 108
Sacramento
California 95827
(916) 362-8947

I Sample Description

See attached Sample Description Information.

The samples were received under chain-of-custody.

II Analysis Request

The following analytical tests were requested:

Lab ID	Your ID	Analysis Description
ST92-01-0274A	AS. 0120-INF1	TPH-gas, Btex
ST92-02-0275A	AS. 0120-INF2	TPH-gas, Btex
ST92-02-0276A	AS. 0120-EFF1	TPH-gas, Btex
ST92-02-0277A	AS. 0120-INF3	TPH-gas, Btex
ST92-02-0278A	AS. 0120-INF4	TPH-gas, Btex

Sparger Technology Scientific, Inc.
With Automation In Mind

3100 Fite Circle, Suite 108
Sacramento
California 95827
(916) 362-8947

III Quality Control

A. **Project Specific QC.** No project specific QC (i.e., spikes and/or duplicates) was requested.

B. **Method Blank Results.** A method blank is a laboratory-generated sample which assesses the degree to which laboratory operations and procedures cause false-positive analytical results for your sample.

No target parameters were detected in the method blank associated with your sample at the reporting limit levels noted on the data sheets in the Analytical Results section.

C. **Laboratory Control Spike.** A Laboratory Control Spike (LCS) is a sample which is spiked with 30 ppb BTEX, and analyzed at approximately 10% of the sample load in order to establish method-specific control limits. The LCS results associated with your samples are on the attached 8020 Modified LCS BTEX Analysis Report.

Accuracy is measured by Percent Recovery as in:

$$\% \text{ recovery} = \frac{(\text{measured concentration}) \times 100}{(\text{actual concentration})}$$

IV Analysis Results

Results are on the attached data sheet.

Sparger Technology Scientific, Inc.
With Automation In Mind

3100 Fite Circle, Suite 108
Sacramento
California 95827
(916) 362-8947

8020/8015 Modified Analysis Report

Attention:	Mr. Bruce Maeda RESNA Industries 42501 Ca Albrae St. Fremont, CA 94538	Date Sampled: Date Received: Date Analyzed:	Jan. 20, 1992 Jan. 21, 1992 Jan. 23, 1992
Project #:	3-30092-42	Project Name:	44 Lewelling San Lorenzo
Client ID:	AS. 0120-INF1	LAB ID:	ST92-01-0274A
Matrix:	Air	Dilution:	

Name	Amount	Detection Limit	Units
Benzene	ND	0.3	ug/L
Toluene	ND	0.3	ug/L
Ethylbenzene	27	0.3	ug/L
Xylenes	15	0.3	ug/L
TPHgas	7100	50	ug/L

Surrogate % Recovery of Trifluorotoluene = 110%

ppb = parts per billion = ug/L = micrograms per Liter
ppm = parts per million = ug/mL = micrograms per milliliter
ND = Not Detected. Compound(s) may be present at concentrations below the detection limit.
NR = Analysis not requested.

R. L. James, Principal Chemist

1-23-92
Date Reported

SPARGER TECHNOLOGY ANALYTICAL LABORATORY, INC. IS CERTIFIED BY THE STATE OF CALIFORNIA DEPARTMENT OF HEALTH SERVICES AS A HAZARDOUS WASTE TESTING LABORATORY
(Certification No. 1614)

Sparger Technology
With Automation In Mind
Scientific, Inc.

3100 Fite Circle, Suite 108
Sacramento
California 95827
(916) 362-8947

8020/8015 Modified Analysis Report

Attention:	Mr. Bruce Maeda RESNA Industries 42501 Ca Albrae St. Fremont, CA 94538	Date Sampled: Date Received: Date Analyzed:	Jan. 20, 1992 Jan. 21, 1992 Jan. 23, 1992
Project #:	3-30092-42	Project Name:	44 Lewelling San Lorenzo
Client ID:	AS. 0120-INF2	LAB ID:	ST92-01-0275A
Matrix:	Air	Dilution:	

Name	Amount	Detection Limit	Units
Benzene	10	0.3	ug/L
Toluene	110	0.3	ug/L
Ethylbenzene	48	0.3	ug/L
Xylenes	110	0.3	ug/L
TPHgas	31000	50	ug/L

Surrogate % Recovery of Trifluorotoluene = 106%

ppb = parts per billion = ug/L = micrograms per Liter
ppm = parts per million = ug/mL = micrograms per milliliter
ND = Not Detected. Compound(s) may be present at concentrations below the detection limit.
NR = Analysis not requested.

R. L. James, Principal Chemist

1-23-92
Date Reported

SPARGER TECHNOLOGY ANALYTICAL LABORATORY, INC. IS CERTIFIED BY THE STATE OF CALIFORNIA DEPARTMENT OF HEALTH SERVICES AS A HAZARDOUS WASTE TESTING LABORATORY
(Certification No. 1614)

Sparger Technology Scientific, Inc.
With Automation In Mind

3100 Fite Circle, Suite 108
Sacramento
California 95827
(916) 362-8947

8020/8015 Modified Analysis Report

Attention:	Mr. Bruce Maeda RESNA Industries 42501 Ca Albrae St. Fremont, CA 94538	Date Sampled: Date Received: Date Analyzed:	Jan. 20, 1992 Jan. 21, 1992 Jan. 23, 1992
Project #:	3-30092-42	Project Name:	44 Lewelling San Lorenzo
Client ID:	AS. 0120-EFF1	LAB ID:	ST92-01-0276A
Matrix:	Air	Dilution:	

Name	Amount	Detection Limit	Units
Benzene	ND	0.3	ug/L
Toluene	ND	0.3	ug/L
Ethylbenzene	ND	0.3	ug/L
Xylenes	ND	0.3	ug/L
TPHgas	ND	50	ug/L

Surrogate % Recovery of Trifluorotoluene = 110%

ppb = parts per billion = ug/L = micrograms per Liter
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8020/8015 Modified Analysis Report

Attention:	Mr. Bruce Maeda RESNA Industries 42501 Ca Albrae St. Fremont, CA 94538	Date Sampled: Date Received: Date Analyzed:	Jan. 20, 1992 Jan. 21, 1992 Jan. 23, 1992
Project #:	3-30092-42	Project Name:	44 Lewelling San Lorenzo
Client ID:	AS. 0120-INF3	LAB ID:	ST92-01-0277A
Matrix:	Air	Dilution:	

Name	Amount	Detection Limit	Units
Benzene	ND	0.3	ug/L
Toluene	1.8	0.3	ug/L
Ethylbenzene	50	0.3	ug/L
Xylenes	4.4	0.3	ug/L
TPHgas	30000	50	ug/L

Surrogate % Recovery of Trifluorotoluene = 104%

ppb = parts per billion = ug/L = micrograms per Liter
ppm = parts per million = ug/mL = micrograms per milliliter
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NR = Analysis not requested.

R. L. James, Principal Chemist

1-23-92
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8020/8015 Modified Analysis Report

Attention:	Mr. Bruce Maeda RESNA Industries 42501 Ca Albrae St. Fremont, CA 94538	Date Sampled: Date Received: Date Analyzed:	Jan. 20, 1992 Jan. 21, 1992 Jan. 23, 1992
Project #:	3-30092-42	Project Name:	44 Lewelling San Lorenzo
Client ID:	AS. 0120-INF4	LAB ID:	ST92-01-0278A
Matrix:	Air	Dilution:	

Name	Amount	Detection Limit	Units
Benzene	ND	0.3	ug/L
Toluene	8.7	0.3	ug/L
Ethylbenzene	51	0.3	ug/L
Xylenes	6.8	0.3	ug/L
TPHgas	9700	50	ug/L

Surrogate % Recovery of Trifluorotoluene = 107%

ppb = parts per billion = ug/L = micrograms per Liter
ppm = parts per million = ug/mL = micrograms per milliliter
ND = Not Detected. Compound(s) may be present at concentrations below the detection limit.
NR = Analysis not requested.

R. L. James, Principal Chemist

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(Certification No. 1614)

1153

Ultramar Inc.
CHAIN OF CUSTODY REPORT

BEACON

Beacon Station No.	Sampler (Print Name)	Date	Form No.
721	Peter Schurman	20-JAN-92	1 of 1

Project No.: 3-30092-42

Sampler (Signature): [signature]

Project Location: 44 LEWELLING, SAN LORENZO

Affiliation: RESNA INDUSTRIES

Sample No./Identification	Date	Time	Lab No.	BTEX	TPH (gasoline)	TPH (diesel)						No. of Containers	REMARKS
AS·0120·INF 1	1/20/92	1120		✓	✓							1	
AS·0120·INF 2	1/20/92	1310		✓	✓							1	72 Hrs Holding
AS·0120-EFF 1	1/20/92	1315		✓	✓							1	Time
AS·0120-INF3	1/20/92	1445		✓	✓							1	
AS·0120-INF4	1/20/92	1530		✓	✓							1	
~~AS·0120-EFF2~~	~~1/20/92~~			✓	✓							1	

Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
[signature]	1/20/92	2110	[signature]	1/20/92	12:45

Report To:
Bruce MAEDA
RESNA INDUSTRIES FREMONT CA

Bill to: ULTRAMAR INC.
525 West Third Street
Hanford, CA 93230
Attention: TERRY FOX

32-8003 1/90

WHITE: Return to Client with Report YELLOW: Laboratory Copy PINK: Originator Copy