Woodward-Clyde Consultants

June 1991

Soil and Groundwater Characterization Study 187 North L Street Livermore, California

Prepared for

Don-Sul, Inc.
187 North L Street
Livermore, CA 94550

June 12, 1991

Prepared by

Woodward-Clyde Consultants
500 12th Street, Suite 100
Oakland, CA 94607-4014

500 12th Street
Suite 100
Oakland, CA 94607-4014
(415) 893-3600

Woodward-Clyde Consultants

June 12, 1991
90C0321A-6000

Mr. Tony Sullins
Don-Sul Inc.
187 North L Street
Livermore, California 94550

Subject: Soil and Groundwater Characterization Study
187 North L Street
Livermore, California

Dear Mr. Sullins:

We are pleased to present the results of the Soil and Groundwater Characterization Study performed at the subject site. The purpose of this study is to explore the extent of petroleum contamination in soil and groundwater, and to evaluate the source of contamination. Two soil borings and five groundwater monitoring wells were installed during this study.

The following report presents the findings and conclusions of this study. Laboratory test results and supporting documentation are attached to the report. We are available to meet with you to discuss the results of this study and respond to questions.

Sincerely,

WOODWARD-CLYDE CONSULTANTS

Albert P. Ridley, CEG 926
Senior Associate

Lois Gruenberg
Senior Staff Engineer

D:\WPDOCS\7\90C0321.ALL\25

0611911455

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

List of Tables

List of Figures

Appendices

SOIL AND GROUNDWATER CHARACTERIZATION STUDY
187 NORTH L STREET
LIVERMORE, CALIFORNIA

EXECUTIVE SUMMARY

The Arrow Rentals site, located at 187 North L Street in Livermore, California, was a former Mobil gas station from about 1951 to at least 1968. Arrow Rentals purchased the property in 1972. Three of the five underground fuel tanks were removed by Arrow Rentals in 1972, because they failed integrity tests. Two tanks that passed integrity tests remained in use until 1984, when they were also removed. No stains or gasoline odors were observed during removal of these two tanks. A new 1,000-gallon underground fuel tank was installed to meet the new California underground tank regulations. The new tank installation includes a vapor monitoring well adjacent to the tank. In 1985 it is reported (Declaration, Gary Pinks, Appendix F) that about 600 gallons of fuel was poured down the vapor well by a fuel delivery truck operator from Petcock Petroleum. Mr. Sullins reports that water was poured into the well from a garden hose some time after the spill.

Because the Livermore Redevelopment Agency is interested in purchasing this site as part of proposed redevelopment of this area, a study of possible site contamination was performed in 1988 and 1989 by Woodward-Clyde Consultants (WCC) on behalf of the Livermore Redevelopment Agency. Those studies showed detectable petroleum contamination in soil and groundwater at the Arrow Rentals site. The Alameda County Health Department has requested Arrow Rentals to perform additional site characterization to evaluate the extent of contamination.

Scope of Work

This study included drilling two exploratory borings (B-1A and B-F) and installing five groundwater monitoring wells. Prior to drilling, a soil gas study was performed by Tracer Research Corporation to explore the distribution of petroleum vapors in the soil. One well

(W-C) is located upgradient of the site, and two wells (W-D, W-E) are located downgradient of the site. One on-site well (W-B) is located downgradient of the former Mobil tanks, and a second on-site well (W-A) is located between the former Mobil tanks and the existing 1,000-gallon tank. Soil and groundwater samples were collected from the boring and wells, and were tested in an analytical laboratory for gasoline, diesel, and petroleum products. Water levels were measured in each of the wells to evaluate the groundwater gradient. These results were evaluated and presented in this report.

Results of Study

Gasoline was detected in soil samples from well W-A near the former Mobil tanks, and from Boring B-1A near the vapor monitoring well at the existing 1,000-gallon tank. Petroleum contamination was found in groundwater from well W-A (6,800 ppb benzene), and from well W-B (22,000 ppb benzene). No petroleum contamination was found in groundwater from wells W-C, W-D, and W-E. Floating gasoline was sampled from well W-1 located east of the former Mobil tanks, and downgradient of the vapor well.

Comparison of fuel fingerprints from the existing 1,000-gallon tank and from well W-1 shows that these materials do not match. Analysis of the product sample from well W-1 by Chevron Research and Technology Laboratory shows that on the basis of organic lead content, the floating product in W-1 is a gasoline produced in 1985. Analysis of organic lead content of gasoline in soil from Boring B-F, at a depth of 16 feet, shows that the gasoline was produced prior to 1985.

Evaluation of groundwater gradient and flow direction shows that the floating product is located in the downgradient direction of the reported 1985 release of Chevron Fuel into the vapor well.

Conclusions

Petroleum contamination in soil in the area of W-1 is most likely the result of leaks from a former pipeline extending from the five former Mobil station tanks to the former pump island closer to L Street. This is supported by detecting gasoline in soil at shallower depths (15 feet) and of higher concentration (1200 ppm) in W-1 east of the former Mobil tanks, and at lower concentrations (120 ppm) and deeper (20 feet) in B-1 and B-3 (25 feet) under the former Mobil tanks. That piping was not used by Arrow Rentals. In 1972 Arrow Rentals

installed a pump at the location of B-F and connected new pipes to the two remaining tanks. The nondetection of gasoline at a depth of 2 feet beneath this pump location in B-F, and only 16 ppm gasoline at a depth of 16 feet in B-F, indicates this pump and piping, operated between 1972 to 1984, is most likely not the source of gasoline in soil near W-1.

Floating product in W-1 is located on site, and has a lead content consistent with a gasoline produced in 1985, and spilled into the vapor well in 1985.

The location of floating product in W-1 is located about 40 feet downgradient of the vapor well and appears consistent with the reported spill in the vapor well in 1985.

The location of dissolved gasoline in groundwater extending a distance of more than 200 feet downgradient of well W-1 appears consistent with an older pipe leak during the period from 1951 to 1968.

The estimated 200- to 500-gallon volume of floating product appears consistent with the approximate volume of the spill in the vapor well in 1985.

About 85 percent of the soil contamination is estimated to be the result of leaks from pipes connected to the former Mobil tanks prior to 1968. About 15 percent of the soil contamination is estimated to be the 1985 Petcock Petroleum spill, into the vapor well.

About 97 to 99 percent of the petroleum groundwater contaminant is estimated to be the result of the Petcock Petroleum spill; about 1 to 3 percent is estimated to be from leaks from pipes connected to the former Mobil tanks prior to 1968.

While a number of options are available for remediation, the soil vapor extraction appears to be most feasible for soil contamination, and groundwater extraction and treatment appears most feasible for groundwater remediation.

INTRODUCTION

The Arrow Rental Site is located at 187 North L Street in Livermore, California. The site was a Mobil gas station for many years prior to 1968. Arrow Rentals purchased the property

in 1972. In 1972 there were five underground fuel storage tanks remaining from the previous gas station operation. Three of the tanks were removed in 1972 because they failed leak detection tests. The two remaining tanks, a 6,000-gallon and a 4,000-gallon tank, remained in use until their removal in 1984. A pump was installed by Arrow Rentals near Boring B-F and connected with new piping to the two remaining tanks in 1972. A new 1,000-gallon underground tank was installed in 1984 to replace the removed tanks. The 1,000-gallon tank is currently in use for the Arrow Rentals operations. In 1985, it is reported that about 600 gallons of Chevron leaded regular gasoline was poured down a vapor monitoring well near the 1,000-gallon tank by the operator of the fuel delivery truck. Following that spill it is reported that water was poured into the vapor well with a garden hose, for about 24 to 30 hours (pers. comm., Tony Sullins).

In 1988 and 1989, the City of Livermore Redevelopment Agency retained Woodward-Clyde Consultants (WCC) to perform soil and groundwater exploration and testing to explore for potential contamination, based on the past site history (WCC 1988, 1989a, 1989b). Those studies detected petroleum contamination in soil and groundwater. The detection of petroleum contamination was reported to Arrow Rentals and to the Alameda County Department of Environmental Health. The Health Department subsequently requested Arrow Rentals to perform additional site characterization, to explore the extent of petroleum contamination, and form the basis for a Site Remediation Plan. Arrow Rentals retained the services of WCC to perform the requested work. The following report describes the results of the site characterization study, which was conducted in accordance with a work plan approved by Alameda County.

Scope of Work

The site characterization study consisted of site exploration, laboratory testing and analysis of the data and preparation of a report. This work, described below, was divided into a number of tasks.

Task 1 - Alternate Source Evaluation. Possible alternate sources of petroleum contamination were evaluated by testing for the presence of former piping, performing a precision integrity test on the 1,000-gallon tank and performing a soil vapor study of the site.

Task 2 - Exploratory Borings and Groundwater Wells. Prior to beginning field exploration a Health and Safety Plan (HSP) was prepared. The HSP considers potential health and safety risks and describes procedures and protective equipment needed for field personnel. Two exploratory boring and five groundwater monitoring wells were installed during this study (see Figure 1). Boring B-1A was located near the existing underground fuel tank, and Boring B-F was located at the former Arrow Rentals pump site. Wells W-A and W-B were drilled on-site, and wells W-C, W-D and W-E were drilled off-site. Well W-A is located in the down groundwater gradient direction from the existing underground fuel tank, and upgradient from W-1 and the former Mobil tanks. Well W-B is located near the north property line, downgradient from W-1 and the former Mobil tanks. Well W-C is located in North L Street, upgradient from the site. Well W-D is located in the rear of a residential property on Chestnut Street. Well W-E is located at the end of M Street Northwest of the site (Figure 1).

Task 3 - Groundwater Sampling. Each of the wells were developed by using a development rig to extract water from the wells to remove sediment. Water samples were collected from each well and transported to the laboratory on ice under chain-of-custody procedures. The water removed during development was stored in drums on site for proper disposal. Prior to sampling the stabilized groundwater level was measured and evidence of floating product was evaluated. The top of the well casings were surveyed by Bissel and Karn, Engineers, San Leandro, California. Measured groundwater depths were used to evaluate groundwater elevations and prepare a groundwater gradient map (Figure 2).

Task 4 - Laboratory Analysis. Selected soil samples from the borings and wells and water samples from wells were tested by Friedman and Bruye Laboratory, Seattle, Washington. A sample of fuel from the existing underground tank (Chevron Fuel) was tested in the Friedman and Bruye Laboratory. Tests included fuel fingerprinting, testing for total petroleum hydrocarbons as gasoline and as diesel (EPA 8015/8020). Some soil and water samples were tested for organic lead content, and selected metals. One soil sample from Boring B-F was tested by Coast to Coast Analytical Laboratories for tetraethyl lead and total petroleum as gasoline.

Water, floating product and fuel from the existing underground tank were submitted to Chevron Laboratories, Richmond, California. Tests were performed to evaluate if the floating

product from the monitoring well contained characteristics of the 600 gallons of Chevron leaded fuel reportedly spilled by the delivery truck operator.

Task 5 - Aquifer Tests. Selected on-site wells were tested using slug test methods to evaluate the conductivity of the water bearing units under the site.

Task 6 - Analysis and Report. This report was prepared describing the results of the exploration and testing. The report describes the evaluation of the extent of soil and groundwater contamination, source(s) of petroleum contamination and possible mitigation methods.

Site Description

The 187 North L Street site is located on the west side of L Street, as shown in Figure 1. The site is about 100 feet wide, and 200 feet deep, and is entirely paved with asphaltic concrete. The former Mobil Station building is currently in use as an office, storage building by Arrow Rentals. The site is fenced and most of the rear (west) portion of the site is used to store rental equipment. A 1,000-gallon underground gasoline tank is located at the southeast corner of the site. Property to the south and west are undeveloped. The Western Pacific Railroad Right-of-Way borders the north side of the property. Residences are located north of the railroad property.

Previous Studies

Previous exploratory borings and wells were drilled by WCC at the site in 1988 and 1989 (WCC 1988, 1989a, 1989b) as part of the initial work for the Livermore Redevelopment Agency. Those borings and wells are shown on Figure 1 as B-1 through B-5, B-7, B-8 and W-1, W-2 and W-3. Gasoline contamination in the soil was detected at 170 parts per million (ppm) at a depth of 20 feet and 220 ppm at 25 feet in B-1. Gasoline was detected in soil boring B-2 at 3.5 ppm at a depth of 2 feet, 8.2 ppm at 5 feet and 1.7 ppm at 25 feet. Gasoline was not detected in soil in B-3 until a depth of 25 feet, where only 1.3 ppm was detected. The greatest concentration of gasoline in soil was detected in W-1, where gasoline was detected at 1200 ppm at 15 feet, 350 ppm at 20 feet, 490 ppm at 25 feet, 160 ppm at 30 feet, 370 ppm at 35 feet and 16,000 ppm at 40 feet. The highest concentration of gasoline at 40 feet is explained as an accumulation of gasoline floating on the groundwater, which was found at a depth of 43 feet.

No gasoline was detected in soil from depths of 2, 5, 10 and 15 feet in B-4 and 5 and 10 feet in B-7. Both B-4 and B-7 were drilled at opposite ends of the former pump island (Figure 1). No significant concentrations of gasoline (1.9 ppm at 5 feet, 1.7 ppm at 25 feet) were found in soil from Boring B-5, located near the existing 1,000-gallon fuel tank.

No gasoline contamination was detected in soil above the water table in Well W-3 and only 1.2 ppm gasoline was detected in Well W-2, with no detection to a depth of 50 feet. Groundwater from Well W-1 contained 210 ppm gasoline, 29 ppm benzene, 30 ppm toluene, 5.4 ppm ethylbenzene and 24 ppm xylenes. Groundwater from Well W-2 contained 0.36 ppm gasoline, 0.0067 ppm benzene, 0.0021 ppm toluene, 0.00047 ppm ethylbenzene and 0.0013 ppm xylenes. Water from Well W-3 contained 11 ppm gasoline, 0.290 ppm benzene, 0.120 ppm toluene, 0.150 ppm ethylbenzene and 0.140 ppm xylenes.

Measured groundwater depths ranged from 43.16 feet in Well W-1 and 44.24 feet in W-2, to 44.5 in W-3. The elevations of the groundwater surface indicated a northwest groundwater flow direction.

FIELD INVESTIGATION

Soil Gas Study

Tracer Research Corporation (TRC) of Tucson, Arizona was subcontracted to perform a soil gas investigation at the Arrow Rentals site on June 11 and 12, 1990. Samples were collected by driving a 3/4-inch-diameter stainless steel probe approximately eight to 10 feet into the subsurface. A truck-mounted hydraulic apparatus was used to push the probe into the soil. The probe end was protected from gathering soil during the driving procedure by inserting a pointed tip which is removed by lifting the probe after reaching the approximate depth of sampling. A fitting attached to the top of the steel probe is connected to a pump and approximately 2 to 5 liters of gas were evacuated from the steel probe. Samples were collected during the purging of the probe by inserting a syringe into the fitting at the top of the probe.

The samples were analyzed on the day sampled using a Varian 3300 gas chromatograph equipped with a flame ionization detector (FID). Samples were analyzed for benzene,

toluene, ethylbenzene, xylenes (BTEX) and total petroleum hydrocarbons. Quality assurance/quality control procedures are described in the report contained in Appendix A.

TRC reported no detection of BTEX above the stated detection limit in all of the samples. Total petroleum hydrocarbons were detected in all of the samples, however only up to 1 µg/L. Figure 2 in the TRC Soil Gas Investigation report dated June 1990 shows an isoconcentration map of the total petroleum hydrocarbons (TPH) at the site.

Borings and Monitoring Wells

Between July 10 and 13, 1990, WCC installed five groundwater monitoring wells at and near the site (monitoring wells W-A, W-B, W-C, W-D, and W-E). Locations for these monitoring wells were based on consideration of the estimated groundwater flow direction from the data from previously built wells W-1, W-2, and W-3. The locations were selected to provide additional monitoring wells in the upgradient and downgradient directions of the known contamination. The wells were completed and screened into the upper, or first groundwater zone. The locations of these monitoring wells are shown on Figures 1 and 2. In addition, one boring was drilled adjacent to the vapor well of the 1,000-gallon underground regular gasoline storage tank in the southeast corner of the property.

The monitoring wells and the boring were advanced under WCC's field observation. Monitoring wells W-C and W-E were drilled using a truck-mounted drilling rig equipped with 8-inch outside-diameter, hollow-stem, continuous flight augers. Wells W-A and W-B were drilled using 12 inch diameter hollow stem augers, to allow installation the 4 inch diameter PVC well casing. These two wells have larger diameter well casing to allow for possible installation of pumps for groundwater extraction. For each well installation, a WCC engineer or hydrogeologist observed the drilling operations and prepared a log of the soils encountered in the monitoring well borings, which are presented in Appendix B. Upon completion of each boring, the monitoring wells were installed as described below. The wells were constructed of 2- or 4-inch-diameter flush threaded, schedule 40 polyvinyl chloride (PVC) casing. The screened intervals of the wells within the upper groundwater zone were placed between about 40 and 60 feet below the ground surface.

The screened portions of the well casings were constructed of slotted 2- or 4-inch-diameter PVC pipe, which contained standard factory-milled slots with a 0.010 inch aperture. The

remainder of each well casing was constructed of unslotted blank PVC well pipe. The filter pack, which consists of No. 2/12 Monterey Type, Lonestar sand, was placed in the annular space between the borehole wall and well casing from the base of the borehole to about one foot above the top of the slotted interval of the well casing. The filter pack was then sealed with approximately 1 foot of 3/8-inch-diameter bentonite pellets placed above the top of the sand pack. The remaining portion of the annulus was sealed with Portland cement grout. A water-tight, locking well cap was placed inside the casing and a traffic-rated Christie box was placed over each well. The well construction details are shown on the log of each monitoring well, in Appendix B.

Drilling equipment including the augers, soil samplers, drop hammer, plug, etc., where decontaminated by steam-cleaning prior to use at each boring. The soil sampler was also decontaminated between each sampling interval in a boring. All PVC well construction materials were also steam-cleaned prior to each installation. Steam cleaning operations were conducted so as to contain the resulting washwater. The washwater was subsequently transferred to drums which were sealed, labeled, and left on-site for proper disposal following completion of all drilling and sampling activities.

Soil Sampling

Soil samples were collected during the advancement of the monitoring well borings. Samples were generally collected at 5-foot intervals in each boring by advancing a 2-inch, outside-diameter, modified California sampler through the hollow stem of the augers. The sampler was driven 18 inches, using a 140 pound hammer with a 30-inch drop. The number of blows required to drive the sampler through each 6-inch portion of the 18-inch drive interval are shown on the boring logs in Appendix B.

The soil samples were retained in four 4-inch-long, 2-inch-diameter brass liners contained within the sampler. The ends of the tube samples were examined by WCC's engineer and the soil was visually classified using the Unified Soil Classification System. The soil descriptions are included in the boring logs. The depth to first encountered groundwater is also shown on the logs.

The soil samples in the lowermost brass liners were retained for potential chemical analyses, while the samples from the adjacent liner were generally used to perform a headspace

analysis in the field for volatile organic compounds. Chemical analyses was performed on soil samples when headspace analyses indicated a presence of volatiles in soils. The headspace test procedure involved emptying the contents of the brass liner into a Ziplock® plastic bag and sealing the bag. The soil was allowed to out-gas inside the sealed bag for approximately 5 minutes. The bag was then pierced with a probe and the air within the bag was tested for total organic vapor with an HNu photoionization detector.

Sampling equipment such as the brass liners and samplers were decontaminated between uses by washing in an Alconox solution followed by two tap water and one distilled water rinses.

The elevations of all new well casings were surveyed, relative to Mean Sea Level (MSL) datum, by means of a closed loop level traverse. The top of each well casing was surveyed to the nearest 0.01 foot. A notch was marked on the casing at the measuring point such that future well level measurements can be taken from the same point. In addition, all wells were surveyed for horizontal control. The surveying was performed by Bissel & Karn Engineers, a licensed land surveyor. All new groundwater monitoring wells were permitted and installed in accordance with Alameda County Flood Control and Water Conservation District regulations and guidelines.

Boring B-1A, located on the east side of the existing (1,000-gallon) underground tank, encountered sandy gravel grading to clayey silt at 25 feet. Field measurements of organic vapors from soil samples from the borings shows no significant detection until a depth of 20 feet, where 50 ppm organic vapors were detected with an HNU photoionization detector (PID). Readings increased to 225 ppm at a depth of 40 feet in B-1A. Groundwater was encountered at a depth of about 42 feet in B-1A.

Boring B-F was drilled at the location of the former gasoline pump, used by Arrow Rentals between 1972 and 1984. That boring encountered clayey gravel from beneath the concrete slab to a depth of 16 feet. The clay content increased near the bottom of the boring. No gasoline odors were observed in soil from Boring B-F to a depth of about 15 feet, where a slight gasoline odor was observed.

Field measurements of organic vapors detected 20 ppm at a depth of 20 feet in Well W-A, increasing to 110 ppm at 25 feet. A strong gasoline odor was observed from soil at a depth of 30 feet continuing to the top of the groundwater at about 44 feet.

Well W-B, located downgradient of the former Mobil underground tanks (Figure 1), did not encounter soil with a significant gasoline odor. The highest HNU reading from soil in W-B was only 30 ppm, at a depth of 40 feet. Groundwater was encountered at a depth of about 44 feet.

Well W-C is located upgradient of the site in the pavement of L Street. No gasoline odors were encountered from soil from W-C. The well was constructed using 2-inch diameter PVC well casing. A meter box cover was installed in the street over the well for protection and security.

Well W-D is located in the rear yard of the Armstrong property at 1951 Chestnut Street. No gasoline odors were detected in soil samples from W-D. A HNU reading of 150 ppm was recorded during drilling at a depth of 45 feet. Groundwater was encountered at a depth of about 42 feet. A 2-inch-diameter well casing was installed in W-D.

Well W-E is located in the pavement of M Street northwest of the site, as shown in Figure 1. No gasoline odors or significant HNU readings were detected during drilling of W-E. Groundwater was encountered at a depth of about 43 feet.

Monitoring Well Development and Groundwater Sampling

Following installation, Datum Exploration was subcontracted to develop the monitoring wells. The five groundwater monitoring wells were developed on July 26 and 27, 1990 by pumping or bailing groundwater and by applying a surge block to the water column. Pumping and bailing were performed with intermittent surging until the resultant groundwater was clear. However, if the well yield was very low, the well was considered developed when a total of at least 10 casing volumes of groundwater was removed and some improvement in well yield was observed. Copies of the well development logs are included in Appendix C.

Groundwater monitoring wells Nos. W-A, W-B, W-C, W-D and W-E were sampled by WCC personnel. The sampling procedure utilized included: 1) measurement of the depth to

groundwater; 2) removal of at least 5 wetted casing columns of groundwater from each well; and 3) allowing the groundwater level within the well to recover to at least 80 percent of its static level prior to obtaining samples. While purging the well, the groundwater from each well was evacuated with either a Teflon® bailer or a suction type pump. Water quality parameters including temperature, pH, and specific conductance were recorded throughout the well purging process. The physical parameters of the purged water, such as turbidity, color and odor, were noted.

Following the well purging activities, each well was allowed to recover to at least 80 percent of the original static groundwater level. Prior to sampling, the groundwater level and water quality parameters were rechecked and verified against the data obtained during the purging activities. Stabilized water quality parameters were used as a general check that the groundwater obtained for the samples was fresh formational water (i.e., had not stagnated in the near vicinity of the well). Monitoring well sampling data including well depth, depth to groundwater, groundwater elevation, conductivity, temperature, pH, and turbidity are shown in Appendix C. The depth to groundwater was established using a Solinst power sounder, with the depth measurements recorded to the nearest 0.01 foot. Groundwater samples were obtained with a clean Teflon® bailer and were carefully decanted into appropriate laboratory prepared sample containers. Samples analyzed for metals were filtered in the field and then decanted into the sample containers. The samples were then placed in laboratory-prepared containers and transported to the analytical laboratory on the day of sampling, under standard chain-of-custody procedures.

In-Situ Hydrologic Tests

Slug tests were performed on Wells W-A and W-B, Figure 1. These wells were selected for slug tests to measure the hydraulic conductivity of the water- bearing strata under the site. A pressure transducer was placed in the well and a selected volume of water was introduced into the well. The time for the water level to return to normal was measured. The results are shown in Appendix C and are discussed in the text of this report.

LABORATORY TESTS

Selected soil and water samples from borings and wells were tested in a commercial analytical laboratory (Friedman & Bruye, Inc.) for total petroleum hydrocarbons as gasoline,

and diesel (EPA 8015 modified) and for benzene, toluene, ethylbenzene, and xylenes (BTEX) (EPA 8020). Gas chromatograph methods were also used to perform fuel fingerprint tests on soil and water samples. Soil and water samples were also tested for organic lead content, cadmium, chromium, copper, nickel, vanadium, and zinc. Selected samples were also analyzed for the presence of phenol, naphthalene, 2-methyl naphthalene, and dye. A fuel fingerprint and analysis for BTEX and organic lead was performed on a sample of fuel from the existing 1,000-gallon tank filled with Chevron fuel. A sample of floating product from well W-1 (Figure 3), and water from wells W-A and W-B were analyzed in the Chevron Research and Technology Company Laboratory for characteristics which might identify the fuel as Chevron leaded gasoline from August of 1985. Chevron Research tested the samples using gas chromatography and a flame ionization detector to determine hydrocarbon composition and an electron capture detector to measure lead alkyl concentration. Detergent additive was analyzed by Sep-Pak extraction and infrared spectroscopy. The results of laboratory tests are included in Appendix C. One soil sample from Boring B-F was analyzed by Coast to Coast Analytical Laboratories for tetraethyl lead and total petroleum hydrocarbons as gasoline. Using a method developed by Dr. Brian Andresen, consultant, the lead content per gallon of gasoline in this soil was evaluated.

RESULTS

Extent of Soil and Groundwater Contamination

Soil Contamination. Laboratory analyses of soil samples from borings and wells indicate that gasoline contaminated soil is located on the site. No gasoline contamination was detected in soil samples from off-site wells W-C, W-D, and W-E, as shown in Table 1.

Soil samples from a depth of 15 feet in Well W-1 contained 1,200 parts per million (ppm) Total Petroleum Hydrocarbons (TPH) as gasoline. The detected concentrations of TPH as gasoline ranged from 160 to 370 ppm in soil from 20 to 35 feet in well W-1. At 40 feet in W-1 the soil contained 16,000 ppm TPH as gasoline. Laboratory analyses detected 2 ppm gasoline at 30 feet, and 1,000 ppm gasoline at 40 feet in Well W-A, located southeast of W-1 (Figure 5). A field vapor analyzer (HNU photo ionization detector) measured 50 ppm organic vapors at 20 feet in Boring B-1A. The HNU detected 130 ppm at 35 feet, and 225 ppm at 40 feet in Boring B-1A. Laboratory tests of soil from 10, 15, 20, 30, and 35 feet in B-1A, for total petroleum hydrocarbons as gasoline showed no detection (less than 5 ppm). Soil

from a depth of 40 feet in B-1A contained 350 ppm gasoline. At 45 feet in B-1A soil contained 54 ppm gasoline. No gasoline was detected in soil from a depth of 2 feet in Boring B-F. Analysis of soil from a depth of 16 feet in Boring B-F showed 10 parts per billion (ppb) tetraethyl lead and 16 ppm TPH gasoline. No gasoline was detected above the water table in soil samples from Well W-B located northwest of W-1, at the north property line of the site (Figures 3, 4 and 5). The estimated distribution of soil contamination under the site is shown in Cross-Sections A-A' and B-B' (Figures 5 and 7).

Groundwater Contamination. Analysis of groundwater from off site wells W-C (upgradient), W-D, and W-E (both downgradient) shows no significant detection of petroleum contamination. The detection of 1 part per billion (ppb) benzene, 2 ppb toluene, 1 ppb ethylbenzene, and 1 ppb xylenes in well W-D may be a result of contamination during transport of the water samples, since a travel blank shows detection of 7 ppb benzene, 37 ppb toluene, 14 ppb ethylbenzene, and 43 ppb xylenes. The travel blank may have been contaminated during transport to the laboratory, since a pure fuel sample was also placed in the ice chest with W-D.

The most significant gasoline contamination was found in well W-1, where 4 inches of gasoline (Figure 6) was found floating on the groundwater. After well development the thickness in the well increased to several feet, however, this may be a localized thickness in the well screen. TPH as gasoline was detected at 10 ppm in W-A, and 21 ppm in W-B. As shown in Table 2, benzene was detected at 22,000 ppb in water from W-B, and 6,800 in water from W-A. Toluene, ethylbenzene, and xylenes found in W-A and W-B up to about 7,900 ppb. No measurable floating product was detected in the downgradient well W-B, or the upgradient well W-A. Previous analyses of groundwater in wells W-2 and W-3 detected 6.7 ppb benzene in W-2 and 290 ppb benzene in W-3. The approximate limit of groundwater contamination is shown in Figure 3.

Contaminant Sources

The source of soil and groundwater contamination appears to be from two separate sources. One is a suspected leak between 1951 and at least 1968 from a pipe connected to the former Mobil tanks. A second source is the sudden spill of gasoline into the vapor well in 1985.

Exploration shows the location of floating product to be about 40 feet downgradient of the reported 1985 fuel spill. Floating product detected in well W-1 at about 4-inches thick, is not found in W-A or W-B. Fuel fingerprints of floating product from W-1 does not match the fingerprint of the Chevron fuel in the existing tank or soil from W-A at 40 feet (see Friedman and Bruya report Appendix C). The gas chromatograph peaks for water from W-A and W-B represent the soluble fraction of gasoline.

As shown in Figures 5 and 7, gasoline contaminated soil occurs from a depth of 15 feet downward to the top of groundwater in W-1. Cross-section B-B' shows that gasoline contamination is shallower (15 feet) and has a higher concentration (1200 ppm) in soil from W-1 located east of the former Mobil tanks, and along the approximate pipe route to the Mobil pump island. The gasoline contamination is deeper (20 feet) and less concentrated (120 ppm) in soil from B-1 under the former Mobil tanks. Since only 16 ppm gasoline was detected in soil from 16 feet in Boring B-F, the former Arrow Rentals pump does not appear to be the source of gasoline in soil. Evaluation of the amount of tetraethyl lead in soil from 16 feet in Boring B-F shows the gasoline contained 1.8 grams per gallon, which is ttypical of a pre-1985 gasoline.

Field measurements of organic vapors in soil samples from Boring B-1A adjacent to the vapor monitoring well at the tank storing Chevron fuel shows detection of 50 ppm at 20 feet, 25 ppm at 25 feet, 50 ppm at 30 feet, 130 ppm at 35 feet, and 225 ppm at 40 feet. However, laboratory tests of soil at those depths, for TPH as gasoline, shows no detection (less than 10 ppm), until a depth of 40 feet where 350 ppm gasoline is detected. The low concentration of gasoline detected in soil near the reported June, 1985, fuel spill into the vapor monitoring well may be explained as a result of the reported pouring of a large volume of tap water into the vapor well using a garden hose, following the spill.

The laboratory tests performed on floating product in W-1, and dissolved product in W-A and W-B provide the most conclusive evidence for the origin of the fuel in the groundwater. Chevron Research (Appendix C) reports that the lead content of the fuel in W-1 is 0.18 g/gal. Considering a 10 percent evaporation of the gasoline the fuel originally had a lead content of about 0.16 g/gal. Chevron reports that this lead content is consistent with gasolines produced between late 1985 and 1988. Chevron (Appendix C) reports that gasolines spilled before 1985 typically retain most of their lead, with lead levels of 0.5 to 3.0 g/gal. Tests

indicate that the gasoline from W-1 contains a polybutene-amine detergent. Chevron used a polybutene-amine-containing F310 detergent in its leaded gasolines until 1987.

Chevron Research reports that Mobil also used a polybutene-amine-containing detergent. Chevron Research report dated October 16, 1990 (Appendix C) also reports that there is nothing in the chromatogram of gasoline from W-1 to indicate that it could not have come from the Richmond refinery. In 1985 Chevron was adding 0.22 g/gal lead to its leaded regular gasolines. The November 1985 gasoline contained more than 95 percent of its lead as tetraethyl isomer. The W-1 gasoline is reported to contain 83 percent of its lead as tetraethyl isomer (TEL). This implies the gasoline from W-1 is not Chevron's. However, this may simply be a result of exposure to the environment or other factors as discussed by Dr. Brian Andresen in an April 30, 1991 letter, Appendix C.

The location of the floating product about 40 feet downgradient from the vapor well (Figure 3) is consistent with the anticipated location after five years. Using the conductivity data from slug tests ($k = 4 \times 10^{-4}$ cm/sec), and the northwest gradient (0.0071 ft/ft), and gasoline spill at the vapor monitoring well could have moved about 15 feet northwest since 1985. With a local and temporary increase in gradient, by pouring water down the vapor monitoring well (pers. comm., Tony Sullins), or from rainfall, the gasoline could have moved up to 40 feet northwest since 1985. Addition of water from a hose at an estimated 5 gallons per minute for about 30 hours could have added 9,000 gallons of water to the vapor monitoring well. That volume of water could easily have washed the gasoline from the area of the vapor monitoring well and moved it to its present location. The approximate volume of floating product is also consistent with the approximate 600 gallons of gasoline reported spilled in the vapor monitoring well. Using a measured thickness of about 4 inches, an estimated diameter of floating product of 25 feet, and a soil porosity of about 40 percent, about 200 to 500 gallons of gasoline could be floating on the groundwater at W-1. A tank integrity test performed on the 1,000-gallon tank (Appendix D) shows the tank is "tight" per National Fire Protection Association Standards.

The low concentration of lead in gasoline from W-1 (0.18 g/gal) is the strongest indicator that the W-1 gasoline is a gasoline produced around 1985. Gasolines produced before 1985 typically contained 0.5 to 3.0 g/gal lead. Therefore, the floating product clearly is not a pre-

1985 gasoline, and whether it is a Chevron product or not it is likely to be the gasoline delivered by Petcock Petroleum and spilled into the vapor monitoring well.

Based on the estimated groundwater flow rate of between 3 and 8 feet per year, the dissolved gasoline plume, extending over 200 feet downgradient from W-1, is not likely to be from the 1985 spill. This evaluation supports the conclusion that the source of that dissolved gasoline plume is from the earlier pipe leak during the period 1951 to 1968. A leak in 1960 from the vicinity of the Mobil pipes could have moved up to 250 feet downgradient by 1991.

Does this mean contam in W-2 and W-3 are from pre 1985?

EVALUATION OF MITIGATION MEASURES

Soil and groundwater containing petroleum hydrocarbons can be remediated using techniques that have proven effective and have been used successfully at other sites in the San Francisco Bay Area. Soil remediation methods include excavation and removal of contaminated soil and transportation to an approved waste site, excavation and on-site bioremediation using natural soil bacteria and removal to a waste disposal site, in-situ bioremediation, or in-situ vapor extraction. Each of these methods have limitations as to their feasibility.

Soil Excavation

Soil contaminated with gasoline extends to a depth of 43 feet in W-1 and B-1A where the groundwater table is encountered. The soil contamination is assumed to extend laterally from W-1 in about a 25-foot radius. The volume of contaminated soil around W-1 is estimated to be about 2,000 cubic yards. It is anticipated that some significant contaminated soil (greater than 100 ppm TPH) will be found under the existing 1,000-gallon fuel tank. That soil might extend from about 35 to 43 feet under the tank and extend out about 20 feet from the tank. That volume of soil is estimated to be about 350 cubic yards. In this deeper zone the Regional Water Quality Control Board might require removal of soil to a lower TPH concentration of about 10 ppm, or less. Considering the small size of the site and the need to have excavation slopes no steeper than 1 (horizontal) to 1 (vertical) there is a potential that the excavation would extend into L Street. Protection of L Street might require support of the slopes with retaining structures such as shoring or sheet piles. With a sloped excavation about 15,000 cubic yards of uncontaminated soil would be excavated and then replaced in the hole.

Excavated soil would be removed to an approved waste site, and the excavation would be refilled with clean soil. The excavated soil could also be stored on-site and treated by aeration and bioremediation prior to removal from the site. The relative costs of removal could then be reduced since the treated soil could possibly be disposed of at a Class III Landfill instead of a Class I facility. Considering the extra cost of shoring, removal and replacement of clean soil, and hauling to a waste site, the excavation option may not be appropriate for this site.

Soil Vapor Extraction

Petroleum contaminated soil above the saturated zone can be treated to remove volatile hydrocarbons by extraction of soil gas (the gas in the soil pores) using a vapor extraction system (VES). The extraction system consist of one or more small diameter extraction wells drilled into the vadose zone (unsaturated zone of soil) above the groundwater table. A vacuum pump is used to draw soil gas from the extraction wells. The removed vapors are either released into the air, if permitted, or a pumped through activated carbon filled canisters to remove the petroleum vapors prior to discharge to the atmosphere. The vacuum pump and carbon canisters would probably require about two parking spaces. The system might use two 55-gallon drums of activated carbon, for a small system, or two 1,000-pound canisters for a large system. Spent carbon is replaced with new carbon and the spent carbon is returned to the manufacturer for regeneration. Such a system might operate for at least one year.

Bioremediation of Groundwater

Contaminated groundwater can be treated by extraction and treatment in a closed loop bioremediation system. The system would consist of one or more groundwater extraction wells (the 4-inch on-site wells) and a grid of injection wells. Extracted water would be pumped to an above ground tank where oxygen, nutrients, and heat would be added to the water. This mixture would be metered into the injection wells to increase and maintain the in-situ bacteria and microorganism population necessary to remediate the soil and groundwater in the subsurface. This method might require substantial initial documentation before regulatory agency approval. At least one year might be required to complete remediation of the soil and groundwater. A second year might be needed to reach desired cleanup levels. This method is generally less expensive than the VES and other groundwater

extraction and treatment systems. However, permitting might require a pilot study before gaining approval, which would be time consuming.

Groundwater Extraction and Treatment

Extraction of petroleum contaminated groundwater and treatment is a proven technology that has been used for many years. The system is similar to that described above, but the groundwater is treated in a treatment plant on the surface. The two on-site 4-inch diameter wells could be used for extraction of groundwater. Groundwater would first be pumped through an oil/water separator and then through a canister of activated carbon prior to discharge to the sanitary sewer. The carbon would be replaced as necessary to achieve the allowable discharge concentrations. The cost of operations would depend upon the amount of petroleum product in the groundwater. Systems are available that can be brought to the site in a prefabricated unit on a trailer. The initial operations would extract much of the floating product which would be separated for disposal along with the used carbon canisters. As contaminant concentrations decrease the operations costs would decrease. An extraction and treatment system is expected to operate for at least one year, and then for another year until the cleanup concentrations are achieved. This method of groundwater treatment would be more easily permitted, and could be installed in less time than the bioremediation system.

EVIDENCE OF SITE HISTORY

Research has produced confirmation that a Mobil Service Station was located at 187 North L Street From 1951 to at least 1968. Copies of this information are contained in Appendix E. A "Ten Year Service Award" dated 1961 was found inside the building in 1972 after Arrow Rentals purchased the site. A City of Livermore Building Permit for an underground storage tank at 187 North L Street is dated December 2, 1960. Valley Mobil Service is listed in the October 1966 Pacific Telephone directory, and the 1968 Livermore City Directory.

The declaration of Mr. Michael Comer (Appendix F) documents Mr. Comer's observations of removal of the two remaining underground tanks in the spring of 1985. He states that he observed no noticeable odor of gasoline coming from the soils at the bottom of the tank pit, nor did the soil in the tank pit have a dark discolored look which is characteristic of a tank which has been leaking. He concluded that the two tanks had not been leaking.

The declaration of Mr. Gary R. Pinks (Appendix F) documents his observations of the gasoline spill by Petcock Petroleum on June 18, 1985. Mr. Pinks states that he was present at 187 North L Street when the delivery truck from Petcock Petroleum arrived to deliver an order of regular gasoline. Mr. Comer observed that the delivery truck driver had put the nozzle of the fill hose into the vapor well rather than the mouth of the tank. Mr. Comer states that the driver called Petcock Petroleum on this truck radio and reported he had dropped 600 gallons of gas into the dirt. Mr. Comer states that a day or so after the spill the Petcock delivery truck returned and delivered gasoline into the tank.

DISCUSSION

Since the costs of remediation are anticipated to be significant some discussion of the relative causes of contamination is appropriate. The distribution of gasoline contaminated soil indicates that most of the contaminated soil appears to be located beneath the location of piping from the pump island to the five former underground gasoline tanks, in operation for many years by Mobil Oil Company from 1951 until about 1968. The estimated relative volume of contaminated soil under pipes to the former Mobil tanks is estimated to be about 2,000 cubic yards, or about 85 percent of the estimated total contaminated soil. About 350 cubic yards of contaminated soil is estimated to underlie the existing tank and vapor well spill, or about 15 percent of the total contaminated soil. Therefore about 85 percent of the gasoline-contaminated soil appears to be a result of pipe leakage from 1951 to 1968, and about 15 percent appears to be a result of the 1985 spill into the vapor well. The calculated 1.8 g of tetraethyl lead and other lead isomers per gallon of gasoline in soil from Boring B-F supports this conclusion, since this is typical of a pre-1985 gasoline.

Considering that the laboratory tests have shown that the floating product in W-1 is a gasoline produced in 1985, based upon its lead content and other characteristics, and that the approximate 200- to 500-gallon volume is consistent with the reported Petcock Petroleum spill of 600 gallons in August of 1985, the floating product is the result of the Petcock spill. The remaining portion of the reported 600-gallon spill most likely remains in the soil and backfill under and around the existing tank. Since the soil contamination in W-1, under the piping to the former Mobil tanks, extends downward to the top of groundwater, some groundwater contamination might be the result of releases from the piping to the former Mobil Tanks. Most likely the more downgradient dissolved fraction of gasoline (BTEX) is

the result of an earlier release related to the soil contamination under the piping to the former Mobil tanks between 1951 to 1968.

The broad aerial extent of the groundwater contaminant plume downgradient of the former Mobil tanks is considered to be due to releases from piping before 1972. Considering the relatively low concentrations of gasoline in that plume as compared to the volume of floating gasoline from the 1985 spill, the greatest amount of gasoline floating and dissolved in the groundwater is from the 1985 spill. About 97 to 99 percent of the gasoline floating on and dissolved in the groundwater appears to be due to the 1985 spill. This is based on an estimated 200 to 500 gallons of floating product and a 100-foot diameter of contaminated groundwater with about 3-1/2 gallons of dissolved gasoline from the 1985 spill. About 1 to 3 percent of the gasoline in the groundwater could be due to releases from 1951 to 1968. This is based upon an estimated 7 gallons of gasoline in the broad groundwater plume.

The remediation effort to recover each of these releases from the groundwater will be dependent more upon the aerial extent of the contaminant plume. Assuming moderate recovery of about 1/2 gallon per minute for pumping of groundwater for treatment, about 1 to 2 years would be needed to extract the 1985 spill. Assuming the same recovery rate, more than 5 years would be needed to pump and treat groundwater from the broad plume. The time required for groundwater remediation could be reduced by addition of extraction wells to increase the rate of extraction of groundwater.

SUMMARY OF CONCLUSIONS

1. Based on this data, gasoline contamination in soil and groundwater at the site is the result of two separate sources: (1) a pipe leak from pipes connected to former Mobil tanks between 1951 and 1968, and (2) a sudden spill into a vapor monitoring well by Petcock Petroleum in 1985.

2. Laboratory tests of samples of soil and groundwater for petroleum products indicates that soil contaminated with gasoline is located primarily on-site in the vicinity of well W-1 from a depth of about 15 to 43 feet, and near Boring B-1A from about 35 to 43 feet.

3. Floating gasoline found in well W-1 has a lead content consistent with a gasoline produced around 1985, and spilled by Petcock Petroleum into the vapor well in 1985.

4. The location of the floating product in W-1, about 40 feet downgradient from the reported Petcock Petroleum spills, appears consistent with the estimated present location for a spill at the vapor well in 1985. Floating product appears to be located on-site in the vicinity of W-1.

5. The estimated volume of floating product from measured thickness and diameter is consistent with the reported 600-gallon spill by Petcock Petroleum at the vapor monitoring well.

6. Laboratory tests of groundwater from off-site wells W-C (upgradient), W-D and W-E (downgradient) show no significant detection of gasoline or BTEX. One ppb benzene in Well W-D is most likely a result of cross contamination during transport to the laboratory. Dissolved fractions of gasoline (BTEX) extend off-site in the downgradient direction towards W-D and W-E.

7. Laboratory tests of soil from a depth of 16 feet in Boring B-F shows the tetraethyl lead content of gasoline in this soil is consistent with a gasoline produced prior to 1985. The source of this gasoline is most likely a pipe leak from the former Mobil tanks prior to 1968.

8. About 85 percent of the soil contamination appears to be the result of leaks from piping to the former Mobil underground fuel tanks prior to 1972. About 15 percent of the soil contamination appears to be the result of the 1985 Petcock Petroleum spill.

9. About 97 to 99 percent of the groundwater contaminant appears to be the result of the Petcock Petroleum spill, and about 1 to 3 percent appears to be the result of leaks from the former Mobil tanks, prior to 1968. Assuming a 1/2-gallon-per-minute recovery rate, about 1 to 2 years might be needed to extract the groundwater contamination from the 1985 spill. At the same extraction rate more than 5 years would be needed to extract the pre-1985 groundwater contamination.

10. While a number of options are available for remediation of soil and groundwater, the most feasible soil remediation method is soil vapor extraction, and the most feasible groundwater remediation method is groundwater extraction and treatment with carbon filters.

LIMITATIONS

The scope of this investigation is limited by time constraints, expense, and practicality. A limited number of samples were taken at locations on and off the site, and a limited number of chemical analyses were performed on those samples. Professional opinions concerning the presence of gasoline and petroleum products were developed based upon the resulting data. It would be prohibitively expensive and time consuming to sample all locations on and off site for all substances which are now, or in the future might be, considered hazardous. Therefore, WCC cannot be held responsible should the investigation fail to detect the presence or quantity of all hazardous substances at all locations on and off site in the study area.

REFERENCES

Woodward-Clyde Consultants, 1988, consultants report entitled, "Phase I Environmental Assessment, Railroad Avenue Property, Livermore, California", dated December 27, 1988, prepared for Livermore Redevelopment Agency.

Woodward-Clyde Consultants, 1989a, consultants report entitled, "Phase II Site Exploration, Railroad Avenue Property, Livermore, California", prepared for Livermore Redevelopment Agency.

Woodward-Clyde Consultants, 1989b, consultants report entitled, "Phase III Environmental Assessment, 187 North L Street, Livermore, California", prepared for Livermore Redevelopment Agency.

Table 1 LABORATORY TEST RESULTS OF SOIL SAMPLES **

Arrow Rentals, 187 North L Street, Livermore,CA

Sample No.	TPH Gas. (ppm)	Organic Pb (ppb)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylenes (ppb)	2-Methyl Naphthalene (ppm)	Naphthalene (ppm)	Phenol (ppm)	Dyes	Cd (ppm)	Cr (ppm)	Cu (ppm)	Ni (ppm)	V (ppm)	Zn (ppm)
B-1A-10	<10															
B-1A-15	<10															
B-1A-20	<10	<5														
B-1A-30	<10	<5														
B-1A-35	<10															
B-1A-40	380	<5														
B-1A-45	54	<5														
B-1A-50	<10	<5														
P-1	<0.5		<500	<500	<500	<500										
B-F-1,2	16	10*	2	25	30	34										
W-A-20	<1	<1	810	320	240	210					0.2	2.3	12	64	0.3	11
W-A-30	2	<1	890	130	35	1200	<1	<1	<10		<.1	23	13	55	6.3	23
W-A-35		<1									0.6	31	15	6.9	9.1	15
W-A-40	1050		12000	37000	7500	27000				none						
W-B-25	<1	<1									<.1	76	15	82	6.3	21
W-B-30							<1	<1	<1							
W-B-40	<1		890	260	110	70					0.2	22	18	74	7.1	14
W-C-20	<10		<10	<1	<1	<1				none						
W-C-40	<10															
W-D-25	<1		<10	<1	<1	<1				none						
W-D-40	<1		<10	<1	<1	<1										
W-E-20	<10															
W-E-40	<10															

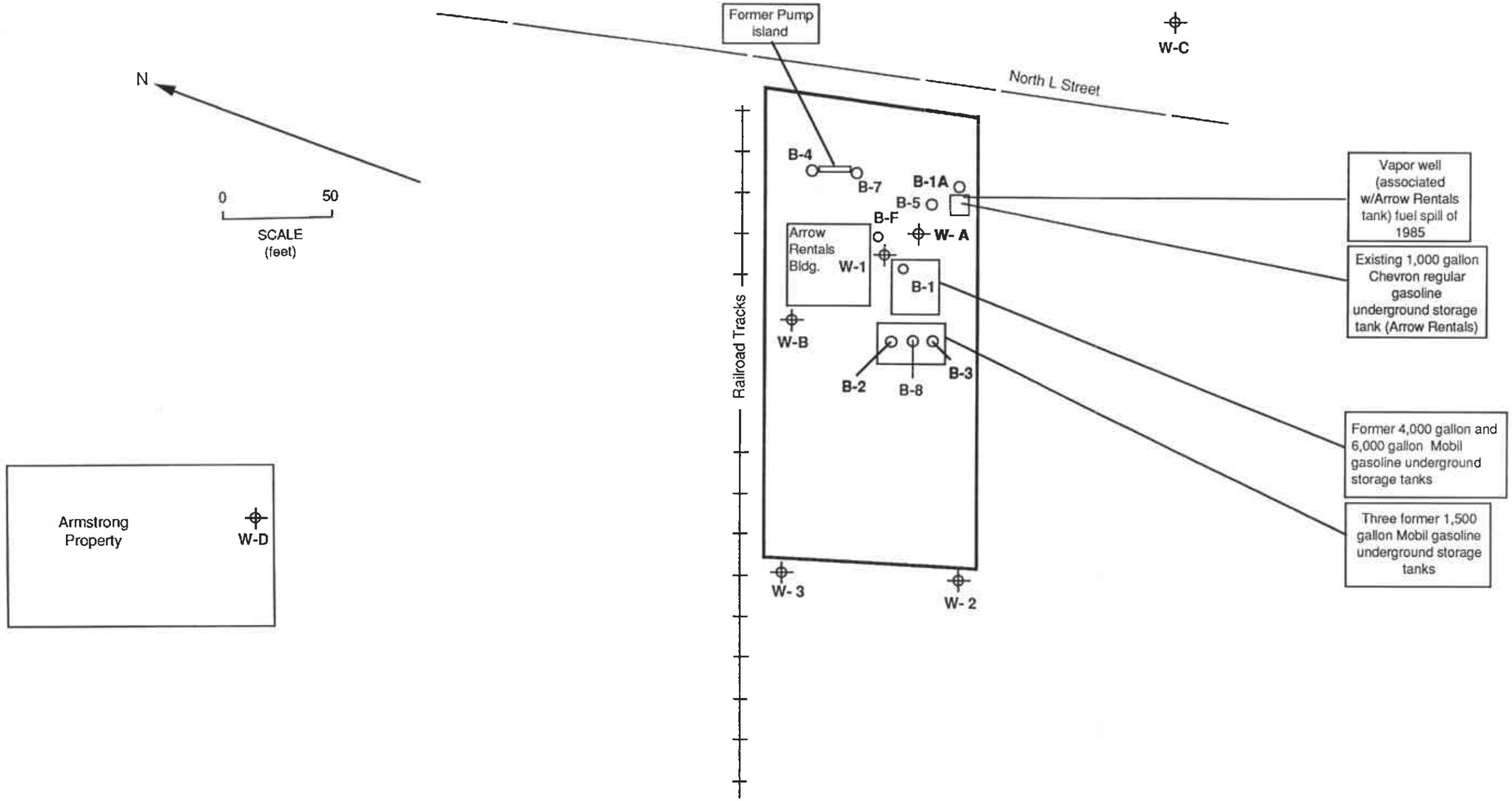
*= Tetraethyl lead, **= Previous laboratory tests summarized in Appendix C

Table 2 LABORATORY TEST RESULTS OF WATER SAMPLES ***

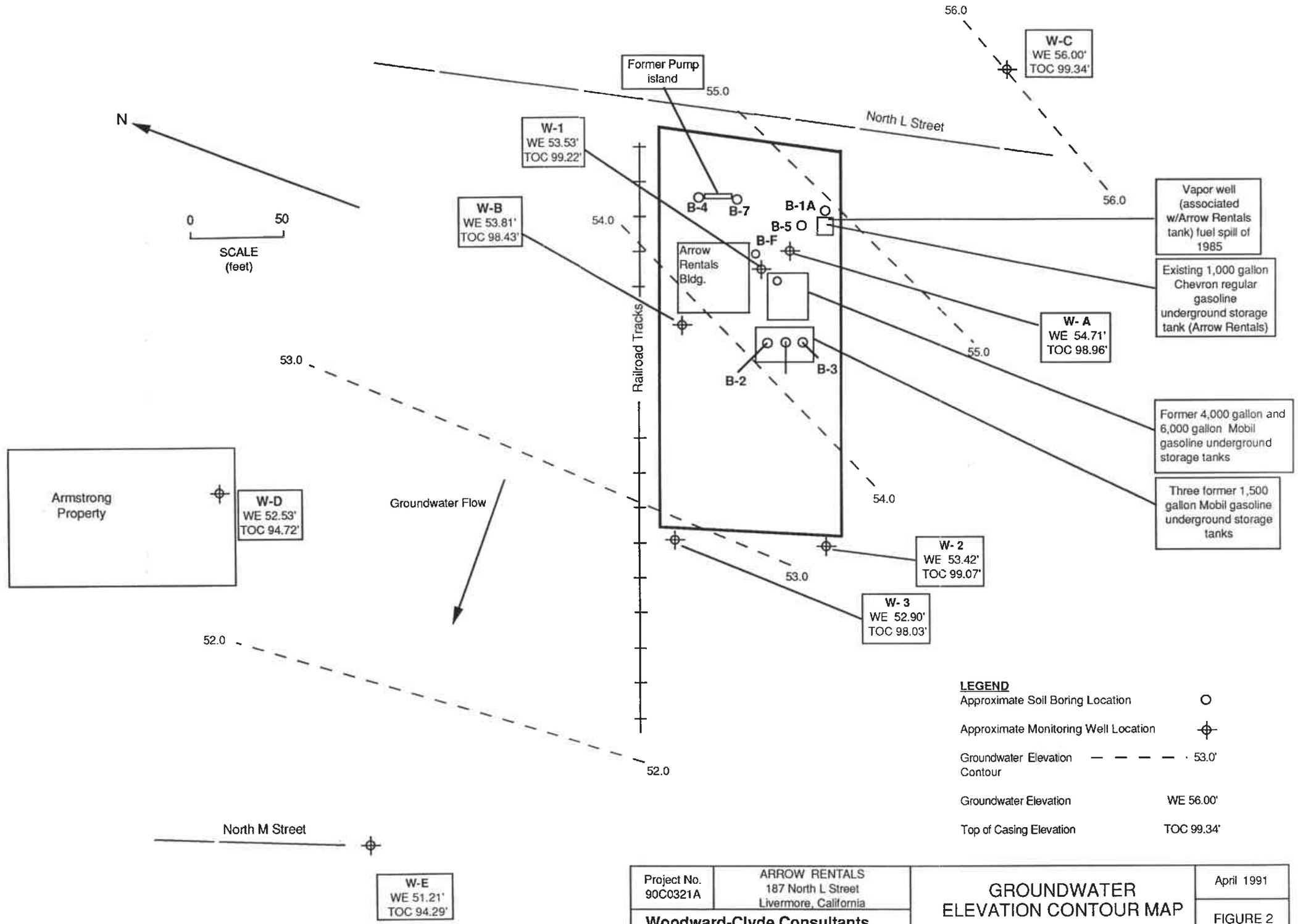
Arrow Rentals, 187 North L Street, Livermore, CA

Sample Number	Benzene (ppb)	Toluene (ppb)	Ethyl Benzene (ppb)	Xylenes (ppb)	TPH Gas. (ppm)	TPH Dies. (ppm)	Org. Pb (ppm)	Phenol (ppm)	Naphth-alene (ppm)	2 Methyl Naphthalene (ppm)	Cd (ppm)	Cr (ppm)	Cu (ppm)	Ni (ppm)	V (ppm)	Zn (ppm)	Tetra Alkyl Lead (g/gal)	Tetra Ethyl Lead %ofPb	Total Hydro Carbon ppm/(ppb)
W-1**	6.40%	4.70%	1.30%	5.10%				<1,000	<1,000	200									
W-1Dupe**	6.60%	4.70%	1.30%	5.10%				<1,000	<1,000	200									
W-A	6800	5500	620	3400	10	2.4		<0.1	<0.01	<0.01	<0.1	<0.1	<0.1	0.2	<0.1	<0.1			
W-A Dupe	6900	5600	620	6800							<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
W-B	22000	7900	2000	4000	13	1.7		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1			
W-B2*	21000	7300	1800	3700	21	1.6		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1			
W-C	<1	<1	<1	<1	<0.01	<0.1		<0.1	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
W-D	1	2	1	1	0.1	<0.1		<0.1	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	0.2			
W-E	<1	<1	<1	<1	<0.01	<0.1		<0.1	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
W-EB	11	11	4	3	1.7	0.1		<0.1	>0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			
FT**	4.20%	8.90%	1.70%	6.10%			<50												
FT(Pres)**	4.20%	8.90%	1.70%	6.20%			<50												
W1-CH																	0.18g/gal	83%ofPb	
WA-CH																			7.6ppm
WB-CH																			2.4ppm
TB																			(73ppb)

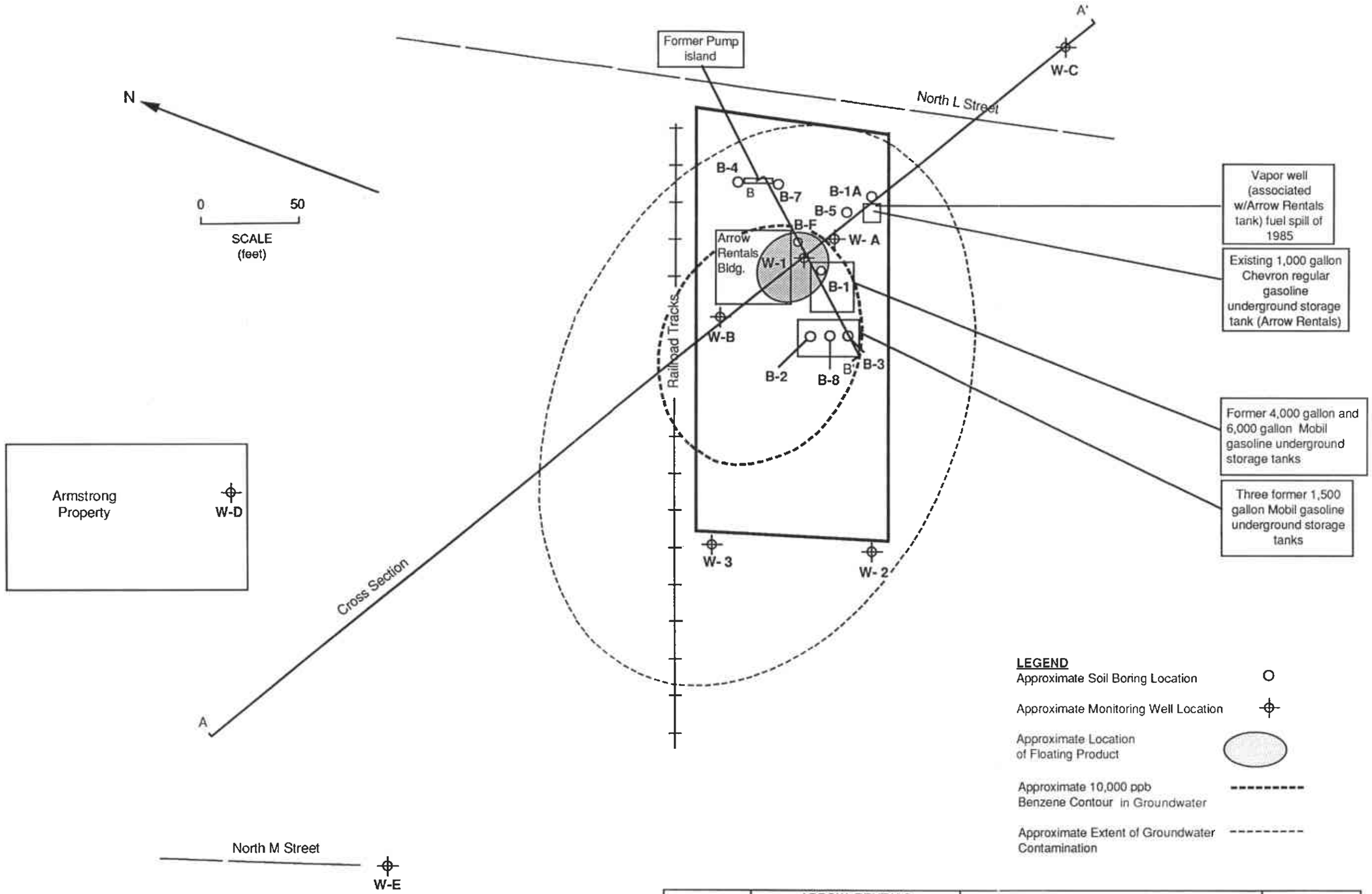
*= Duplicate, **= Fuel Product, ***= Previous Laboratory Tests Summarized in Appendix C



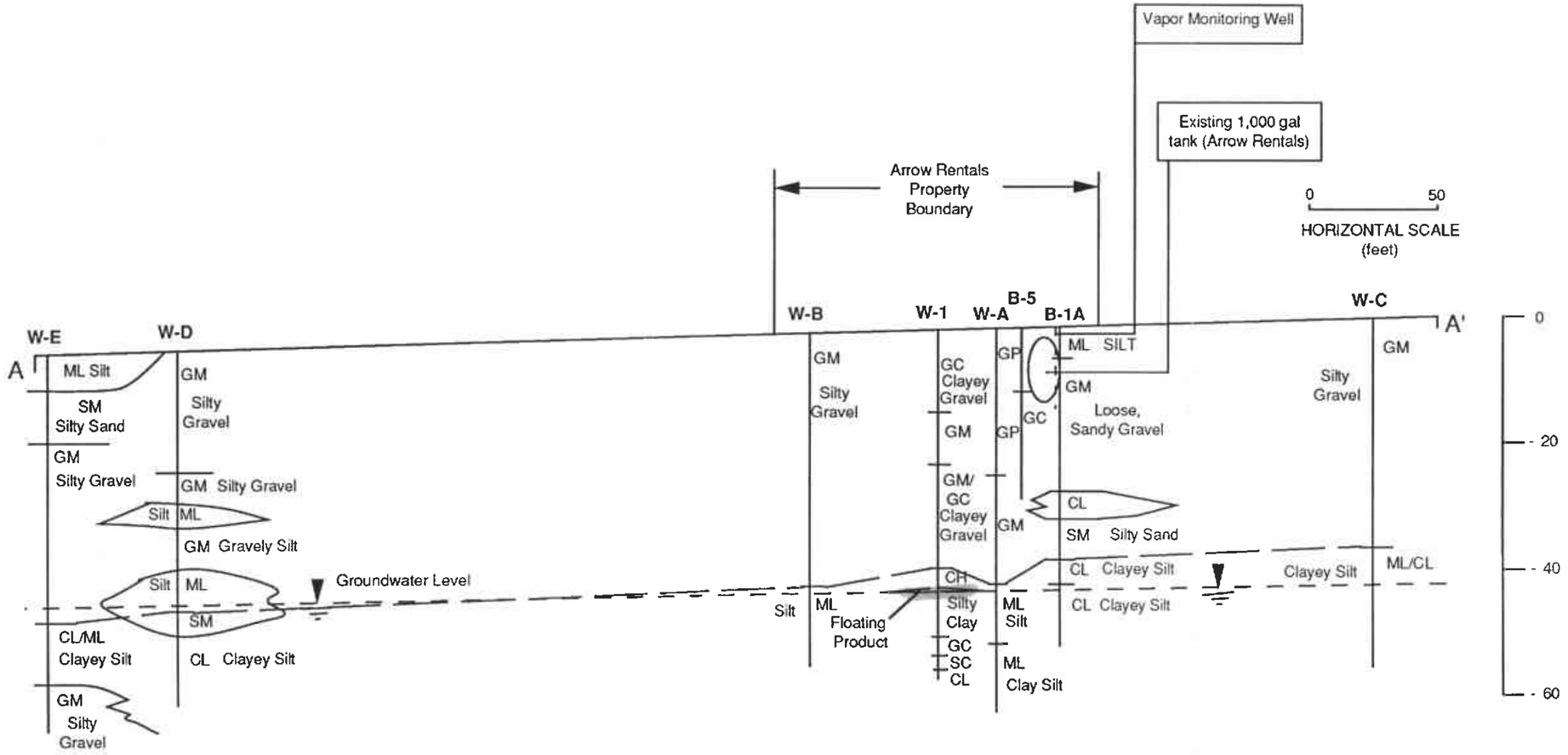
Project No. 90C0321A	ARROW RENTALS 187 North L Street Livermore, California	SITE PLAN	April 1991
Woodward-Clyde Consultants			FIGURE 1



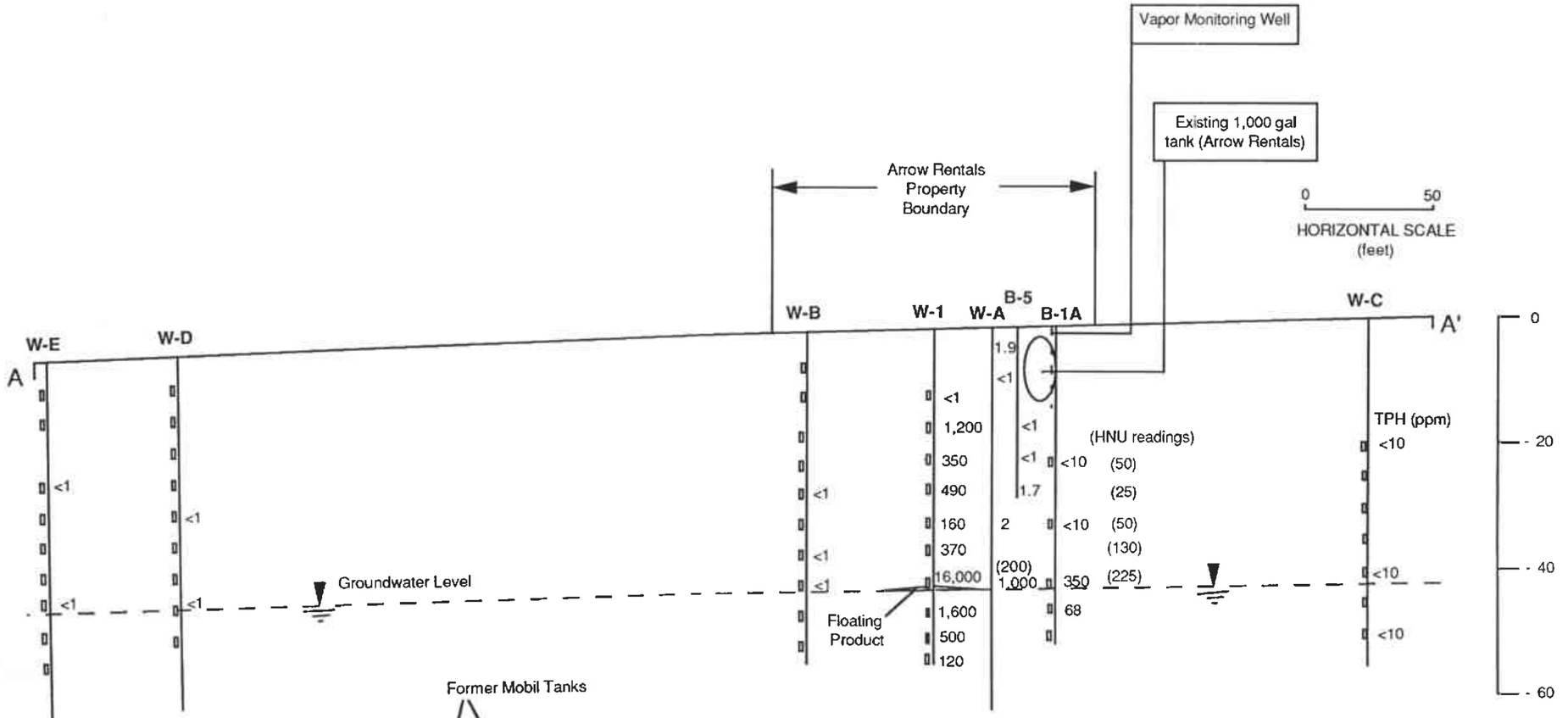
Project No. 90C0321A	ARROW RENTALS 187 North L Street Livermore, California	GROUNDWATER ELEVATION CONTOUR MAP	April 1991
Woodward-Clyde Consultants			FIGURE 2



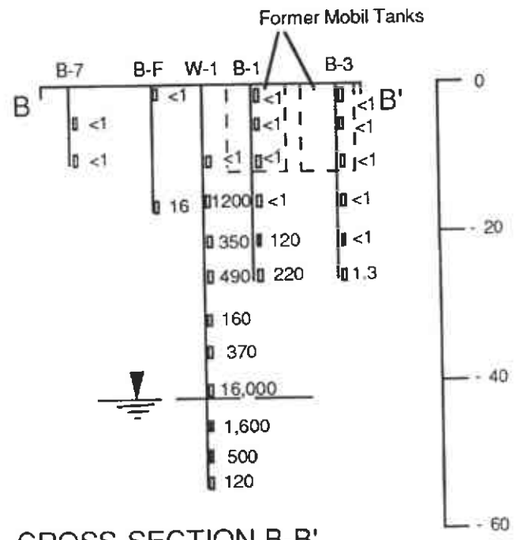
Project No. 90C0321A	ARROW RENTALS 187 North L Street Livermore, California	BENZENE CONTAMINANT CONTOUR MAP IN GROUNDWATER	April 1991
Woodward-Clyde Consultants			FIGURE 3



Project No. 90C 0321A	Arrow Rentals 187 North L Street Livermore, California	CROSS-SECTION A-A'	APRIL 1991
Woodward-Clyde Consultants			FIGURE 4

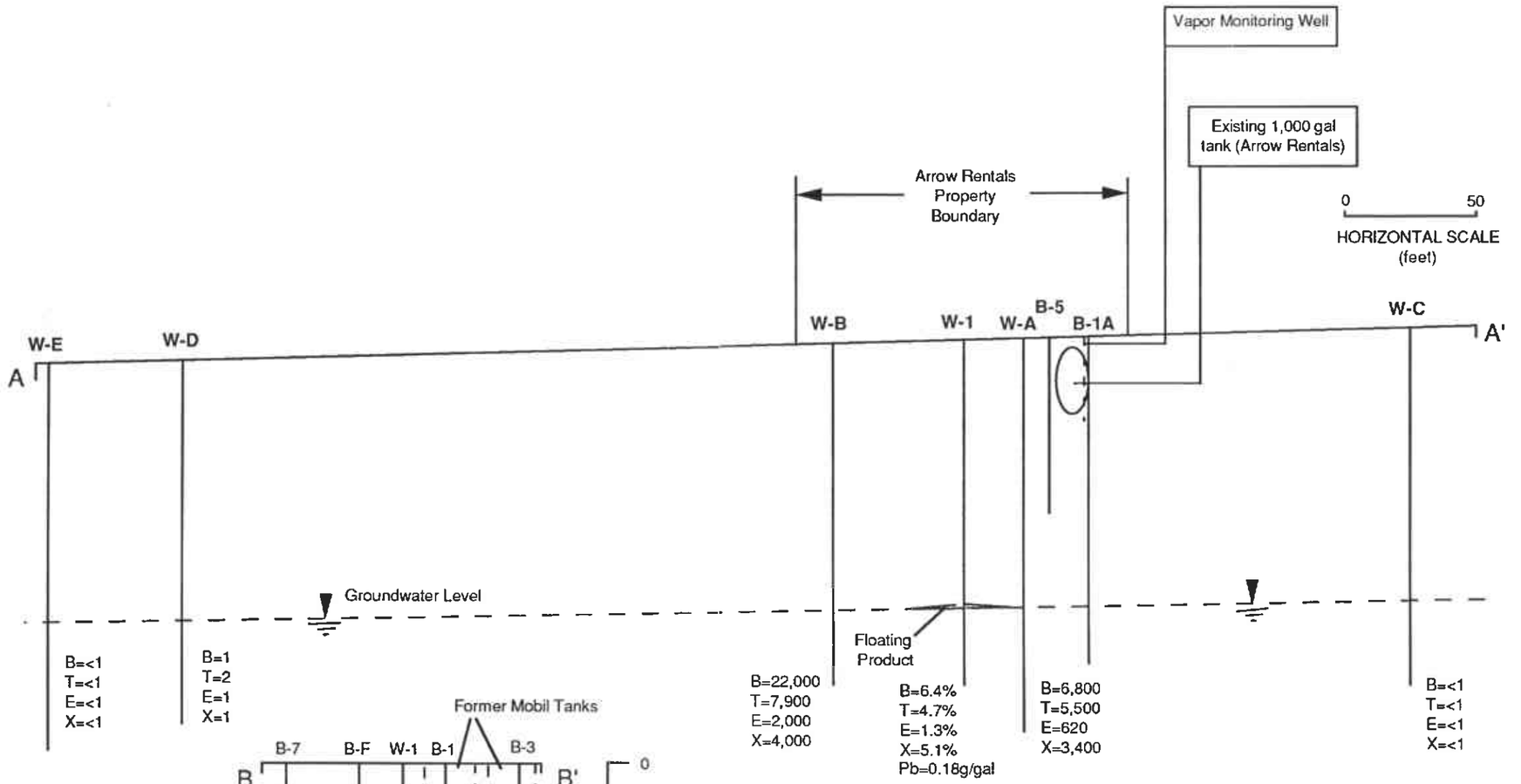


CROSS-SECTION A-A'

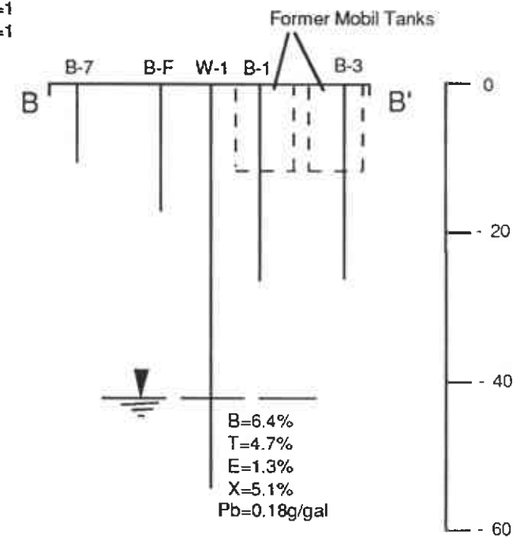


CROSS-SECTION B-B'

Project No. 90C 0321A	Arrow Rentals 187 North L Street Livermore, California	VERTICAL DISTRIBUTION OF TPH IN SOIL	APRIL 1991
Woodward-Clyde Consultants			FIGURE 5

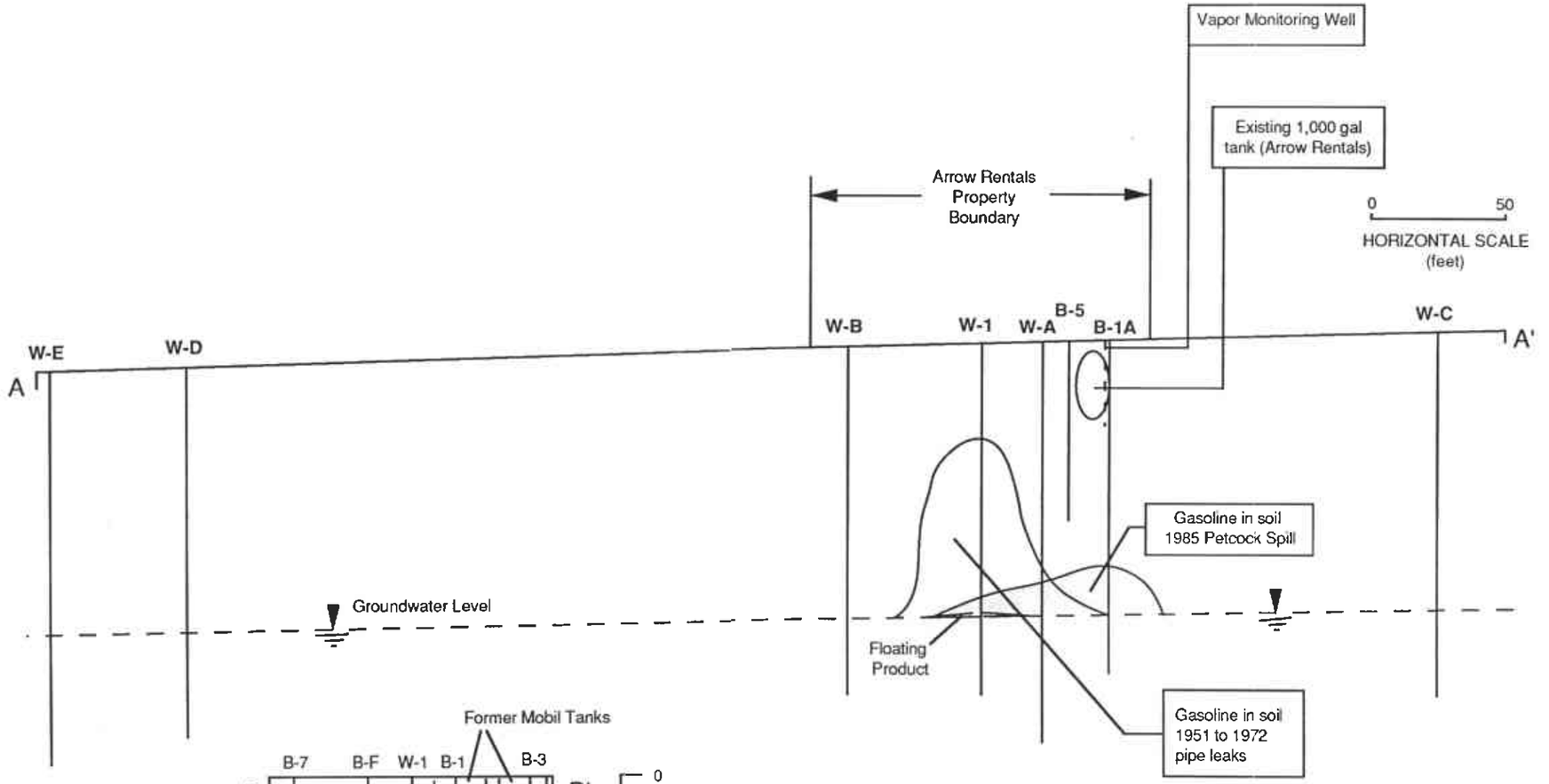


CROSS-SECTION A-A'

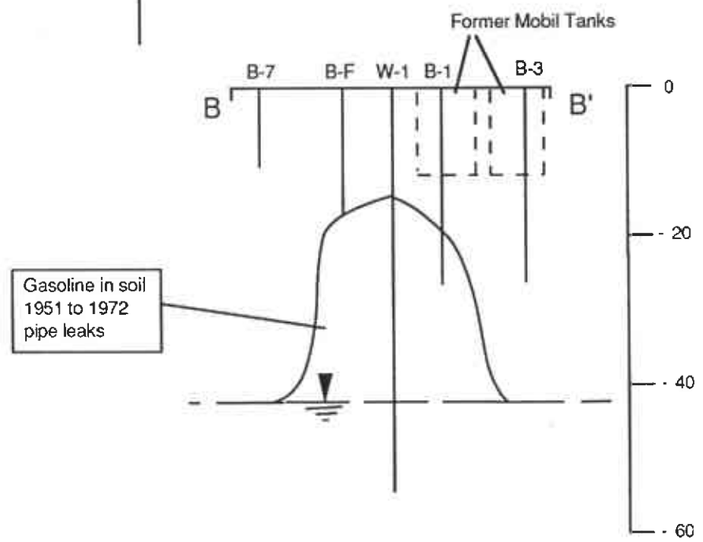


CROSS-SECTION B-B'

Project No. 90C 0321A	Arrow Rentals 187 North L Street Livermore, California	BTEX CONCENTRATIONS IN GROUNDWATER	APRIL 1991
Woodward-Clyde Consultants			FIGURE 6



CROSS-SECTION A-A'



CROSS-SECTION B-B'

Project No. 90C 0321A	Arrow Rentals 187 North L Street Livermore, California	APPROXIMATE SOIL CONTAMINANT PLUMES	APRIL 1991
Woodward-Clyde Consultants			FIGURE 7

APPENDIX A
TRACER RESEARCH REPORT

PREPARED FOR:

Woodward-Clyde Consultants
500 12th Street
Oakland, California 94607-4014
(415) 874-3125

SHALLOW SOIL GAS INVESTIGATION
ARROW RENTALS
187 NORTH "L" STREET
LIVERMORE, CALIFORNIA

JULY 1990

SUBMITTED BY:

Tracer Research Corporation

190522S.REP
1-90-522-S

TABLE OF CONTENTS

INTRODUCTION

A shallow soil gas investigation was performed by Tracer Research Corporation (TRC) at Arrow Rentals located 187 North "L" Street in Livermore, California. The investigation was conducted on June 11 and 12, 1990 under contract to Woodward-Clyde Consultants. The purpose of the investigation was to characterize the nature and extent of volatile organic compounds (VOCs) present in the subsurface.

During this survey, a total of twenty-four soil gas samples were collected and analyzed in the field. The analytical equipment was calibrated for the following compounds:

benzene
toluene
ethylbenzene
xylenes
total hydrocarbons (THC)

Xylenes are reported as the total of the three xylene isomers and total hydrocarbons are reported as gasoline range constituents consisting of approximately C_4-C_9 aliphatic, alicyclic and aromatic compounds.

The compounds in this suite were chosen as target compounds based on their suspected presence in the subsurface and amenability to soil gas detection. Soil gas samples were screened on the flame ionization detector (FID).

SHALLOW SOIL GAS INVESTIGATION - METHODOLOGY

Shallow soil gas investigation refers to a method developed by TRC for investigating underground contamination from volatile organic chemicals (VOCs) such as industrial solvents, cleaning fluids and petroleum products by looking for their vapors in the shallow soil gas. The method involves pumping a small amount of soil gas out of the ground through a hollow probe driven into the ground and analyzing the gas for the presence of volatile contaminants. The presence of VOCs in shallow soil gas indicates the observed compounds may either be in the vadose zone near the probe or in groundwater below the probe. The soil gas technology is most effective in mapping low molecular weight halogenated solvent chemicals and petroleum hydrocarbons possessing high vapor pressures and low aqueous solubilities. These compounds readily partition out of the groundwater and into the soil gas as a result of their high gas/liquid partitioning coefficients. Once in the soil gas, VOCs diffuse vertically and horizontally through the soil to the ground surface where they dissipate into the atmosphere. The contamination acts as a source and the above ground atmosphere acts as a sink, and typically a concentration gradient develops between the two. The concentration gradient in soil gas between the source and ground surface may be locally distorted by hydrologic and geologic anomalies (e.g. clays, perched water); however, soil gas mapping generally remains effective because distribution of the contamination is usually broader in areal extent than the local geologic barriers and is defined using a large data base. The presence of geologic obstructions on a small scale tends to create anomalies in the soil gas-groundwater correlation, but generally does not obscure the broader areal picture of the contaminant distribution.

Soil gas contaminant mapping helps to reduce the time and cost required to delineate underground contamination by volatile contaminants. The soil gas investigation does this by outlining the general areal extent of contamination. Conventional bore holes or observation wells are used to verify both the presence and extent of the subsurface contamination as indicated in the soil gas survey. In this manner, soil gas contaminant mapping can assist in determining the placement of monitoring wells. Thus, the likelihood

of drilling unnecessary monitoring wells is reduced. The soil gas survey is not intended to be a substitute for conventional methodology, but rather to enable conventional methods to be used efficiently.

EQUIPMENT

Tracer Research Corporation utilized a one ton Ford analytical field van that was equipped with one gas chromatograph and two Spectra Physics computing integrators. In addition, the van has two built-in gasoline powered generators that provide the electrical power (110 volts AC) to operate all of the gas chromatographic instruments and field equipment. A specialized hydraulic mechanism consisting of two cylinders and a set of jaws was used to drive and withdraw the sampling probes. A hydraulic hammer was used to assist in driving probes past cobbles and through unusually hard soil.

SAMPLING PROCEDURES

Sampling probes consisted of 7-14 foot lengths of 3/4 inch diameter hollow steel pipe that are fitted with detachable drive tips. Soil gas samples were collected by driving the steel probe to a depth of 8-10 feet below grade. Once inserted into the ground, the above-ground end of the sampling probes were fitted with a steel reducer and a length of polyethylene tubing leading to a vacuum pump. Gas flow is monitored by a vacuum gauge to insure that an adequate flow is obtained. To adequately purge the volume of air within the probe, 2 to 5 liters of gas is evacuated with a vacuum pump. During the soil gas evacuation, samples are collected in a glass syringe by inserting a syringe needle through a silicone rubber segment in the evacuation line and down into the steel probe. Ten milliliters of gas are collected for immediate analysis in the TRC analytical field van. Soil gas is subsampled (duplicate injections) in volumes ranging from 1 uL to 2 mL, depending on the VOC concentration at any particular location.

Sample probe vacuum, measured with a vacuum gauge, ranged from two to twenty-three inches Hg. Maximum pump vacuum was measured at twenty-six inches Hg.

ANALYTICAL PROCEDURES

One Varian 3300 gas chromatograph, equipped with a flame ionization detector (FID), was used for the sample analyses. The FID was used for the analysis of benzene, toluene, ethylbenzene, xylenes and total hydrocarbons. Separation of the FID compounds was achieved on a 6' by 1/8" OD packed column with OV-101 as the stationary phase. The column was contained in a temperature controlled oven and nitrogen was used as the carrier gas.

Hydrocarbon compounds detected in soil gas were identified by chromatographic retention time. Quantification of compounds was achieved by comparison of the detector response of the sample with the response measured for calibration standards (external standardization). Instrument calibration checks were run periodically throughout the day and system blanks were run at the beginning of the day to check for contamination in the soil gas sampling equipment. Air samples were also routinely analyzed to check for background levels in the atmosphere.

Detection limits for the compounds of interest are a function of the injection volume as well as the detector sensitivity for individual compounds. Thus, the detection limit varies with the sample size. Generally, the larger the injection size the greater the sensitivity. However, peaks for compounds of interest must be kept within the linear range of the analytical equipment. If any compound has a high concentration, it is necessary to use small injections, and in some cases to dilute the sample to keep it within linear range. This may cause decreased detection limits for other compounds in the analyses.

The detection limits range down to approximately 0.02 ug/L for compounds screened on the FID, depending on the conditions of the measurement, in particular, the sample size. If any component being analyzed is not detected, the detection limit for that compound in that analysis is given as a "less than" value (e.g. <0.02 ug/L). Detection limits obtained from GC analyses are calculated from the current response factor, the sample size, and the estimated minimum peak size (area) that would have been visible under the conditions of the measurement.

QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Tracer Research Corporation's normal quality assurance procedures were followed in order to prevent any cross-contamination of soil gas samples.

- Steel probes are used only once during the day and then washed with high pressure soap and hot water spray or steam-cleaned to eliminate the possibility of cross-contamination. Enough probes are carried on each van to avoid the need to reuse any during the day.
- Probe adaptors (TRC's patented design) are used to connect the sample probe to the vacuum pump. The adaptor is designed to eliminate the possibility of exposing the sample stream to any part of the adaptor. Associated tubing connecting the adaptor to the vacuum pump is replaced periodically as needed during the job to insure cleanliness and good fit. At the end of each day the adaptor is cleaned with soap and water and baked in the GC oven.
- Silicone tubing (which acts as a septum for the syringe needle) is replaced as needed to insure proper sealing around the syringe needle. This tubing does not directly contact soil gas samples.
- Glass syringes are usually used for only one sample per day and are washed and baked out at night. If they must be used twice, they are purged with carrier gas (nitrogen) and baked out between probe samplings.
- Injector port septa through which soil gas samples are injected into the chromatograph are replaced on a daily basis to prevent possible gas leaks from the chromatographic column.

- Analytical instruments are calibrated each day by analytical standards from Chem Service, Inc. Calibration checks are also run after approximately every five soil gas sampling locations.
- Subsampling syringes are checked for contamination prior to sampling each day by injecting nitrogen carrier gas into the gas chromatograph.
- Prior to sampling each day, system blanks are run to check the sampling apparatus (probe, adaptor, 10 cc syringe) for contamination by drawing ambient air from above ground through the system and comparing the analysis to a concurrently sampled ambient air analysis.
- All sampling and subsampling syringes are decontaminated each day and no such equipment is reused before being decontaminated. Microliter size subsampling syringes are reused only after a nitrogen carrier gas blank is run to insure it is not contaminated by the previous sample.
- Soil gas pumping is monitored by a vacuum gauge to insure that an adequate gas flow from the vadose zone is maintained. A reliable gas sample can be obtained if the negative pressure reading on the vacuum gauge is at least 2 inches Hg less than the maximum pressure of the pump.

RESULTS

Concentrations of hydrocarbons in the C_4-C_9 range were detected slightly above background in the subsurface at the Arrow Rentals site in Livermore, California. A total of 24 soil gas samples and 6 ambient air samples were collected at this site. The total hydrocarbons detected in these samples were not attributable to benzene, toluene, ethyl benzene or xylenes as no significant levels of these specific compounds were detected in the soil gas. The total hydrocarbons reported were generally lighter, early eluting compound in the C_4-C_9 range. The analytical data reported in micrograms per liter (ug/L) for this site is condensed in Appendix A and maps showing sampling locations and isoconcentration contours are included in Appendix B.

An isoconcentration contour map was generated for total hydrocarbons in the C4-C9 range (Figure 2). The highest level of total hydrocarbons was detected at sampling location SG-3 with a concentration of 2 ug/L. This location, along with sampling location SG-2, was contained within a 1 ug/L contour line that was open to the north. Sampling location SG-15 with a concentration of 1 ug/L was also contained within an open-ended contour at the north-east portion of the site. Several other sampling locations on the site were contained within 0.1 ug/L contour lines. These 0.1 ug/L contour line are somewhat speculative and border on being insignificant but the sake of completeness they are included. Additional sampling locations would be necessary to completely define the plumes depicted.

CONCLUSIONS

The soil gas survey conducted at the Arrow Rentals Site found slightly elevated levels of hydrocarbons (C_4-C_9) in the subsurface. Several contour lines were generated at this site, depicting a small plume just above the level of significance. The highest concentrations of total hydrocarbons were detected in sampling location SG-3 located near the north corner of the office building. To further delineate and define the total hydrocarbon plume additional samples would be necessary.

APPENDIX A: ANALYTICAL DATA

WOODWARD CLYDE CONSULTANTS/ARROW RENTALS/LIVERMORE, CALIFORNIA JOB#1-90-522-S

06/11/90

CONDENSED DATA

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	THC ug/l
AIR	<0.04	<0.05	<0.05	<0.07	<0.05
SG1-10'	<0.04	<0.05	<0.05	<0.07	0.4
SG2-10'	<0.08	<0.1	<0.1	<0.1	1
SG3-10'	<0.04	<0.05	<0.05	<0.07	2
SG4-10'	<0.08	<0.1	<0.1	<0.1	<0.1
SG5-10'	<0.08	<0.1	<0.1	<0.1	<0.1
SG6-10'	<0.04	<0.05	<0.05	<0.07	0.6
AIR	<0.04	<0.05	<0.05	<0.07	2
SG7-10'	<0.08	<0.1	<0.1	<0.1	<0.1
SG8-10'	<0.08	<0.1	<0.1	<0.1	<0.1
SG9-10'	<0.08	<0.1	<0.1	<0.1	<0.1
SG10-10'	<0.08	<0.1	<0.1	<0.1	<0.1
SG11-10'	<0.08	<0.1	<0.1	<0.1	0.7
AIR	<0.04	<0.05	<0.05	<0.07	0.3

Analyzed by: P. Bausman
Checked by: K. Proctor
Proofed by: L. Laplander

WOODWARD CLYDE CONSULTANTS/ARROW RENTALS/LIVERMORE, CALIFORNIA JOB#1-90-522-S

06/12/90

CONDENSED DATA

SAMPLE	BENZENE ug/l	TOLUENE ug/l	ETHYL BENZENE ug/l	XYLENES ug/l	THC ug/l
SG12-10'	<0.04	<0.05	<0.06	<0.06	<0.05
AIR	<0.04	<0.05	<0.06	<0.06	<0.05
SG13-10'	<0.04	<0.05	<0.06	<0.06	<0.05
SG14-10'	<0.04	<0.05	<0.06	<0.06	<0.05
SG15-8'	<0.04	<0.05	<0.06	<0.06	1
SG16-10'	<0.04	<0.05	<0.06	<0.06	<0.05
AIR	<0.04	<0.05	<0.06	<0.06	<0.05
SG17-10'	<0.04	<0.05	<0.06	<0.06	0.2
SG18-10'	<0.04	<0.05	<0.06	<0.06	<0.05
SG19-10'	<0.04	<0.05	<0.06	<0.06	<0.05
SG20-10'	<0.04	<0.05	<0.06	<0.06	0.5
SG21-10'	<0.04	<0.05	<0.06	<0.06	0.8
SG22-10'	<0.04	<0.05	<0.06	<0.06	0.4
SG23-10'	<0.04	<0.05	<0.06	<0.06	0.4
SG24-10'	<0.04	<0.05	<0.06	<0.06	0.2
AIR	<0.04	<0.05	<0.06	<0.06	<0.05

Analyzed by: P. Bausman
Checked by: K. Proctor
Proofed by: S. Kaplander

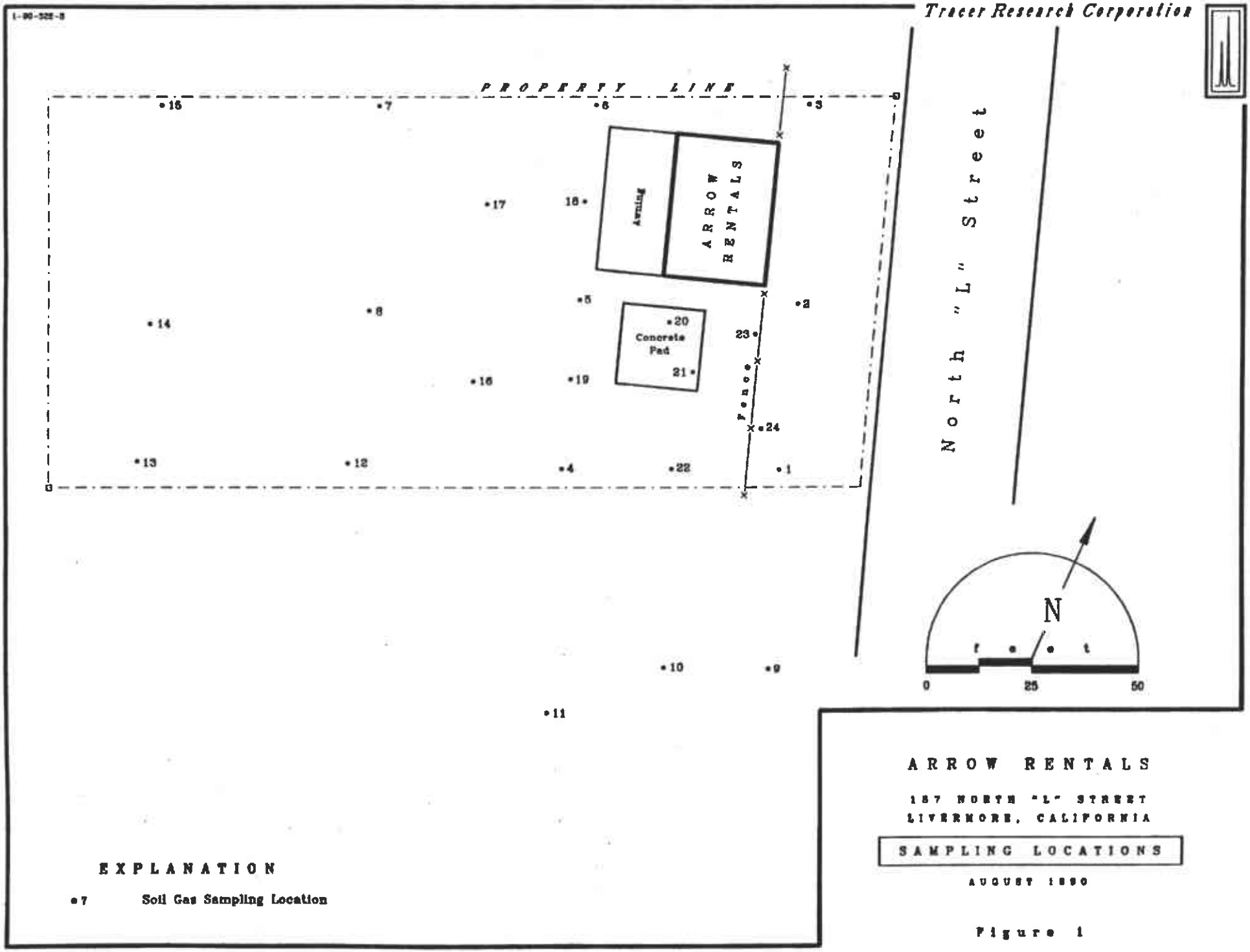

Tracer Research Corporation
PROPERTY LINE
ARROW RENTALS
Awning
Concrete Pad
Fence
North "L" Street
N
f e e t
0
25
50
EXPLANATION
•7 Soil Gas Sampling Location
ARROW RENTALS
187 NORTH "L" STREET
LIVERMORE, CALIFORNIA
SAMPLING LOCATIONS
AUGUST 1990

Figure 1

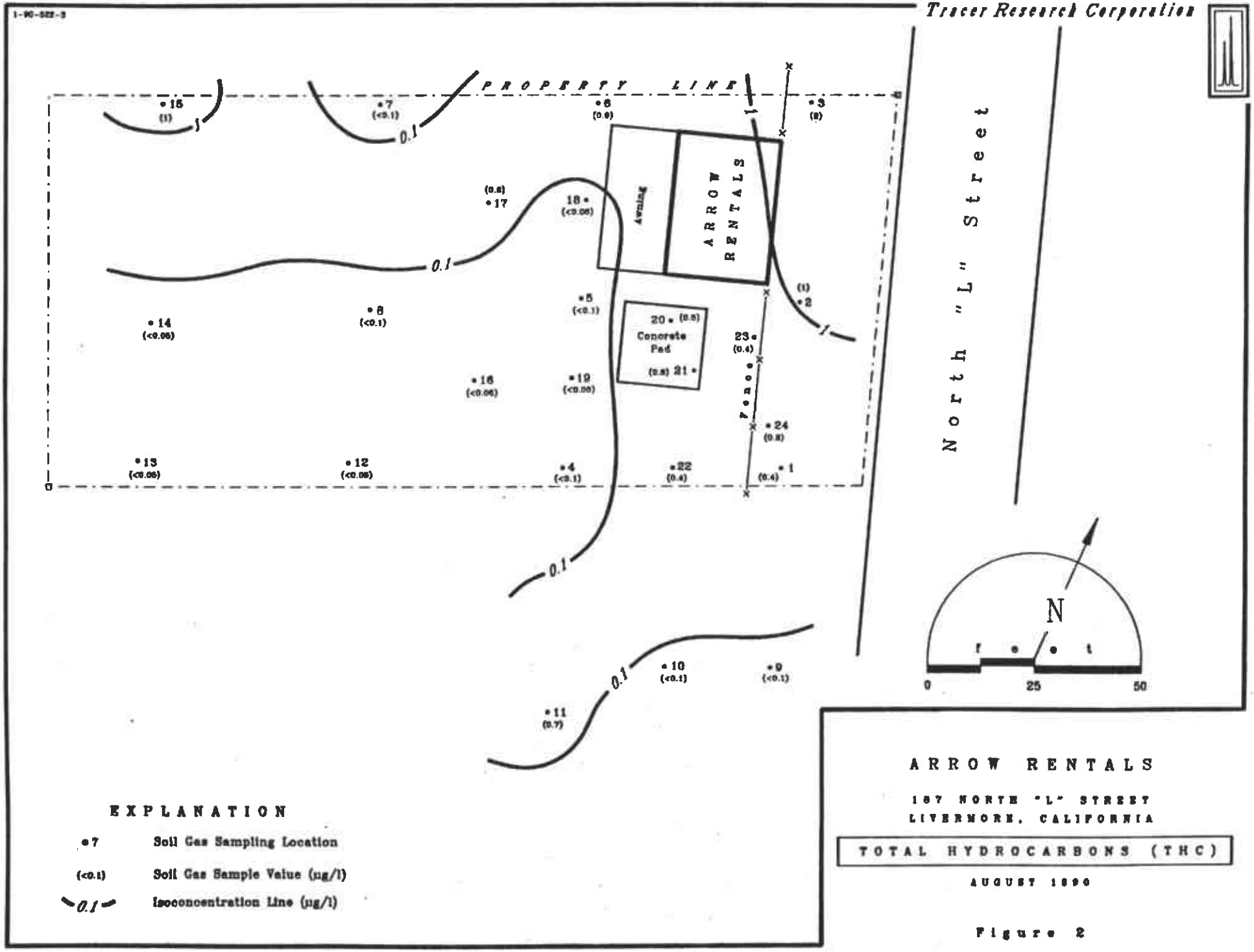

Tracer Research Corporation
1-90-SEE-3
PROPERTY LINE
ARROW RENTALS
Awning
Concrete Pad
Fence
North "L" Street
N
0
25
50
EXPLANATION
•7 Soil Gas Sampling Location
(<0.1) Soil Gas Sample Value (µg/l)
0.1 Isoconcentration Line (µg/l)
ARROW RENTALS
187 NORTH "L" STREET
LIVERMORE, CALIFORNIA
TOTAL HYDROCARBONS (THC)
AUGUST 1990

Figure 2

APPENDIX B
BORING AND WELL LOGS

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS **NO.** 90C0321A

BORING LOCATION W-A, between W-1 and tank		ELEVATION AND DATUM	
DRILLING AGENCY Kvilhaug	DRILLER Rod Furlow, Brian Vincent	DATE STARTED / DATE FINISHED 7/12/90 → 7/12/90	
DRILLING EQUIPMENT B 61 Mobile Drill		COMPLETION DEPTH 63 ft.	SAMPLER 2 in.
DRILLING METHOD Hollow Stem Auger	DRILL BIT	NO. OF SAMPLES DIST.	UNDIST. 6
SIZE AND TYPE OF CASING 4 "-diameter Schedule 40 PVC		WATER LEVEL FIRST 50 ft.	COMPL. 24 HRS. 44.25
TYPE OF PERFORATION 0.010 Slotted PVC	FROM 57 -1/2 TO 42 FT	LOGGED BY: Lois Gruenberg	CHECKED BY:
SIZE AND TYPE OF PACK Monterey Sand # 2/12	FROM 63 TO 40 FT		
TYPE OF SEAL NO. 1 Bentonite Pellets	FROM 40 TO 36 -1/2 FT		
NO. 2 5 sack, 3/4" agg - Grout/ Quick mix to set Christy box	FROM 36 - 1/2 TO 0 FT		

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
	Asphalt Concrete - 4 inches				
5	Cuttings-Gravel (GP), some silt, much resistance.		5		No sample taken
10	Grades to more silty		10	35 50/ 6	Sample: W-A-10 HNU = 1 ppm
15			15	50/ 6	little recovery no sample
20	SILTY, GRAVELLY SAND (GM), gray brown, gravels to 1/2 ", very coarse to coarse sand, trace clay, wet, loose, odor.		20	35 50/ 6	Sample: W-A-20 HNU= 15 ppm
25			25	50/ 6	Sample: W-A-25 HNU = 110 ppm
30			30	45 50/ 6	Sample: W-A-25 Very strong odor in borehole

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES: BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
35			35	50/6	Sample: W-A-35 HNU > 200 ppm
40	SILT (ML), brown with black patches, with some clay, some coarse sand, soft to medium stiff, moist.		40	5 9 20	Sample : W-A-40 HNU = 250 ppm
45	Grades to homogenous brown, abundant clay, no sand, medium stiff to stiff, moist		45	35 30 35	Sample: W-A-45 HNU = 150 ppm
50	Grades to saturated		50	25 25 25	Sample: W-A-50 HNU = 100 ppm
55			55		
60			60		
					Boring terminated at approximately 53 ft. below grade.

FIELD LOG OF BORING NO. W-A SHEET 2 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

BORING LOCATION 187 N. L Street, Livermore, CA		ELEVATION AND DATUM	
DRILLING AGENCY Kvilhaug	DRILLER Mike Crocker, Joel Vigil	DATE STARTED 7/10/90 / DATE FINISHED 7/10/90	
DRILLING EQUIPMENT B 53 Mobile Drill		COMPLETION DEPTH 50	SAMPLER 2 in.
DRILLING METHOD Hollow Stem Auger	DRILL BIT	NO. OF SAMPLES DIST.	UNDIST. 10
SIZE AND TYPE OF CASING None		WATER LEVEL FIRST 47 ft	COMPL. 24 HRS.
TYPE OF PERFORATION None	FROM TO FT	LOGGED BY: Lois Gruenberg	CHECKED BY:
SIZE AND TYPE OF PACK None	FROM TO FT		
TYPE OF SEAL NO. 1 None	FROM TO FT		
NO. 2 Grout	FROM 51-1/2 TO 0 FT		

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
	Asphalt Concrete - 4 inches.				
	Cuttings- SILT (ML), brown with orange, gravels to 1/2 ", loose.				
5	SANDY, SILTLY GRAVEL (GM), brown-gray and black gravels, very coarse, moist, gravels to 1/2", loose.		5	7 13 15	Sample: B-1-5 HNU= no response
10	Grades to more silt, some clay, slightly wet.		10	10 19 23	Sample: B-1-10 HNU= 10 ppm
15	Grades to moist with pockets of wet clay.		15	35 50 50	Sample: B-1-15 HNU= no response
20	Noticeable odor and sheen in pockets of moisture.		20	20 40 36	Sample: B-1-20 HNU= 50 ppm
25	CLAYEY SILT (CL), brown, gravels to 1/2 ", some very coarse sand, loose, moist to wet.		25	20 35 35	Sample: B-1-25 HNU= 25 ppm
30	SILTY SAND (SM), brown-gray, very coarse sand, gravels to 1/2 ", trace clay, moist to wet, loose to medium dense.		30	12 17 27	Sample B-1-30 HNU = 50 ppm

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES	BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
35	CLAYEY, SANDY SILT (SM-CL), brown-gray with some orange, coarse sand, wet.		35		5 12 5	Sample: B-1-35 HNU = 130 ppm
	Very easy drilling encountered.					
40	CLAYEY SILT (CL), homogenous brown, noticeable hydrocarbon odor soft, wet.		40		4 5 5	Sample : B-1-40 HNU =225 ppm
45	Grades to mottled with some, small, white and black pebbles, odor.	▽	45		2 3 3	Sample: B-1-45 HNU= 180 ppm
50	Grades to gray with rare layer of coarse sand, odor, saturated.		50		10 15 17	Sample: B-1-50 HNU= 110 ppm
						Boring terminates at approximately 51-1/2 feet below grade.
55			55			
60			60			

FIELD LOG OF BORING NO. B-1A SHEET 2 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

BORING LOCATION W-B		ELEVATION AND DATUM	
DRILLING AGENCY Kvilhaug	DRILLER Rod Furlow, Brian Vincent	DATE STARTED 7/12/90 → DATE FINISHED 7/13/90	
DRILLING EQUIPMENT B 61 Mobile Drill		COMPLETION DEPTH 55	SAMPLER
DRILLING METHOD Hollow Stem Auger	DRILL BIT	NO. OF SAMPLES DIST.	UNDIST. 6
SIZE AND TYPE OF CASING 4 "-diameter Schedule 40 PVC		WATER LEVEL FIRST 48 ft.	COMPL. 24 HRS. 44.62
TYPE OF PERFORATION 0.010 Slotted PVC	FROM 55 TO 40 FT	LOGGED BY: Lois Gruenberg	CHECKED BY:
SIZE AND TYPE OF PACK Monterey Sand # 2/12	FROM 55 TO 32 FT		
TYPE OF SEAL NO. 1 Bentonite Pellets	FROM 32 TO 30 FT		
NO. 2 Grout/Quick mix to set Christy box	FROM 30 TO 0 FT		

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
	Cement Concrete - 4 inches				
5	SILTY GRAVELS (GM), brown to dark brown, trace clay, damp, loose.		5	12 25 50	No recovery
	Gravels 1/2 to 2 "				
10	Grades to more silty, moist.		10		No sample taken
15	Grades to gray brown with orange patches more silt, some clay, moist		15	50/ 6	Little recovery, 2" gravel stuck in sampler HNU = 10 ppm
20			20	40 50/ 6	Little recovery HNU= 15 ppm
25			25	50/ 6	Sample: W-B-25 HNU = 2 ppm
30			30	50/ 6	Sample: W-B-30 HNU = 2 ppm

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
35			35	50/6	Sample : W-B-35 HNU >20 ppm
40	SILT (ML), brown with black patterns, some clay, medium-low plasticity, moderately soft, damp to moist.		40	8 12 15	Sample : W-B-40 HNU = 2 ppm
45	Grades to brown with green-yellow and gray, black patches, mottling		45	17 19 26	Sample: W-B-45 HNU = 30 ppm
50			50	5 25 40	Sample: W-B-50
55			55		Boring terminated at approximately 55 feet below grade.
60			60		

FIELD LOG OF BORING NO. W-B SHEET 2 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

BORING LOCATION: Across Arrow Rentals on North L St.		ELEVATION AND DATUM	
DRILLING AGENCY: Kvilhaug	DRILLER: Mike Crocker, Joel Vigil	DATE STARTED: 7/11/90	DATE FINISHED: 7/11/90
DRILLING EQUIPMENT: B 53 Mobile Drill		COMPLETION DEPTH: 55 ft.	SAMPLER: 2 in.
DRILLING METHOD: Hollow Stem Auger	DRILL BIT	NO. OF SAMPLES: DIST.	UNDIST.: 6
SIZE AND TYPE OF CASING: 2 "-diameter Schedule 40 PVC		WATER LEVEL: FIRST 47 ft.	COMPL.: 24 HRS. 43.34
TYPE OF PERFORATION: 0.010 Slotted PVC	FROM 55 TO 45 FT	LOGGED BY: Lois Gruenberg	CHECKED BY:
SIZE AND TYPE OF PACK: Monterey Sand # 2	FROM 55 TO 37 - 1/2 FT		
TYPE OF SEAL: NO. 1 Bentonite Pellets	FROM 37 - 1/2 TO 35 FT		
TYPE OF SEAL: NO. 2 Grout/ Quick mix to set Christy box	FROM 35 TO 0 FT		

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES: BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
	Asphalt Concrete - 5 inches Gravel base to 1/2 "-diameter, silty, brown, dry				
5	SILTY GRAVEL/GRAVELLY SILT (GM) brown, some silt, some very large rocks, dry to slightly damp, loose.		5		No sample taken.
10			10		No sample taken.
15			15		No sample taken.
20			20	20 40 35	Sample: W-C-20 HNU= no response
25	Grades to more silt with trace clay, moderately stiff.		25	17 18 20	Sample: W-C-25 HNU= no response
30			30	20 35 40	Sample: W-C-30 HNU = no response

FIELD LOG OF BORING NO. W-C SHEET 1 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
35	CLAYEY SILT (ML-CL), brown with dark brown and orange blotches, some gravels to 3/8", moist to wet, moderately stiff.		35	6 18 23	Sample: W-C-35 HNU = no response
40	Grades to brown-gray, less gravels, stiff.		40	20 35 35	Sample : W-C-40 HNU < 1 ppm
45			45	18 20 22	Sample: W-C-45
50	Grades to saturated.		50	8 20 25	Sample not taken No recovery
55			55		Boring terminated at approximately 55 feet below grade.
60			60		

FIELD LOG OF BORING NO. W-C SHEET 2 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

BORING LOCATION 1951 Chestnut, Livermore, CA (In backyard of residence of William Armstrong)		ELEVATION AND DATUM	
DRILLING AGENCY Kvilhaug	DRILLER Rod Furlow, Brian Vincent	DATE STARTED / DATE FINISHED 7/12/90 → 7/12/90	
DRILLING EQUIPMENT B 61 Mobile Drill		COMPLETION DEPTH 57 - 1/2 ft.	SAMPLER 2 in.
DRILLING METHOD Hollow Stem Auger	DRILL BIT	NO. OF SAMPLES DIST.	UNDIST. 6
SIZE AND TYPE OF CASING 4 "-diameter Schedule 40 PVC		WATER LEVEL FIRST 46 ft.	COMPL. 24 HRS. 42.19
TYPE OF PERFORATION 0.010 Slotted PVC	FROM 57 - 1/2 TO 42 FT	LOGGED BY: Lois Gruenberg	CHECKED BY:
SIZE AND TYPE OF PACK Monterey Sand # 2/12	FROM 57 - 1/2 TO 39 - 1/2 FT		
TYPE OF SEAL NO. 1 Bentonite Pellets	FROM 34 TO 32 FT		
NO. 2 Grout	FROM 32 TO 0 FT		

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
	Some grass and dry, silty soil in backyard.				
5	Cuttings - SILTY (GM), brown, gravels to 3/8 ", dry.		5	50/ 6	Sample not taken HNU < 1 ppm
10	GRAVELLY SILT (GM), brown with black and orange blotches, fractured gravels to 1/2 ", trace clay, moist, very dense.		10	30 25 28	Little recovery HNU < 1 ppm
15			15	25 50/ 6	Sample: W-D-15 HNU = 1 ppm
20	SILTY GRAVEL (GM), brown, gravels to 1", trace clay, loose, moist, very dense .		20	50/ 6	Sample not taken HNU= 1.5 ppm
25	SILT (ML), brown with black patches, some clay, soft.		25	12 12 14	Sample: W-D-25 HNU = 1.75 ppm
30	GRAVELLY SILT/SILTY GRAVEL(GM), brown with gray rocks, trace clay, moist to wet, rock stuck in sampler.		30	50/ 6	Rock stuck in sampler No response HNU

FIELD LOG OF BORING NO. W-D SHEET 1 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO. 90C0321A

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
35	SILT (ML), brown with black patches, some clay, moderately stiff.		35	12 15 20	Sample: W-D-35 HNU = 2 ppm
40	SANDY SILT (SM), brown, homeogenous, coarse sand, dense, wet. Some sloughing occured from 40 to 34 feet, just above the sand pack, during drilling.		40	30 50/ 6	Sample :W-D-40 HNU = 1.5 ppm
45	CLAYEY SILT (CL), brown, medium plasticity, moderately soft, wet.		45	12 15 22	Sample: W-A-45 HNU = 150 ppm
50			50		
55			55		
60			60		Boring terminated at approximately 57-1/2 feet below grade.

FIELD LOG OF BORING NO. W-D SHEET 2 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTALS NO 90C0321A

BORING LOCATION	End of M Street, Livermore, CA	ELEVATION AND DATUM	
DRILLING AGENCY	Kvilhaug	DRILLER Mike Furlow, Joel Vincent	DATE STARTED 7/10/90 → DATE FINISHED 7/10/90
DRILLING EQUIPMENT	B 53 Mobile Drill	COMPLETION DEPTH 61 ft.	SAMPLER 2 in.
DRILLING METHOD	Hollow Stem Auger	DRILL BIT	NO. OF SAMPLES DIST.	UNDIST. 8
SIZE AND TYPE OF CASING	2 "-diamter Schedule 40 PVC	WATER LEVEL FIRST 47 ft.	COMPL. 24 HRS. 43.08
TYPE OF PERFORATION	0.010 Slotted PVC	FROM 60 - 1/3 TO 40 - 1/2 FT	LOGGED BY: Lois Gruenberg	CHECKED BY:
SIZE AND TYPE OF PACK	Monterey Sand # 2/12	FROM 61 TO 37 FT	
TYPE OF SEAL NO. 1	Bentonite Pellets	FROM 30 TO 29 FT	
TYPE OF SEAL NO. 2	5 sack, 3/4" agg. - Grout / Quick Seal to set Christy box	FROM 29 TO 0 FT	

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES BLOW COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
	Asphalt Concrete - 4 "				
	Cuttings - SILT (ML), gravels to 1/2 ", brown, loose.				
5	SILTY SAND (SM) , brown and gray, some gravels to 1/2 ", quartz gravels with black veins, fryable, loose.		5	10 14 18	Sample: W-E-5 HNU= 2 ppm
10	GRAVELLY SILT/ SILTY GRAVEL (GM), brown, some silt, fractured, very hard rocks.		10	20 30 40	Sample: W-E-10 HNU= 2.5 ppm
15	SILTY, SANDY GRAVEL mixture, brown with orange, gravels to 1/2 ", some clay, loose, damp to moist.		15	12 25 25	Sample: W-E-15 HNU= no response
20			20	15 20 28	Sample: W-E-20 HNU= no response
25			25	12 20 28	Sample: W-E-25 HNU= no response
30			30	28 50/ 5	Sample W-E-30 HNU = no response

FIELD LOG OF BORING NO. W-E SHEET 1 OF 2

Woodward-Clyde Consultants

PROJECT NAME ARROW RENTAL NO. 90C0321A

DEPTH (feet)	LITHOLOGIC DESCRIPTION	Well Completion Diagram	DEPTH (feet)	SAMPLES	BLOW-COUNTS	REMARKS (Drill Rate, Fluid Loss, Odor, etc.)
35	Grades to wet.		35		12 15 12	Sample: W-E-35 HNU < 1 ppm Little recovery
	Very soft drilling encountered. Sloughing occured at approximately 37 to 30 feet during well installation.					
40	CLAYEY SILT (ML-CL), brown, some medium sand, homogeneous, soft, moist.		40		2 3 5	Sample : W-E-40 HNU < 1 ppm
45	Grades to less sand, brown with faint black blebs.		45		5 8 8	Sample: W-E-45 HNU = no response
	More difficult drilling encountered.					
50	GRAVELS (GM), pebbles black/gray, saturated, some silt.		50		20 30 25	Sample not taken.
55			55			
60			60			Boring terminated at approximately 61 feet below grade.

FIELD LOG OF BORING NO. W-E SHEET 2 OF 2

Woodward-Clyde Consultants

Project: Arrow Rentals 90C0321A

Well Number and Location: Boring B-F at former Arrow Gas Pump			Elev. and Datum:
Drilling Agency: Arrow Rentals	Driller: Tony Sullins		Date Started: 3/11/91 Date Completed: 3/12/91
Drilling Equipment: Bobcat			Total Depth: 16 ft.
Drilling Method : flight auger	Drill bit: 8- inch		Sampler: Bulk, in 4inch brass liners
Size and Type of Casing: NA			Water Level: First / Compl. / 24 HRS.
Type of Perforation: NA	From: ft To: ft		No. of Samples: Dist. 2 / Undist.
Size and Type of Pack: NA	From: ft To: ft		
Seal: Bentonite Pellets NA	From: ft To: ft		Logged by: A. Ridley
Grout NA	From: ft To: ft		Checked by:

Depth (feet)	LITHOLOGIC DESCRIPTION	LITHOLOGY	MONITORING WELL CONSTRUCTION	Sample	Blow Counts	REMARKS
	Concrete pavment- 4 inches thick SILTY GRAVEL(GM) FILL					
1						
2	CLAYEY GRAVEL (GC) -dark brown with sand, moist, with gravel to 1" diameter	GC		P-1		P-1 collected on 1/22/91 from this location in brass liner, no gasoline odor
3						
4						
5						
6						
7						
8						
9	Difficult drilling, larger gravel to 4" diameter					
10						
11	Increasing clay content, moist					no gasoline odor
12						
13						
14						
15	Boring terminated at 16 ' in CLAYEY GRAVEL	GC				
16				1,2		B-F-1 and 2 in brass liners, slight gasoline odor

FIELD LOG BORING NO. B-F page 1 of 1

APPENDIX C

LABORATORY ANALYSES AND FIELD AQUIFER TESTS

MAY 06 1991

April 30, 1991

Mr. Peter McDonald, Suite 210
400 Main Street
Pleasanton, Ca. 94566

Dear Mr. McDonald:

I have read the fuel characterization data report by Chevron Research and Technology Company dated October 16, 1990. The results of their analyses are most interesting and I would like to comment on some of their findings.

It was stated that the results of their chemical tests were not conclusive and some ambiguities in the data were seen. The conclusions were that the alkyl lead isomers were not present in the correct pattern, yet their was a possibility that a detergent additive utilized by Chevron may have been present.

The level of tetraalkyllead was found to be near 0.18 g/gal. and appeared to be similar to regular gasolines formulated after 1985. It was stated that Chevron formulated a regular fuel with 0.22 g/gal lead in 1985 and that 95% of the lead was in the form of tetraethyllead. The sample from the Arrow Rental Co. was found to be only 83% tetraethyllead, implying that the unknown fuel was not Chevron.

The numbers and quantitative data do not exactly match between the commercial product of the Richmond refinery and the unknown fuel. However, the numbers generated from the unknown fuel are very close, considering a weathered fuel, and one exposed to bacterial decomposition and water hydrolysis.

It also would be informative to ascertain what the pattern of the other alkyllead compounds were in the unknown Arrow Rental fuel. Has Chevron ever utilized others mixtures of alkyllead compounds (triethylmethyllead, diethyldimethyllead, etc.)? These could be the additives seen with the unknown sample.

Finally, from the data, analytical error, precision, and variability with the results obtained from standards are not presented for samples exposed to the environment. Therefore, the values of 95% and 83% appear very close, considering the analytical method and type of sample.

From the results of the Chevron laboratory, it appears that the fuel is a modern, regular gasoline, containing lead at concentrations similar to post 1985 refinery fuels. The analysis

utilizing gas chromatography with flame photo-ionization detectors may be adequate for these analyses, however, no precision or degree of accuracy was presented which may validate the numbers and comparison. From these findings, I am left with the conclusion that the unknown fuel from the Arrow Rental Co. is most probably Chevron which was accidentally poured down a vapor monitoring well at the site in 1985.

I hope that I have been some help with the review of these data. If you would require additional information or analytical testing, please call me at (415) 422-0903.

Sincerely,

Brian D. Andresen

Brian D. Andresen, Ph.D.

3. Identification of Tetraethyllead (TEL)

After the GC-MS mass chromatogram plots of m/z 208, 237, and 295 will highlight TEL and other lead isomers. The TEL profiles will be seen near naphthalene (m/z 128) in the mixture of fuel compounds. The mass chromatogram plots will clearly confirm regular fuel in the soil sample.

4. Semi-Quantitation of TEL

Once the mass chromatogram plots of TEL have been obtained the areas of each of the three ions is generated (by computer). The areas are summed and compared directly to the area of the total ionization plot.

$$\frac{\text{Area (208 + 337 + 295)}}{\text{Area of the Total Ion Plot}} = \text{Fraction \% of TEL in the Fuel}$$

Fractional % x 3784g/gallon fuel = g TEL/gallon

Discussion

All of the isolated fuel is carefully concentrated to avoid loses to the volatiles in the fuel. The choice of methylene chloride or carbon disulfide is important because these solvents are so very volatile, capable of extracting fuels from soil easily, and generate few competing fragment ions in the mass spectrometer.

The choice of mass chromatogram plots (m/z 208, 237, and 295) are diagnostic of TEL in gasolines. No other fragment ions from other hydrocarbons generate these characteristic ions which must appear at exactly the same retention time.

The calculation of the amount of TEL in the final extract is semi-quantitative. If the soil is particularly rich in naturally occurring organic compounds, a blank soil sample should be analyzed under the identical conditions. The total ion plot area is then subtracted from the total ion plot are of the gasoline contaminated soil sample.

Soil samples, soaking with fuel, can have the TEL determined to within very close agreement to values obtained directly from raw fuel. The more the sample has to be concentrated, the more difficult it will be to accurately determine the amount of TEL/gallon. However, this approach will clearly demonstrate the difference between grams/gallons and fractional gram amounts of TEL/gallon in regular gasoline.

I hope that these procedures will aid in your investigations. They are reasonable easy to perform and have a good change of success when the samples are fresh.

4/23/90

BRIAN D. ANDRESEN

WORK ADDRESS:

Lawrence Livermore National Laboratory
University of California
Condensed Matter and Analytical
Sciences Division - Chemistry
P.O. Box 5507, L-310
Livermore, California 94550
(415) 422-0903

HOME ADDRESS:

7694 Hillsdale Court
Pleasanton, California 94566
(415) 846-2783

PERSONAL

Born: Reed City, Michigan (January 20, 1947).

PROFESSIONAL OBJECTIVES

To use the training obtained in synthetic organic chemistry, mass spectrometry, and computer assisted analysis of organic compounds in environmental, biomedical or related research areas. To design unique analytical equipment for trace organic analysis.

EXPERIENCE

(1) **Assistant Professor** at the University of Florida, College of Pharmacy (1974-1979), responsible for teaching undergraduate and graduate students techniques in drug analysis, initiating research concerning the synthesis of drugs incorporating stable isotopes, and in identifying trace levels of drugs and biologically active compounds in man and in the marine environment.

(2) **Assistant Director** of the University of Florida, College of Pharmacy's Analytical Toxicology Laboratory District IV, Licensed Director (Clinical Chemistry) Florida State Certified (No. 00067), (1974-1981).

(3) **Associate Professor (Tenured 1982)** at the Ohio State University, College of Medicine, **Department of Pharmacology.** Courtesy Appointment in the **Department of Obstetrics and Gynecology,** College of Medicine. **Director of Mass Spectrometry Facilities,** College of Medicine (1979-1983).

(4) **Director** of the National Reye's Syndrome Research Laboratory, at The Ohio State University College of Medicine (1980-1983).

(5) National Institutes of Health **(NIH) Grant Review Cadre Member** for Cancer of the Pancreas and Large Bowel (1980-1984).

(6) Perinatology Program in **Maternal-Fetal Medicine and Neonatology**, Associate, The Ohio State University, Department of Obstetrics, Gynecology and Neonatology, 1981-1983.

(7) Courtesy Appointment: **Faculty Member in the Department of Obstetrics and Gynecology, School of Medicine,** The Ohio State University, 1981-1983.

(8) Central Ohio Heart Association **Peer Review Cadre Member**, 1982-1983.

(9) **Senior Research Scientist**, Environmental and Biomedical Sciences Divisions, Instrumentation and Measurement Sciences Section (1983-1988) at the Lawrence Livermore National Laboratory.

(10) **Senior Research Scientist**, Condensed Matter and Analytical Sciences Division, Chemistry Special Projects (1988-present).

(10) Drug Enforcement Administration Certified (No. PA0183296) as a **Director of an Analytical Laboratory** (1976-present).

(11) Department of Energy, Subcommittee Member: **Detection Sub-Group, "Research and Development to Counter the Narcotics Threat"**, part of the Intelligence Research and Development Council (IR&DC) under the direction of the CIA/ORD (1987-Present).

EDUCATION

1972-1974	Ph.D. obtained under Professor Klaus Biemann at Massachusetts Institute of Technology (MIT), Department of Chemistry. Thesis Title: "Deuterium Labeling in Drug Metabolism Studies by Mass Spectrometry".
1971-1972	Second Master's degree obtained at Woods Hole Oceanographic Institute (MIT-WHOI Joint Program) in the Chemical Oceanography Department. Thesis Title: "Identification of the Organic Components in Green River Shale".
1969-1971	First Master's degree obtained at Massachusetts Institute of Technology (MIT), Department of Chemistry in Analytical Chemistry.
1965-1969	Undergraduate Education Florida State University Major in Chemistry, minor in math, biology and oceanography (GPA 3.2/4.0 overall, 3.7/4.0 science).

INSTRUMENTATION

1. **Mass Spectrometry** - Proficiency in high resolution mass spectrometry using either a CEC-110B or Varian MAT 311A double focusing instruments. Experienced with both electronic and photographic recording capabilities and with computer control and calculations of high resolution data. **Much experience** with low

and high resolution mass spectrometry for generating and interpreting mass spectral data. Extensive use of combined gas chromatography-mass spectrometry-computer systems. Have been involved with the complete installation, maintenance, and upgrade of existing instruments including Varian-Finnigan, Hewlett-Packard, Dupont, Hatachi, Nuclide, and Nicolet. Hold several patents in GC-MS interfacing and new analytical equipment.

2. **Gas Chromatography** - Proficiency in the use of all types of gas chromatographic equipment and techniques. Very familiar with packed and capillary column gas chromatographic-mass spectrometry techniques and interfacing.

3. **High Pressure Liquid Chromatography** - Familiar with equipment and techniques necessary for the identification and quantitation of compounds in biological fluids. Have been responsible for an Altex and Spectro-Physics HPLC systems used to isolate and quantitate drugs in body fluids.

4. **Computers** - Familiar with IBM 1800, PDP-11/34, HP-2200 computers and data handling equipment. Very familiar with microcomputers and techniques for data acquisition and reduction, having built a Z-80, 32K RAM, dual-disk drive system. Also have built a 635K, 10 megabit IBM-XT computer (with associated hardware and software) and taught courses related to high speed analog-to-digital data recording and manipulation.

5. **Other Specialized Techniques** - Much research and teaching experience has been acquired in the areas of infrared, ultraviolet, and nuclear magnetic resonance instrumentation and spectral interpretation. Have had much experience with design and problem solving in electronics. Experienced with isolated organ perfusion apparatus and experimentation. Recently have gained much experience with fiber optics, lasers, and remote sensing utilizing optical fibers.

ORGANIC SYNTHESIS

Proficient in a wide variety of synthetic skills, having synthesized many **natural products**, drugs, **drug metabolites**, as well as useful intermediates. Work has also included the development of useful synthetic pathways for the preparation of **isotopically labelled compounds** for internal standards in quantitative analysis, and labelled drugs for feeding experiments in pharmacological studies of drug metabolism in animals and man. Recently have gained much experience in the synthesis of potent **carcinogens and mutagens** in overcooked food. Research work has also centered on the isolation, characterization and synthesis of **pollutants** in the San Francisco bay. This work includes chemicals isolated from seawater, ocean sediments and fish.

MEDICAL BACKGROUND

Analyses have been performed on the **body fluids** of over 1200 patients suffering from **drug overdose**. This work was performed

in Boston at MIT, at the University of Florida and at The Ohio State University to aid doctors with immediate body fluids analyses utilizing computer controlled gas chromatography and mass spectrometry to provide rapid and reliable information for the identification of the toxic substances in comatose patients. Quite often this work has included the analysis of and testimony concerning drugs, alcohol, and poisons. Major research interest has centered on the identification of biologically significant compounds in disease states and during pregnancy. Much work has been aimed at the complete analysis of amniotic fluids, spinal fluids, and the identification of abnormal compounds in the body fluids of Reye's Syndrome victims. The compound identifications have included both environmental compounds, drugs and metabolites, and new biochemicals of potential toxicity. Much experience has been obtained concerning animal surgeries with dogs, rats and baboons. In baboons, a considerable amount of work has been performed in the area of fetal pharmacology. In these surgical experiments, live baboon fetuses were removed, studied and returned to the uterus to be carried to term. Much experience has also been gained concerning complications of pregnancy in women.

GENERAL

Have worked on a variety of projects including the analysis of the Apollo Lunar samples for organic chemical content; anti-tumor compounds; fish migration and the chemical characterization of home stream water; crustacean communication, pheromones, and sex attractants between male and female lobsters; oil shale analysis by combined gas chromatography and mass spectrometry; pseudo-Jupiter soil analyses; the identification of various pollutants in river and ocean water (Chemical Oceanography); the identification of antibiotics from marine plants and animals; Fetal Alcohol Syndrome (FAS); the identification of chemicals indicative of distinct disease states (Reye's Syndrome, Maple Syrup Urine Disease); drug metabolism studies, including the identification of metabolites of beta-blockers, (acebutolol); the characterization of amniotic fluids by gas chromatography and mass spectrometry to identify chemicals indicative of the maturity and health of the developing fetus; and more recently the synthesis of mutagenic substances in over cooked food. In addition, techniques have been developed to identify the accelerants in arson cases, or the identification of underground gasoline leaks utilizing mass spectrometry and pattern recognition.

Most mass spectrometry work has required the analysis of many different types of environmental and biological samples. These have included solid, liquid and gaseous samples. Central to this work has been the development of new procedures for the analysis of blood, urine, cerebral spinal fluids, serum, breath, bile, stomach contents, vitreous humor (from the eye), amniotic fluids, meconium, follicular fluids (from human ovaries), tissues (liver, brain, muscle, skin), and many varied samples of biological origin. All of these studies have presented many challenging

situations which require unique sample handling and derivatization techniques, yet allowed added experiences to be gained in the types of unusual compounds that may be encountered during any gas chromatography-mass spectrometry-computer analysis. New areas of interest have included computer profiling techniques for the comparisons of diseased and healthy body fluid and tissue samples by gas chromatography and mass spectrometry. With these new computerized profiling techniques we are now able to observe major and subtle changes in the body chemistry. This new area of research may be important for disease state diagnosis.

MASS SPECTROMETRY FACILITIES

In addition, much time has been spent in the **development of mass spectrometry research groups and mass spectrometry facilities** within the three different University systems (The University of Florida, The Ohio State University, and the University of California at Berkeley [Lawrence Livermore National Laboratory]). In this capacity, many students and laboratory personnel have been trained in the **art of mass spectrometry**, including instrument maintenance, electronics design, chemical analysis, and problem solving. This final point has been especially important. Mass spectrometry has been taught as a sophisticated tool, capable of solving problems which are often encountered in the analysis of submicrogram amounts of components within a complex biological matrix. **Students** who leave our group have a much greater appreciation for the capabilities and limitations of computer guided gas chromatography-mass spectrometry systems in analytical chemistry and a better understanding of its power when applied to environmental or biomedical problems.

NEW METHODS OF ANALYSIS

Recently new methods have been developed for sample introduction into a mass spectrometer. These include **Electrophoresis-Mass Spectrometry (EPMS)** and a new type of **Moving Belt Interface** for high performance liquid chromatography-mass spectrometry. Both designs are completely original and promise to give an added dimension to the mass analysis of complex mixtures containing polar or thermally labile molecules which have previously been most difficult to analyze by standard mass spectral techniques. From this work four new patent applications have been submitted.

The Electrophoresis-Mass Spectrometry interface has resulted in an **IR-100 Award** for 1986. This award recognizes the top 100 best research and development ideas which have been judged on the basis of their significance, uniqueness, and usefulness from a technical standpoint. The competition considered many thousands of applicants world wide.

New methods are currently being developed to review mass spectral data directly with the aid of an IBM PC. It is the goal of this research to utilize high speed microcomputers to manipulate mass spectral data for pattern recognition.

TO: Mr. Al Ridley

FROM: Brian D. Andresen

RE: Identification and semi-quantitation of tetraethyllead in soils by extraction and GC-MS analysis

Enclosed is my procedure for the isolation of trace amounts of gasoline from soils. Although there is no EPA number for these analyses, they work well for a variety of sample types. The procedures are divided into three parts: (1) Following sample concentration, the GC-MS analysis is directed toward generating a recognizable gasoline profile. (2) Fragment ions associated with tetraethyllead (TEL) are highlighted and their areas determined. (3) A semi-quantitative treatment of the data is obtain an estimate of the original TEL in the regular gasoline calculated.

1. Fuel Isolation from Soils

Into a clear beaker (with aluminum foil top) is added 100 to 200 g of fresh soil which has revealed the characteristic smell of gasoline. The soil is broken into small pieces under a volume of methylene chloride (b.p. 40°C) or carbon disulfide (b.p. 46°C) which is sufficient to cover the soil sample. The mixture of solvent and soil is then placed in an ultrasonic bath for 15 minutes (avoiding excessive heat) to extract the fuel from the soil.

The beaker is removed from the ultrasonic bath and the fine sediments are allowed to settle (approximately 10 minutes). The clear solvent layer is decanted into a pear shaped flask and rotary evaporated carefully so that the solvent is removed slowly while cold. The extraction solvent is reduced to a volume of approximately 1.0 to 0.5 mL (never to dryness) and immediately capped and then analyzed by computer controlled gas chromatography-mass spectrometry.

2. Gas Chromatographic-Mass Spectrometric Analysis

Approximately 2 uL of the extracted sample is injected into a capillary GC-MS instrument. A concentrated enough sample should be injected to insure a strong fuel signature with a reasonably intense total ionization plot. A capillary column is not essential, however, it will allow the separation of the very volatile extraction solvent from the fuel. The GC conditions should be initiated near 40-50°C to insure separation of the fuel from the extraction solvent. The temperature program conditions should ramp high enough (250°C) to allow all gasoline components to elute during the GC-MS run. The mass spectrometer should record all mass spectral data (45-400 amu).

BIBLIOGRAPHY

BRIAN D. ANDRESEN, Ph.D.

PUBLICATIONS

1. M.V. Djuricic, D. Vitorovic, B.D. Andresen, H.S. Hertz, R.C. Murphy, G. Preti, and K. Biemann, "Acids Obtained by Oxidation of Kerogens of Ancient Sediments of Different Geographic Origins", Advances in Organic Geochemistry, (Pergamon Press, Oxford, England, 1971), 305-321.

2. H.S. Hertz, B.D. Andresen, M.V. Djuricic, and K. Biemann, "The Isolation and Identification of Gamma-Lactones in the Acidic Fraction of Aleksinac (Yugoslavian) Shale Bitumen", Geochim. et Cosmochimica Acta, 37: 1987 (1973).

3. K. Biemann and B.D. Andresen, "Gas Chromatography/Mass Spectrometry in Drug Analysis", Anal. Chem., 45: 1213A (1975).

4. B.D. Andresen, R.H. Hammer, J.L. Templeton, M.J. Moldowan, and HL. Panzik, "Phenolic metabolite, 2-ethyl-yl-2-(4-hydroxyphenyl)-glutarimide in Human Urine Following Chronic Ingestion of Glutethimide (Doriden)", Research Comm. Chem. Pathology and Pharmacol., 10: 443-453 (1975).

5. B.D. Andresen, J.L. Templeton, R.H. Hammer, H.L. Panzik, and M.J. Moldowan, "Definitive Characterization of the Para-Hydroxyphenyl Metabolite of Glutethimide in Human Urine", Research Comm. Chem. Pathology and Pharmacol., 12: 627-633 (1975).

6. B.D. Andresen, J.L. Templeton, R.H. Hammer, H.L. Panzik, and M.J. Moldowan, "Identification of a Methylated Catechol Metabolite of Glutethimide (Doriden) in Human Urine", Research Comm. Chem. Pathology and Pharmacol., 13: 193-201 (1976).

7. B.D. Andresen, J.L. Templeton, R.H. Hammer, and H.L. Panzik, "Synthesis an d Characterization of a Catechol Metabolite of Glutethimide (Doriden) in Human Urine", Research Comm. Chem. Pathology and Pharmacol., 14: 259-268 (1976).

8. R.J. Perchalski, B.D. Andresen, and B.J. Wilder, "Reaction of Carbomazepine with Dimethylformamide-dimethylacetal (For Gas Chromatography)", Clinical Chemistry, 22: 1229-1230 (1976).

9. B.D. Andresen, F.T. Davis, J.L. Templeton, R.H. Hammer, and H.L. Panzik, "Synthesis and Characterization of Alpha-phenyl-gamma-Butyrolactone, a Metabolite of Glutethimide, Phenobarbital and Primidone, in Human Urine", Research Comm. Chem. Pathology and Pharmacol., 15: 21-30 (1976).

10. B.D. Andresen, M.D. Long, R.H. Hammer , and H.L. Panzik, "Synthesis of 2-ethyl-2-(3-nitro-4-hydroxyphenyl)-glutarimide and 2-ethyl-2-(4-hydroxyphenyl)-glutarimide", Intern. Organic Prep. and Procedures, 8: 282-285 (1976).

11. B.D. Andresen, "Synthesis of Sodium Formate-^{13}C and Oxalic Acid-$^{13}C_2$", J. Organic Chem., 42: 2790 (1977).

12. B.D. Andresen, F.T. Davis, J.L. Templeton, H.L. Panzik, and R.H. Hammer, "Toxicology of Alpha-phenyl-gamma-butyrolactone, a Metabolite of Glutethimide in Human Urine", Res. Comm. Chem. Pathol. Pharm., 18: 439-451 (1977).

13. B.D. Andresen, "Synthesis of D,L-1-^{13}C-methionine", J. Lab. Comp. Radio. Pharm., 15: 731-738 (1978).

14. L. Erb and B.D. Andresen",The Fetal Alcohol Syndrome (FAS)", Clinical Pediatrics 17: 644-649 (1978).

15. G. Fritz and B.D. Andresen, "Oxygen Fixation in the Biosynthesis of Ferulic Acid by Green Zea Mays", Phytochem. 17: 1011-1012 (1978).

16. G. Fritz and B.D. Andresen, "Oxygen Incorporation in the Biosynthesis of p-Courmaric Acid in Seedlings of Zea Mays", Phytochem., 17: 531-582 (1978).

17. M.V. Djuricic, D. Vitorovic, H. Hertz, B. Andresen, and K. Biemann, "Relationship Between the Bitumen and Kerogen of an Australian Torbanite", Org. Geochem., 1: 79-84 (1978).

18. B.D. Andresen and K. Biemann, "A Synthesis of 5-phenyl-5-phenyl-d_5-hydantoin", J. Lab. Comp. Radio. Pharm., 15: 479-488 (1978).

19. B.D. Andresen and D.E. Weitzenkorn, "Synthesis of Pemoline-d_5, A Metabolic Probe for Hyperactivity", J. Lab. Comp. Radio. Pharm., 15: 469-478 (1978).

20. B.D. Andresen, F.T. Davis, P.O. Toskes, and C.E. King, "Synthesis of Taurine-$^{13}C_2$, a Potential Probe for Human $^{13}CO_2$ Breath Tests", J. Lab . Comp. Radio. Pharm., 15: 731-738 (1978).

21. B.D. Andresen and W.A. Wagner, "A Small Electric Spot Welder", Med. Instrum., 13: 98 (1979).

22. B.D. Andresen, F.T. Davis, and M.D. Long, "Identification and Synthesis of a Methylated Catechol Metabolite of Glutethimide Isolated from Biological Fluids of Overdose Victims", J. Pharm. Sci., 68: 283-288 (1979).

23. B.D. Andresen and K. Biemann, "Synthesis of 5-ethyl-d_5-5-phenyl-2-thioxobarbituric Acid, Primidone-ethyl-d_5, and Phenobarbital-ethyl-d_5", J. Label. Comp. and Radiopharm., 16: 681-688 (1979).

24. L. Jovanovic, M. Djuricic, D. Vitorovic, B. Andresen, K. Biemann, "Carboxylic Acids Isolated From Extracts of Aleksinac Oil Shale", J. Glas. Hem. Drus. Beograd., 44: 605-613 (1979).

25. B.D. Andresen and F.T. Davis, "Metabolism of Acebutolol-d_6 in the Rat Correlates with the Metabolism of Acebutolol in Man", Drug Metabolism and Disposition, 79: 360-365 (1979).

26. B.D. Andresen, K. Biemann, "A Synthesis of 5-Phenyl-5-Phenyl-D_5-Hydantoin", Current Chemical Reactions 1:430 (1979).

27. T. Ives, P. Pevonka, B. Andresen, and R. Yost, "Effect of Methyldopa on Urine Glucose Test Methods", Am. J. Hosp. Pharm., 37: 683-687 (1980).

28. B.D. Andresen, W.A. Wagner, and F.T. Davis, "A Microcomputer Assisted Mass Spectral Data Acquisition System Utilizing a Mass Marker", Anal. Chem., 52: 379-384 (1980).

29. J.Z. Yetiv, G.A. Tejwani, B.D. Andresen, and J.R. Bianchine, A.M.A. Drug Evaluations, 4th Edition, Prepared by the A.M.A. Dept. of Drugs. Current Therapy, Edited by H.F. Conn and W.G. Saunders, Philadelphia, New Engl. J. Med., 303:1309 (1980).

30. Li-Shei Lin and B. Andresen, "The Metabolic Fate and Beta Cell Toxicity of Vacor (3-N-pyridylmethyl-N'-p-nitrophenylurea) in the Rat", The Pharmacologist, 22: 245 (1980).

31. J.R. Bianchine and B. Andresen, "Clinical Correlates of Changes in Receptors During Aging", Neural Regulatory Mechanisms During Aging, Alan R. Liss, Inc., New York, 1980, pp. 129-141.

32. D. Eneanya and B. Andresen, "Characterization of Diethyldithiocarbamate Glucuronide by Gas Chromatography and Mass Spectrometry", The Pharmacologist, 22: 243 (1980).

33. K.J. Ng, B.D. Andresen, and J.R. Bianchine, "Capillary Gas Chromatographic-Mass Spectrometric Profiles of Trimethylsilyl Derivatives of Organic Acids from Amniotic Fluids of Different Gestational Age", J. of Chromatography, 228: 43-50 (1980).

34. D. Eneanya, J.R. Bianchine, D.O. Duran, and B. Andresen, "The Action and Metabolic Fate of Disulfiram", Annual Reviews of Pharmacology and Toxicology, 21: 575-596 (1981).

35. D. Eneanya, B. Hanumiah, N. Gerber, B.D. Andresen, and J. Bianchine, "Diethyldithiocarbamic Acid-Induced Choleresis in the Isolated Perfused Rat Liver and Intact Rat", The Pharmacologist, 23: 279 (1981).

36. B.D. Andresen, K. Ng, J. Wu, and J.R. Bianchine, "Helium Preheater for the Open-Split Interface", Biomedical Mass Spectrometry, 8: 237-239 (1981).

37. L. Erb and B.D. Andresen, "Hyperactivity, a Possible Consequence of Maternal Alcohol Consumption", Pediatric Nursing 7: 30-51 (1981).

38. J.R. Bianchine, N. Gerber, and B.D. Andresen, "Geriatric Medicine", Current Concepts, A Scope Publication (The Upjohn Company, 1981).

39. G.B. Bartley, M.D. Hilty, B.D. Andresen, A.C. Clairmont, and S.P. Maschke, "Maple Syrup' Urine Odor Due to Fenugreek Ingestion", The Lancet, 305: 467 (1981).

40. H.J. McClung, M. Nahata, B. Andresen, M. Hilty, and B. Kerzner, "The Use of Hepatoxic Drugs in Reye's Syndrome", J. Nat. Reye's Syndrome Foundation, 1: 47-53 (1981).

41. B.D. Andresen, M.S. Alexander, K.J. Ng, and J.R. Bianchine, "Aspirin and Reye's disease: A Reinterpretation", The Lancet, 1: 903 (1982).

42. B.D. Andresen, K.J. Ng, J.D. Iams, and J.R. Bianchine, "Cotinine in Amniotic Fluids from Passive Smokers", The Lancet 1: 791-792 (1982).

43. W.F. Rayburn and F.P. Zuspan (Editors), P.J. Schneider, B.D. Andresen, and C.J. Latiolais (Associate Editors), **Drug Therapy in Obstetrics and Gynecology**, Appleton-Century-Crofts, Norwalk, Conn. (1982).

44. B. Rayburn and B. Andresen, "Principles of Perinatal Pharmacology", in Drug Therapy in Obstetrics and Gynecology (First Edition), F. Zuspan, Ed.,. (Appleton-Century-Croft, Connecticut, 1982), Chapter 1, pp. 1-8.

45. B.D. Andresen, "Physio-Chemical Properties of Drugs in Obstetrics and Gynecology", in Drug Therapy in Obstetrics and Gynecology, F. Zuspan, Ed. B. Andresen, Associate Ed. (Appleton-Century-Croft, Connecticut, 1982), pp. 375-378.

46. D.I. Eneanya, B. Hanumiah, N. Gerber, B.D. Andresen, and J.R. Bianchine, "Dose-Dependent Kinetics of Diethyldithiocarbamic Acid", Clinical Research, 2(30): 251 (1982).

47. B.D. Andresen, "Not a Matter of Size (The Placental Barriers)", Science News Letter, 121: 307 (1982).

48. M. Alexander, B.D. Andresen, and J.R. Bianchine, "Salicylate Determinations in Reye's Syndrome by HPLC", The Pharmacologist 24, 454 (1982).

49. J. Matsumoto, J. Bianchine, R. Thompson, D. Sharp, K.J. Ng, B. Andresen, and N. Gerber, "Pharmacokinetics of Xenobiotics in Animals Treated with Perfluorochemical Artificial Bloods", The Pharmacologist, 24: 417 (1982).

50. J. Bianchine, B.D. Andresen, M. Alexander, and K. Ng, "The Aspirin/Reye's Syndrome Link", The Lancet, 2, 903 (1982).

51. B.D. Andresen, K. Ng, and J. Bianchine, "Profiling Methods of Cerebral Spinal Fluids by Computer-Guided Capillary Gas Chromatography Mass Spectrometry", Clinical Research, 30: 716 (1982).

52. D. Eneanya, B. Andresen, N. Gerber, and J.R. Bianchine, "Identification and Characterization of the Glucoronide Metabolite of Diethyldithiocarbamic Acid in the Bile from Isolated Perfused Rat Liver by Gas Chromatography and Mass Spectrometry", Res. Commun. Chem. Pathol. Pharmacol., 41: 441-447 (1983).

53. G. Fritz, D.D. Fetterolf, R. Yost, and B. Andresen, "Oxygen Fixation into Hydroxyproline in Etiolated Maize Seedlings - Verification by Tandem Mass Spectrometry", Plant Physiol., 73: 860-861 (1983).

54. K. Ng, B. Andresen, M. Hilty, and J. Bianchine, "Capillary Gas Chromatography-Mass Spectrometry Computer Profiles and Comparisons of the Serum and Urine of Reye's Syndrome Victims", Clinical Research, 31: 393 (1983).

55. J. Bianchine, (Ed.) and B. Andresen, et al., (Associate Editors), Recent Advances in Clinical Therapeutics - Psychopharmacology, Neuropharmacology, and Gastrointestinal Therapeutics, (Grune and Stratton Pub. Co., San Francisco, Ca., 1983).

56. J. Matsumoto, J. Bianchine, R. Thompson, D. Sharp, B. Andresen, K. Ng, and N. Gerber , "Disposition of Phenytoin in Rats Treated with Fluorsol-43, A Perfluorochemical and Artificial Blood Substitute", Proc. West. Pharmacol. Soc., 26: 403-407 (1983).

57. K. Ng, B. Andresen, M. Hilty, and J. Bianchine, "Identification of Long Chain Dicarboxylic Acids in the Serum of Two Patients with Reye's Syndrome", J. Chromatography, 276: 1-10 (1983).

58. D.A. Contos, B. Andresen, F.B. Thomas, and J. Bianchine, "Analysis of Gastric Juice by Gas Chromatography-Mass Spectrometry (GC-MS)", Pharmacologist, 25: 182 (1983).

59. A. Chu, L. Neruker, and B. Andresen, "Reye's Syndrome Patients Compared to Siblings and Parents", J. Nat. Reye's Syndrome Found., 4: 55-56 (1983).

60. B.D. Andresen, B. Wise, K. Ng, and G. Wise, "Mass Spectrometry In Clinical Chemistry, II.", J. Med. Tech., 2: 245-250 (1985).

61. B. Andresen, "Reye's Syndrome", Merit Students Encyclopedia, 16: 2-3, MacMillan Pub. Co., N.Y., N.Y. (1985).

62. C.W. Anderson, K.J. Ng, B.D. Andresen, L. Cordero, "Benzyl Alcohol Poisoning in a Premature Newborn Infant", Am. J. Obstet. Gynecol., 148: 344-346 (1984).

63. M. Borrisud, R. O'Shaughnessy, M.S. Alexander, B.D. Andresen, "Metabolism and Disposition of Ritodrine in a Pregnant Baboon", Am. J. Obstet. Gynecol., 152: 1067-1072 (1985).

64. M. Borrisud, M.S. Alexander, B.D. Andresen, "Interspecies Variation in Ritodrine Metabolism", Am. J. Obstet. Gynecol., 153: 332-334 (1985).

65. B.D. Andresen and B. Wiese, "Mass Spectrometry", in Textbook of Clin. Chem. (Ed., N. Tietz), Chapter 1, Section 10: 197-208 (1986).

66. M.G. Knize, B.D. Andresen, S.K. Healy, N.H. Shen, P.R. Lewis, L.F. Bjeldanes, F.T. Hatch, and J.S. Felton, "Effects of Temperature, Patty Thickness and Fat Content on the Production Mutagens in Fried Ground Beef", Food Chem. Toxicol., 23: 1035-1040 (1985).

67. K.R. Grose, J.L. Grant, L.F. Bjeldanes, B.D. Andresen, S.K. Healy, P.R. Lewis, J.S. Felton, and F.T. Hatch, "Isolation of the Carcinogen IQ From Fried Egg Patties", J. Agric. Food Chem., 34: 201-202 (1986).

68. J.S. Felton, M. G. Knize, N.H. Shen, P.R. Lewis, B.D. Andresen, J.Happe and F.T. Hatch, "Isolation and Identification of a New Mutagen From Fried Ground Beef: 2-Ami no-1-methyl-6-phenyl-imidazo[4,5-b]pyridine (PhIP)", Carcinogenesis 7: 1081-1086 (1986).

69. B.F. Rayburn and B.D. Andresen, "Principles of Perinatal Pharmacology", in Drug Therapy in Obstetrics and Gynecology (Second Edition), F. Zuspan, Ed., B. Andresen, Associate Ed. (Appleton-Century-Croft, Connecticut, 1986), Chapter 1. pp. 3-12.

70. B.D. Andresen, "Chemical Properties of Drugs", in Drug Terapy in Obstetrics and Gynecology, F. Zuspan, Ed. B. Andresen, Associate Ed. (Appleton-Century-Croft, Connecticut, 1986), pp. 477-493.

71. A. B. Chu, L. S. Nerurkar, N. Witzel, B. D. Andresen, et al, "Reye's Syndrome - Salicylate Metabolism, Viral Antibody Levels, and other Factors in Surviving Patients and Unaffected Family Members", Am. J. Diseases Children., 140: 1009-1012 (1986).

72. J.S. Felton, M.G. Knize, Na.H. Shen, B.D. Andresen, L.F. Bjeldanes, and F.T. Hatch, "Identification of the Nutagens in Cooked Beef", Environmental Health Perspectives 67: 17-24 (1987).

73. B.D. Andresen, B.W. Hurtuk, and K.J. Ng, "Mass Spectrometry", Fundamentals of Clinical Chemistry, N. Tietz, Ed. Chapter 2, Sec. 8, pp 137-143, W.B. Saunders, Co., Philadelphia, PA. (1987).

74. B.D. Andresen and E. Raber, "Chemical Characterization and Analysis of Sea Water Samples", Classified Publication: COVD-3655 (1987) Lawrence Livermore National Laboratory.

75. R.B. Spies, B.D. Andresen, and D. Rice, "Benzthiazoles In Estuarine Sediments as Indicators of Street Runoff", Nature 327: 697-699 (1987).

76. R.B. Spies and B.D. Andresen, "Benzthiazoles in Estuarine Sediments as Indicators of Street Runoff", in Energy and Technology Review (Lawrence Livermore National Laboratory, Livermore, Ca, August, 1987, pp. 30-34.

77. B.D. Andresen, E. Raber, R. Howley-Fedder, et al., "Procedure for Collection and Preparation of Water Samples for Chemical Analyses", Classified Publications: COVDS-4354 and COVD-4201 (1987).

79. B.D. Andresen and E. Raber, ".....Sample Analysis...", Classified Publication: COVD-4789 (1988).

80. M.F. Singleton, J.F. Cooper, B.D. Andresen, and F.P. Milanovich, "Laser Induced Bulk Damage in Potassium Dihydrogen Phosphate Crystal", UCRL-97658, Feb. 1988.

81. M.F. Singleton, J.F. Cooper, B.D. Andresen, and F.P. Milanovich, "Laser-Induced Bulk Damage In Potassium Dihydrogen Phosphate Crystal", Appl. Phys. Lett. 52: 857-859, (1988).

82. B. D. Andresen and W. Burks, "Chemical Analysis of Three Samples", Classified Publication COVC-5149 Lawrence Livermore National Laboratory (1988).

83. B.D. Andresen, "Hypertensive Disorders", (in Textbook of Clinical Laboratory Sciences, (Edited) B. G. Davis, M. L. Bishop, and D. Mass, J.B. Lippincott, Chapt 4, pp. 34-57, 1989).

84. B.D. Andresen and E. Raber, "INF-CCAT Assessemtns", Classified Publication COVD-89-6339 (March, 1989).

WORKSHOPS AND TRAINING SEMINARS

1. B.D. Andresen, "Applications of Mass Spectrometry for Clinical Toxicology", Workshop presented at the 31st Annual Meeting of the Am. Ass. Clinical Chemists, New Orleans, July 16, 1979.

2. D. Eisenberg, Y. Nordhav, and B.D. Andresen, "Underground Storage Tanks - Advanced Level Course", Workshop presented at the April 20-22 Hazamacon 87 - Assoc. Bay Area Governments - Training Institute, Santa Clara, California.

3. D. Eisenberg, Y. Nordhav, and B.D. Andresen, **"Underground Storage Tanks - Advanced Level Course"**, Workshop presented July 30, 1987 at the Association of Bay Area Governments (Oakland, CA).

4. D. Eisenberg, Y. Nordhav, and B.D. Andresen, **"Underground Storage Tanks - Advanced Level Course"**, State of California Water Resources Control Board Training Course. Presentations:
   a. Sept. 1-3, 1987 (Sacramento, CA.)
   b. Sept. 14-16, 1987 (Los Angeles, CA)
   c. Sept. 23-25, 1987 (Irvine, CA).

ABSTRACTS

1. K. Biemann, C.E. Costello, and B.D. Andresen, "Mass spectrometric Identification of Drugs and Their Metabolites in Body Fluids", 166th National Meeting, Am. Chem. Society, Chicago, IL (1973).

2. H.L. Panzik, J.L. Templeton, R.H. Hammer, B.D. Andresen, P. Doering, and M.P. Pevonka, "Peritoneal Dialysis for Management of Severe Glutethimide Intoxication", 21st Meeting, Academy of Pharmaceutical Sciences, Abstract of Papers, 6: 154 (1976).

3. B.D. Andresen, M.D. Long, J.L. Templeton, R.H. Hammer, H.L. Panzik, and F.T. Davis, "Synthesis of Characterization of Metabolites of Glutethimide", 21st Meeting, Academy of Pharmaceutical Sciences, Abstracts of Papers, 6: 155 (1976).

4. B.D. Andresen, "Doriden", Biotransformation Reviews, Series C: 10370-10371 (1977).

5. D. Eneanya, P. Hanumiah, N. Gerber, B. Andresen, and J. Bianchine, "Dose-Dependent Kinetics of Diethyldithiocarbonic Acid", presented at the American Federation for Clinical Research, Atlanta, Georgia, June 1981.

6. K. Ng, J.R. Bianchine, and B. Andresen, "Capillary Gas Chromatography of Cerebral Spinal Fluid from Alzheimer Dementia Patients", The 12th Annual National Meeting for the American Aging Association (San Francisco, Ca., September, 1982), p. 20.

7. K.J. Ng, B.D. Andresen, J.R. Bianchine, J.D. Iams, R.W. O'Shaugnessy, and F.P. Zuspan, "Capillary Gas Chromatographic-Mass Spectrometric Profiling of Organic Acids in Human Amniotic Fluids", Society for Gynecologic Investigation Abstracts, March of Dimes National Foundation Birth Defects Conf. Proc., June 15, 1982, p. 165.

8. M.S. Alexander and B.D. Andresen, "Acebutolol in the Isolated Perfused Rat Liver", presented at the 83rd Am. Soc. for Clinical Pharmac. and Therapeutics, Lake Buena Vista, Fl., March 1982.

9. M.S. Alexander and B.D. Andresen, "Salicylate Determination in Reye's Syndrome by Liquid Chromatography", 8th Annual Bio-Medical Forum, Ohio State University, ISCABER Society, June 1982.

10. J. Matsumoto, J. Bianchine, R.M. Thompson, D. Sharp, N. Gerber, K. Ng, and B.D. Andresen, "Pharmacokinetics of Xenobiotics in Animals Treated with Perfluorochemical Artificial Bloods", ASPET/SOT (1982).

11. K. Ng, B.D. Andresen, et al., "Capillary Gas Chromatography-Mass Spectrometry Profiling of Organic Acids in Human Amniotic Fluids", Society for Gynecologic Investigation, March of Dimes Birth Defects Conf., June 15, 1982, p. 165.

12. K.J. Ng, J.R. Bianchine, B.D. Andresen, and L. Hersey, "Capillary Gas Chromatographic-Mass Spectrometric Analysis of Cerebral Spinal Fluid in Alzheimer Dementia Patients", Am. Aging Assoc. Proc., 5: 137 (1983).

13. K.J. Ng, B.D. Andresen, and J. Bianchine, "Capillary Gas Chromatography-Mass Spectrometric Profiles of Trimethylsilyl Derivatives of Serum Organic Acids from Reye's Syndrome Patients", 31st Annual Conference on Mass Spectrometry (Boston, Massachusetts, 1983), p. 449.

14. D. Contos, B.D. Andresen, J.R. Bianchine, and F. Thomas, "Analysis of Gastric Juice of Gas Chromatography-Mass Spectrometry (GC-MS)", 9th Annual Bio-Medical Forum, Ohio State University, ISCABER, June 1983.

15. D. Contos, J. Iams, N. McMahon, B. Andresen, J. Bianchine, K. Ng, and F. Zuspan, "Caffeine Consumption During Pregnancy and Amniotic Fluid Cholesterol and Palmitic Acid Levels Measured by GC/MS", 165th Annual Birth Defects Conf., March of Dimes, June 20, 1983, Seattle, Wa.

16. D.A. Contos, B.D. Andresen, F.B. Thomas, and J.R. Bianchine, "Gastric Juice Comparisons by Gas Chromatography-Mass Spectrometry", College of Medicine, Department of Pharmacology, The Ohio State University, American Society for Pharmacology and Experimental Therapeutics, August 7-11, 1983, Philadelphia, Pa.

17. K. Ng, B.D. Andresen, M.D. Hilty and J. Bianchine, "Comparison of Capillary Gas Chromatographic-Mass Spectrometric Profiles and Non-Fatal Cases of Reye's Syndrome", American Federation for Clinical Research, Washington, D.C., April 1983.

18. B.D. Andresen, B.L. Wise, and K.J. Ng, "Mass Spectrometry in Clinical Chemistry", J. Med. Tech., 1(5): 391 (1984).

19. J.S. Felton, M.G. Knize, M.G. Shen, B. Andresen, F.T. Hatch, and L.F. Bjeldanes, "Identification of the Mutagens in Cooked Beef", 1984 Intern. Chem. Congr. Pac. Basin Soc., Honolulu, HI, December 16-21, 1984 (Abstract 02C03).

20. L. Kempton, K. Stone and B. Andresen, "Clinical Correlates of Active and Passive Smoking on the Fetus and Infant", Midwest Nursing Research Society Meeting, Minneapolis, Ind., April 1984.

21. M.G. Knize, B.D. Andresen, et. al, "Isolation and Identification of Two New Mutagens From Fried Ground Beef", Sixteenth Annual Meeting of the Environmental Mutagen Society, February 1985, Las Vegas, Nevada, Environ. Mutagen., 7(Suppl. 3), 81 (1985).

22. J.S. Felton, M.G. Knize, B.D. Andresen, N. Shen, S.K. Healy, L.F. Bjeldanes, and F.T. Hatch, "Cooked beef mutagens: compounds formed and quantitative estimate of yield", Sixteenth Annual Meeting of the Environmental Mutagen Society, February 1985, Las Vegas, Nevada, Environ. Mutagen., 7(Suppl. 3), 81 (1985).

23. R.B. Spies, D.W. Rice, P.A. Montagna, and B.D. Andresen, "Evidence For an Effect of Organic Contaminants On Successful Reproduction of Starry Flounder in San Francisco Bay", Sixth International Ocean Disposal Symposium, April 21-23, Asilomar Conference Center, Pacific Grove, California, (Abstract 930, page 114 (1986).

24. M.F. Singleton, J.F. Cooper, F.P. Milanovich, and B.D. Andresen, "Laser Damage Studies of Potassium Dihydrogen Phosphate Single Crystals", Seventh American Conference on Crystal Growth, July 12-17 Monterey, CA., pages 265-266 (1987).

PATENTS AND PATENTS PENDING

1. B.D. Andresen and K. Ng, The Ohio State University (1982): "Helium Preheater for the Open Split Capillary Gas Chromatograph-Mass Spectrometer Interface", Awarded July 5, 1983, **No. 4,391,778.**

2. B.D. Andresen and K. Ng, The Ohio State University (1982): "Method for the Analysis of Materials by Chromatography and Mass Spectrometry", Awarded February 26, 1985, **No. 4,501,817.**

3. B.D. Andresen, M. Alexander, and D. Sharp, "A New Synthesis of Acebutolol", (Has passed all preliminary reviews and is awaiting final assignment of U.S. Patent Number, 1987).

4. B.D. Andresen and M. Alexander, Intermediates for the Synthesis of Acebutolol", (Has passed all preliminary reviews and is awaiting final assignment of U.S. Patent Number, 1987).

5. B. Garron and B.D. Andresen, "A Wireless Sound and Communication System", Patent submitted to Washington, June 1987.

6. B.D. Andresen and Eric Fought, "Electrophoresis Mass Spectrometry", Awarded November 10, 1987, **No. 4,705,616.**

7. B.D. Andresen and Eric Fought, "Interface for Liquid Chromatograph-Mass Spectrometer", Awarded September 19, 1989, **No. 4,867,947.**

8. B.D. Andresen and Vinit Saxena, "Chromatography Column/Moving Belt Interface", Awarded April 26, 1988, **No. 4,740,298.**

9. B.D. Andresen and Vinit Saxena, "Chromatography Column-Electrophoresis System", Awarded November, 24, 1987, **No. 4,708,782.**

10. B.D. Andresen and F. Milanovich, "Platinum Catalyzed 'Huemorph' - A Fiber Optic Based Hydrogen Gas Sensor", Patent Disclosure Submitted September 1986.

11. B.D. Andresen and F. Milanovich, "Gasoline 'Huemorph' Fiber Optic Based Gasoline and Other Solvent Sensor", Patent Disclosure Submitted September 1986.

PUBLICATIONS (In Press, Submitted, or In Preparation)

1. K.J. Ng, B.D. Andresen, and J.R. Bianchine, "Capillary Gas Chromatographic-Mass Spectrometric Profiles of Organic Acids from Amniotic and Other Body Fluids", in Reproductive Medicine Series (Marcel Dekker, Inc. Publishers).

2. K.J. Ng, B.D. Andresen, J.R. Bianchine, J.D. Iams, R.W. O'Shaugnessy, M. Nelson, F.P. Zuspan, and L.F. Stempel, "Variation in Hippuric Acid Concentration in Amniotic Fluid with Gestational Age", J. Obstetrics and Gynecology.

3. M. Alexander, M. Borrisud, B. Andresen, A. Staubus, S. Jacobs, S. Roemer, and J. Bianchine, "Acebutolol and its Metabolites Following Oral and Intravenous Administration in Man", Clin. Pharmacology and Therapeutics.

4. B.E. Watkins, M.G. Knize, C.J. Morris, B.D. Andresen, et. al., "Synthesis of derivatizes of the Cooked-Food Mutagens IQ, MeIQx, and PhIP as Haptenic Compounds", (Submitted Hetercycles 1987).

TEACHING ACTIVITIES
(Shared With Other Department Members at The Ohio State University)

1. Pharmacology 824 - Psychopharmacology
2. Pharmacology 702 - Practice of Pharmacology (Laboratory methods)
3. Pharmacology 700 - Phase II Medical Students Required Pharmacology Course
4. Pharmacology 609 - Molecular Pharmacology
5. Pharmacology 600 - Introduction to Pharmacology
6. Pharmacology 400 - Pharmacology for Clinical Chemistry Technologist

TEACHING ACTIVITIES (Total Responsibility)

1. Pharmacology 850 - General Pharmacology Review (All Topics in Pharmacology)

2. Pharmacology 860 - Chromatography and Instrumental Methods of Drug Assay (With Biomedical Mass Spectrometry)

3. Pharmacology 999 - Graduate Student Supervision

4. Analytical Pharmaceutical Procedures - 445
(1979-1983 University of Florida)

5. Pharmaceutical Laboratory - 447
(1979-1983 University of Florida)

GRADUATE STUDENTS (Under My Supervision)

1. Mrs. Judy Lubbers - M.D. and Ph.D. Candidate
2. Mrs. Diane Moreno - Ph.D. Candidate
3. Mrs. Li-Shei Lin - Master' Student (Awarded 1981)
4. Ms. Cynthia Beach - Ph.D. Candidate (Awarded 1983)
5. Dr. Kwokei Ng - Ph.D. Candidate (Awarded 1981)
6. Dr. Dennis Eneanya - Ph.D. Candidate (Awarded 1981)
7. Dr. Ginn Wu - Postdoctoral Fellow
8. Dr. Dale Sharp - Postdoctoral Fellow
9. Dr. Matana Borrisud - Ph.D. Candidate (Awarded 1983)
10. Mr. Harry Duran, Mr. Jason Chang, Ms. Denise Contos, Ph.D. Canadates (partially suported in my laboratory)
11. Dr. Michael Alexander -Ph.D. candidate (awarded 1983)

OTHER STUDENT SUPERVISION (The University of Florida)

1. Dr. Frank Davis - Ph.D. Student (awarded 1978)

2. Mr. James Templeton - Masters Student (Awarded 1977)

3. Dr. Harry Panzik - Postdoctoral Fellow

(Ph.D. **THESIS and DISSERTATIONS DIRECTED)**

1. "Applications of Synthetic Organic Chemicstry, Stable Isotope Labelling, and Mass Spectrometry to Drug Metabolism Studies", Dr. Frank Davis (1978).

2. "Gas Chromatographic-Mass Spectrometric Profiling of Organic Acids of Human Amniotic Fluid", Dr. Kwokei Ng (1981).

3. "Metabolic Study of Ritodrine With High Performance Liquid Chromatography", Dr. Matana Borrisud (1983).

4. "Metabolic Studies of Acebutolol by HPLC and GC-MS", Dr. Michael Alexander (1983).

MEDICAL STUDENTS (Receiving Awards and Financial Support While Under My Supervision)

1. Mrs. Mary Ann Gravinstein
2. Mr. Stephan Gravinstein
3. Mr. James Kotsonas
4. Ms. Barbara Bunn
5. Mr. Rick Kukukla
6. Mr. David Bray
7. Ms. Linda Weber

GRANTS AWARDED AS THE PRINCIPAL INVESTIGATOR AT THE OHIO STATE UNIVERSITY

1. The Ohio State University School of Medicine Starter Grant, $5,000: "The Characterization of Unusual Compounds in the Urine of Reye's Syndrome Patients" (1980), Grant #540107.

2. The Ohio State University Graduate Research Program, $5,400: "Acebutolol - A Threat of Toxic Metabolites", (1980), Grant #221312.

3. The National Reye's Syndrome Foundation, $21,000: "A Reye's Syndrome Analytical Facility" (1908-1983), Grant #713086.

4. The Central Ohio Heart Foundation, $12,000: "The Impact of Metabolites of Acebutolol on Cardiofunction" (1980), Grant #713369.

5. The Stohler Isotope Chemical Co., $5,000: "The Analysis and Synthesis of Labelled Compounds" (1980), Grant #536577.

6. The Central Ohio Heart Association, $15,000: "The Potential Danger of In-Vivo Acebutolol Decomposition" (1981-1982).

GRANTS AWARDED AS CO-INVESTIGATOR AT THE OHIO STATE UNIVERSITY (Principal Investigator)

1. The National Institutes of Health, $433,497: "Unsaturated Fatty Acids, Prostaglandins, and Diabetes;" (Dr. Howard Sprecher, 1981-1985).

2. Public Health Services, $95,767: "Prostaglandin Control of Macrophage Anti-tumor Activity", (Dr. B.S. Zwilling, 1981-1985).

3. The National Institutes of Health, No. 669,218: "Stochastic Fourier Transform Ion Cyclotron Resonance Mass Spectrometry", (Dr. Allan Marshall, 1983-1986).

GRANTS AWARDED AT THE LAWRENCE LIVERMORE NATIONAL LABORATORY (As Principal Investigator)

1. The Institutional Research and Development Grants (LLNL), "Electrophoretic Mass Spectrometry", $59,000 (1985).

2. The Institutional Research and Development Grants (LLNL), "Electrophoretic Mass Spectrometry", $120,000 (1986).

3. The Institutional Research and Development Grants (LLNL), "High Performance Liquid Chromatography High Resolution Mass Spectrometry", $110,000 (1985)

4. The Institutional Research and Development Grants (LLNL), "High Performance Liquid Chromatography High Resolution Mass Spectrometry", $119,000 (1986).

5. Department of Energy, "Galileo Project", $27,000 (1986-1989).

6. Department of Energy, "Very Small Mass Spectrometer (VSMS)", $360,00 (1988-1990).

GRANTS AWARDED AT THE LAWRENCE LIVERMORE NATIONAL LABORATORY (As Co-investigator)

1. National Institutes of Health, "Mutagens From Cooking of Food", (Dr. Fred Hatch, $3,800,000, 1981-1987).

2. National Institutes of Health, "Immunoassays for the Detection of Cooking-Food-Mutagens", (Dr. James Felton, $724,821, 1985-1987).

3. National Institutes of Health, "Genotoxicity of Food Related to 1,2-Dicarbonyl Compounds in Cooked Food", (Dr. Robert Taylor, $330,177, 1985-1987).

4. Oakridge National Laboratory, "Improved <u>In-Situ</u> Detection of Organic Compounds", (Dr. Fred Milanovich, $210,00, (1986-1987).

5. Environmental Protection Agency, "Groundwater Monitoring By Spectroscopy With Optical Fibers and Optrodes", (Dr. Fred Milanovich, $150,000, 1983-1986).

6. Department of Energy, "Subsurface Organic Chemical Analysis Using Remote Fiber Optic Technology", (Dr. Florence Harrison, $30,000, 1985-1986).

7. Department of Energy, "Chemical Characterization and Analysis Techniques (CCAT-Organic)", R. Hawley-Fedder and B.D. Andresen (Co-Principal Investigators) $385,000 (1986-1988).

8. Department of Energy, "SKYBRIGHT", R. Hawley-Fedder, E. Raber, and B. Andresen, $1,200,000 (1986-1989).

9. Various Government Agencies, "Unique Projects of Interest" (1989-1990), supporting funds.

COMMUNITY SERVICES

Miscellaneous seminars for various departments at The University of Florida.

Miscellaneous seminars for various departments at The Ohio State University.

Central Ohio Heart Chapter, Inc. (many community presentations concerning science in medicine, Columbus, Ohio Museum of Science and Technology, Continuous Video Tape).

Miscellaneous radio programs on drugs of abuse (AM 610, FM 96, and FM 98 Columbus, OH)

Reye's Syndrome National Laboratory presentations (many radio and television programs)

Reye's Syndrome - New York Times Newspaper (1981).

Ohio State Coronor's Association Annual Seminar Presentations (1980-1983).

New Horizons in Science Presentations - UPI and AP News Updates

North Florida District IV Medical Examiner Toxicology Laboratory Coronor's Association Annual Seminar Presentations - 1974-1979.

Livermore Police - Drug Taskforce.

AWARDS

1. Director - Nation Reye's Syndrome Research Laboratory - Awarded June 1981 at the National Press Club, Washington, D.C.

2. Industrial Research (IR 100) - Awarded June 1987 at the Museum of Science and Industry, Chicago, IL. for the newly invented Electrophoresi-Mass Spectrometry Interface.

LECTURES

Lions Clubs
Rotary Club
National Telephone Companies
American Associations of Clinical Chemists

MISCELLANEOUS

The Presendent's Club - Financial contributions to the Ohio State University Alumnae Fund.

Included in the American Men and Women of Science - 1982, Fifteenth Edition, page 134.

Contribution - National Baseball Hall of Fame - 1939 Centennial Coin.

CONSULTANT TO OR MASS SPECTROMETRY RELATED WORK WITH THE FOLLOWING GROUPS

1. Stohler Isotope Chemicals, Inc. - Waltham, Massachusetts
2. Syntex Laboratories, Inc. - Palo Alto, California
3. Adria Laboratories, Inc. - Dublin, Ohio
4. Varian MAT - Breman, Germany
5. Florida Crime Lab - Tallahassee, Florida
6. Columbus Testing Laboratory, Inc. - Columbus, Ohio
7. Isotope Labelling Company - Whippany, New Jersey
8. Anchor Hocking - Lancaster, Ohio
9. Childrens Hospital - Columbus, Ohio
10. Sepragen, Corporation - San Leandro, CA.
11. Baseline Environmental Consulting - Oakland, Ca.
12. Homestake Minning Co. Davy McKee Corp.
13. ST&E, Inc. - Livermore, Ca. (415) 449-8516.
14. Distributors Processing Inc. Porterville, CA, (209) 781-0297.
15. Midwest Physicans Network - Minneapolis, MN, (612) 863-5613.
16. Fiber Chem., Inc. - Albuquerque, NM, (505) 292-6901.
17. Alliance Technologies Corp. - Bedford, Mass. (617) 275-9000.
18. Laser Cartrige Reconditioning - Dublin, Ca. (415)846-9062.

CONSULTANT WITH THE FOLLOWING LAW FIRMS

1. Mr. Dan Conner and Associates - Columbus, Ohio, (614) 464-2025
2. Mr. R. William Meeks and Associates - Columbus, Ohio, (614) 228-3569.
3. Mr. Steve Larson and Associates - Columbus, Ohio, (614) 224-0343.
4. Mr. Boyd Binning - Columbus, Ohio, (614) 224-1979.
5. Mr. Richard Bush -Parkersburg, West Virginia, (304) 485-6438.
6. Mr. Paul Cassidy and Associates - Columbus, Ohio, (614) 228-3569.
7. Mr. Gary Dumm - Columbus, Ohio, (614) 477-2593.
8. Mr. James Hill - Circleville, Ohio, (614) 477-2173.
9. Mr. Michael Hoddox and Mr. Ronald Lasmer - Zanesville, Ohio, (614) 452-9358.
10. Mr. Rober Moses - Columbus, Ohio, (614) 294-2678.
11. Mr. William Simonton - Pennsboro, West Virginia, (304) 659-2966.
12. Mr. Rodney Wubdin - Harrisville, West Virginia.
13. Mr. Larry Supp and Associates - Morristown, New Jersey, (201) 267-5200.
14. Mr. Thomas Bell, Mr. Robert Addison and Associates - Jackson, Mississippi, (601) 969-7607.
15. Mr. James R. Kingsley - Circleville, Ohio, (614) 477-2546.
16. Mr. Joe A. Rosenfield - Columbus, Ohio, (614) 469-9922.
17. Mr. Rodney C. Wincom - Harrisville, West Virginia, (304) 643-4440.
18. Mr. Leonard Siegal - Columbus, Ohio, (614) 866-4025.
19. Mr. Thomas Orvis - Oakland, Ca. (415) 328-5510
20. Mr. Terry Broughton - Dublin, Ca. (415) 828-4428
21. Mr. Harry Traback - Livermore, Ca.(415) 447-7020
22. Mr. Terry Moore - Cincinnati, Ohio (513) 961-6200
23. Mr. Michael Murry - Oakland, Ca. (415) 451-4600

CONSULTANT FOR THE FOLLOWING TELEPHONE COMPANIES CONCERNING ENVIRONMENTAL CONTAMINATION

1. Pacific Bell (San Ramon, Ca.):
   Miss Dorthy (D.J.) Allen - (415) 823-9820
   and Mr. E.J.(Ed) Koehler - (415) 823-9821

2. Bell Atlantic (Arlington, Va.):
   Mr. Christopher E. Mandel, AIC - (703) 974-3757

3. C & P Telephone Company of Virginia (Richmond, Va.):
   Mr. Ruben Burton, Jr., Mr. Gene Lane, and
   Mr. George Hamner, Legal Department - (804) 772-3512

4. South Central Bell (Baton Rouge, Louisiana):
   Mr. Joe Pat Carnahan - (504) 292-6465.

5. South Central Bell (Huntsville, Alabama):
   Mr. Mark A. Ray, Claims Office - (205) 532-8678.

6. Mountain Bell, Station 29 (Albuquerque, New Mexico):
   Mr. Gill Quesada - (505) 765-8113.

7. General Telephone of The Southwest (San Angelo, Texas):
   Mrs. Rosemary Davis - (915) 944-5335

8. Ohio Bell (Cleveland, Ohio):
   Mr. Al Richards - (216) 822-42283

9. Bellcore (Piscataway, New Jersey)
   Mr. Robert Allen - (201) 981-7825

10. Bell South Services (Birmingham, Alabama):
    Mr. Shep Holladay - (205) 321-8835

11. GTE (Fort Wayne, Indiana), Security Department:
    Mr. Mike Connell - (219) 461-2653.

12. New Jersey Bell (Newark, N.J.):
    Mr. E.J. Carroll - (210) 649-2206.

13. GTE (Carrolton, Texas) Security Dept.:
    Mr. Ben Day - (214) 466-0738.

14. GET (Plano, Texas) Security Department:
    Mr. Bill Handcock - (,
    Mr. Chris Schnaithman - (214) 403-0404, and
    Mrs. Susan Freeman (214) 495-3112 x 3622.

15. South Central Bell - Security Department:
    Mr. Jeffrey Morrison - (318) 222-8596.

16. Ohio Bell (Columbus, Ohio) - Calims Department:
    Mr. John Hicks - (614) 223-6211.

- CAPABILITIES -

I. **GASOLINE ANALYSIS - IDENTIFICATION OF PETROLEUM PRODUCTS**

A. Fingerprinting and Pattern Recognition
B. Lead Content
C. Underground Tanks - Leak Identification
D. Asphalt - Characterization
E. Rocket, Jet, Missile - Propulsion Fuel Analysis

II. **IDENTIFICATION BY THE CHEMICAL MATCHING OF MATERIALS**

A. Paper, Metals, Plastics, Ink, Water, Oils, etc.
B. Gun Powder - Contact Memory
C. Blood Residues Containing Unknown Substances
D. Fingerprints and Smudges Containing Biological Materials
E. Explosive Characterization
F. Air and Gas Samples for Trace Level Analysis

III. **TRACE ANALYSIS OF ORGANIC CHEMICAL RESIDUES**

A. On the Soles of Shoes, Paper, Leather, Cloths, etc.
B. On Skin: The Hands for Trace Organic Residues
C. In Breath: Nicotine, Marijuana, etc.
D. In Hair Samples for Trace Organic Compounds of Interest

IV. **ARSON**

A. Identification of Acceleration
B. Chemical Analysis of Materials
C. Explosive Analysis - Residues

V. **BLOOD PROFILES**

A. Total Analysis of Blood Components - Characterization of Individuals as to Health and Types of Foods Ingested
B. Drugs in All Body Fluids (Blood, Urine, Saliva, etc.
C. Adverse Drug Reactions and Pharmacology

VI. **URINE ANALYSIS**

A. Types of Foods Ingested and Overall Metabolic Health
B. Drugs Analysis - Rapid and Noninvasive

VII. **TRACE ANALYSIS OF DRUG RESIDUES**

A. GC-MS-Computer Analysis: Confirmation and Quantitation
B. Thin Layer Chromatography - Rapid Screening
C. Field Test for Marijuana and (THC) Residues
D. Field Tests for Cocaine or Other Illicit Drugs
E. Hair Analysis by GC-MS

VIII. INSTRUMENTATION AND OTHER SKILLS

A. Mass Spectrometry Installation

B. Gas Chromatography-Mass Spectrometry-Computer Design

C. Synthetic Organic Chemistry

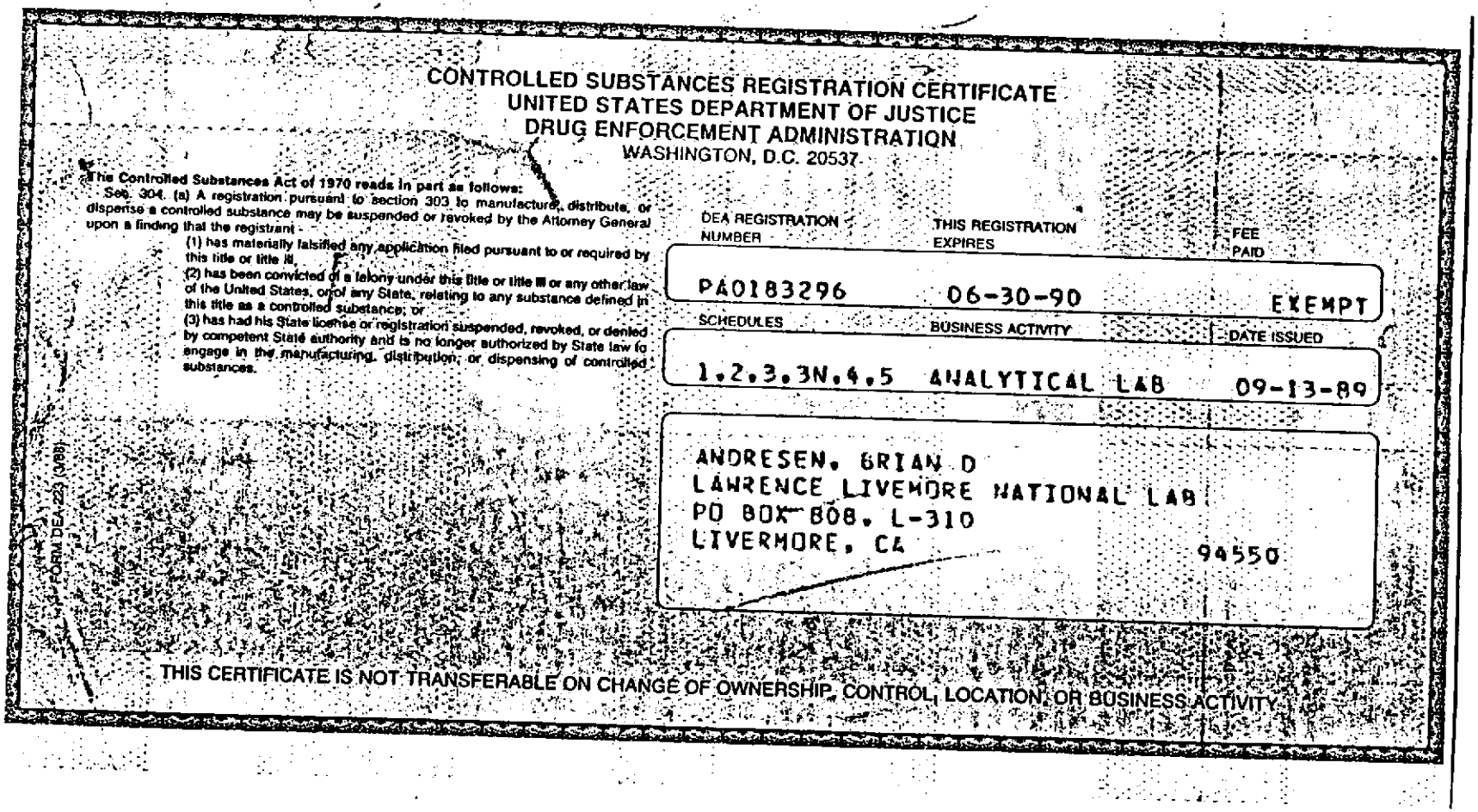
   a. Design and Carry out Experiments
   b. Prepare Target Compounds
   c. Apparatus - Glass Blowing

D. Electronics Design and Construction

   a. Generate Bread-board Layouts
   b. Professional Quality Prototype
   c. Construction and Fabrication
   e. Graphics and Silk Screening
   d. Circuit Board Design and Fabrication
   e. Machining and Fabrication of Parts

E. Recipes, Formulas, and Trade Secrets

   a. Identification of Chemical Formulas
   b. Chemical Code Breaking
   b. Preparation of Trade Secret Recipes



CONTROLLED SUBSTANCES REGISTRATION CERTIFICATE
UNITED STATES DEPARTMENT OF JUSTICE
DRUG ENFORCEMENT ADMINISTRATION
WASHINGTON, D.C. 20537

The Controlled Substances Act of 1970 reads in part as follows:
Sec. 304. (a) A registration pursuant to section 303 to manufacture, distribute, or dispense a controlled substance may be suspended or revoked by the Attorney General upon a finding that the registrant -
(1) has materially falsified any application filed pursuant to or required by this title or title III,
(2) has been convicted of a felony under this title or title III or any other law of the United States, or of any State, relating to any substance defined in this title as a controlled substance; or
(3) has had his State license or registration suspended, revoked, or denied by competent State authority and is no longer authorized by State law to engage in the manufacturing, distribution, or dispensing of controlled substances.

DEA REGISTRATION NUMBER	THIS REGISTRATION EXPIRES	FEE PAID
PA0183296	06-30-90	EXEMPT

SCHEDULES	BUSINESS ACTIVITY	DATE ISSUED
1.2.3.3N.4.5	ANALYTICAL LAB	09-13-89

ANDRESEN, BRIAN D
LAWRENCE LIVERMORE NATIONAL LAB
PO BOX 808, L-310
LIVERMORE, CA 94550

THIS CERTIFICATE IS NOT TRANSFERABLE ON CHANGE OF OWNERSHIP, CONTROL, LOCATION, OR BUSINESS ACTIVITY.

FORM DEA-223 (Ret.)

STATE OF FLORIDA **Department of Health And Rehabilitative Services**

OFFICE OF LABORATORY SERVICES

DATE	FILE NO.	BATCH NO.
01/14/80	JC 0008143	5148

THE CLINICAL LABORATORY DIRECTOR NAMED BELOW IS LICENSED UNDER THE PROVISIONS OF CHAPTER 483 FOR THE PERIOD EXPIRING JUNE 30, 1980 IN THE FOLLOWING SPECIALTIES ...

2

ANDERSON BRIAN D
OHIO STATE UNIVERSITY
DEPARTMENT OF PHARMACOLOGY O.S.U.
333 W 10TH AVENUE
COLUMBUS OHIO 43210

X	MICROBIOLOGY
2	SEROLOGY
X	CLINICAL CHEMISTRY
X	HISTOCOMPATIBILITY
X	CYTOLOGY
X	HISTOPATHOLOGY
X	CLINICAL PATHOLOGY
X	HISTOCOMPATIBILITY TECHNOLOGY
X	CYTOTECHNOLOGY
X	SPECIAL

Reubin Graham
GOVERNOR

DISPLAY IN A CONSPICUOUS PLACE

STATE OF FLORIDA
Department of Health And Rehabilitative Services
OFFICE OF LABORATORY SERVICES

ANDERSON BRIAN D

CLINICAL LABORATORY DIRECTOR
HAS PAID THE FEE REQUIRED BY CHAPTER 483
FOR THE PERIOD EXPIRING JUNE 30, 1980

Brian D. Anderson
SIGNATURE

Reubin Graham
GOVERNOR

PLEASE READ IMPORTANT INFORMATION ON REVERSE

WAIVER CARD - FOLD HERE

OFFICE OF LABORATORY SERVICES
POST OFFICE BOX 210
JACKSONVILLE FL 32231

AUDIT CONTROL NO.	FILE NO	BATCH NO.	FEE AMOUNT
035976	JC0008143	5148	$30.00

COAST · TO · COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	•	San Luis Obispo, CA 93401	•	(805) 543-2553	•	Fax (805) 543-2685
751 S. Kellogg, Suite A	•	Goleta, CA 93117	•	(805) 964-7838	•	Fax (805) 967-4386
1885 North Kelly Road	•	Napa, CA 94558	•	(707) 257-7211	•	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	•	Sacramento, CA 95826	•	(916) 368-1333	•	Fax (916) 362-2484
2400 Cumberland Dr.	•	Valparaiso, Indiana 46383	•	(219) 464-2389	•	Fax (219) 462-2953

April 15, 1991

Mr. Albert Ridley
Woodard-Clyde Consultants
500 12th St. Suite 100
Oakland, CA 93607

Re: Analysis of Soil for Gasoline and Tetraethyl Lead

Dear Mr. Ridley:

Coast-to-Coast Analytical Services analyzed sample H-01024-1 using the quantitative techniques specified by EPA 8270. A calibration curve using authentic tetraethyl lead supplied by Dupont Chemical Co. was used for quantification of tetraethyl lead (m/e 237) in mg/Kg of the sample matrix. The percent recoveries for the matrix spike and matrix spike duplicate were 64% and 50% respectively. The gasoline was not measured quantitatively by the semi-volatile GC/MS method. We did present the composition of tetraethyl lead in gasoline based on the non-quantitative semi-volatile method for gasoline as proscribed by the method supplied by Woodward-Clyde.

Quantitative measurement of gasoline was obtained using EPA method 5030 (Purge & Trap) with CAL DHS DRAFT TPH (modified) by GC/MS. Quantitation using the total ion current was based on an authentic gasoline standard. Matrix spike and matrix spike duplicate were 100% and 88%, respectively. The composition of tetraethyl lead in gasoline was calculated based on this more accurate and precise value for gasoline. The gasoline appears to be highly weathered and diminished in the lighter molecular weight hydrocarbons present in new gasoline. The additive methyl t-butylether was not detected in the sample.

Instrument and method blanks for the analytical batches containing sample H-01024-1 were free of tetraethyl lead and gasoline at and above the Practical Quantitation Limit. Instrument tuning criteria were met with each analytical batch run.

Respectfully submitted,
Coast-to-Coast Analytical Services

Mary Havlicek

Mary Havlicek, Ph.D., President

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	•	San Luis Obispo, CA 93401	•	(805) 543-2553	• Fax (805) 543-2685
751 S. Kellogg, Suite A	•	Goleta, CA 93117	•	(805) 964-7838	• Fax (805) 967-4386
1885 North Kelly Road	•	Napa, CA 94558	•	(707) 257-7211	• Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	•	Sacramento, CA 95826	•	(916) 368-1333	• Fax (916) 362-2484
2400 Cumberland Dr.	•	Valparaiso, Indiana 46383	•	(219) 464-2389	• Fax (219) 462-2953

CLIENT: Albert Ridley
Woodward-Clyde Consultants
500 12th St. Ste. 100
Oakland, CA 94607

Lab Number : H-1024-1
Project : 90C0321A-4000 Arrow Rentals
Analyzed : 03/27/91
Analyzed by: DP
Method : GC/MS

REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
B-F-1-16' & B-F-2-16'	Soil	Al Ridley	03/12/91	03/13/91

CONSTITUENT	(CAS RN)	*PQL mg/Kg	RESULT mg/Kg	NOTE
TOTAL SEMIVOLATILE PETROLEUM HYDROCARBONS				1,2,3
Total Petroleum Hydrocarbons (Gasoline)		5.	24.	
Tetraethyl Lead		0.005	0.010	

CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)
(1) Sample Preparation on 03/25/91 by RAD using Methylene Chloride in Sonic Bath.
(2) The composition of Tetraethyl Lead in Gasoline is 1.2g/Gallon.
(3) Quantitative values for gasoline are more accurate when extraction is done by EPA Method 5030 (Purge & Trap).

04/11/91
MSD5/ZC09A/#C26A
MH/rdl/drc/elr
HC25M550

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Donald R. Cortes, Group Leader

Mary Havlicek, Ph.D.
President

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road • San Luis Obispo, CA 93401 • (805) 543-2553 • Fax (805) 543-2685
751 S. Kellogg, Suite A • Goleta, CA 93117 • (805) 964-7838 • Fax (805) 967-4386
1885 North Kelly Road • Napa, CA 94558 • (707) 257-7211 • Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800 • Sacramento, CA 95826 • (916) 368-1333 • Fax (916) 362-2484
2400 Cumberland Dr. • Valparaiso, Indiana 46383 • (219) 464-2389 • Fax (219) 462-2953

QC Batch ID: HC25M550

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 03/27/91
Analyzed by: DP
Method : GC/MS

INSTRUMENT BLANK
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
INSTRUMENT BLANK	Soil			

CONSTITUENT	(CAS RN)	*PQL mg/Kg	RESULT mg/Kg	NOTE
TOTAL SEMIVOLATILE PETROLEUM HYDROCARBONS				
Total Petroleum Hydrocarbons (Gasoline)		5.	ND	
Tetraethyl Lead		0.005	ND	

CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)

04/11/91
MSD5/ZC07A
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Donald R. Cortes, Group Leader

Mary Havlicek, Ph.D.
President

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	San Luis Obispo, CA 93401	(805) 543-2553	Fax (805) 543-2685
751 S. Kellogg, Suite A	Goleta, CA 93117	(805) 964-7838	Fax (805) 967-4386
1885 North Kelly Road	Napa, CA 94558	(707) 257-7211	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	Sacramento, CA 95826	(916) 368-1333	Fax (916) 362-2484
2400 Cumberland Dr.	Valparaiso, Indiana 46383	(219) 464-2389	Fax (219) 462-2953

QC Batch ID: HC25M550

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 03/27/91
Analyzed by: DP
Method : GC/MS

METHOD BLANK
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
METHOD BLANK	Soil			

CONSTITUENT	(CAS RN)	*PQL mg/Kg	RESULT mg/Kg	NOTE
TOTAL SEMIVOLATILE PETROLEUM HYDROCARBONS				1
Total Petroleum Hydrocarbons (Gasoline)		5.	ND	
Tetraethyl Lead		0.005	ND	

CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)
(1) Sample Preparation on 03/25/91 by RAD using Methylene Chloride in Sonic Bath.

04/11/91
MSD5/ZC08A
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Donald R. Cortes, Group Leader

Mary Havlicek, Ph.D.
President

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	San Luis Obispo, CA 93401	(805) 543-2553	Fax (805) 543-2685
751 S. Kellogg, Suite A	Goleta, CA 93117	(805) 964-7838	Fax (805) 967-4386
1885 North Kelly Road	Napa, CA 94558	(707) 257-7211	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	Sacramento, CA 95826	(916) 368-1333	Fax (916) 362-2484
2400 Cumberland Dr.	Valparaiso, Indiana 46383	(219) 464-2389	Fax (219) 462-2953

QC Batch ID: HC25M550

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 03/27/91
Analyzed by: DP
Method : GC/MS

QC SPIKE
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
QC SPIKE	Soil			

CONSTITUENT	*PQL mg/Kg	SPIKE AMOUNT	RESULT mg/Kg	%REC	NOTE
TOTAL SEMIVOLATILE PETROLEUM HYDROCARBONS					1,2
Tetraethyl Lead	0.005	0.50	0.32	64.	

CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)
(1) Sample Preparation on 03/25/91 by RAD using Methylene Chloride in Sonic Bath.
(2) Spike was in analyte-free soil.

04/11/91
MSD5/ZC10A
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Donald R. Cortes, Group Leader

Mary Havlicek, Ph.D.
President

COAST · TO · COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	San Luis Obispo, CA 93401	(805) 543-2553	Fax (805) 543-2685
751 S. Kellogg, Suite A	Goleta, CA 93117	(805) 964-7838	Fax (805) 967-4386
1885 North Kelly Road	Napa, CA 94558	(707) 257-7211	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	Sacramento, CA 95826	(916) 368-1333	Fax (916) 362-2484
2400 Cumberland Dr.	Valparaiso, Indiana 46383	(219) 464-2389	Fax (219) 462-2953

QC Batch ID: HC25M550

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 03/27/91
Analyzed by: DP
Method : GC/MS

QC SPIKE
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
QC SPIKE DUPLICATE	Soil			

CONSTITUENT	*PQL mg/Kg	SPIKE AMOUNT	RESULT mg/Kg	%REC	%DIFF	NOTE
TOTAL SEMIVOLATILE PETROLEUM HYDROCARBONS						1,2
Tetraethyl Lead	0.005	0.50	0.25	50.	14.	

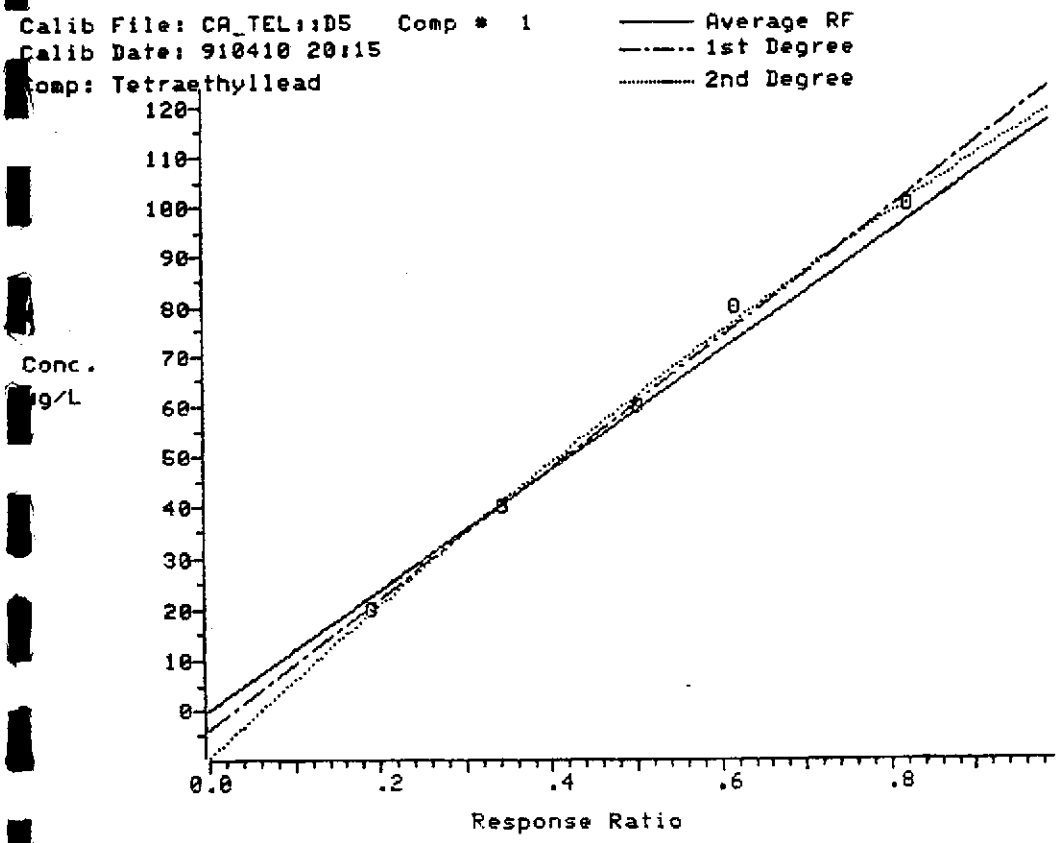
CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)
(1) Sample Preparation on 03/25/91 by RAD using Methylene Chloride in Sonic Bath.
(2) Spike was in analyte-free soil.

04/11/91
MSD5/ZC11A
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Donald R. Cortes, Group Leader

Mary Havlicek, Ph.D.
President



Compound # 1 Calib File: CA_TEL::D5

Compound: Tetraethyllead
Istd: 1,4-Dichlorobenzene-d4

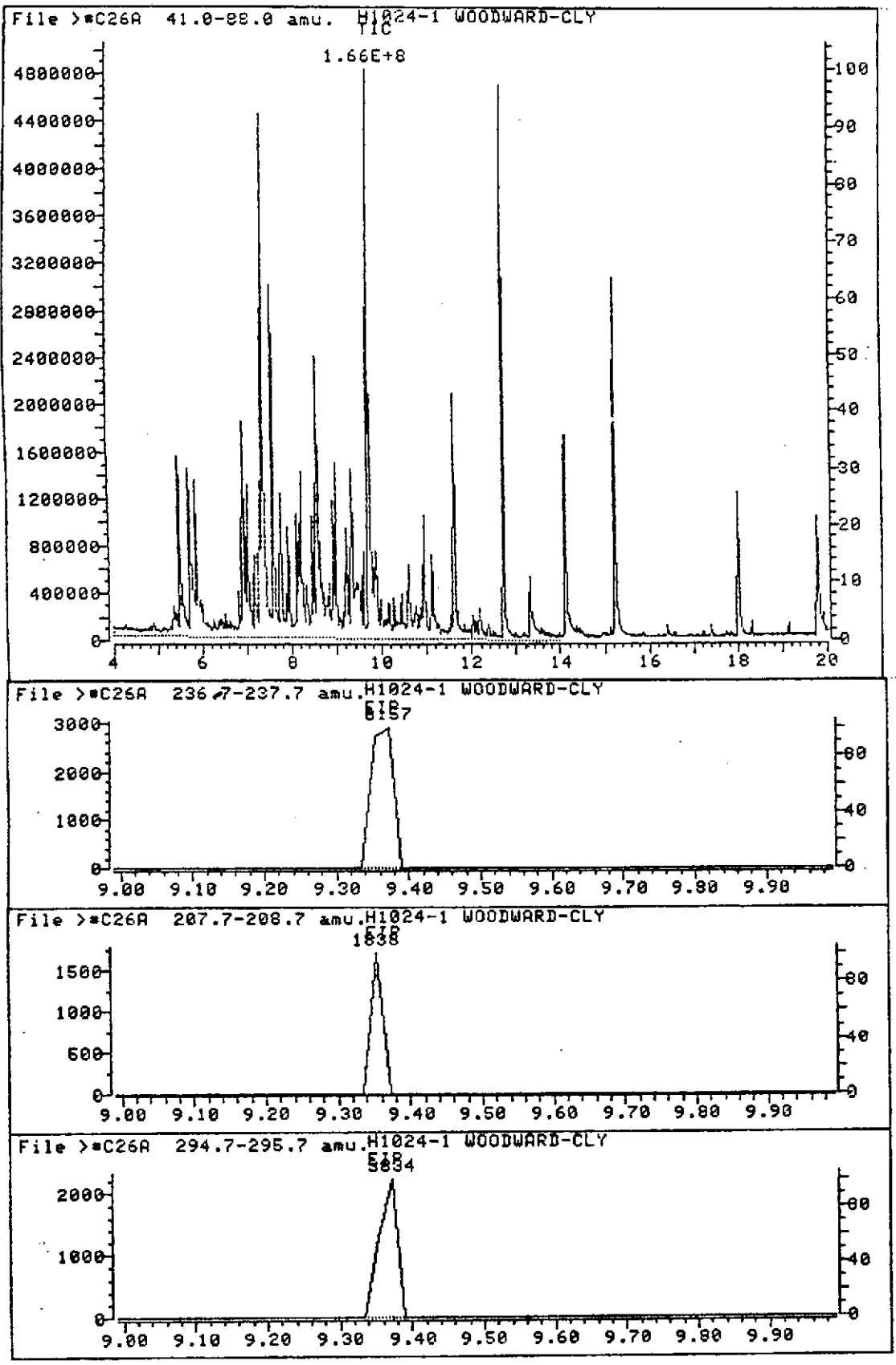
File: >#C19A >#C20A >#C21A >#C22A >#C23A
Conc: 20.00 40.00 60.00 80.00 100.00
Rf: .37935 .34402 .33459 .30955 .32967

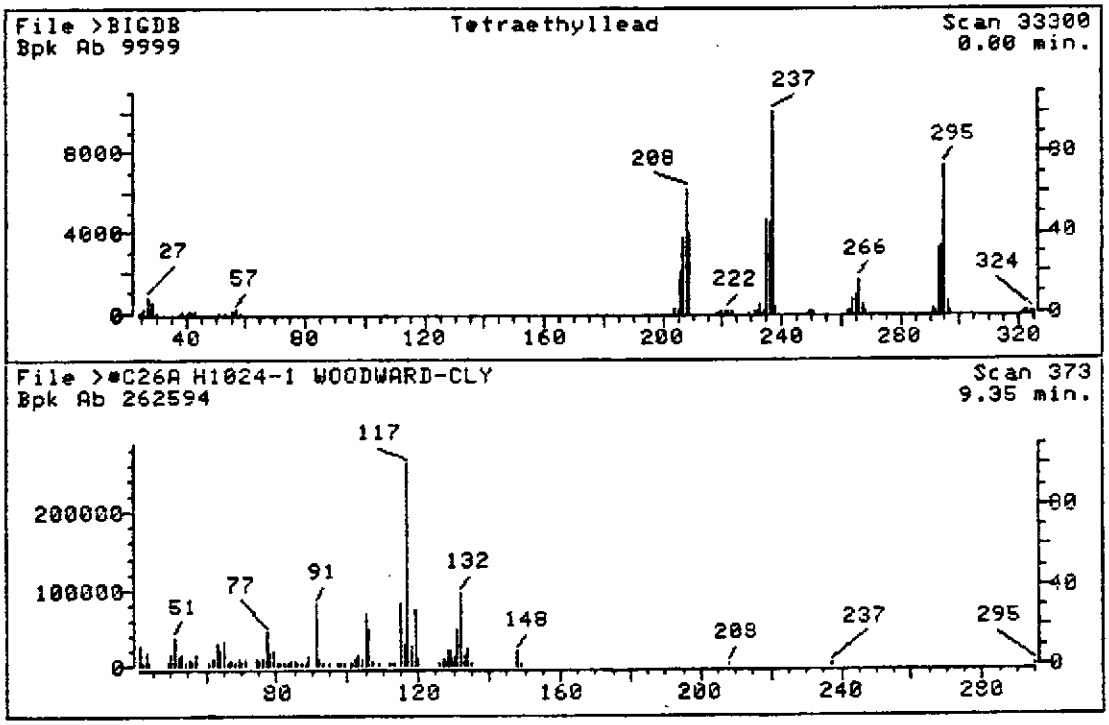
Average of 5 Rfs: .33944 (7.55 % Rsd) Rx: .0000000 Ry: .0000000
1st Degree Equation: y = -.096006 + 3.219230(x)
1st Degree Corr Coef: .9970747
2nd Degree Equation: y = -.231935 + 3.879870(x) + -.652235(x^2)
2nd Degree Corr Coef: .9978902

In the above equations:

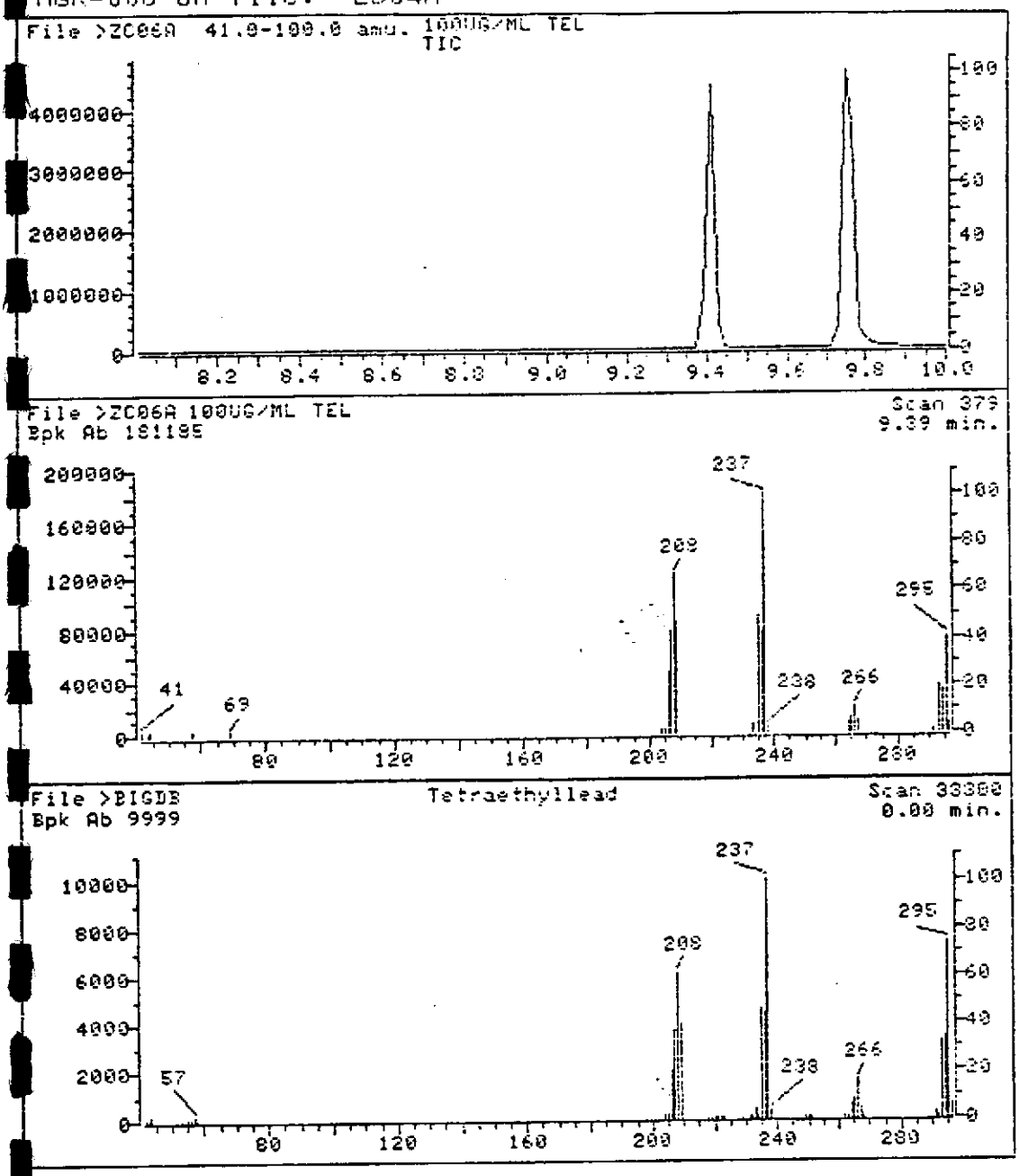
$$y = \frac{\text{Conc Std}}{\text{Conc Istd}} \qquad x = \frac{\text{Area Std}}{\text{Area Istd}}$$

Istd Conc for all calibration points is: 40.00


File >*C26A 41.0-88.0 amu. H1024-1 WOODWARD-CLY
TIC
1.66E+8
4800000
4400000
4000000
3600000
3200000
2800000
2400000
2000000
1600000
1200000
800000
400000
0
100
90
80
70
60
50
40
30
20
10
0
4
6
8
10
12
14
16
18
20
File >*C26A 236.7-237.7 amu.H1024-1 WOODWARD-CLY
EIC
6157
3000
2000
1000
0
60
40
0
9.00
9.10
9.20
9.30
9.40
9.50
9.60
9.70
9.80
9.90
File >*C26A 207.7-208.7 amu.H1024-1 WOODWARD-CLY
EIC
1838
1500
1000
500
0
60
40
0
9.00
9.10
9.20
9.30
9.40
9.50
9.60
9.70
9.80
9.90
File >*C26A 294.7-295.7 amu.H1024-1 WOODWARD-CLY
EIC
5834
2000
1000
0
60
40
0
9.00
9.10
9.20
9.30
9.40
9.50
9.60
9.70
9.80
9.90


File >BIGDB
Bpk Ab 9999
Tetraethyllead
Scan 33300
0.00 min.
8000
4000
0
27
57
208
222
237
266
295
324
80
40
0
40
80
120
160
200
240
280
320
File >#C26A H1024-1 WOODWARD-CLY
Bpk Ab 262594
Scan 373
9.35 min.
200000
100000
0
51
77
91
117
132
148
208
237
295
80
40
0
80
120
160
200
240
280

TMGR-006 on file: ^ED04A



COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	San Luis Obispo, CA 93401	(805) 543-2553	Fax (805) 543-2685
751 S. Kellogg, Suite A	Goleta, CA 93117	(805) 964-7838	Fax (805) 967-4386
1885 North Kelly Road	Napa, CA 94558	(707) 257-7211	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	Sacramento, CA 95826	(916) 368-1333	Fax (916) 362-2484
2400 Cumberland Dr.	Valparaiso, Indiana 46383	(219) 464-2389	Fax (219) 462-2953

CLIENT: Albert Ridley
Woodward-Clyde Consultants
500 12th St. Ste. 100
Oakland, CA 94607

Lab Number : H-1024-1
Project : 90C0321A-4000 Arrow Rentals
Analyzed : 04/11/91
Analyzed by: DZ
Method : As Listed

REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
B-F-1-16' & B-F-2-16'	Soil	Al Ridley	03/12/91	03/13/91

CONSTITUENT	(CAS RN)	*PQL mg/Kg	RESULT mg/Kg	NOTE
FUEL FINGERPRINT ANALYSIS				1,2,3,4
Benzene	(71432)	0.001	0.002	
Toluene	(108883)	0.001	0.025	
Ethylbenzene	(100411)	0.001	0.030	
Xylenes		0.001	0.34	
1,2-Dichloroethane (EDC)	(107062)	0.001	ND	
Ethylene Dibromide (EDB)	(106934)	0.001	ND	
Total Purgeable Petroleum Hydrocarbons (Gasoline)		0.1	16.	
BTX as a percent of fuel			2.1	
Percent Surrogate Recovery			107.	

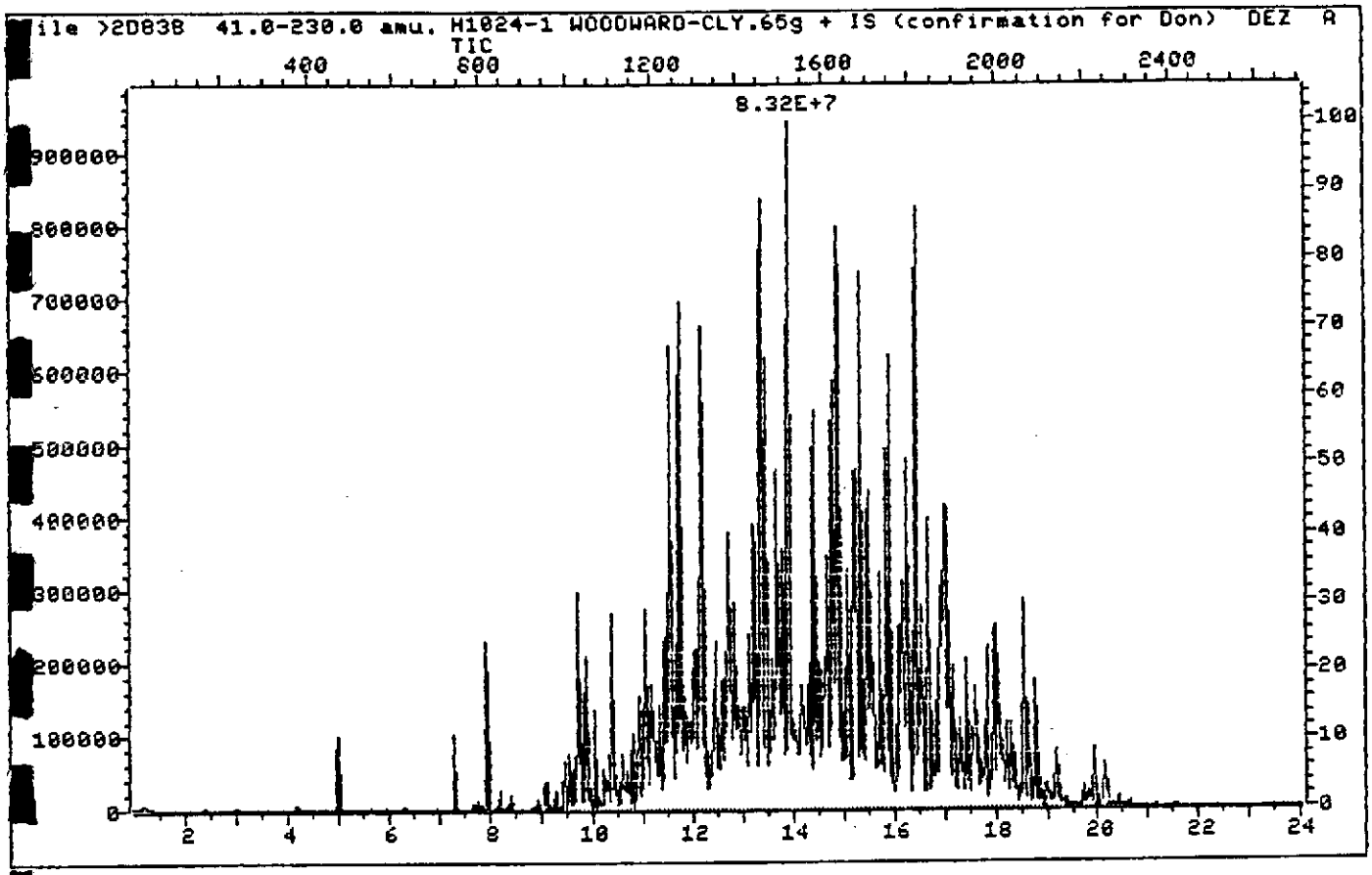
CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)
(1) ANALYZED by CAL DHS DRAFT TPH (modified) and EPA 8240 (GC/MS)
(2) EXTRACTED by EPA 5030 (purge-and-trap)
(3) The composition of Tetraethyl Lead in Gasoline is 1.8g/Gallon.
(4) Fuel Fingerprint analysis originally done on 4/1/91.

04/15/91
MSD2/2D83B
MH/erc
HD11M2

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Frank R. Guenther, Ph.D., Technical Director

Mary Havlicek, Ph.D.
President


ile >2D838 41.0-230.0 amu. H1024-1 WOODWARD-CLY.65g + IS (confirmation for Don) DEZ A
TIC
8.32E+7
400
800
1200
1600
2000
2400
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
100
90
80
70
60
50
40
30
20
10
0
2
4
6
8
10
12
14
16
18
20
22
24

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	San Luis Obispo, CA 93401	(805) 543-2553	Fax (805) 543-2685
751 S. Kellogg, Suite A	Goleta, CA 93117	(805) 964-7838	Fax (805) 967-4386
1885 North Kelly Road	Napa, CA 94558	(707) 257-7211	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	Sacramento, CA 95826	(916) 368-1333	Fax (916) 362-2484
2400 Cumberland Dr.	Valparaiso, Indiana 46383	(219) 464-2389	Fax (219) 462-2953

QC Batch ID: HD11M2

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 04/11/91
Analyzed by: DZ
Method : As Listed

METHOD BLANK
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED	DATE RECEIVED
METHOD BLANK	Soil			

CONSTITUENT	(CAS RN)	*PQL mg/Kg	RESULT mg/Kg	NOTE
FUEL FINGERPRINT ANALYSIS				1,2
Benzene	(71432)	0.001	ND	
Toluene	(108883)	0.001	ND	
Ethylbenzene	(100411)	0.001	ND	
Xylenes		0.001	ND	
1,2-Dichloroethane (EDC)	(107062)	0.001	ND	
Ethylene Dibromide (EDB)	(106934)	0.001	ND	
Total Purgeable Petroleum Hydrocarbons (Gasoline)		0.1	ND	
BTX as a percent of fuel			Not Appl.	
Percent Surrogate Recovery			110.	

CCAS is Certified by CA Department of Health Services: Laboratory #131
*RESULTS listed as 'ND' were not detected at or above the listed PQL (Practical Quantitation Limit)
(1) ANALYZED by CAL DHS DRAFT TPH (modified) and EPA 8240 (GC/MS)
(2) EXTRACTED by EPA 5030 (purge-and-trap)

04/15/91
MSD2/2D82B
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Frank R. Guenther, Ph.D., Technical Director

Mary Havlicek, Ph.D.
President

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	•	San Luis Obispo, CA 93401	•	(805) 543-2553	•	Fax (805) 543-2685
751 S. Kellogg, Suite A	•	Goleta, CA 93117	•	(805) 964-7838	•	Fax (805) 967-4386
1885 North Kelly Road	•	Napa, CA 94558	•	(707) 257-7211	•	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	•	Sacramento, CA 95826	•	(916) 368-1333	•	Fax (916) 362-2484
2400 Cumberland Dr.	•	Valparaiso, Indiana 46383	•	(219) 464-2389	•	Fax (219) 462-2953

QC Batch ID: HD11M2

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 04/11/91
Analyzed by: DZ
Method : As Listed

QC SPIKE
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE RECEIVED
QC SPIKE	Soil		

CONSTITUENT	*PQL mg/Kg	SPIKE AMOUNT	RESULT mg/Kg	%REC	NOTE
FUEL FINGERPRINT ANALYSIS					1,2
Benzene	0.001	0.003	0.003	100.	
Toluene	0.001	0.010	0.010	100.	
Ethylbenzene	0.001	0.002	0.002	100.	
Xylenes	0.001	0.010	0.010	100.	
1,2-Dichloroethane (EDC)	0.001		NS		
Ethylene Dibromide (EDB)	0.001		NS		
Total Purgeable Petroleum Hydrocarbons (Gasoline)	0.1	0.8	0.8	100.	
BTX as a percent of fuel		36.	32.		
Percent Surrogate Recovery		108.	110.		

CCAS is Certified by CA Department of Health Services: Laboratory #131
* RESULTS listed as 'NS' were not spiked. PQL = Practical Quantitation Limit
(1) ANALYZED by CAL DHS DRAFT TPH (modified) and EPA 8240 (GC/MS)
(2) EXTRACTED by EPA 5030 (purge-and-trap)

04/15/91
MSD2/2D85B
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Frank R. Guenther, Ph.D., Technical Director

Mary Havlicek, Ph.D.
President

COAST - TO - COAST ANALYTICAL SERVICES

Air, Water & Hazardous Waste Sampling, Analysis & Consultation
Certified Hazardous Waste, Chemistry, Bacteriology & Bioassay Laboratories

141 Suburban Road	San Luis Obispo, CA 93401	(805) 543-2553	Fax (805) 543-2685
751 S. Kellogg, Suite A	Goleta, CA 93117	(805) 964-7838	Fax (805) 967-4386
1885 North Kelly Road	Napa, CA 94558	(707) 257-7211	Fax (707) 226-1001
9333 Tech Center Dr., Ste. 800	Sacramento, CA 95826	(916) 368-1333	Fax (916) 362-2484
2400 Cumberland Dr.	Valparaiso, Indiana 46383	(219) 464-2389	Fax (219) 462-2953

QC Batch ID: HD11M2

CLIENT: Coast-to-Coast Analytical Services
141 Suburban Rd. Ste. C-4
San Luis Obispo, CA 93401

Analyzed : 04/11/91
Analyzed by: DZ
Method : As Listed

QC SPIKE
REPORT OF ANALYTICAL RESULTS

SAMPLE DESCRIPTION	MATRIX	SAMPLED BY	SAMPLED DATE RECEIVED
QC SPIKE DUPLICATE	Soil		

CONSTITUENT	*PQL mg/Kg	SPIKE AMOUNT	RESULT mg/Kg	%REC	%DIFF	NOTE
FUEL FINGERPRINT ANALYSIS						1,2
Benzene	0.001	0.003	0.003	100.	0.	
Toluene	0.001	0.010	0.009	90.	10.	
Ethylbenzene	0.001	0.002	0.002	100.	0.	
Xylenes	0.001	0.010	0.010	100.	0.	
1,2-Dichloroethane (EDC)	0.001		NS			
Ethylene Dibromide (EDB)	0.001		NS			
Total Purgeable Petroleum Hydrocarbons (Gasoline)	0.1	0.8	0.7	88.	13.	
BTX as a percent of fuel		36.	32.			
Percent Surrogate Recovery		108.	112.			

CCAS is Certified by CA Department of Health Services: Laboratory #131
* RESULTS listed as 'NS' were not spiked. PQL = Practical Quantitation Limit
(1) ANALYZED by CAL DHS DRAFT TPH (modified) and EPA 8240 (GC/MS)
(2) EXTRACTED by EPA 5030 (purge-and-trap)

04/15/91
MSD2/2D86B
MH/erc
H1024-1

Respectfully submitted,
COAST-TO-COAST ANALYTICAL SERVICES, INC.

Frank R. Guenther, Ph.D., Technical Director

Mary Havlicek, Ph.D.
President

Attn: Albert Ridley

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

Chain of Custody Record

PROJECT NO. 90C0321A-4000
Arrow Rentals

SAMPLERS: (Signature) Al Ridley

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608	Tetraethyl Lead By Special Method			Number of Containers	REMARKS (Sample preservation, handling procedures, etc.)
3/12/91	8:45AM	B-F-1-16'	composite					X			1	Brass Liner
3/12/91	8:48AM	B-F-2-16'						X			1	Brass Liner

Sample From 16' depth 8" dia auger boring

① Tetraethyl Lead test By Special Method described separately.

"Combine samples as Needed for analysis" AR

See Mary H. about "special method" mass spec.

2-week TAT

TOTAL NUMBER OF CONTAINERS: 2 Brass Liners

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Al Ridley	3/12 9:50 AM				Darla Elwick Intact

METHOD OF SHIPMENT:	SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME
Federal Express			Bertha Rubalcaba	3/13/91

Woodward-Clyde Consultants

Chain of Custody # 910025

January 24, 1991

Albert Ridley
Woodward-Clyde Consultants
500 12th Street; Suite #100
Oakland, CA 94607-4014

Dear Mr. Ridley:

Enclosed is the report for (Project ID 90C0321A) samples which were received at Woodward-Clyde Analytical Laboratory January 22, 1991.

The report consists of the following sections:

I Sample Description
II Analysis Results

No problems were encountered with the analysis of your samples.

If you have any questions, please feel free to call.

Sincerely,

Edward R. Morales
Lab Manager

COC# 910025

I SAMPLE DESCRIPTION

WCC LAB ID	SAMPLE ID	MATRIX	DATE SAMPLED	CONTAINERS	ANALYSIS DESCRIPTION
910025-01-01	P-1(SOIL)	SOIL	01-22-91	4" BRASS LINER	TPH/BTEX

The samples were received under chain of custody, in good condition.

VOLATILE PETROLEUM HYDROCARBONS
MODIFIED EPA METHOD 8015/5030

PROJECT NAME: ARROW RENTALS
PROJECT NUMBER: 90C0321A
PROJECT MANAGER: ALBERT RIDLEY

COC# 910025

WCC LAB ID	SAMPLE ID	MATRIX	COLLECTION DATE	EXTRACTION DATE	ANALYSIS DATE	DETECTION LIMIT (mg/kg)	TPH (mg/kg)
METHOD BLANK	-	-	-	-	01-23-91	0.5	ND
910025-01-01	P-1(SOIL)	SOIL	01-22-91	-	01-23-91	0.5	ND

QUALITY ASSURANCE SUMMARY

REC 1	REC 2	%RPD
91	94	3

Quantitated as Gasoline.

REVIEWED BY:

BENZENE, TOLUENE, ETHYLBENZENE, XYLENES DATA SHEET
MODIFIED EPA METHOD 8020/5030

PROJECT NAME: ARROW RENTALS
PROJECT NUMBER: 90C0321A
PROJECT MANAGER: ALBERT RIDLEY

COC# 910025

WCC LAB ID	SAMPLE ID	MATRIX	COLLECTION DATE	EXTRACTION DATE	ANALYSIS DATE	DETECTION LIMIT (ug/kg)	BENZENE (ug/kg)	TOLUENE (ug/kg)	ETHYL BENZENE (ug/kg)	XYLENES (ug/kg)
METHOD BLANK	-	-	-	-	01-23-91	5	ND	ND	ND	ND
910025-01-01	P-1(SOIL)	SOIL	01-22-91	-	01-23-91	5	ND	ND	ND	ND

QUALITY ASSURANCE SUMMARY

REC 1	REC 2	%RPD
95	108	13

REVIEWED BY:

SOIL 9/0025

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

Chain of Custody Record

PROJECT NO. Arrow Rentals 90C0321A -4000

SAMPLERS: (Signature) A. Ruby

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608	EPA 8015 (BTEX)	Number of Containers
1/22	2:00 PM	P-1 (Soil)						X	1

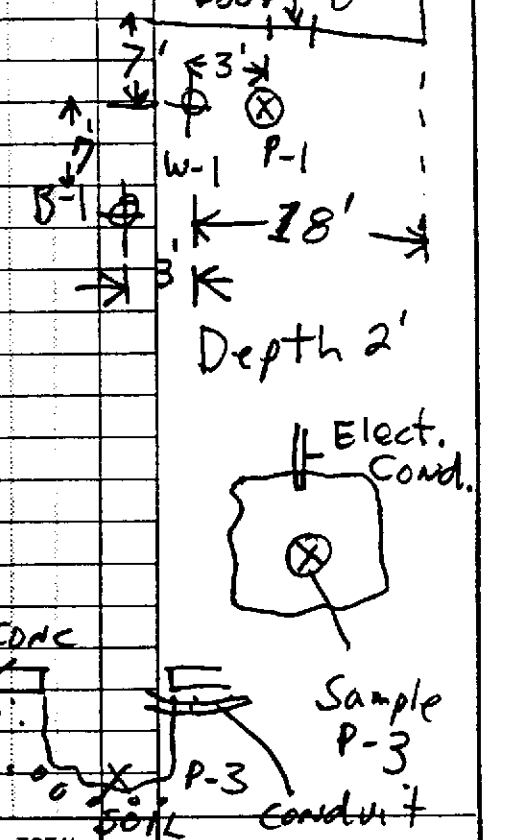
ANALYSES

REMARKS (Sample preservation, handling procedures, etc.)

5 DAY TAT

(1) Test for 8015 gasoline with BTEX

SHOULD BE CLEAN



TOTAL NUMBER OF CONTAINERS: 1

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
A. Ruby	1/22/91 1440				

METHOD OF SHIPMENT:	SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME
			Lisa Loiselle	1/22/91 1440

Chevron Real Estate Management Company
A Division of Chevron Industries, Inc.
225 Bush Street, San Francisco, California
Mail Address PO Box 7137, San Francisco, CA 94120 7137

October 16, 1990

FUEL CHARACTERIZATION DATA
LIVERMORE SITE

Mr. Albert P. Ridley, C.E.G.
Woodward-Clyde Consultants
500 12th Street, Suite 100
Oakland, CA 94607-4014

Dear Al:

Attached please find results of samples that you submitted to Chevron Research and Technology Company (CRTC) for analysis. As we discussed, Chevron is providing assistance to Woodward-Clyde in the determination of the possible source of hydrocarbon contamination at 187 North L Street, Livermore. However, this assistance is not to be construed as an admission of liability by Chevron in relation to the incident that occurred at the above mentioned address.

It is my understanding that I will be shortly receiving a bill from CRTC for work completed. I will then pass this bill to Woodward-Clyde for payment.

If you have any questions, please give me a call at (415) 894-5427.

Very truly yours,

Beth Johnke

E. P. Johnke
Environmental Specialist

EPJ:oct
Attachment

cc: J. P. Gorman
E. A. Harvey

CHEVRON RESEARCH AND TECHNOLOGY COMPANY
ANALYTICAL SCIENCES UNIT PROJECT SUMMARY

Log No.	4527	Requested by	E. P. Johnke
Date Initiated	08/23/90	Location	575 Market, Room 1882
Date Completed	10/04/90	Phone	894-5427
Charge Code	TT52508		

Project Description: Analyze one hydrocarbon sample, labeled W1-CH, and three water samples, labeled WA-CH, WB-CH, and TB, taken from Arrow Rentals property at 187 North L Street in Livermore, CA. The site was a Mobil gas station for over 30 years. Seven years ago a new gas tank was installed by Arrow Rentals. The tank has been supplied by a Chevron jobber, Petcock Petroleum, since then. In June of 1985, the Petcock delivery driver mistakenly poured gasoline down a vapor monitoring well at the site. Determine whether the hydrocarbon contamination comes from the old Mobil station or the 1985 accident.

Result: The results are not definitive, but suggest that the gasoline may have been produced in about 1985. The lead alkyl isomer pattern suggests Chevron did not produce the gasoline, while the detergent additive analysis suggests we may have.

W1-CH contains leaded regular grade gasoline. The tetraalkyllead content of the sample is 0.18 g/gal. The gasoline is no more than 10% evaporated, so that if we account for the evaporation, we calculate that the original lead level must have been no less than 0.16 g/gal. This level is typical of gasolines produced between late 1985 and 1988. If some of the lead has biodegraded or dissolved, the original level would be somewhat higher than 0.16. These processes occur slowly, however, and gasolines spilled before 1985 typically retain most of their lead, with lead levels of 0.5 to 3.0 g/gal. gasoline. The infrared spectrum of the gasoline shows that it is oxidized from exposure to air. It also has a rather weak absorbance at 1230 cm^{-1} that may be due to a polybutene-amine type detergent additive. Chevron used polybutene-amine-containing F310 detergent in leaded gasolines up until 1987. Mobil also uses a polybutene amine containing detergent. A dye analysis was not run because we have no record of what kind of dyes Chevron or Mobil have used in the past.

We have no chromatograms of Chevron June 1985 gasolines in our files. We do have a chromatogram of Chevron Supreme Unleaded produced at our Richmond refinery in late November 1985. There is nothing in this chromatogram to indicate that the W1-CH sample could not have come from the Richmond refinery. We also have an lead alkyl analysis of Chevron Regular Leaded gasoline produced at the Richmond refinery in November 1985. Chevron was adding 0.22 g/gal lead to its leaded regulars at that time. The November 1985 gasoline contained more than 95% of its lead as the tetraethyl isomer (TEL). The W1-CH gasoline contains only 83% of its lead as the tetraethyl isomer. This implies that the WL-CH gasoline is not Chevron's. However, it is possible that Chevron purchased an exchange gasoline from another supplier. Nick

Clark of Supply and Distribution (944-6212) should have the 1985 records on Livermore area exchange gasoline purchases.

The three water samples were extracted with carbon disulfide to determine the concentration of hydrocarbon present. The hydrocarbon in WA-CH is present at 7.6 uL/L (ppm), high enough to recognize it as dissolved or entrained gasoline. WA-CH contains 2.4 uL/L hydrocarbon, predominately the soluble aromatics from gasoline. TB hydrocarbons are present at 73 nL/L (ppb), and do not have a clear relationship to gasoline. None of the samples contain enough hydrocarbon for gasoline additive analysis.

Analytical Approach: The samples were analyzed by gas chromatography using a flame ionization detector (GC/FID) to determine hydrocarbon composition and an electron capture detector (GC/PID) to measure lead alkyl concentration. Water samples were extracted with carbon disulfide and analyzed by GC/FID. Detergent additive was analyzed by Sep-Pak extraction and infrared spectroscopy.

Reported by J. Kimberlin, E. A. Harvey

EPJohnke
AWVerstuyft
THGouw
JKimberlin
EAHarvey
file

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

Chain of Custody Record

PROJECT NO. 90C0321A - 4000

SAMPLERS: (Signature) Jon Hans

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608	GC - Fuel Fingerprint						Number of Containers	REMARKS (Sample preservation, handling procedures, etc.)
8/22	14 00	W1 - C H(a)						X						1	1
8/22	14:00	W1 - (H (b)												1	℄
8/22	12:40	WA - (H (a)						X						1	
8/22	1335	WA - (H (b)												1	
8/22	245	WB - (H (a)						X						1	
8/22	13:30	WB - (H (b)												1	
8/22		TB						X						1	
8/22		TB												1	

Test for presence of CHEVRON Leaded Gasoline from approximately June 1985: Additives, Dyes, Benzene concentrations, Fuel finger-print, GC Chromatogram and results to

Al Ridley
Woodward Clyde Consultants
500 12th St #100
OAK, CA
(415) 874-3125

TOTAL NUMBER OF CONTAINERS: 8

RELINQUISHED BY : (Signature)	DATE/TIME	RECEIVED BY : (Signature)	RELINQUISHED BY : (Signature)	DATE/TIME	RECEIVED BY : (Signature)
Jon Hans	8/22 15:20	Sylvia Barker			

METHOD OF SHIPMENT :	SHIPPED BY (Signature)	COURIER : (Signature)	RECEIVED FOR LAB BY : (Signature)	DATE/TIME
	EDF	Don Hall		8/23

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

August 28, 1990

Al Ridley, Project Leader
Woodward Clyde Consultants
500 12th Street, Suite 100
Oakland, CA 94607-4041

Dear Mr. Ridley:

Enclosed are the results of the analyses of the samples submitted on August 4, 1990 from Project 90C0321A.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Andrew John Friedman, Chemist

AJF/fae

Enclosures

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90CO321A

RESULTS OF ANALYSES OF THE WATER SAMPLES FOR BTX AND ETHYLBENZENE USING THE HEADSPACE METHOD
Results Reported as ng/mL (ppb)

Sample #	Benzene	Toluene	Et-Benzene	Xylene *m,p*	Xylene *o*
W-B	22,000	7,900	2,000	4,000	1,800
W-B2	21,000	7,300	1,800	3,700	1,700
W-EB	11	11	4	3	5
W-D	1	2	1	1	1
W-E	<1	<1	<1	<1	<1
W-C	<1	<1	<1	<1	<1
W-A	6,800	5,500	620	3,400	1,700
Travel Blank	7[a]	37[a]	14[a]	43[a]	22[a]
Quality Assurance					
Method Blank	<1	<1	<1	<1	<1
W-A (Duplicate)	6,900	5,600	620	6,800	1,800
W-A (Matrix Spike) Spiked @ 1,000 ppb Percent Recovery	**b**	**b**	**b**	**b**	**b**
W-A (Matrix Spike Duplicate) Spiked @ 1,000 ppb Percent Recovery	**b**	**b**	**b**	**b**	**b**

[a] - Contamination found is likely from the previous sample. This is supported by no confirmation of this analyte via second column confirmation analysis.

[b] - The amount spiked was insufficient to give meaningful recovery data.

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90CO321A

RESULTS OF ANALYSES OF THE PRODUCT SAMPLES FOR BTX AND ETHYLBENZENE USING THE HEADSPACE METHOD
Results Reported as Percent

Sample #	Benzene	Toluene	Et-Benzene	Xylene	
				m,p	*o*
F-T	4.2 %	8.9 %	1.7 %	6.1 %	2.6 %
F-T (PRES)	4.2 %	8.9 %	1.7 %	6.2 %	2.6 %

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE WATER SAMPLES FOR NONHALOGENATED ORGANICS BY EPA METHOD 8015 (GAS AND DIESEL) Results Reported as mg/L (ppm)

Sample #	Gasoline (ppm)	Diesel (ppm)
W-B	13	1.7
W-B2	21	1.6
W-EB	1.7	0.1
W-D	0.1	<0.1
W-E	<0.01	<0.1
W-C	<0.01	<0.1
W-A	10	2.4
Travel Blank	0.5	<0.1
Quality Assurance		
Method Blank	<0.01	<0.1
Tap Water (Matrix Spike) Spiked @ 10 ppm Percent Recovery	87%	107%
Tap Water (Matrix Spike Duplicate) Spiked @ 10 ppm Percent Recovery	91%	74%

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE WATER SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
W-B	The gas chromatographic trace was indicative of a water soluble fraction of gasoline. This characterization is based on the presence of light hydrocarbons and monocyclic aromatic hydrocarbons (MCA) as the only compounds found in the sample.
W-B2	The gas chromatographic trace was indicative of a water soluble fraction of gasoline. This characterization is based on the presence of light hydrocarbons and monocyclic aromatic hydrocarbons (MCA) as the only compounds found in the sample.
W-EB	The gas chromatographic trace was indicative of very low levels of the water soluble fraction of gasoline. This characterization is based on the presence of light hydrocarbons and MCA.
W-EB	The gas chromatographic trace contained only traces of highly volatile hydrocarbons, mostly butanes.
W-E	The gas chromatographic trace was indicative of no contamination.
W-C	The gas chromatographic trace was indicative of no contamination.
W-A	The gas chromatographic trace was indicative of the water of a soluble fraction of gasoline. This characterization is based on the presence of light hydrocarbons and MCA.
Travel Blank	The gas chromatographic trace contained trace levels of benzene and toluene. Nothing else was seen.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE PRODUCT SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
F-T	The gas chromatographic trace was indicative of a fresh gasoline. This characterization is based on a relatively typical pattern of peaks from *n*-C_4 to ca *n*-C_{10} with a maximum at ca *n*-C_7 along with augmented levels of monocyclic aromatic hydrocarbons. Examination of the relative proportions of the four peaks we have found to be most conservative in gasolines gave abundance ratios of 1:1.17:0.861:0.0935. This did not match the W-1 or W-A-40 patterns. Analysis of the sample for organic lead gave <50 ppm.
F-T (PRES)	The gas chromatographic trace was indicative of a fresh gasoline. This characterization is based on a relatively typical pattern of peaks from *n*-C_4 to Ca *n*-C_{10} with a maximum at ca *n*-C_7 along with augmented levels of monocyclic aromatic hydrocarbons. Examination of the relative proportions of the four peaks we have found to be most conservative in gasolines gave abundance ratios of 1:1.06:0.794:0.0876. This did not match the W-1 or W-A-40 patterns. Analysis of the sample for organic lead gave <50 ppm.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE WATER SAMPLES FOR PHENOL, NAPHTHALENE, AND 2-METHYL NAPHTHALENE
Results Reported as mg/L (ppm)

Sample #	Phenol (ppm)	Naphthalene (ppm)	2-Methyl Naphthalene (ppm)
W-B	<0.1	<0.01	<0.01
W-B2	<0.1	<0.01	<0.01
W-EB	<0.1	<0.01	<0.01
W-D	<0.1	<0.01	<0.01
W-E	<0.1	<0.01	<0.01
W-C	<0.1	<0.01	<0.01
W-A	<0.1	<0.01	<0.01
Travel Blank	<0.1	<0.01	<0.01
Quality Assurance			
Method Blank (Tap Water)	<0.1	<0.01	0.02
Tap Water (Matrix Spike) Spiked @ 2.2 ppm Percent Recovery		120%	49%
Tap Water (Matrix Spike Duplicate) Spiked @ 2.2 ppm Percent Recovery		120%	51%

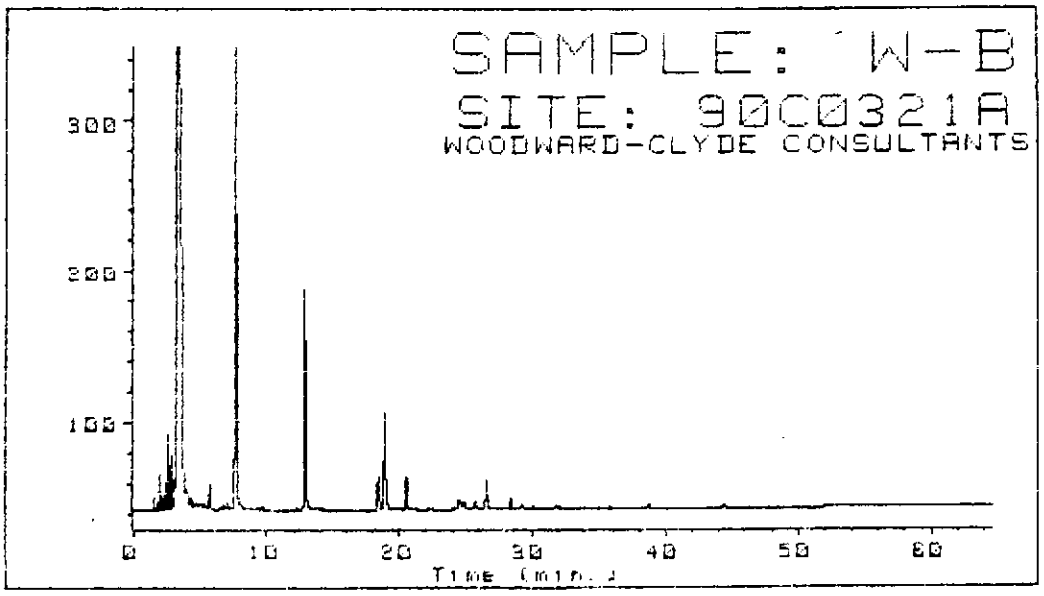
FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 4, 1990
Project: 90C0321A

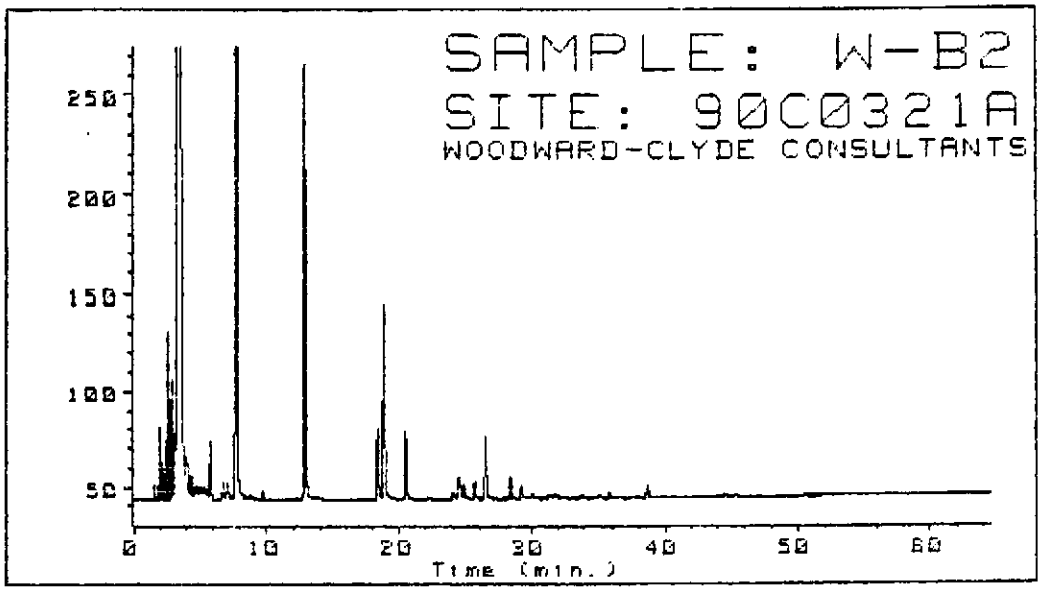
RESULTS OF ANALYSES OF THE WATER SAMPLES FOR SELECTED METALS BY ICP
Results Reported as mg/L (ppm)

Sample #	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Nickel (ppm)	Vanadium (ppm)	Zinc (ppm)
W-B	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
W-B2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
W-EB	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
W-D	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
W-E	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
W-C	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
W-A	<0.1	<0.1	<0.1	0.2	<0.1	<0.1
Travel Blank	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Quality Assurance						
Method Blank	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
W-A (Duplicate)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
W-A (Matrix Spike) Spiked @ 10 ppm Percent Recovery	81%	89%	91%	52%	77%	59%
W-A (Matrix Spike Duplicate) Spiked @ 10 ppm Percent Recovery	81%	93%	93%	58%	80%	60%



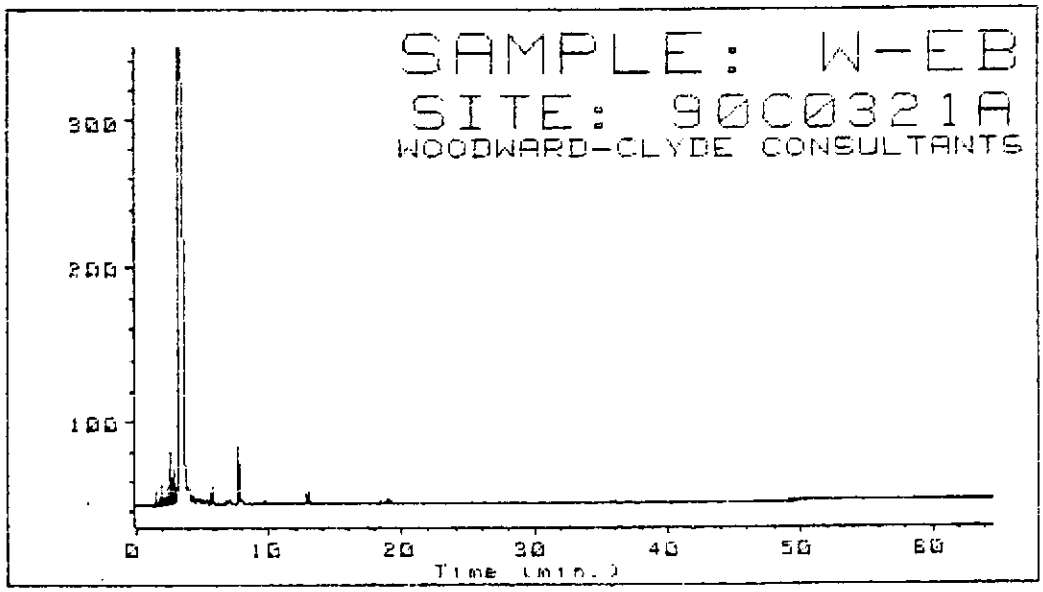
T: null.
Z: null.
Y: Sig. 2 of V3:WGC_A12A.D
X: Sig. 2 of V3:WWC_A14A.D

[DE]



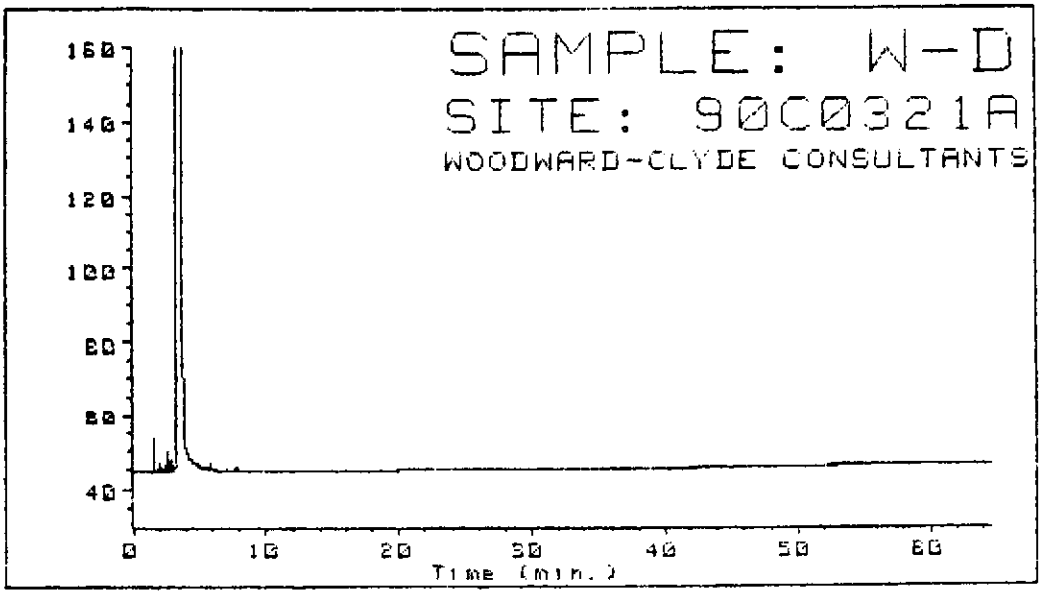
T: null.
Z: Sig. 2 of V3:WGC_A12A.D
Y: Sig. 2 of V3:WWC_A14A.D
X: Sig. 2 of V3:WWC_A15A.D

[DE]



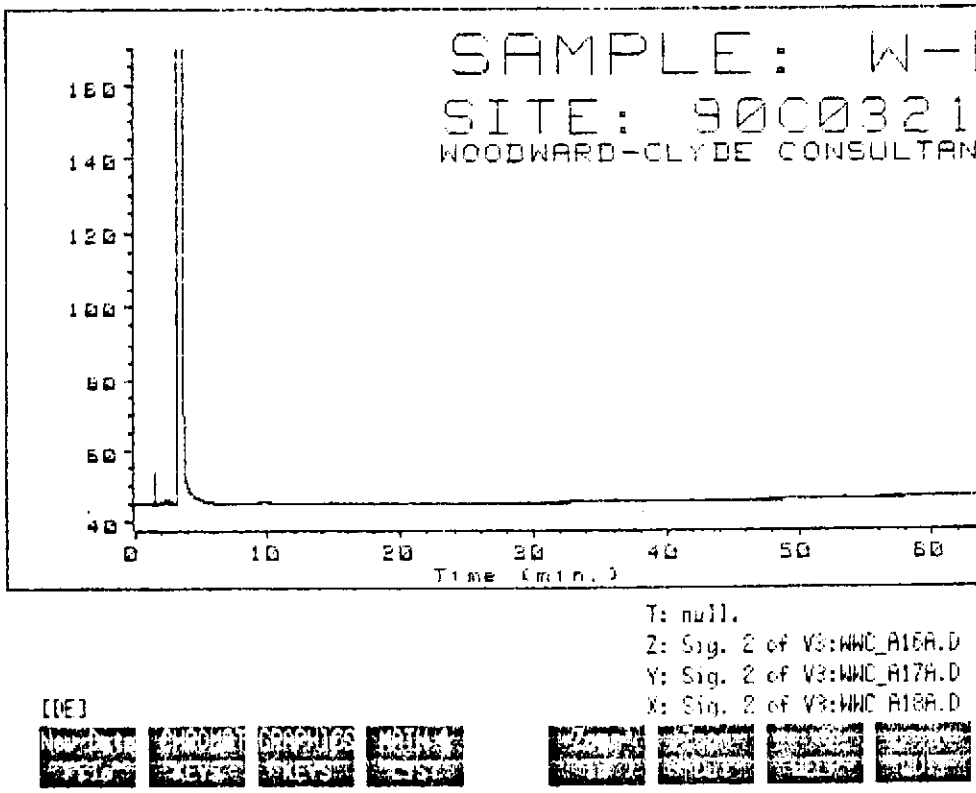
T: null.
Z: null.
Y: null.
X: Sig. 2 of V3:WWC_A16A.D

[DE]



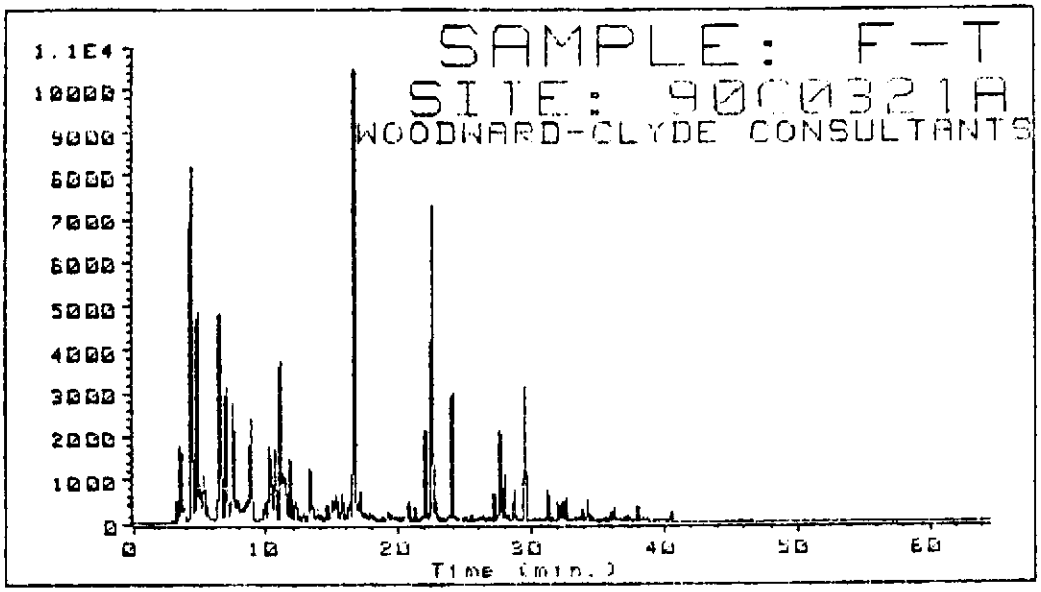
T: null.
Z: null.
Y: Sig. 2 of V3:WWC_A16A.D
X: Sig. 2 of V3:WWC_A17A.D

[DE]



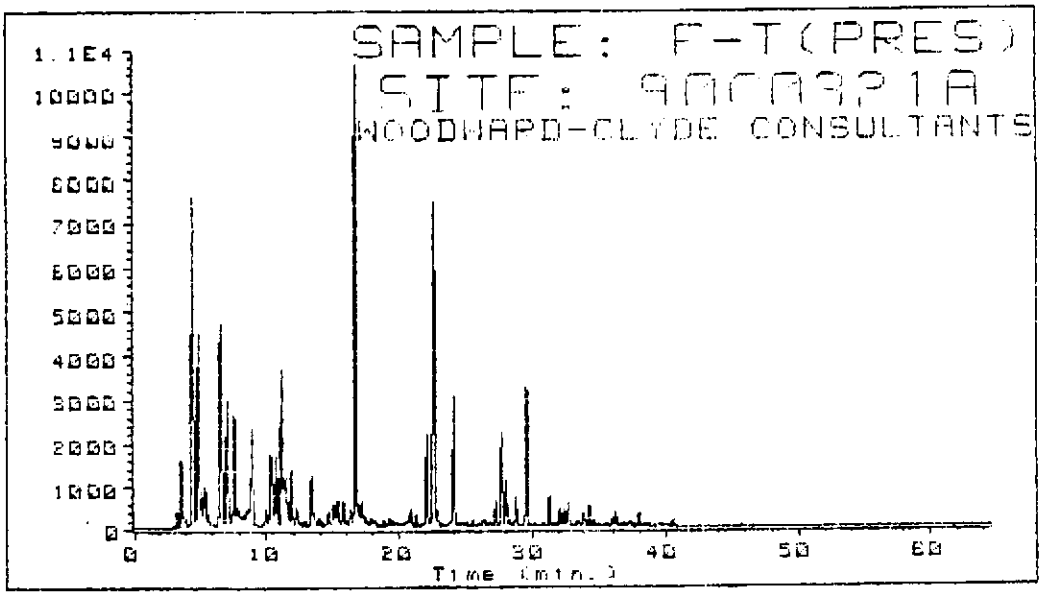
T: null.
Z: Sig. 2 of V3:WWC_A16A.D
Y: Sig. 2 of V3:WWC_A17A.D
X: Sig. 2 of V3:WWC_A18A.D

[DE]



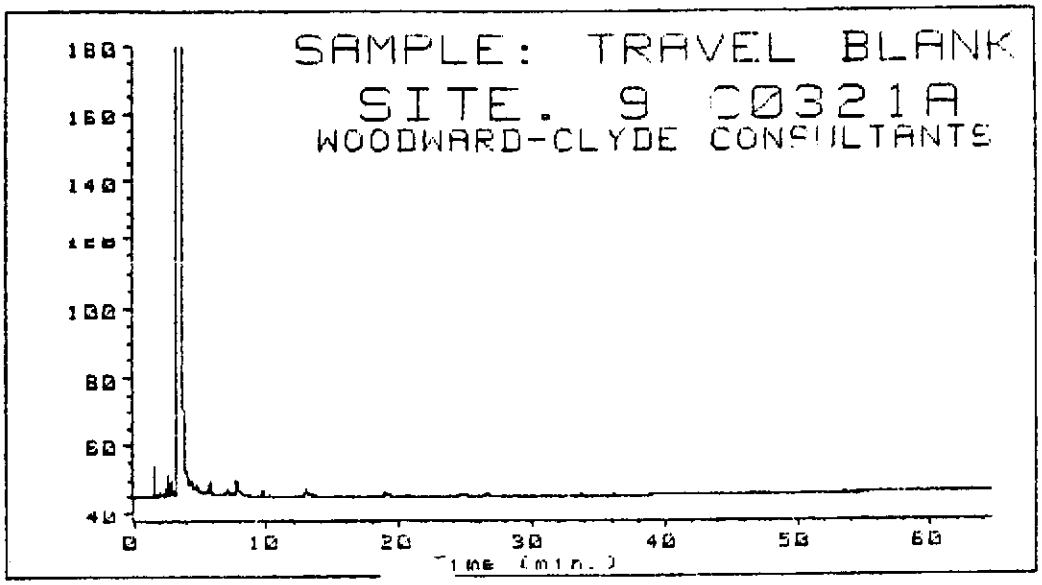
T: null.
Z: null.
Y: null.
X: Sig. 2 of V3:WCA_A03A.D

[DE]



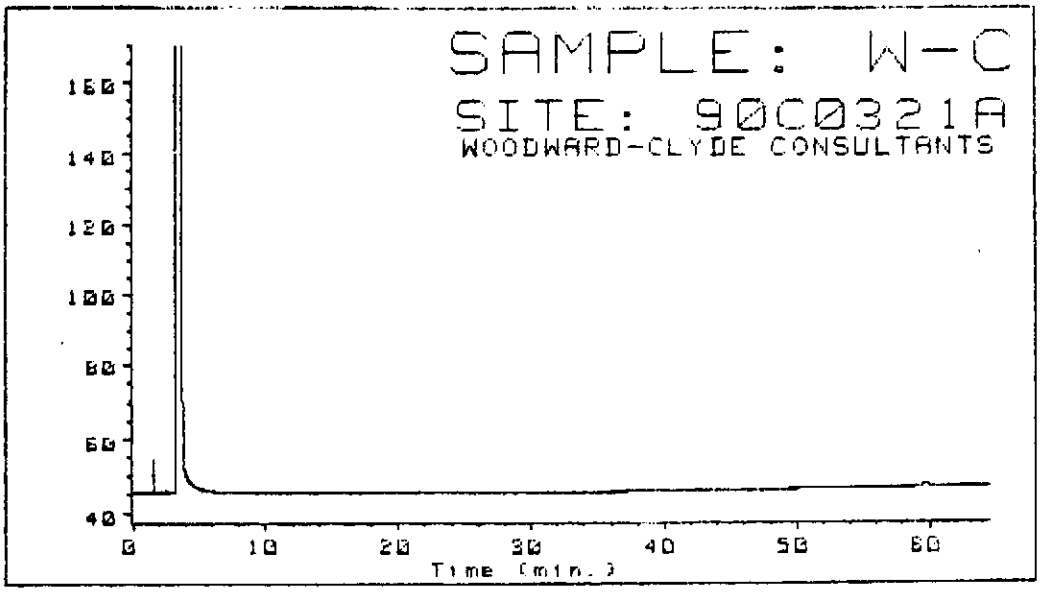
T: null.
Z: null.
Y: Sig. 2 of V3:WCA_A03A.D
X: Sig. 2 of V3:WCA_A04A.D

[DE]



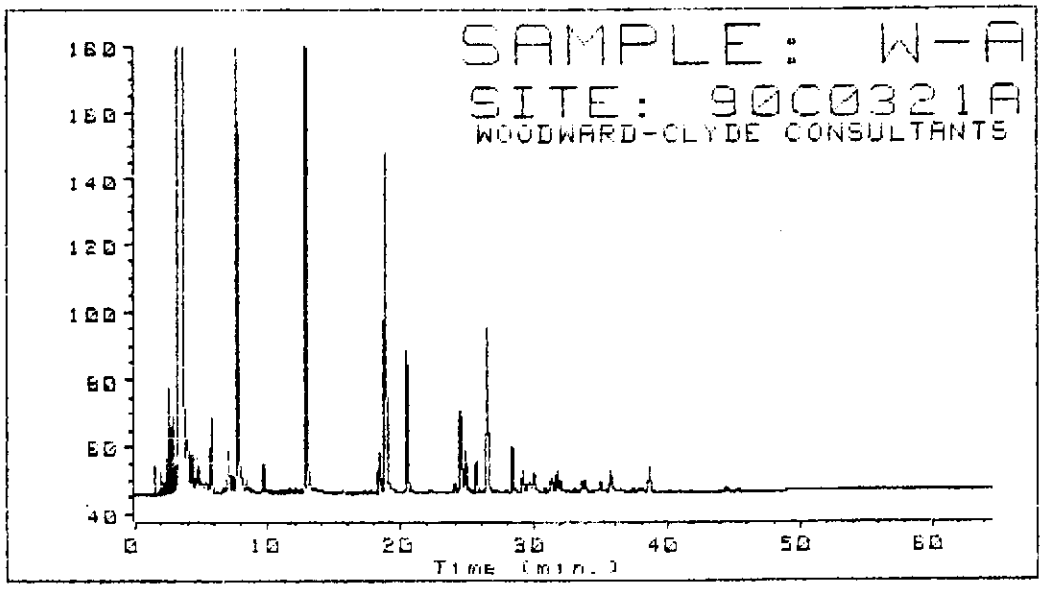
T: Sig. ? of V3:WWC_A18A.D
Z: Sig ? V3:WWC_A19A.D
Y: Sig of V3:WWC_A20A.D
X: Sig. 2 of V3: 21A.D

[DE]



T: Sig. 2 of V3:WWC_A16A.D
Z: Sig. 2 of V3:WWC_A17A.D
Y: Sig. 2 of V3:WWC_A18A.D
X: Sig. 2 of V3:WWC_A19A.D

[DE]



T: Sig. 2 of V3:WWC_A17A.D
Z: Sig. 2 of V3:WWC_A18A.D
Y: Sig. 2 of V3:WWC_A19A.D
X: Sig. 2 of V3:WWC_A20A.D

[DE]

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

September 28, 1990

Al Ridley, Project Leader
Woodward-Clyde Consultants
500 12th Street, Suite 100
Oakland, CA 94607-4014

Dear Mr. Ridley:

Enclosed are the results of the analyses of the samples submitted on July 13, 1990 from Project 90C0321A.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Andrew John Friedman, Chemist

AJF/fae

Enclosures

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: September 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR GASOLINE BY GC/FID (MODIFIED 8015)
Results Reported as µg/g (ppm)

Sample #	Gasoline (ppm)
W-C-20	<10
W-C-40	<10
B-1-10	<10
B-1-15	<10
B-1-20	<10
B-1-30	<10
B-1-35	<10
B-1-40	350
B-1-45	54
B-1-50	<10
W-E-20	<10
W-E-40	<10

Quality Assurance

Method Blank	<10
B-1-40 (Duplicate)	<10
B-1-40 (Matrix Spike) Spiked @ 500 ppm Percent Recovery	130%
B-1-40 (Matrix Spike Duplicate) Spiked @ 500 ppm Percent Recovery	97%

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: September 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR ORGANIC LEAD BY AA
Results Reported as µg/g (ppm)

Sample #	Organic Lead (ppm)
B-1-20	<5
B-1-30	<5
B-1-40	<5
B-1-45	<5
Quality Assurance	
Method Blank	<5
B-1-30 (Duplicate)	<5

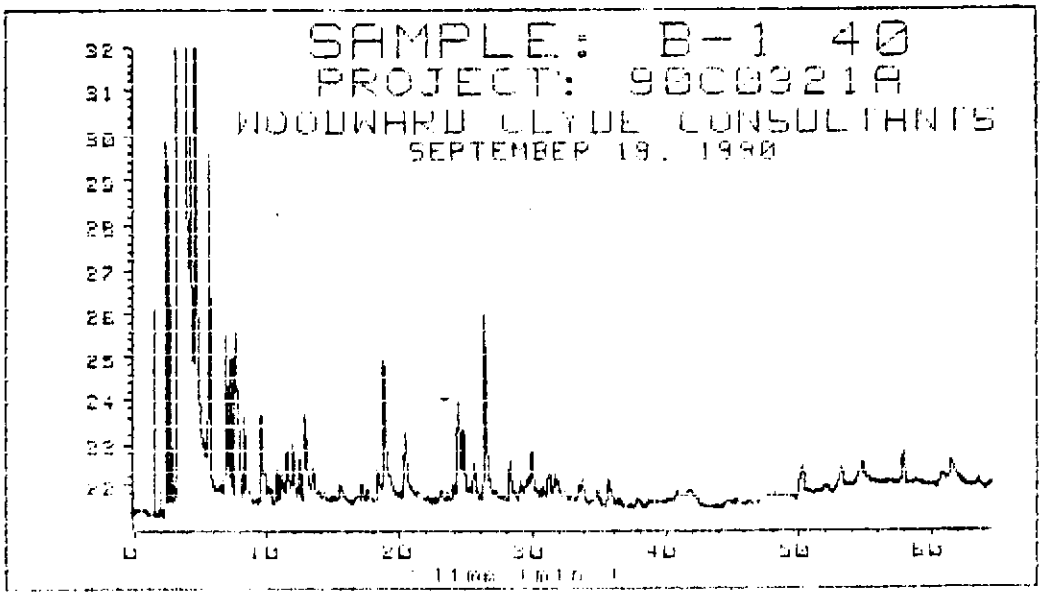
FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: September 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

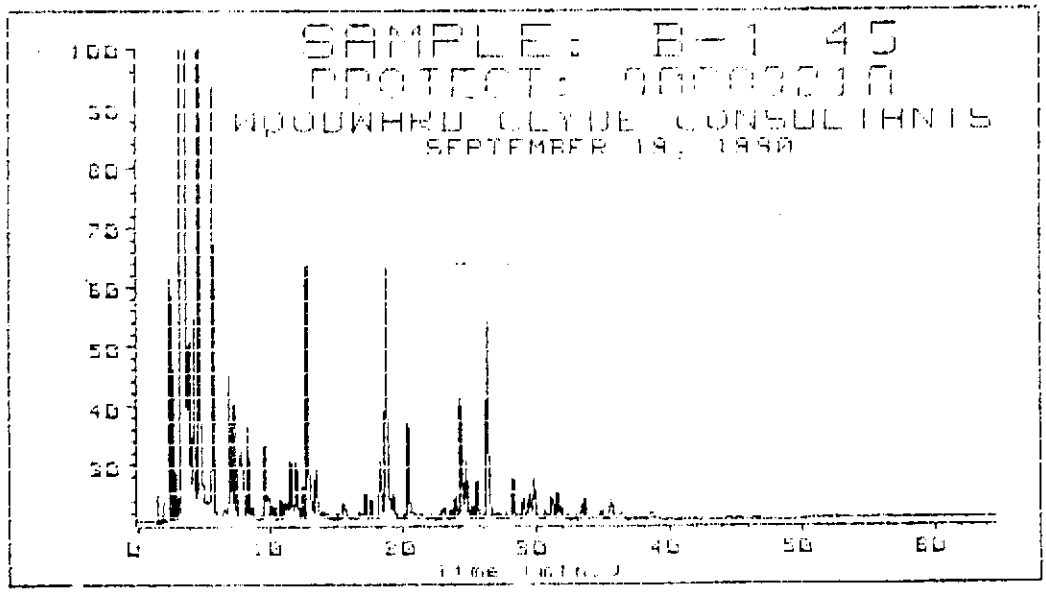
RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
B-1 40	The gas chromatographic trace was indicative of a low boiling petroleum product, such as gasoline. This characterization is based on the presence of a relatively typical suite of peaks present from ca *n*-C_4 to *n*-C_{12} with a maximum at ca *n*-C_6. Augmented levels of benzene, toluene, ethylbenzene and the xylnes were seen which is common to most gasolines. Examining the four peaks we have found to be most conservative in gasolines we found the following relative abundances: 1:0.936:2.10:2.31. These values are considerably different from samples analyzed previously from this project.
B-1 45	The gas chromatographic trace was indicative of a low boiling petroleum product, such as gasoline. This characterization is based on the presence of a relatively typical suite of peaks present from ca *n*-C_4 to *n*-C_{12} with a maximum at ca *n*-C_6. Augmented levels of benzene, toluene, ethylbenzene and the xylnes were seen which is common to most gasolines. Examining the four peaks we have found to be most conservative in gasolines we found the following relative abundances: 1:0.719:3.27:3.13. These values are similar to those from sample B-1 40 (above), though not a complete match, and different from other samples received from this project (W-1, W-A-40 or the F-T samples).



T: null.
Z: null.
Y: null.
X: Sig. 2 of DATA:WWC_A01A.D

[DF]



T: null.
Z: null.
Y: Sig. 2 of DATA:WWC_A01A.D
X: Sig. 1 of DATA:WWC_A02A.D

[DF]

oodward-Clyde Consultants

600 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

WORK ORDER FOR SAMPLES
~~Chain of Custody Record~~ *
PER COC dated 7/13/92

PROJECT NO. 90C0321A

SAMPLERS: (Signature) Lois Gruenberg

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608	TPH & BTEX	TPH diesel	Fuel Fingerprint *	GCMS **	Methods ***	(1)	Number of Containers
		W-C-20						X						1
		W-C-25												1
		W-C-30												1
		W-C-35												1
		W-C-40						X	X	X	X			1
		W-C-45												1
		B-1-5												1
		B-1-10						X						1
		B-1-15						X						1
		B-1-20						X		X		X		1
		B-1-25												1
		B-1-30						X				X	X	1
		B-1-35						X		X				1
		B-1-40						X				X	X	1
		B-1-45						X				X		1
		B-1-50						X						1
		W-E-5												1
		W-E-10												1
		W-E-15												1
		W-E-20						X						1
		W-E-25												1
		W-E-30												1
		W-E-40						X	X	X	X			1
		W-E-45												1
												TOTAL NUMBER OF CONTAINERS		

* aging of fuels

** for petroleum dig indicators

*** tetraethyl lead, V, Cr, ~~Cd~~, Zn, ~~Cu~~, Ni just analyze

(1) 2-methyl-naphthalene, Naphthalene, Phenol

(2) split sample, perform 2 analyses for TPH gas BTEX ONLY

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)

METHOD OF SHIPMENT:	SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

August 28, 1990

Al Ridley, Project Leader
Woodward Clyde Consultants
500 12th Street, Suite 100
Oakland, CA 94607-4041

Dear Mr. Ridley:

Enclosed are the results of the analyses of the samples submitted on August 3, 1990 from Project 90CO321A-3000.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Andrew John Friedman

Andrew John Friedman, Chemist

AJF/fae

Enclosures

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 3, 1990
Project: 90CO321A-3000

**RESULTS OF ANALYSES OF THE WATER SAMPLE
FOR BTX AND ETHYLBENZENE
USING THE HEADSPACE METHOD
Results Reported as ng/mL (ppb)**

Sample #	Benzene	Toluene	Et-Benzene	Xylene m,p	Xylene o
W-A	16,000[a]	18,000[a]	1,900[a]	7,700[a]	3,600[a]

[a] - Value reported exceeded the calibration range established for the sample.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 3, 1990
Project: 90CO321A-3000

RESULTS OF ANALYSES OF THE PRODUCT SAMPLE FOR BTX AND ETHYLBENZENE USING THE HEADSPACE METHOD
Results Reported as ng/g (ppb)

Sample #	Benzene	Toluene	Et-Benzene	Xylene *m,p*	Xylene *o*
W-1	6.4%	4.7%	1.3%	5.1%	2.3%
Quality Assurance					
W-1 (Duplicate)	6.6%	4.7%	1.3%	5.1%	2.3%

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 3, 1990
Project: 90CO321A-3000

RESULTS OF ANALYSES OF THE WATER SAMPLE FOR PHENOL, NAPHTHALENE, AND 2-METHYL NAPHTHALENE
Results Reported as mg/L (ppm)

Sample #	Phenol (ppm)	Naphthalene (ppm)	2-Methyl Naphthalene (ppm)
W-A	<0.5	<0.5	<0.05

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 3, 1990
Project: 90CO321A-3000

RESULTS OF ANALYSES OF THE PRODUCT SAMPLE FOR PHENOL, NAPHTHALENE, AND 2-METHYL NAPHTHALENE
Results Reported as mg/L (ppm)

Sample #	Phenol (ppm)	Naphthalene (ppm)	2-Methyl Naphthalene (ppm)
W-1	<1,000	<1,000	200
Quality Assurance			
Method Blank	<1,000	<1,000	<100
W-1 (Duplicate)	<1,000	<1,000	200
W-1 (Matrix Spike) Spiked @ 10,000 ppm % Recovery	b	150%	50%
W-1 (Matrix Spike Duplicate) Spiked @ 10,000 ppm % Recovery	b	150%	50%

b - The analyte indicated was not added to the matrix spike sample.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 3, 1990
Project: 90C0321A-3000

RESULTS OF ANALYSES OF THE WATER SAMPLE FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
W-A	The gas chromatographic trace was indicative of a water soluble fraction of gasoline. This characterization is based on the presence of mostly monocyclic aromatic hydrocarbons (BTEX + C_3 - Benzenes).

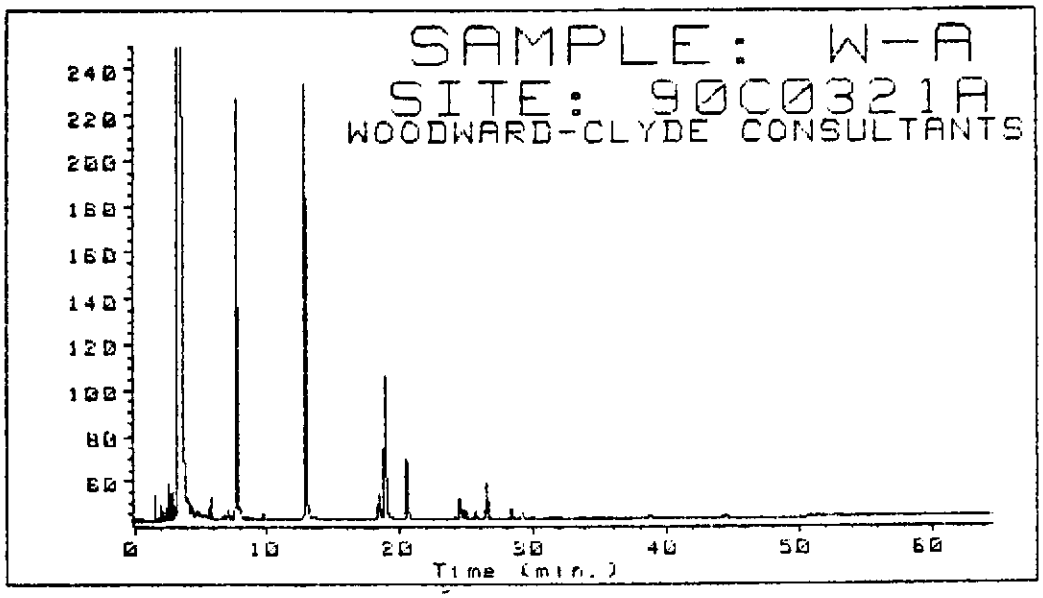
FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: August 3, 1990
Project: 90C0321A-3000

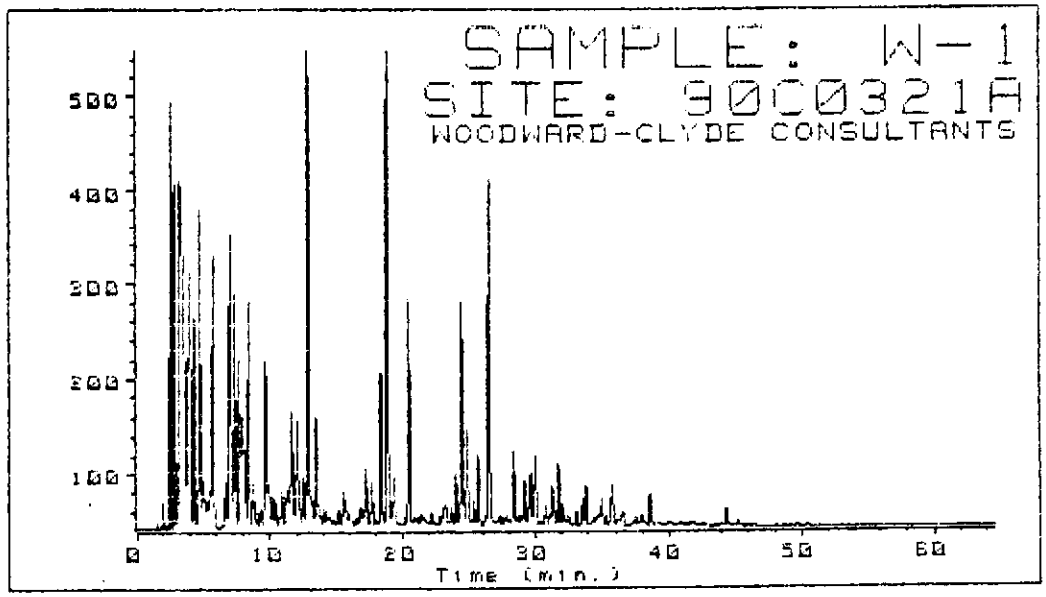
RESULTS OF ANALYSES OF THE PRODUCT SAMPLE FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
W-1	The gas chromatographic trace was indicative of a fresh gasoline. This characterization is based on the presence of a relatively typical pattern of peaks present from ca *n*-C_4 to *n*-C_{12} with a maximum at ca *n*-C_7, along with augmented levels of the monocyclic aromatic hydrocarbons. Examination of the relative proportions of the four peaks we have found to be most conservative in gasolines gave abundance ratios of 1:2.01:1.64:0.153. These did not give a good match to the F-T or W-A-40 samples. Analysis of the sample for organic lead gave a value of 100 ppm.



T: null.
Z: null.
Y: null.
X: Sig. 2 of V3:WWC_A09A.D

[DE]



T: null.
Z: null.
Y: Sig. 2 of V3:WWC_A10A.D
X: Sig. 2 of V3:WWC_A10A.D

[DE]

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

August 28, 1990

Al Ridley, Project Leader
Woodward Clyde Consultants
500 12th Street, Suite 100
Oakland, CA 94607-4041

Dear Mr. Ridley:

Enclosed are the results of the analyses of the samples submitted on July 13, 1990 from Project 90C0321A.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Andrew John Friedman

Andrew John Friedman, Chemist

AJF/fae

Enclosures

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90CO321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR ORGANIC LEAD BY AA
Results Reported as µg/g (ppm)

Sample #	Organic Lead (ppm)
W-A-20	<1
W-A-30	<1
W-A-35	<1
W-B-25	<1
W-B-35	<1

Quality Assurance

W-A-20 (Duplicate)	<1
W-A-20 (Matrix Spike) Spiked @ 2.5 ppm Percent Recovery	120%
W-A-20 (Matrix Spike Duplicate) Spiked @ 2.5 ppm Percent Recovery	120%

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR DYE CHARACTERIZATION BY THIN LAYER CHROMATOGRAPHY

Sample #	GC Characterization
W-D-25	No dyes found.
W-A-40	No dyes found.
W-B-40	No dyes found.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
W-D-25	The gas chromatographic trace was not indicative of any hydrocarbon contamination.
W-D-40	The gas chromatographic trace was not indicative of any hydrocarbon contamination.
W-A-20	The gas chromatographic trace was not indicative of any hydrocarbon contamination.
W-A-30	The gas chromatographic trace was not indicative of any hydrocarbon contamination.
W-A-40	The gas chromatographic trace was indicative of weathered gasoline. This characterization is based on the presence of a relatively typical pattern of peaks present from ca *n*-C_4 to *n*-C_{12} with a maximum at *n*-C_8. Only low levels of monocyclic aromatics were probably present. They were mostly solubilized or biodegraded. Examination of the relative proportions of the four peaks we have found to be most conservative in gasolines gave abundance ratios of 1:4.26:3.88:0.442. These did not give a good match to the F-T or W-1 samples.
W-A-50	The gas chromatographic trace was not indicative of any hydrocarbon contamination.
W-B-40	The gas chromatographic trace was not indicative of any hydrocarbon contamination.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90CO321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR GASOLINE BY GC/FID (MODIFIED 8015) Results Reported as µg/g (ppm)

Sample #	Gasoline (ppm)
W-D-25	<1
W-D-40	<1
W-A-20	<1
W-A-30	2
W-A-40	1,000
W-B-25	<1
W-B-35	<1
W-B-40	<1
Quality Assurance	
Method Blank	<1
W-A-40 (Duplicate)	640
W-A-40 (Matrix Spike) Spiked @ 100 ppm Percent Recovery	**a**
W-A-40 (Matrix Spike Duplicate) Spiked @ 100 ppm Percent Recovery	**a**

a - The amount spiked was insufficient to give meaningful recovery data.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90CO321A

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BTX AND ETHYLBENZENE USING THE HEADSPACE METHOD
Results Reported as ng/g (ppb)

Sample #	Benzene	Toluene	Et-Benzene	Xylene *m,p*	Xylene *o*
W-D-25	<10	<1	<1	<1	<1
W-D-40	<10	<1	<1	<1	<1
W-A-20	410	320	240	210	190
W-A-30	390	130	35	1,200	750
W-A-40	12,000	37,000	7,500	27,000	13,000
W-B-25	<10	<1	<1	<1	<1
W-B-35	690	260	110	70	35
W-B-40	<10	<1	<1	<1	<1
Quality Assurance					
Method Blank	<10	<1	<1	<1	<1
W-A-40 (Duplicate)	8,900	29,000	6,000	23,000	11,000
W-A-40 (Matrix Spike) Spiked @ 1,000 ppb Percent Recovery	**a**	**a**	**a**	**a**	**a**
W-A-40 (Matrix Spike Duplicate) Spiked @ 1,000 ppb Percent Recovery	**a**	**a**	**a**	**a**	**a**

a - The amount spiked was insufficient to give meaningful recovery data.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

RESULTS OF ANALYSES OF THE WATER SAMPLES FOR SELECTED METALS BY ICP
Results Reported as mg/L (ppm)

Sample #	Cadmium (ppm)	Chromium (ppm)	Copper (ppm)	Nickel (ppm)	Vanadium (ppm)	Zinc (ppm)
W-A-20	0.2	2.3	12	64	0.3	11
W-A-30	<0.1	23	13	55	6.3	23
W-A-35	0.6	31	15	6.9	9.1	15
W-B-25	<0.1	76	15	82	6.3	21
W-B-35	0.2	22	18	74	7.1	14
Quality Assurance						
Method Blank	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
W-A-30 (Duplicate)	0.1	26	16	68	7.4	21
W-A-30 (Matrix Spike) Spiked @ 100 ppm Percent Recovery	55%	66%	70%	77%	[a]	60%
W-A-30 (Matrix Spike Duplicate) Spiked @ 100 ppm Percent Recovery	54%	53%	64%	39%	[a]	56%

[a] - The analyte indicated was not added to the matrix spike sample.

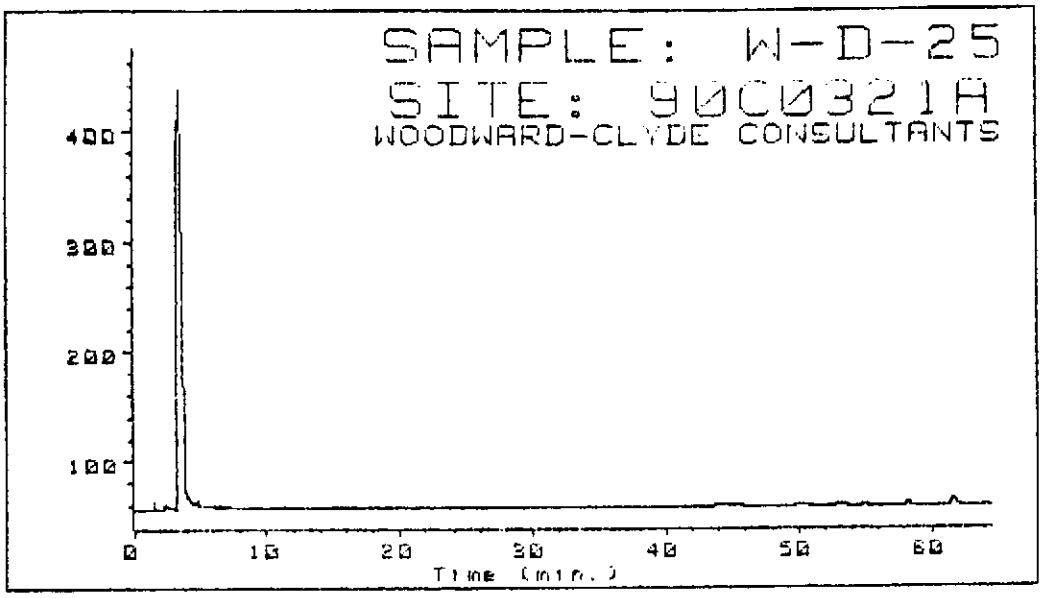
FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 28, 1990
Date Submitted: July 13, 1990
Project: 90C0321A

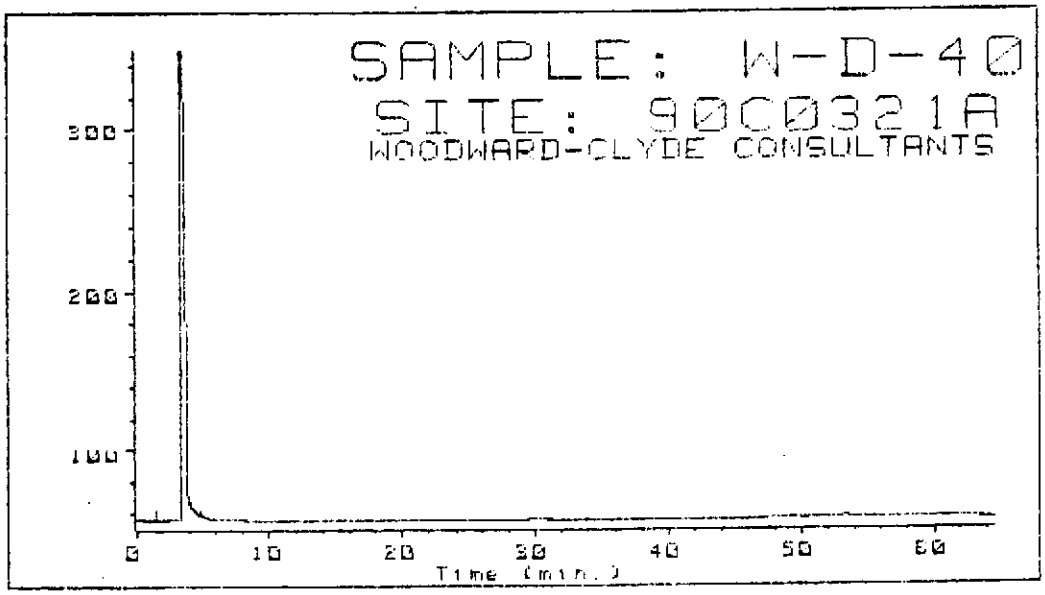
RESULTS OF ANALYSES OF THE SOIL SAMPLES
FOR PHENOL, 2-MEHTYL NAPHTHALENE, AND NAPHTHALENE
Results Reported as µg/g (ppm)

Sample #	Phenol (ppm)	Naphthalene (ppm)	2-Methyl Naphthalene (ppm)
W-A-30	<10	<1	<1
W-B-30	<10	<1	<1
Quality Assurance			
Method Blank	<10	<1	2



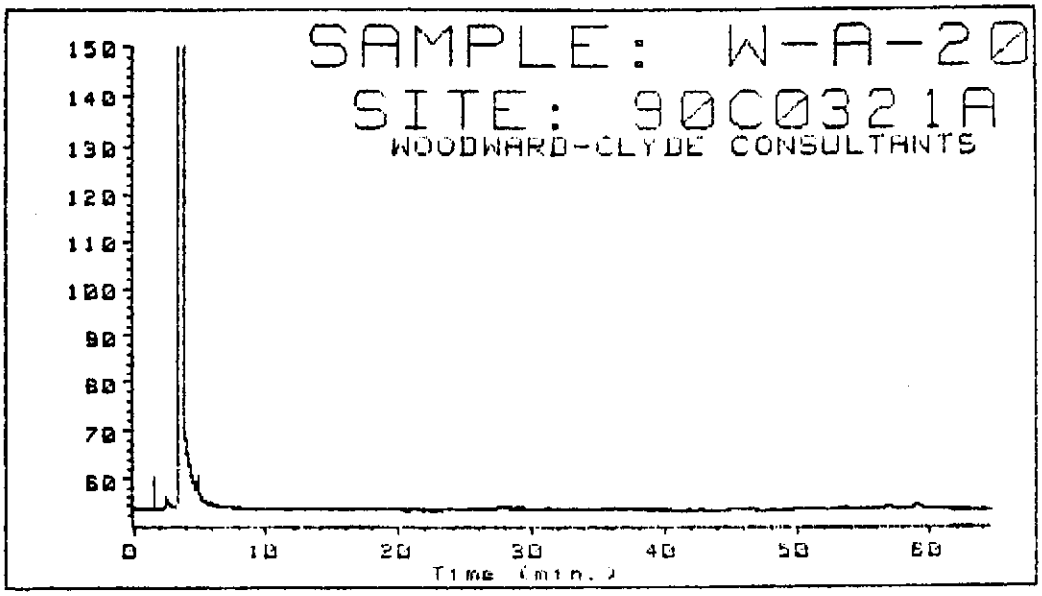
T: null.
Z: null.
Y: null.
X: Sig. 2 of V3:WDC_A01A.D

[DE]



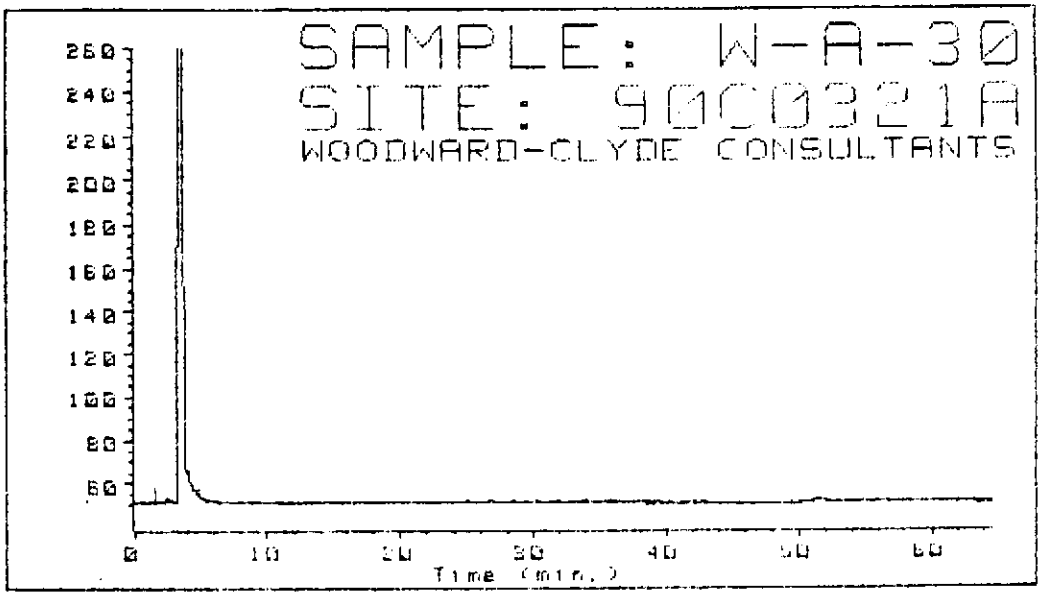
T: null.
Z: null.
Y: Sig. 2 of V3:WDC_A01A.D
X: Sig. 2 of V3:WDC_A02A.D

[DE]



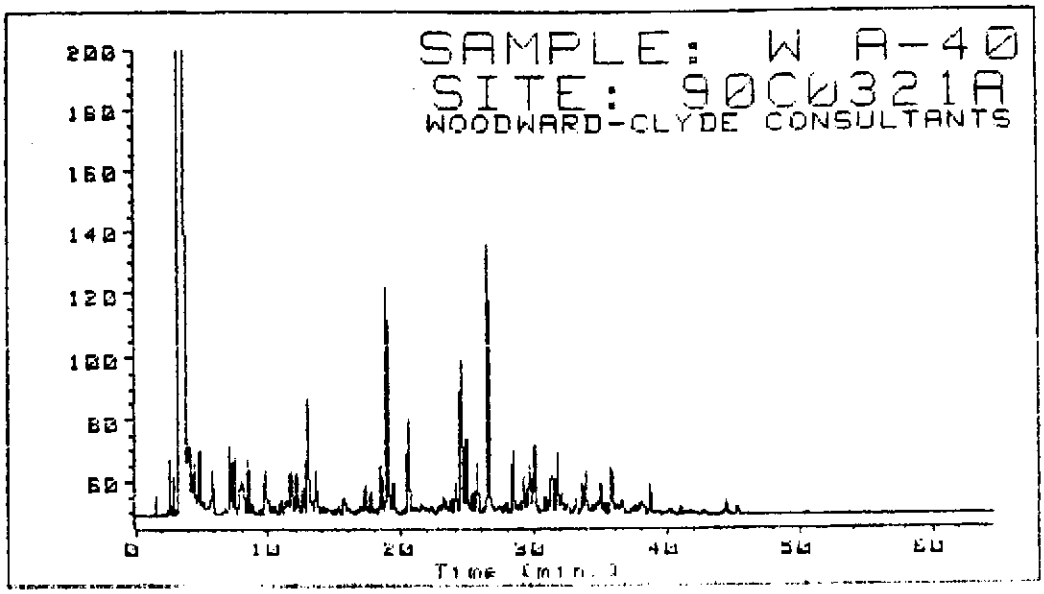
T: null.
Z: null.
Y: null.
X: Sig. 2 of V3:WDC_A02A.D

[DE]



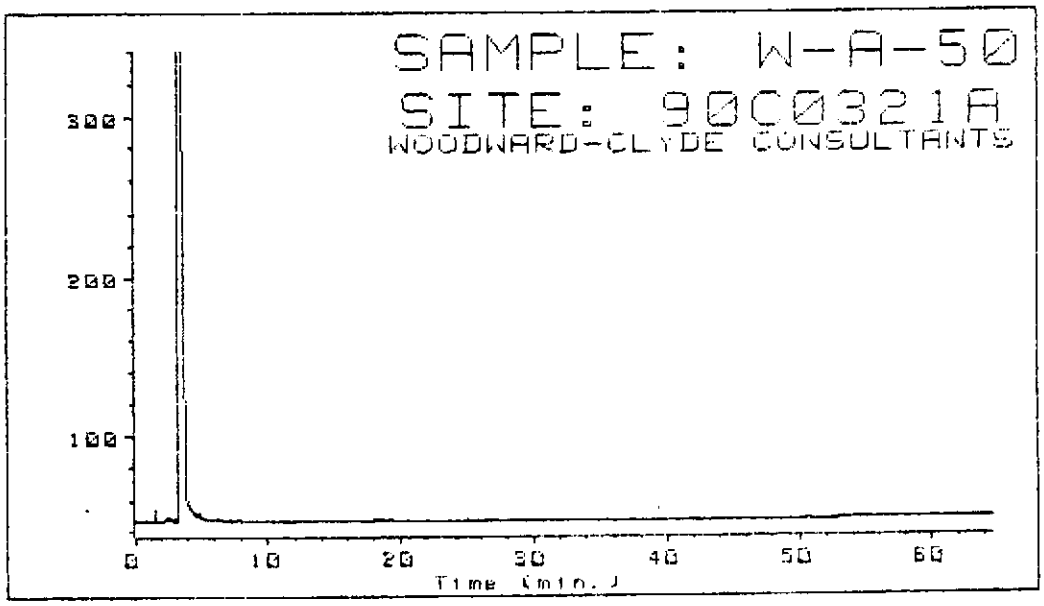
T: null.
Z: null.
Y: Sig. 2 of V3:WDC_A03A.D
X: Sig. 2 of V3:WDC_A04A.D

[DE]



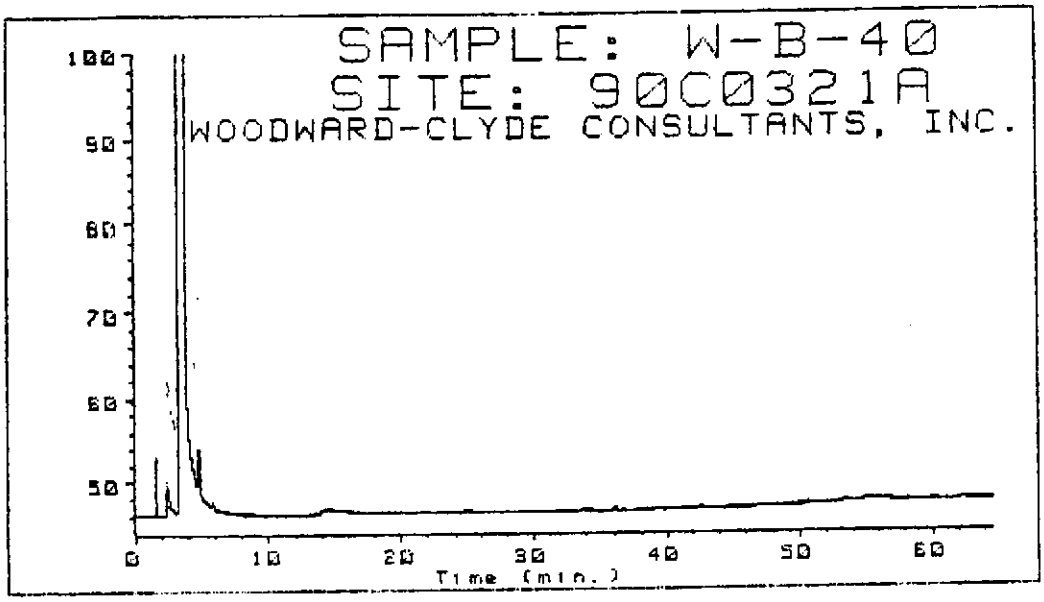
T: null.
Z: Sig. 2 of V3:WDC_A03A.D
Y: Sig. 2 of V3:WDC_A04A.D
X: Sig. 2 of V3:WDC_A05A.D

[DE]



T: Sig. 2 of V3:WDC_A03A.D
Z: Sig. 2 of V3:WDC_A04A.D
Y: Sig. 2 of V3:WDC_A05A.D
X: Sig. 2 of V3:WDC_A06A.D

[DE]



T: null.
Z: null.
Y: null.
X: Sig. 2 of V8:WOC_A07A.D

[DE]

red cover AJT 7

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600 fax (415) 874-3268

Chain of Custody Record

PROJECT NO. 90C0321A

SAMPLERS: (Signature) Lois Gruenberg

ANALYSES

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608					Number of Containers	REMARKS (Sample preservation, handling procedures, etc.)
7/12		W-D-5										1	FEDEX 7/13/90 TO: Friedman + Bruya Inc 3008-B 16th Ave West Seattle, WA 98119 Attn: Lois Gruenberg (415) 874-1725
		W-D-15										1	
		W-D-25										1	
		W-D-30										1	
		W-D-35										1	
		W-D-40										1	
		W-D-45										1	
		W-A-10										1	Contact Al Ridley (415) 874-3425 for analyses
		WA-20										1	
7/13		W-A-25										1	
		W-A-30										1	
		W-A-35										1	
		W-A-40										1	
		W-A-45										1	
		W-A-50										1	
		W-B-25										1	
		W-B-30										1	
		W-B-35										1	
		W-B-40										1	
		W-B-45										1	
		W-B-50										1	

TOTAL NUMBER OF CONTAINERS: 21

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Lois Gruenberg	7/13 1700				
METHOD OF SHIPMENT: ICE CHEST w/ blue ice		SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

Chain of Custody Record

PROJECT NO. 90C0321A

SAMPLERS: (Signature) Lois Gruenberg

DATE	TIME	SAMPLE NUMBER	General Mineral	Priority Pollutant Metals	EPA Method 624	EPA Method 625	EPA Method 608						Number of Containers	REMARKS (Sample preservation, handling procedures, etc.)
7/11		W-C-20										13	1	Contact: Al Ridley (415) 874-3125 for analyses
		W-C-25										14	1	
		W-C-30										15	1	
		W-C-35										16	1	
		W-C-40										17	1	
		W-C-45										18	1	
7/10		B-1-5										1	1	
		B-1-10										20	1	
		B-1-15										21	1	
		B-1-20										22	1	
		B-1-25										23	1	
		B-1-30										24	1	
		B-1-35										25	1	
		B-1-40										26	1	
		B-1-45										27	1	
		B-1-50										28	1	
		W-E-5										1	1	
		W-E-10										10	1	
		W-E-15										11	1	
		W-E-20										12	1	
		W-E-25										13	1	
		W-E-30										14	1	
		~~W-E-35~~												
		W-E-40										15	1	
		W-E-45										96	1	

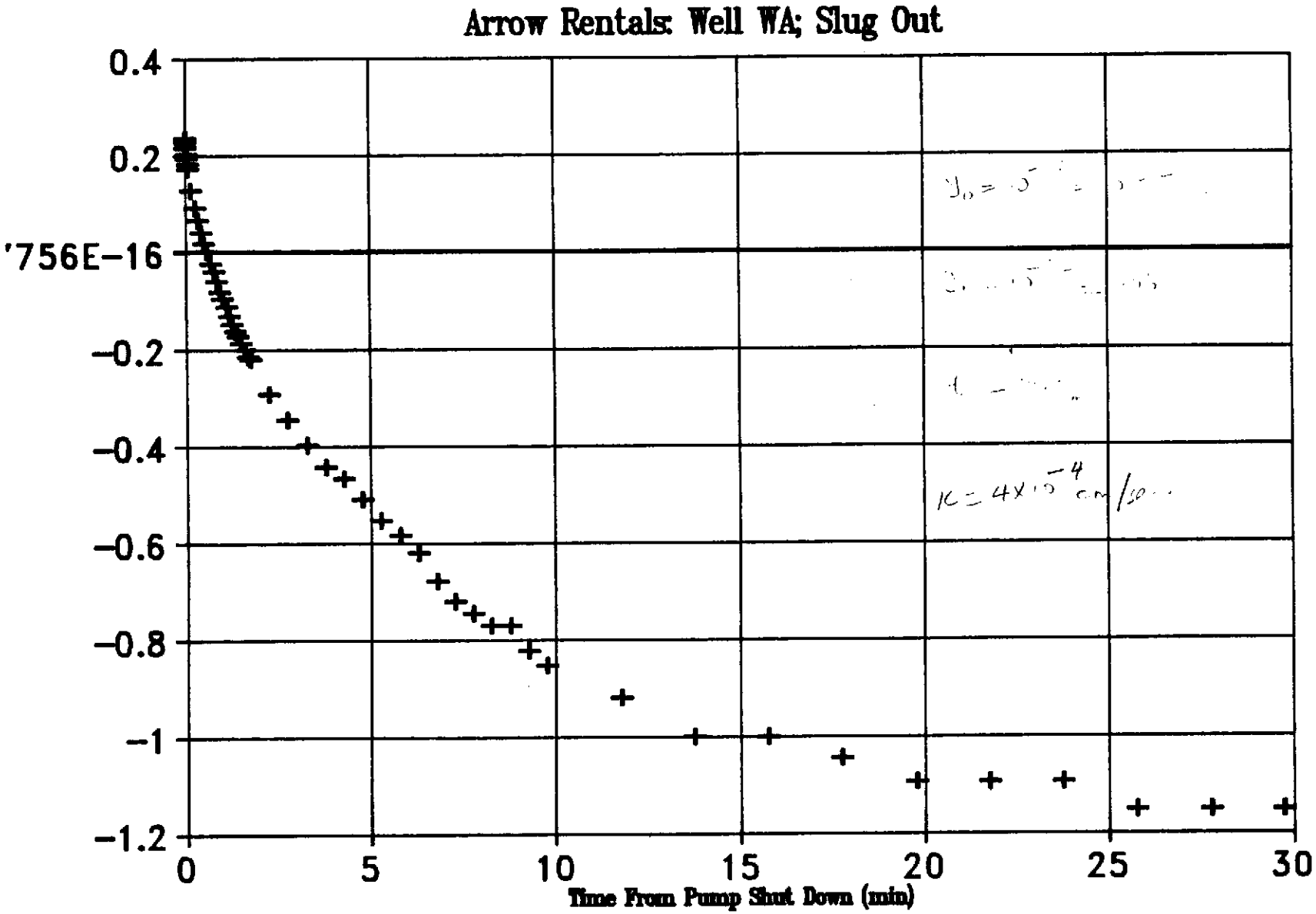
TOTAL NUMBER OF CONTAINERS: 24

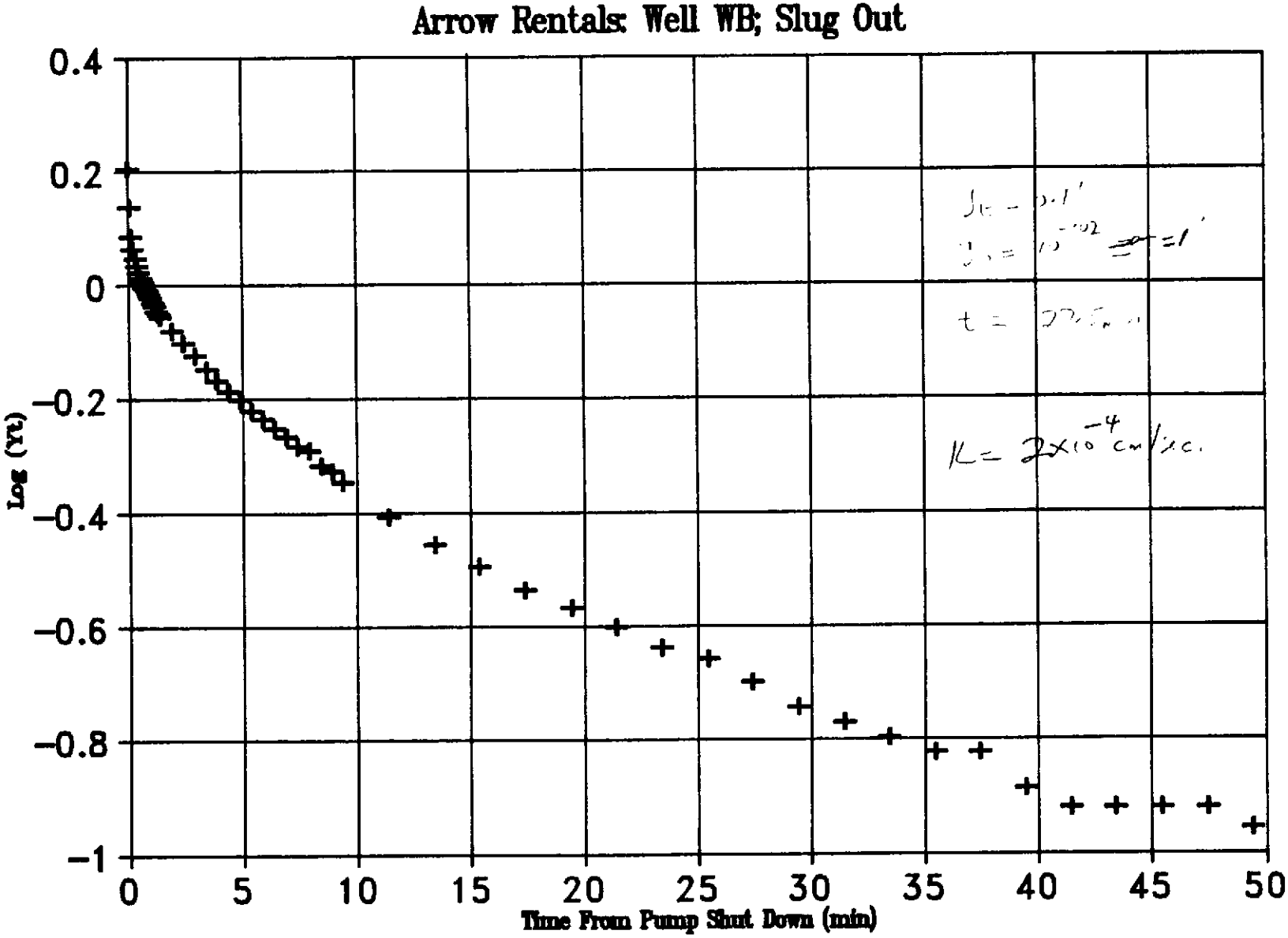
FED. EXP 7/13/90 TO:
Friedman + Bruya Inc
3008-B 16th Ave West
Seattle, WA 98119

FROM Woodward-Clyde, Lois Gruenberg (415) 874-1766

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Lois Gruenberg	7/13 4:30 PM				

METHOD OF SHIPMENT:	SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME
ICE Chest w/ dry ice				


Arrow Rentals: Well WA; Slug Out
0.4
0.2
'756E-16
-0.2
-0.4
-0.6
-0.8
-1
-1.2
0
5
10
15
20
25
30
Time From Pump Shut Down (min)


Arrow Rentals: Well WB; Slug Out
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
Log (Yt)
0
5
10
15
20
25
30
35
40
45
50
Time From Pump Shut Down (min)

FIELD ACTIVITY REPORT
ARROW RENTALS, LIVERMORE, CA
90C0321A-3000

FIELD PERSONEL: Jacki Lee
SUBCONTRACTOR: Frank Briggs, Datum Corporation

PURPOSE: To develop five new monitoring wells and obtain water levels on existing wells. Collect samples if gasoline is present.

GENERAL SUMMARY: Each new monitoring well received partial development. Additional pumping is still required for complete development.

WELL DEVELOPMENT PROCEDURES (see Table 1)

1. Initial water level and total depth were measured from the north rim of the well casing, surface completion was checked.

2. Bailed out as much silt deposit as possible.

3. Swab the screen interval for 10 to 15 minutes (for 4 inch wells only).

4. Bail well again after swabbing.

5. Pump well if possible until silt was minimal (for well W-D).

COMMENTS:

Well W-A: No floaters were present, however, strong gasoline odor was detected. A water sample was collected. Subcontractor was able to bail the well dry after 215 gallons were removed. Well was bailed again on the second day. High amount of silt is still present.

Well W-B: No floaters or odor were detected. No sample was collected. Subcontractor was able to bail the well dry after 70 gallons. Allowed a recharge time of 15 minutes. Only 10 gallons were removed before well went dry again. Amount of settled silt is about 50 ml.

Well W-C: No odor was detected. Originally started out with very thick silt. After removing about 3-4 gallons, viscosity was like water, however, still a high presence of silt. Subcontractor could not bail dry.

Well W-D: No odor was detected. Subcontractor could not get a 8 foot long bailer down the well.. It would get stuck at various depths. However, a 3 foot long bailer fits down the well to total depth. This well was hand-bailed. Silt is present.

A total of 10 empty barrels were left at the site. All discharged groundwater is stored in labelled barrels. Total number of barrels used for development is 22 barrels.

Groundwater samples from wells W-A and W-1 were sent along with a travel blank to Seattle, WA. Samples from Well W-1 was pure product.

10-31-90

Jackie,
Surge was 2"-4" of product First Day, Next day Filled Bucket to top w/ Fuel!
10-31-90 al

TABLE1. WELL DEVELOPMENT FOR ARROW RENTAL, LIVERMORE, CA.

WELL I.D.	DATES OF DEVELOPMENT	INITAL WATER LEVEL (FEET)	INITIAL TOTAL DEPTH (FEET)	TOTAL AMOUNT OF WATER BAILED (GALLONS)	TOTAL TIME OF SWABBING (minutes)	TOTAL AMOUNT OF WATER DISCHARGED (BAILED AND PUMPED)	COMMENTS
W-A	7/26 & 7/27	44.25	57.99	165	12	250	GASOLINE ODOR
W-B	7/27	44.62	55.12	100	0	100	BAILED DRY
W-C	7/27	43.34	50.3	30	0	30	
W-D	7/26	42.19	58.65	250	10	550	
W-E	7/27	43.08	58.61	35	0	35	CROOKED WELL
EXISTING WELLS							
W-1		45.69					PURE PRODUCT
W-2		45.65					GASOLINE ODOR
W-3		45.13					GASOLINE ODOR

HEALTH AND SAFETY COMPLIANCE AGREEMENT

I, the undersigned, have received a copy of the health and safety plan for the project identified below. I have read the plan, understand it, and agree to comply with all of the health and safety requirements therein. I understand that I may be prohibited from continuing work on the project for failing to comply.

I have __ have not __ (check one) been briefed by a project safety authority on the health and safety requirements of the project.

Project No. 9000321A-3000

Project Title _____

Date of Plan _____

FRANK BRIGGS
Print Name

FRANK BRIGGS
Signature

DATOM
Firm

7/25/90
Date

Woodward-Clyde Consultants

500 12th Street, Suite 100, Oakland, CA 94607-4041
(415) 893-3600

Chain of Custody Record

PROJECT NO. 90C0321A-3000

SAMPLERS: (Signature)

DATE	TIME	SAMPLE NUMBER	Sample Matrix (S)oil, (W)ater, (A)ir	EPA Method	EPA Method	EPA Method	EPA Method	Fuel Fingerprint	TPH, BTEX	2-methylnepthalene	Napthalene	Phenol		Number of Containers	REMARKS (Sample preservation, handling procedures, etc.)
10/5/90	0755	Travel Blank												1	Normal Turnaround Results to
7/26/90	0900	W-1												2	Al Ridley, copy
7/26/90	0855	W-A						X	X	X	X	X		2	to LOIS GRUENBERG
7/27/90	1125	W-1 *						X	X	X	X	X		2	

Remarks: * please use this sample for analyses. On both dates, could not achieve zero headspace. Use 7/26/90 sample if necessary.

TOTAL NUMBER OF CONTAINERS: 7

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
[signature]	7/27/90 1200				

METHOD OF SHIPMENT:	SHIPPED BY: (Signature)	COURIER: (Signature)	RECEIVED FOR LAB BY: (Signature)	DATE/TIME
Federal Express				

Sample No. W-A

W-1 ℄= 45.69
collected rust/orange gasoline from top of bailer.. couldn't get zero headspace.
0900
T. Blank from Oct5, 0755

W-A
Bailed out 110gallons
Swab 0933- 0945
Bail out 55gallons
Pump: Bailing ℄= 48.70
Water level:
W-2 45.65 slight gas odor on probe
W-3 45.13

WATER SAMPLE LOG

Sample No. W-A

Project No.: 900321A-5000 Date: 7/26/90
Project Name: AKRON RENTAL, LIVERMORE
Sample Location: Just Right of Driveway.
Well Description: 4" sch 40, PVC
Weather Conditions: Clear Skies; 21°c in shade; warm
Observations / Comments: No Floaters; however strong odor- collected samples (2) one from top & bottom of bailer - clear in color

Quality Assurance

Sampling Method: New Disposable Bailer
Method to Measure Water Level: Solinst
Pump Lines: New / (Cleaned) Bailer Lines: New / (Cleaned)
Method of cleaning (Pump / Bailer) * Steam cleaned
pH Meter No.: 0230957 Calibrated 7.00+10.0@25
Specific Conductance Meter No.: 13752 Calibrated red-lined
Comments: TD= 57.63;

Sampling Measurements

Water Level (below MP) at Start: 44.25 End:
Measuring Point (MP): Toc (N rim)

Time	Discharge (gallons)	pH	Temp. (°C)	Specific Conductance (µmhos / cm)	Turbidity	Color	Odor	Comments
	205							5gal silt with oil
1150	205	7.08	21	950	HIGH	dk BRN	slight gas	
1206	215	7.23	20	890	"	"	"	
7/27/90 1547	240	7.24	21	899	"	lt brn	"	
1612	250	7.33	22	999	"	"	"	
—	—							

Total Discharge: 315 Casing Volumes Removed:
Method of disposal of discharged water: To labelled barrels
Number and size of sample containers filled: 7 barrels

Collected by:

Woodward-Clyde Consultants
500 12th Street, Suite 100, Oakland, CA 94607-4014
(415) 893-3600

Sample No. W-B

quit @1515 on W-B. Going to W-A again

WATER SAMPLE LOG

Sample No. W-B

Project No.: 90C0321A-3000 Date: 7/26/90 / 7/27/

Project Name: ARROW RENTAL

Sample Location: W-B behind shop

Well Description: 4" sch 80

Weather Conditions: Hot. clear skies

Observations / Comments: No Floaters, no odors. no sample

Quality Assurance

Sampling Method: New Desposable Bailer

Method to Measure Water Level: Solinst

Pump Lines: New / Cleaned Bailer Lines: New / (Cleaned)

Method of cleaning Pump / (Bailer): Steam cleaned

pH Meter No.: 0230957 Calibrated 7/27/90

Specific Conductance Meter No.: 13152 Calibrated refined

Comments: TD = 54.62 + .30 = 55.12

bail, swab, bail; water too low to pump. bailing dry

wait 1 1/5 min. → full 10' bailer. → only bail out 10g.

Sampling Measurements

Water Level (below MP) at Start: 44.62 End:

Measuring Point (MP): TOC (NRIM)

Time 7/27/90	Discharge (gallons)	pH 12	Temp. (°C)	Specific Conductance (µmhos / cm)	Turbidity	Color	Odor	Comments
1220	≈30	7.16	20	1099	HIGH	Tan Brown	slo	1" 15ml of silt
1351	70	7.05	21	1011	"	Lt Brown	"	50ml of silt
1503	100	7.10	23	1100	"	"		50ml of silt
		2 BARRELS - BY TREE						

Total Discharge: 100 Casing Volumes Removed:

Method of disposal of discharged water: To bbls. (2)

Number and size of sample containers filled: None

Collected by: JLee / DATUM

Woodward-Clyde Consultants
500 12th Street, Suite 100, Oakland, CA 94607-4014
(415) 893-3600

Sample No.

8-8:30 DOWNTIME - GET CLEVIS TO FIT DOWN 2" well.

WATER SAMPLE LOG

Sample No. W-C

Project No. : 90C0321A-3000 Date: 7/26/90

Project Name: Arrow Rentals

Sample Location: ON EUCLID STREET. ON opposite side of A. Rental, just S of Rooney's

Well Description: 2" sch 80

Weather Conditions: warm, sun, foggy, 20°C

Observations / Comments:

Quality Assurance

Sampling Method: New Disposable bailer

Method to Measure Water Level : Solinst

Pump Lines: New / Cleaned Bailer Lines: New / (Cleaned)

Method of cleaning Pump (Bailer): Steam cleaned

pH Meter No.: 0230957 Calibrated 7/26/90 7 + 10 AM

Specific Conductance Meter No.: #13752 Calibrated red-lined

Comments: TD = 50.30 + .0 = 50.30

Sampling Measurements

Water Level (below MP) at Start: 43.34 End:

Measuring Point (MP): TOC (N Rim)

Develop time 7/27/90	Discharge (gallons)	pH	Temp. (°C)	Specific Conductance (µmhos / cm)	Turbidity	Color	Odor	Comments
0847	~~20~~ 25	8.48	19	1250	HIGH	BRN		thick
0903	≈ 2.0	7.90	20	1000	"	"		"
917	≈ 3.0	7.69	19.5	≈ 930	"	"		300ml thick LI hot thick LI starting to produce more water
0927	≈ 8.0	7.72	20	900	"	"		
1002	30	7.63	20	890	"	"		

Total Discharge: 30 Casing Volumes Removed:

Method of disposal of discharged water: 1 barrel

Number and size of sample containers filled: None

Collected by: JLee / DATUM

Woodward-Clyde Consultants
500 12th Street, Suite 100, Oakland, CA 94607-4014
(415) 893-3600

Sample No.

start Bailing @ 1345 - Mike dropped off barrels (10 of them) total # of new barrels = 20 barrels.

WATER SAMPLE LOG

Sample No. W-E

Project No.: 90C03214-3000 Date: 7/26 - 7/27 - Dev

Project Name: Arrow Rental

Sample Location: On dead end st - next to D+M Auto Shop.

Well Description: 2" (middle of Rd) next to D+M AutoShop.

Weather Conditions: 29°C in shade

Observations / Comments: Well is crooked throughout, barely get 10' bailer down well.

Quality Assurance

Sampling Method: RB Cleaned Disposable Bailer from W-

Method to Measure Water Level: Solinst

Pump Lines: New / Cleaned Bailer Lines: New / (Cleaned)

Method of cleaning Pump (Bailer) Steam cleaned

pH Meter No.: 0230957 Calibrated @1056 7+10

Specific Conductance Meter No.: 13752 Calibrated red-lined

Comments: TD = 58.31 + .30 = 58.61

Sampling Measurements

Water Level (below MP) at Start: 43.08 End:

Measuring Point (MP): TOC (N RIM)

Time 7/27/90	Discharge (gallons)	pH	Temp. (°C)	Specific Conductance (µmhos / cm)	Turbidity	Color	Odor	Comments
1414	10	7.49	22	899	HIGH	[illegible]	NO	
1604	30	7.38	21	899	"	"	"	
1693	35	7.34	21	880	"	"	"	

Total Discharge: 35 Casing Volumes Removed:

Method of disposal of discharged water: 1 barrel

Number and size of sample containers filled: None

Collected by: JLee/DATUM

Woodward-Clyde Consultants
500 12th Street, Suite 100, Oakland, CA 94607-4014
(415) 893-3600

Sample No.

1515 - 1525 - Swab
pump @ 1515

WATER SAMPLE LOG

Sample No. W-D

Project No.: 90C0321A -3000 Date: 7/26/90

Project Name: ARROW RENTALS

Sample Location: BEHIND PINK HOUSE, IN it's Backyard

Well Description: 4" Sch 80 PVC

Weather Conditions: HOT - clear skies

Observations / Comments:

Quality Assurance

Sampling Method: None

Method to Measure Water Level: Solinst

Pump Lines: New / Cleaned Bailer Lines: New / (Cleaned)

Method of cleaning Pump (Bailer): Steam Cleaned

pH Meter No.: 0230957 Calibrated 7/26/90

Specific Conductance Meter No.: 15752 Calibrated Ref-Lined

Comments: TD = 58.65

Sampling Measurements

Water Level (below MP) at Start: 42.19 End:

Measuring Point (MP): TOC (N RIM)

Time	Discharge (gallons)	pH	Temp. (°C)	Specific Conductance (µmhos / cm)	Turbidity	Color	Odor	Comments
1414	130	7.40	21.5	850	HIGH	Lt BRN	?	1 gal/min
1458	250	7.39	21	800	"	"	"	50 ml/min
1552	300	7.38	21	800	"	"	"	min
1626	450	7.44	22	800	"	"	"	min
1638	500	7.46	21	800	MOD	Lt Brn	"	min
1648	550	7.36	21	800	MOD SILT	"	"	"

Total Discharge: 550 Casing Volumes Removed:

Method of disposal of discharged water: TO 11 barrels

Number and size of sample containers filled: 2 voc's (TPH, BTEX, phenol)

Collected by: Glee / Ostrom

Woodward-Clyde Consultants
500 12th Street, Suite 100, Oakland, CA 94607-4014
(415) 893-3600

FEDERAL EXPRESS

USE THIS AIRBILL FOR DOMESTIC SHIPMENTS WITHIN THE CONTINENTAL U.S.A., ALASKA AND HAWAII.
USE THE INTERNATIONAL AIR WAYBILL FOR SHIPMENTS TO PUERTO RICO.
QUESTIONS? CALL 800-238-5355 TOLL FREE.

AIRBILL
PACKAGE TRACKING NUMBER
5917290466

9335M 5917290466

SENDER'S COPY

SENDER'S COPY

Sender's Federal Express Account Number: 0941-0474-2
Date: 7/27/92

From (Your Name) Please Print: Jacki Lee
Your Phone Number (Very Important): (415 874-3038
Company: WOODWARD-CLYDE CONSULTANTS
Department/Floor No:
Street Address: 500 12TH ST STE 100
City: OAKLAND
State: CA
ZIP Required: 9 4 6 0 7

To (Recipient's Name) Please Print: Shipping/Receiving Dept.
Recipient's Phone Number (Very Important): (206) 295 8272
Company: Friedman + Bruya
Department/Floor No:
Exact Street Address (We Cannot Deliver to P.O. Boxes or P.O. Zip Codes.): 2008-E 16th Ave West
City: Seattle
State: WA
ZIP Required: 98119

YOUR INTERNAL BILLING REFERENCE INFORMATION (First 24 characters will appear on invoice.): 900321A-3000

IF HOLD FOR PICK-UP, Print FEDEX Address Here
Street Address:
City:
State:
ZIP Required:

PAYMENT 1 [X] Bill Sender 2 [ ] Bill Recipient's FedEx Acct No 3 [ ] Bill 3rd Party FedEx Acct No 4 [ ] Bill Credit Card
5 [ ] Cash
Expiration Date

4 SERVICES (Check only one box)

Priority Overnight Service (Delivery by next business morning.†)
11 [X] YOUR PACKAGING
16 [ ] FEDEX LETTER *
12 [ ] FEDEX PAK *
13 [ ] FEDEX BOX
14 [ ] FEDEX TUBE

Standard Overnight Service (Delivery by next business afternoon.†)
51 [ ]
56 [ ] FEDEX LETTER *
52 [ ] FEDEX PAK *
53 [ ] FEDEX BOX
54 [ ] FEDEX TUBE

Economy Service (formerly Standard Air) (Delivery by second business day.††)
30 [ ] ECONOMY SERVICE

Heavyweight Service (for FedEx Box or any package over 150 lbs.)
70 [ ] HEAVYWEIGHT **
80 [ ] DEFERRED HEAVYWEIGHT **

DELIVERY AND SPECIAL HANDLING
1 [ ] HOLD FOR PICK-UP (If box 4b)
2 [ ] DELIVER WEEKDAY
3 [X] DELIVER SATURDAY (Extra charge) (Not available for all locations)
4 [ ] DANGEROUS GOODS (Extra charge) (CSS not available for Dangerous Goods Shipments)
5 [ ] CONSTANT SURVEILLANCE SVC. (CSS) (Extra charge) (Release Signature Not Applicable)
6 [ ] DRY ICE lbs
7 [ ] OTHER SPECIAL SERVICE
8 [ ]
9 [ ] SATURDAY PICK-UP (Extra charge)
10 [ ]
11 [ ] HOLIDAY DELIVERY (If offered)

PACKAGES	WEIGHT In Pounds Only	YOUR DECLARED VALUE (See right)	OVER SIZE
Total	Total	Total	

DIM SHIPMENT (Heavyweight Services Only) [ ] lbs

Received At
1 [ ] Regular Stop 2 [ ] Drop Box
3 [X] No Call Stop 4 [ ] B.S.C. 5 [ ] Station
Total Charges

SERVICE CONDITIONS, DECLARED VALUE AND LIMIT OF LIABILITY

Use of this airbill constitutes your agreement to the service conditions in our current Service Guide, available upon request. See back of sender's copy of this airbill for information.

We will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery, misdelivery, or misinformation, unless you declare a higher value, pay an additional charge, and document your actual loss for a timely claim. Maximum amount limitations found in the current Federal Express Service Guide apply. Your right to recover from Federal Express for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental, consequential, or special is limited to the greater of $100 or the declared value specified to the left. Recovery cannot exceed actual documented loss.

In the event of untimely delivery, Federal Express will at your request and with some limitations, refund all transportation charges paid. See Service Guide for further information.

Sender authorizes Federal Express to deliver this shipment without obtaining a delivery signature and shall indemnify and hold harmless Federal Express from any claims resulting therefrom.

5 Release Signature:
Date/Time

Federal Express Use
Base Charges
Declared Value Charge
Other 1
Other 2
Total Charges

REVISION DATE 10/89
PART #119421 FXF-M 11/89
FORMAT #014
014
PRINTED IN U.S.A.

Table 1

Organic Vapor Concentrations Measured with an HNu Photoionization Detector

Boring Number	Depth feet	Maximum HNU Reading* (ppm-HNu Units
B-1	2	0
	5	0
	10	0
	15	0
	20	5.6
	25	68.5
B-2	2	0
	5	0
	10	0
	15	0
	20	0
	25	32.6
B-3	2	0
	5	0
	10	0
	15	0
	20	3.1
	25	1.2
B-4	2	0
	5	0
	10	0
	15	0
B-5	2	0
	5	0
	10	0
	15	0
	20	0
	25	16.3
B-6	2	0
	5	0
	10	0
	15	0
	20	0
	25	0

* Relative hydrocarbon levels

Table 2

Summary of Laboratory Analyses of Soil Samples

Total Petroleum Hydrocarbons and BTEX (EPA 8015/8020)

Boring Number	Depth (feet)	TPH gasoline (ppm)	TPH diesel (ppm)	Benzene ppm	Toluene ppm	Ethyl-benzene ppm	xylene ppm
B-1	2	ND	NT	ND	ND	ND	ND
	5	ND	NT	ND	ND	ND	ND
	10	ND	NT	ND	ND	ND	ND
	15	ND	2.3	ND	ND	ND	ND
	20	170	NT	2.1	1.4	0.22	1.5
	25	220	NT	ND	2.4	2.1	11.0
B-2	2	3.5	NT	ND	ND	ND	0.1
	5	8.2	NT	ND	ND	ND	ND
	10	ND	NT	ND	ND	ND	ND
	15	ND	2.3	ND	ND	ND	ND
	25	1.7	NT	ND	ND	ND	0.13
B-3	2	ND	NT	ND	ND	ND	ND
	5	ND	NT	ND	ND	ND	ND
	10	ND	NT	ND	ND	ND	ND
	15	ND	2.6	ND	ND	ND	ND
	20	ND	NT	ND	ND	ND	ND
	25	1.3	NT	ND	ND	ND	ND
B-4	2	ND	NT	ND	ND	ND	ND
	5	ND	NT	ND	ND	ND	ND
	10	ND	NT	ND	ND	ND	ND
	15	ND	NT	ND	ND	ND	ND
B-5	2	ND	NT	ND	ND	ND	ND
	5	1.9	NT	ND	ND	ND	ND
	10	ND	NT	ND	ND	ND	ND
	15	ND	NT	ND	ND	ND	ND
	20	ND	ND	ND	ND	ND	ND
	25	1.7	NT	ND	ND	ND	ND
B-6	5	1.8	NT	ND	ND	ND	ND
	10	ND	NT	ND	ND	ND	ND
	15	ND	NT	ND	ND	ND	ND
	20	ND	NT	ND	ND	ND	ND
	25	ND	NT	ND	ND	ND	ND

ND = Non-Detected
NT = Not-Tested

8810220T/COT

Table 2 (concluded)
Summary of Soil Samples Analytical Laboratory Results

Volatile Organics (EPA 8240)

Boring Number	Depth (feet)	Benzene µg/kg	toluene µg/kg	Ethyl-benzene µg/kg	xylene µg/kg
B-1	25	380	7,100	6,400	52,000
B-2	25	ND	ND	ND	550

Semi-Volatile Organics (EPA 8240)

Boring Number	Depth (feet)	Component	Concentration µg/kg
B-1	25	2-Methylnaphthalene	3,500
		2-Naphthalene	3,400
		phenol	300

Metals Analyses
1940 Railroad Ave.

Boring Number	Depth (feet)	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Hg mg/kg	Zn mg/kg
B-6	2	42	34	100	5.8	0.035	36
	5	43	16	100	4.4	0.059	35
(TTLC)*		(2500)	(2500)	(2000)	(1000)	(20)	(5000)
(STLC)+		(560)	(25)	(20)	(5)	(0.2)	(250)

* TTLC = Total Threshold Limit Concentration (CAC, Title 22)
+ STLC = Soluble Threshold Limit Concentration (CAC, Title 22)

Table 1. ELEVATIONS OF MEASURING POINTS AND ELEVATION OF GROUNDWATER, 187 NORTH L STREET, LIVERMORE, CALIFORNIA

Well Number	Measuring Point Elevation (Project Datum, feet)	Depth to Groundwater (feet)	Elevation (feet) June 2, 1989
W-1	99.22	43.16	56.06
W-2	99.07	44.24	54.83
W-3	98.03	44.50	53.53

Note: Assumed temporary benchmark elevation 100 feet.

Table 2. SUMMARY OF SOIL SAMPLE ANALYTICAL RESULTS FOR MONITORING WELLS W-1, W-2 AND W-3 AND BORINGS B-7 AND B-8, 187 NORTH L STREET, LIVERMORE, CALIFORNIA

Well/ Boring Number	Sample Depth	High Boiling Point Hydrocarbons (Diesel) (ppm)	Low Boiling Point Hydrocarbons (Gasoline) (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Xylenes (ppm)
W-1	5'	NR	ND	ND	ND	ND	ND
	10'	NR	ND	ND	ND	ND	ND
	15'	NR	1,200	ND	21	20	130
	20'	380	350	2.5	14	6.3	30
	25'	NR	490	3.5	24	9.4	46
	30'	NR	160	1.0	7.9	3.6	18
	35'	NR	370	2.4	20	8.2	40
	40'	1,500	16,000	220	1,100	340	1,500
	45'	NR	1,600	30	120	34	160
	50'	NR	2,500	28	200	59	270
	55'	NR	120	3.2	10	2.7	13
W-2	5'	NR	1.2	ND	0.14	ND	ND
	10'	NR	ND	ND	0.1	ND	ND
	15'	NR	ND	ND	0.1	ND	ND
	20'	NR	ND	ND	ND	ND	ND
	25'	NR	ND	ND	ND	ND	ND
	30'	NR	ND	ND	ND	ND	ND
	35'	NR	ND	ND	ND	ND	ND
	40'	NR	ND	ND	ND	ND	ND
	45'	ND	ND	ND	ND	ND	ND
	50'	NR	ND	ND	ND	ND	ND
W-3	5'	NR	ND	ND	ND	ND	ND
	10'	NR	ND	ND	ND	ND	ND
	15'	NR	ND	ND	ND	ND	ND
	20'	NR	ND	ND	ND	ND	ND
	25'	NR	ND	ND	ND	ND	ND
	30'	NR	ND	ND	ND	ND	ND
	35'	NR	ND	ND	ND	ND	ND
	40'	ND	ND	ND	ND	ND	ND
	45'	NR	ND	ND	ND	ND	ND
	50'	NR	12	0.06	ND	ND	ND

Table 2. SUMMARY OF SOIL SAMPLE ANALYTICAL RESULTS FOR WELLS W-1, W-2 AND W-3 AND BORINGS B-7 AND B-8, 187 NORTH L STREET, LIVERMORE, CALIFORNIA

Well/ Boring Number	Sample Depth	High Boiling Point Hydrocarbons (Diesel) (ppm)	Low Boiling Point Hydrocarbons (Gasoline) (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylbenzene (ppm)	Xylenes (ppm)
B-7	5'	ND	ND	ND	ND	ND	ND
	10'	NR	ND	ND	ND	ND	ND
B-8	5'	NR	ND	ND	ND	ND	ND
	10'	ND	ND	ND	ND	ND	ND
Detection Limits:		1.0	1.0	0.05	0.1	0.1	0.1

ND = Not Detected
NR = Analysis Not Run

Table 3. SUMMARY OF GROUNDWATER SAMPLE ANALYTICAL RESULTS, NOVEMBER 1988, 187 NORTH L STREET, LIVERMORE, CALIFORNIA

Well Number	Micrograms per Liter (ug/L)					
	High Boiling Point Hydrocarbon (Diesel)	Low Boiling Point Hydrocarbon (Gasoline)	Benzene	Toluene	Ethyl Benzene	Xylenes
W-1	300,000	210,000	29,000	30,000	5,400	24,000
W-2	ND	360	6.7	2.1	0.47	1.3
W-3	2,200	11,000	290	120	150	140
Detection Limits:	50.0	30.0	0.3	0.3	0.3	0.3
State or Federal Drinking Water Limits (MCLS)	--	--	1.0	2,000	680	1750
State Drinking Water Action Levels	--	--	0.7	100	680	620

ND = Not Detected

APPENDIX D
TANK INTEGRITY TEST

Data Chart for Tank System Tightness Test

AS PRINT

1. OWNER Property ☑ Tank(s) ☑
Name: Arrow Rental Address: 187 North L St Livermore Cal. Representative: Telephone:
Name: Address: Representative: Telephone:

2. OPERATOR
Name: Arrow Rental Address: "Same" Telephone:

3. REASON FOR TEST (Explain Fully)
Annual Test

4. WHO REQUESTED TEST AND WHEN
Name: Tony Sullins Title: Owner Company or Affiliation: Arrow Rental Date:
Address: Telephone:

5. TANK INVOLVED (Use additional lines for manifolded tanks)

Identify by Direction	Capacity	Brand/Supplier	Grade	Approx. Age	Steel/Fiberglass
South-East	1,000	Pitcock	Reg	5yrs	Steel

6. INSTALLATION DATA

Location	Cover	Fills	Vents	Siphons	Pumps
L St	concrete	4"	1 1/2"	none	suction
North inside driveway, Rear of station, etc.	Concrete, Black Top, Earth, etc.	Size, Tiefill make, Drop tubes, Remote Fills	Size, Manifolded	Which tanks?	Suction, Remote, Make it known

7. UNDERGROUND WATER
Depth to the Water table: 120+
Is the water over the tank? ☐ Yes ☑ No

8. FILL-UP ARRANGEMENTS
Tanks to be filled 8:00 a.m. 2/9/90 Date Arranged by Tony Sullins Name 455-1900 Telephone
Extra product to "top off" and run tank tester. How and who to provide? Consider NO Lead.
Terminal or other contact for notice or inquiry — Company: Name: Telephone:

9. CONTRACTOR, MECHANICS, any other contractor involved

10. OTHER INFORMATION OR REMARKS
Additional information on any items above. Officials or others to be advised when testing is in progress or completed. Visitors or observers present during test, etc.

11. TEST RESULTS
Tests were made on the above tank systems in accordance with test procedures prescribed for as detailed on attached test charts with results as follows:

Tank Identification	Tight	Leakage Indicated	Date Tested
South-East	Tight	+.008	2/9/90

12. SENSOR CERTIFICATION
2/9/90 Date
15085 Serial No. of Thermal Sensor

13. This is to certify that these tank systems were tested on the date(s) shown. Those indicated as "Tight" meet the criteria established by the National Fire Protection Association Pamphlet 329.

Technicians
1. Michael Comer
Certification # 614811388
State Lic. # 98-1347

Comer Petroleum Equip. Testing Contractor or Company. By: Signature
PO Box 1651 Pleasanton, Calif. Address

PN882

Cert'd

27. Sensor Calibration 16601/16602 — LOG OF TEST PROCEDURES			30. HYDROSTATIC PRESSURE CONTROL		31. VOLUME MEASUREMENTS (V) RECORD TO .001 GAL			34. TEMPERATURE COMPENSATION USE FACTOR (a)			38. NET VOLUME CHANGING EACH READING	39. ACCUMULATED CHANGE
28. DATE / TIME (24 hr.)	Record details of setting up and running test. (Use full length of line if needed.)	29. Reading No.	Standpipe Level in Inches: Beginning of Reading	Standpipe Level in Inches: Level to which Restored	32. Product in Graduate: Before Reading	32. Product in Graduate: After Reading	33. Product Replaced (-) Product Recovered (+)	35. Thermal Sensor Reading	36. Change Higher + Lower − (c)	37. Computation (c) × (a) = Expansion + Contraction −	Temperature Adjustment — Volume Minus Expansion (+) or Contraction (-) (#33(V) — #37(T))	At Low Level compute Change per Hour (NFPA criteria)
08:30	Arrive Job Site, check tank to see if product is needed											
09:00	Had Arrow Rental get 25 additional gallons to top off equip.											
09:30	Set up equip.											
09:45	Check to see if any water is present in tank or in tank ext. No water detected											
10:00	Start Recirculation Flushed air eliminator											
10:15	Took API Sample											
10:30	Start High Level Test			42				.089		.0022		
10:45	"	1	43.5	42	.495	.565	+.070	.320	+41	+.090	-.020	
11:00	"	2	43.0	42	.565	.615	+.050	.355	+25	+.055	-.005	
11:15	"	3	43.4	42	.615	.680	+.065	.386	+31	+.068	-.003	
11:30	"	4	43.4	42	.680	.750	+.070	.419	+33	+.073	-.003	
	Low Level Test			12								
11:45	"	1	14.0	12	.180	.270	+.090	.452	+33	+.073	+.017	
12:00	"	2	13.2	12	.270	.330	+.060	.479	+27	+.059	+.001	
12:15	"	3	13.1	12	.330	.380	+.050	.508	+29	+.064	-.014	
12:30	"	4	13.2	12	.380	.440	+.060	.537	+29	+.064	-.004	-.004
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

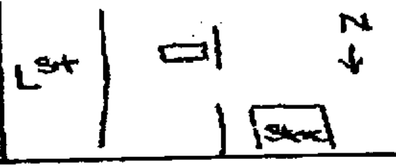
14. Arrow Rental — 187 North L St — Livermore — Calif — 8/15/90
Name of Supplier, Owner or Dealer — Address No. and Street(s) — City — State — Date of Test

15. TANK TO TEST

South-East
Identify by position

Brand and Grade

15a. BRIEF DIAGRAM OF TANK FIELD



16. CAPACITY

Nominal Capacity 1000 Gallons

By most accurate capacity chart available 1036 Gallons

From
- [ ] Station Chart
- [x] Tank Manufacturer's Chart
- [ ] Company Engineering Data
- [ ] Charts supplied with
- [ ] Other

17. FILL-UP FOR TEST

Stick Water Bottom before Fill-up Ø in. Ø Gallons 45½" Tank Diameter in.

Inventory	Gallons	Total Gallons on Reading
Full Tank		1036
Top off		+ 10
Water		Ø
Total Product		1046

Transfer total to line 25a

18. SPECIAL CONDITIONS AND PROCEDURES TO TEST THIS TANK

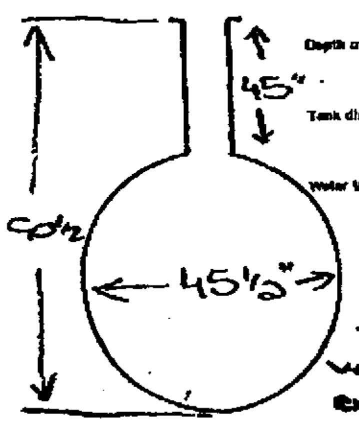
- [ ] Water in tank
- [ ] Line(s) being tested with LVLLT
- [ ] High water table in tank excavation

See manual sections applicable. Check below and record procedure in log (27).

Use maximum allowable test pressure for all tests. Four pound rule does not apply to doublewalled tanks.

Complete section below:

1. Is four pound rule required? Yes [ ] No [x]
2. Height to 12" neck from bottom of tank 106" in.
3. Pressure at bottom of tank 2.75 P.S.I.
4. Pressure at top of tank 1.58 P.S.I.



Depth of burial 45 in.
Tank dia. 45½ in.
Water table 180+ in.

NOTES: Water Level was checked thru a monitor well in the tank excavation

The above calculations are to be used for dry soil conditions to establish a positive pressure advantage, or when using the four pound rule to compensate for the presence of subsurface water in the tank area.

Refer to N.F.P.A. 30, Sections 2-3.2.4 and 2-7.2 and the tank manufacturer regarding allowable system test pressures.

19. TANK MEASUREMENTS FOR TSTT ASSEMBLY

Bottom of tank to grade* 90½ in.
Add 30" for "T" probe assy. 30 in.
Total tubing to assemble — approximate 120½ in.

20. EXTENSION HOSE SETTING

Tank top to grade* 45 in.
Extend hose on suction tube 8" or more below tank top 6 in.

*If Fill pipe extends above grade, use top of fill.

22. Thermal-Sensor reading after circulation 08285 digits
46-47 °F Between

23. Digits per °F in range of expected change 312 digits

COEFFICIENT OF EXPANSION (Complete after circulation)

24a. Corrected A.P.I. Gravity

Observed A.P.I. Gravity 58.8
Hydrometer employed 6 H
Observed Sample Temperature 54° °F
Corrected A.P.I. Gravity @ 60°F, From Table A N/A
Coefficient of Expansion for Involved Product From Table B N/A

Transfer COE to Line 25b.

21. VAPOR RECOVERY SYSTEM

- [x] Stage I
- [ ] Stage II

24b. COEFFICIENT OF EXPANSION RECIPROCAL METHOD

Type of Product Reg
Hydrometer Employed 6 H
Temperature in Tank After Circulation 46.6 °F
Temperature of Sample 54° °F
Difference (+/-) +7.4 °F
Observed A.P.I. Gravity 58.8
Reciprocal 1488 Page # 62

1046 ÷ 1488 = .702956
Total quantity in full tank (16 or 17) — Reciprocal — Volume change in this tank per °F

Transfer to Line 26.

24c. FOR TESTING WITH WATER see Table C & D

Water Temperature after Circulation Table C N/A °F
Coefficient of Water Table D N/A

Added Surfactant? [ ] Yes [ ] No Transfer COE to Line 25b.

25. (a) 1046 × (b) N/A = (c) N/A gallons
Total quantity in full tank (16 or 17) — Coefficient of expansion for involved product — Volume change in this tank per °F

26 [redacted]) . 7 [redacted] 95 [redacted] 312 [redacted] .002253 [redacted]
Volume change per °F (25 or 24 [redacted] — Digits per °F in test — Volume change per digit

APPENDIX E

HISTORICAL EVIDENCE OF MOBIL SERVICE STATION

EVIDENCE OF EXISTENCE OF MOBIL SERVICE STATION AT 187 NORTH "L" STREET IN LIVERMORE, CALIFORNIA CIRCA 1951-1968

1. Pacific Telephone Directory, October 1966, Page 507

2. 1968 Livermore City Directory, Page 53

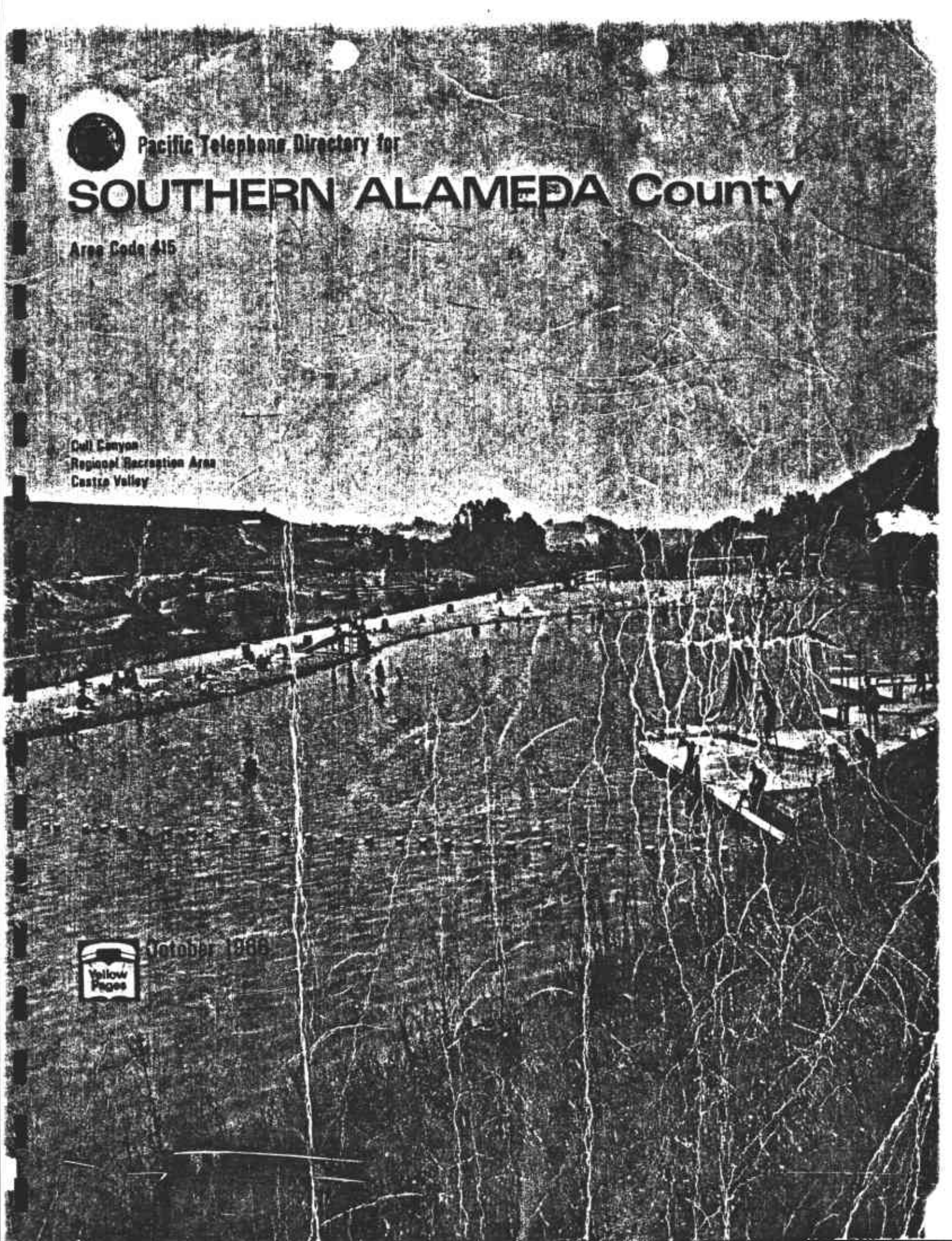
3. City of Livermore Building Permit to Socony-Mobile Co. For Underground Storage Tank, December 2, 1960

4. Mobil Oil Company, Ten Year Service Award to John Bowersox, 1961

Pacific Telephone Directory for

SOUTHERN ALAMEDA County

Area Code 415



Cull Canyon
Regional Recreation Area
Castro Valley

October 1986

Yellow Pages

Service Stations—Gasoline & Oil—(Cont'd)

...ick's Chevron Service Stn
1259-1st(L) ---- 447-0494
McDOUGALL'S RICHFIELD SERVICE
41980 Fremont Bl(F) ---- 657-4217
(Please See Advertisement Page 504)
...Sam Service
...4 E 14th(SL) ---- 278-6833
MEADOW SQUARE CHEVRON
41500 Blacow Rd(F) ---- 656-9890
(Please See Advertisement Page 505)
...Auto Clinic
...9 Foothill Bl ---- 582-5673
...n Mobil Serv
43201 Misn Bl(F) ---- 656-9972
MISSION PASS SHELL SERV
...6 Misn Bl(F) ---- 657-4587
...Lido Faire Serv
...rk Bl & Decoto Bl(N) ---- 793-9805

MOBIL PRODUCTS—
ARROYO SERVICE
1496 Grant Av(SLZ) ---- 278-0924
BILL'S MOBIL SERVICE CENTER
1974 W Tennysn Rd ---- 783-9732
BOB'S MOBIL SERVICE
494 Rousseau ---- 471-1414
HAVEN GENE SERVICE STN
186 E Lewelling Bl(SLZ) ---- 276-5464
GOLDEN GATE MOBIL SERVICE
1210 Bockman Rd(SLZ) ---- 276-9871
HUB MOBIL SERVICE
4190 Mowry Av(F) ---- 793-4157
MISSION MOBIL SERV
43201 Misn Bl(F) ---- 656-9972
MOBIL SERVICE STN DLRS
2492 Castro Valley Bl(CV) ---- 581-9666
MOBIL SERV STN DLRS
587 Paseo Grnde(SLZ) ---- 276-1271
...YCROFT'S MIKE MOBIL
1485-1st(L) ---- 447-7777
PARK WAY MOBIL SERVICE STN
7197 Village Pkwy Dbln ---- 828-4093
PAT'S MOBIL SERV
1701 B ---- 581-9765
RAY'S SERVICE
404 W Harder Rd ---- 782-0885
RON'S MOBIL SERV
38395 Misn Bl(F) ---- 793-7134
SOUTHGATE MOBIL SERV STN
26089 Calaroga Av ---- 782-6086
SUNDALE MOBIL SERV STN
4997 Stevenson Bl(F) ---- 656-9885
SUTTON BROTHERS MOBIL SERVICE
38501 Hesperian Bl(SLZ) ---- 276-9807
VALLEY MOBIL SERVICE
187 North L(L) ---- 447-9858
VALLEY TIRE SERVICE
1024 Santa Rita Rd(P) ---- 846-5887
VERNE'S MOBIL SERV
1109 W Tennysn Rd ---- 782-4931

Mobil Service Stn Dlrs
...0 Blacow Rd(F) ---- 793-2020
...0 Bockman Rd(SLZ) ---- 276-9871
...089 Calaroga Av ---- 782-6086
...492 Castro Valley Bl(CV) ---- 581-9666
...519 Castro Valley Bl(CV) ---- 582-2005
...36 Grant Av(SLZ) ---- 278-0924
...7 H(UC) ---- 471-9985
...4 W Harder Rd ---- 782-0885
...501 Hesperian Bl(SLZ) ---- 276-9807
...86 E Lewelling Bl(SLZ) ---- 276-5464
...8395 Misn Bl(F) ---- 793-7134
...7 Paseo Grnde(SLZ) ---- 276-1271
...997 Stevenson Bl(F) ---- 656-9885
...il Serv Stn Dlrs 1485-1st(L) ---- 447-7777

MOHAWK PRODUCTS—
BOB'S MOHAWK SERV
15526 Hesperian Bl(SLZ) ---- 276-2463
CHARLIE'S MOHAWK 811 D ---- 581-9811
JAKE'S MOHAWK STN
33623 Mission Bl(UC) ---- 471-4054
MOHAWK THRIFTY SERVICE
41093 Fremnt Bl(F) ---- 657-4929
P & D MOHAWK
34956 Fremont Bl(F) ---- 793-9864

Mohawk Super Service 493 West A ---- 783-4453
Mohawk Thrifty Service
41093 Fremnt Bl(F) ---- 657-4929
...nteiro's Service Stn
21305 Mission Bl ---- 581-8563

MORELLI UNION SERVICE STN
38348 Glenmoor Dr(F) ---- 793-3666
(Please See Advertisement Page 505)
NELSON'S BOB CHEVRON SERVICE
19201 Center(CV) ---- 581-0243
Newark Enco
5835 Thorntn Av(N) ---- 793-4550
Newell's Richfield Serv
580 West A ---- 783-9763
Niles Seaside Serv
37376 Misn Bl(F) ---- 793-9609

NORWALK PRODUCTS—

"You Can't Buy Better Gasoline"
NORWALK
—THE EDUCATED PUMP—
"MOTOR-MATCHED" GASOLINES
"WHERE TO BUY IT"
INDEPENDENT DEALERS

Fred's Norwalk Service Stn
2923 Misn Bl ---- 581-9975

Ogren's Union Serv
7375 Amadr Vly Bl Dublin ---- 828-2333
Oliveira Vincent Shell Service
98 Lewelling Bl(SLZ) ---- 278-3873
OLIVEIRA'S CENTRAL SERVICE same as Mobil Service Stn Dlrs
37630 Blacow Rd(F) ---- 793-2020
(Please See Advertisement Page 504)
P & D Mohawk
34956 Fremont Bl(F) ---- 793-9864
PACHECO GEO SIGNAL SERVICE
1301 B ---- 581-9721
Pallitto's Chevron Stn
3084-1st(L) ---- 447-0540
Park Way Mobil Service Stn
7197 Village Pkwy Dbln ---- 828-4093
Parrino Charles Shell Service
22315 Redwd Rd(CV) ---- 581-0727
Pat's Mobil Serv 1701 B ---- 581-9765
PAUL'S UNION CITY SERV
33663 Mish Bl(UC) ---- 471-9941
PAUL'S UNION 76 SERV
915 Whipple Rd(UC) ---- 471-9810
(Please See Advertisement Page 505)
Paxton's Union Serv Stn
590 W Harder Rd ---- 783-9952
PETE MUSKIN'S SUPER SHELL
2724 Castro Valley Bl(CV) ---- 538-2024
(Please See Advertisement Page 502)
Pete's Signal Service
26115 Hesperian Blvd ---- 783-6055
Phil's Chevron Serv 780 Main(P) ---- 846-5672
(Please See Advertisement Page 505)
Pilkington Ron Shell Service
110 W Harder Rd ---- 783-9916
Pilkington Ron's Shell Service
110 W Harder Rd ---- 782-1664
Pleasanton Service Stn
400 Main(P) ---- 846-5517
R & R Signal Service
33103 Misn Bl(UC) ---- 471-0805
RALPH'S RICHFIELD SERVICE
130 Harder Rd ---- 537-7509
Ray's Goodies
44 Lewelling Bl(SLZ) ---- 276-9741
Ray's Flying A Serv
22852 Foothill Bl ---- 537-3354
Ray's Norwalk Serv
16407 E 14th(SL) ---- 276-9975

RAY'S SERVICE
BRAKE SERVICE — TUNE-UPS
WHEEL ALIGN & BALANCING
MUFFLERS & TAIL PIPES
Trailer Rentals — Mobil Products
WE GIVE BLUE CHIP STAMPS
PICK-UP & DELIVERY
404 W Harder Rd ---- 782-0885

Ray's Texaco Service
36389 Mission Bl(F) ---- 793-9937
(Please See Advertisement Page 504)
Red Rooster Hancock
26699 Mission Blvd ---- 582-7976
Redd White's Shell Service
18811 Lake Chabot Rd(CV) ---- 582-9909
RED'S FLYING A SERVICE
Complete Brake Service
Motor Tune-Up-Wheel Alignment
150th Av & E 14th(SL) ---- 357-5811
Reed & Bing's Enco Service
194 Harder Rd ---- 582-9944

REGAL PETROLEUM CORP
HAYWARD 22690 Foothill
Regal Serv Stn
36974 Fremnt Bl(F) ---- 793-8667
Regal Service Sta
20450 Hesperian Bl ---- 783-9064
Regal Service Stns Inc
2780 Castro Vly Bl(CV) ---- 538-2522
Richardson's Union Service
992 Santa Rita Rd(P) ---- 846-9909
RICHEY'S RICHFIELD SERVICE
4088 Thorntn Av(F) ---- 793-1076

RICHFIELD—

RICHFIELD
BORON GASOLINE
Finest Premium
...

"WHERE TO BUY IT"

ADRIAN'S RICHFIELD SERVICE
22696 Main ---- 582-3600
ARNEY'S JIM 24 HR RICHFIELD SERV
Align & Balance-Tune-Ups
Brakes-Mufflers-S & H Green Stamps
2770 Castro Valley Bl(CV) ---- 582-0414
BARBERA & ZARO RICHFIELD SERVICE 174 South L(L) ---- 447-3455
BISSELL DAVE RICHFIELD SERV STN 365 Jackson ---- 538-4545
ED'S RICHFIELD
1679-1st(L) ---- 447-5702
FRANK HARRIS RICHFIELD SERVICE
Open 7 Days 6:30 to 10 PM
Brakes-Wheel Aligning-Tune-Ups
Auto Smog Control Installation
29985 Meekland Av ---- 582-4255
GLENN'S RICHFIELD SERVICE
19601 Center(CV) ---- 582-9954
HINTON'S RICHFIELD SERVICE
24476 Misn Bl ---- 582-9891
JESSUP'S RICHFIELD
3810 Washngtn Bl(F) ---- 656-8439
LON'S RICHFIELD SERVICE STN
Motor Tune-Up & Brake Service
17601 Hesperian Bl(SLZ) ---- 278-5835
Marv's Richfield Serv
15135 Hesperian Bl(SL) ---- 351-3682
MATTOX RICHFIELD SERVICE
20810 Foothl Bl ---- 581-4503
McDOUGALL'S RICHFIELD SERVICE
41980 Fremont Bl(F) ---- 657-4217
RALPH'S RICHFIELD SERVICE
Brakes-Motor Tune Up
Free Pick-Up & Delivery
130 Harder Rd ---- 537-7509
RICHEY'S RICHFIELD SERVICE
4088 Thorntn Av(F) ---- 793-1076
ROY'S RICHFIELD SERVICE
Brakes-Mufflers-Tune-up
Brand Name Tires
Pick-up & Delivery
We Give Blue Chip Stamps
29900 Mission Bl ---- 471-9977

Rick Sanchez Chevron Service
1334-1st(L) ---- 447-0949
Rincon Richfield
899 Rincon Av(L) ---- 447-0169
Roblez Signal Service Stn
33103 Mission Bl(UC) ---- 471-9934
RON'S MOBIL SERV
38395 Misn Bl(F) ---- 793-7134
Ron's Richfield Service
15880 Hesperian Bl(SLZ) ---- 278-2310
Rose's Union 76 Serv Stn
391 West A ---- 581-9979
ROY'S CHEVRON SERV
5269 Crow Cayn Rd(CV) ---- 582-9913
Roy's Richfield Service
29900 Mission Bl ---- 471-9977
Russell & Peck Sunland Service
160 Holmes(L) ---- 447-6180
SALEL SERVICE
15275 Washington Av(SL) ---- 351-8961
San Lorenzo Signal Service
17550 Hesperian Bl(SLZ) ---- 276-6442
San Ramon Village Shell Serv
7194 Amadr Vly Bl Dublin ---- 828-3718
SASLAW DAVID SHELL SERVICE
Shell Products Exclusively
22810 Foothill Bl ---- 581-9995

...Sam Service same as Mobil Service...
Stn Dlrs
9519 Castro Valley Bl(CV) ---- 582-2005
(Please See Advertisement Page 504)
SELVEY L R PHILLIPS 66
35015 Fremont Bl(F) ---- 793-9607
Sexton Douglas Stn 3460-1st(L) ---- 443-1507
Sharpe's Texaco
21120 Redwood Rd(CV) ---- 582-0461
SHELL OIL CO
1097 W Tennyson Rd ---- 782-9920

SHELL OIL PRODUCTS—

Service is our Business
Super Shell Gasoline
Super Shell Motor Oil
Tires Batteries
Accessories
"WHERE TO BUY THEM"

BEDFORD PLAZA SHELL SERV
20500 Hesperian Bl ---- 783-3392
BOB REGO'S SHELL SERVICE
409 A ---- 538-4494
BOB WILKINS SHELL SERVICE
26105 Hesperian Bl ---- 782-9770
BOOTS' SHELL SERV
790 Bockman Rd(SLZ) ---- 278-2333
Branders Peralta Blvd Shell Service
556 Peralta Bl(F) ---- 797-8827
CABRILLO SHELL
4695 Thornton Av(F) ----
CANTIN BROS SHELL SERVICE
35105 Hesperian Bl(SL) ----
CARPENTER'S SUPER SHELL SERVICE
On Hesperian Bl near Tennyson
27501 Loyola Av ---- 783-5877
CHANDLER'S JOE SHELL SERVICE
Pick-Up & Delivery Service
37064 Niles Bl(F) ---- 797-0802
DICK & LARRY'S SHELL SERVICE
42245 Fremont Bl(F) ---- 656-2955
DICK'S SHELL SERV
6714 Thorntn Av(N) ---- 797-0363
ELMER'S SHELL SERV
Next to Castro Village
3288 Castro Valley Bl(CV) ---- 581-
ERNIE'S SHELL SERVICE
707 Main(P) ---- 846-
FIRST STREET SHELL SERVICE
1737-1st(L) ---- 447-5712
HARPER RONALD SHELL SERVICE STN
33503 Mission Bl(UC) ---- 471-4928
HOLIDAY SHELL SERV
29875 Mission Bl ---- 538-0995
HOSICK P J SHELL SERVICE
720 W Tennyson Rd ---- 782-
JIM GEORGE'S SHELL
Authorized GM Mechanic
Foreign Car Parts & Ignition
Foreign Auto Repair Specialists
Tune-Ups-Brakes-Shocks-Mufflers
1962 B ---- 537-6577
JOE MAYNORD'S SHELL SERV
40640 Fremnt Bl(F) ---- 657-3122
KEEL'S SHELL SERV
19592 Center(CV) ---- 582-1077
LEE'S SHELL SERVICE
493 Washington Bl
Misn Sn Jse ---- 656-0391
LIDO SHELL SERVICE
Newark Bl & Jarvis Av(N) ---- 797-1427
MARKUS' SHELL SERVICE
15750 Hesperian Bl(SLZ) ---- 276-9878
MARTIN'S SAM SHELL SERVICE
22253 Foothl Bl ---- 582-6155
MISSION PASS SHELL SERV
42816 Misn Bl(F) ---- 657-4587
OLIVEIRA VINCENT SHELL SERVICE
98 Lewelling Bl(SLZ) ---- 278-3873
PETE MUSKIN'S SUPER SHELL
Open 24 Hours-Night Lubrication
Tune-Ups-Brakes-Shocks-Mufflers
Official Smog Station
2724 Castro Valley Bl(CV) ---- 538-2024
PILKINGTON RON'S SHELL SERVICE 110 W Harder Rd ---- 782-1664
REDD WHITE'S SHELL SERVICE
18811 Lake Chabot Rd(CV) ---- 582-9909
(Continued Next Page)

LIVERMORE
CALIFORNIA

1968 City Directory

INCLUDES

- Alphabetical directory of business concerns and private citizens
- Complete classified business directory
- Street and Avenue guide: a list of householders and occupants of office buildings and businesses with telephones
- Reverse telephone directory: a list of telephone numbers in numerical order
- Rural information of the surrounding area.

AND

- Miscellaneous information about the city and county

Sold by Subscription Only

Published by

JOHNSON PUBLISHING COMPANY, INC.

162 E. 6th Ave., Eugene, Oregon 97401

Please Note: The Street & Avenue Guide and the Reverse Telephone Directory Sections do not appear in the Residence Copies.

SCHOOLS-NURSERY

ARK PRE-SCHOOL & KINDERGARTEN THE 4161 EAST AV 447-6278

SECOND HAND STORES

Goodwill Industries Inc 447-0620Δ
Stark's Bargain House 2136 Railroad Av 447-1973Δ
Thrift Shop 1111 E Stanley Blvd 447-4703Δ

SECRETARIAL SERVICES

Kiseberger Mildred General Secretary 39 S Livermore (#32) 447-0204Δ
Turner Angie Secretarial Service 66 South P 447-5228Δ

SERVICE STATIONS

Armstrong's Union Oil Service 277 North L 447-3012
Barbera & Zaro Richfield Service 174 South L 447-3455Δ
Bireley's Phillips 66 2008-1st 447-1996Δ
Bob's Granada Chevron 1925 Barcelona 443-0866Δ
DEE'S GULF SERVICE 1ST & P STS 443-2284
Doran's Texaco Service 930 Springtown Blvd 443-4511Δ
Douglas Service Station 2620-1st 443-4306Δ
Ed's Richfield Oil Station 1679-1st 447-5702Δ
First Street Mobil Service Station 1485-1st St 447-7777Δ
First Street Shell Service Station 1739-1st St 447-5712Δ
GARY'S SHELL SERVICE 1491 JUNCTION AV 447-1372
Granada Texaco 1175 Catalina Dr 443-3680Δ
Heinz Bob Chevron 1925 Barcelona 443-0866Δ
High's Enco Service 1625 Chestnut 443-1376Δ
Jerry Bireley's Phillips 66 2008-1st 447-1996Δ
Jim's Texaco Service 2730-1st 447-0625Δ
Jim's Union '76' 1771-1st 447-8628Δ
Joe's Texaco Service 4186 East Av 447-6590Δ
Jones Ellis Enco Service 1501 Junction Av 443-0632Δ
Lloyd's Douglas Service 2620-1st 443-4306Δ
McCormick's Chevron Service Station 2259-1st 447-0454Δ
Pallitto's Chevron Service 3884-1st 447-0540Δ
PECK'S SUNLAND SERVICE 160 HOLMES 447-6180
PHIL'S PHILLIPS 66 2680-1ST ST 443-2944

Rincon Richfield 899 Rincon Av 447-0169Δ
Sanchez Rick Chevron Station 1394-1st 447-0949Δ
Sexton's Phillips 66 Service Station 2680-1st 447-4499Δ
Spencer's Gene Richfield Service 286 S Livermore Av 447-7747Δ
Valley Mobil Service 187 North L 447-9858Δ
Vineyard 76 Union Oil Service Station 900 S Livermore Av 447-9727Δ
Watts Union Oil Service Station 1197 Junction Av 447-9807Δ
Williams Ira Shell Service 818 S Livermore Av 447-9097Δ

SEWER CONTRACTORS

Associates Independent Rotory Sewer Rooting 2362-3rd 447-1621Δ

SHEET METAL

BAILEY, TOM-PLUMBING, HEATING & SHEET METAL 2230 RAILROAD AV 447-2808

SHOE REPAIR

Marty's Shoe Service 2230-1st St 447-1356Δ
Vineyard Shoe Repair 3000 Pacific Av

SHOES

Baggio's Family Shoe Store 163 South L 447-2986Δ
Burton's Shoe Store 1891-2nd 447-0772Δ
Carlin's Shoes 3040 Pacific 447-0658Δ
Children's Bootery 3040 Pacific Av 447-0658Δ

(Cont.)

187

12-2-60

STREET No. "L" Street

LOT 6273 ZONE

BUILDING Add Underground Storage Tank

$675.00 FEE $5.00

R. L. Logan Co.

STREET No. "L" Street

BLOCK

OWNER Socony-Mobil Oil Co.

OCCUPANCY PERMIT DATE

ELECTRICAL

PERMIT NO DATE FEE

CONTRACTOR

ROUGH FINISH

GAS

PERMIT NO DATE

CONTRACTOR

SEWER CONNECTION

PERMIT NO DATE

CONTRACTOR

A

b

C

OWNER Socony-Mobil Oil Co. DATE

24 HOURS NOTICE REQUIRED FOR INSPECTIONS
449-4007 between 9:00 a.m. - 4:30 p.m.

CITY OF LIVERMORE — BUILDING INSPECTION RECORD

LOT: BLOCK or TRACT:

Type of Building: Fuel Storage

Value: 1500.

PERMITS	DATE/NO.	CONTRACTOR
BUILDING	12/14/84 31206	OWNER/Builder
PLUMBING/GAS		"
ELECTRIC		
MECHANICAL		
SEWER		
PG&E NOTICE		
ENCROACHMENT		
POOL PRE-GUNITE		
POOL PRE-TILE		
POOL PRE-PLASTER		

INSPECTIONS	DATE	INSPECTOR
YARDS & SETBACKS		
FOUNDATION		
SUBFLOOR/Under flr.		
FRAME		
ELECTRICAL		
PLUMBING		
MECHANICAL		
GAS TEST		
SEWER		
INSULATION		
SHEETROCK		
ROOF		
FIREPLACE/STOVE		
FINAL	1/2/85	[illegible]

NUMBER: 187 STREET: North "L" St. OWNER: Arrow Rentals

John Bowersox

We are pleased you have completed
Ten Years as a Mobil Dealer

By your willingness to render professional services to the motorist, during this time, you have earned this special recognition for business achievement from your customers, from your community and from all of us at

Mobil Oil Company

R Giske
District Sales Manager

1961

N. J. Potts
Division Manager

10 YEARS

APPENDIX F

DECLARATIONS OF MICHAEL COMER AND GARY PINKS

DECLARATION OF GARY R. PINKS

My name is Gary R. Pinks.

I have personal knowledge of all the facts stated in this declaration and, if called as a witness, I could and would testify to them under oath.

I am the Manager at Arrow Rentals at 187 North "L" Street in Livermore, California. On or about June 18, 1985 I was so employed and on duty at Arrow Rentals when the Petcock Petroleum driver arrived to deliver an order of regular gasoline. Our usual order was for 500 gallons of regular grade gasoline.

The driver has to check in with me to get the key to the underground storage tank. On this day, it was a different driver from the driver who usually came from Petcock Petroleum. On this day, the Petcock driver was a shorter, older guy about 50 years old. I gave him the key to the 1000 gallon tank (as shown on attached diagram).

He was outside filling for what seemed like a long time. I stepped outside to see what was happening and saw the he had the nozzle from the gasoline truck in the vapor well rather than the mouth of the tank. I called his attention to the mistake he was making.

He pulled the nozzle out of the vapor well and put it back on the truck. He then immediately called the Petcock Petroleum office on his truck radio and said he was at Arrow Rentals and had just dropped 600 gallons of gas into the dirt. I was standing by his truck and heard his office advise him to get off the radio and to call from the phone inside. One of my employees, Robert Coleman, was also standing by when the radio conversation took place. The Petcock driver did make a phone call from inside Arrow Rentals and then he left.

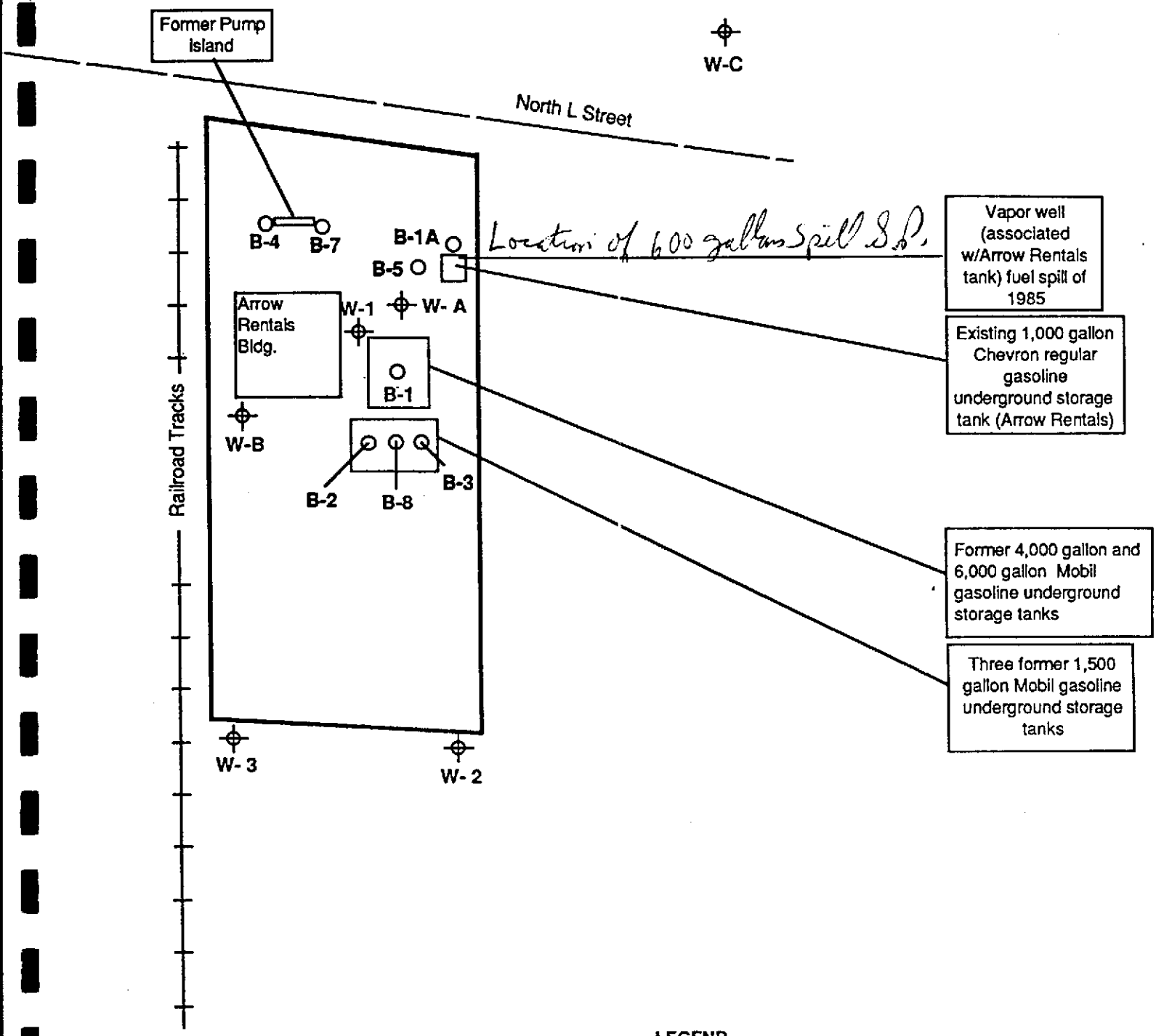
A day or so after the spill, the regular driver for Petcock showed up and delivered the gasoline we had originally ordered.

I declare under penalty of perjury under the laws of the State of California that the foregoing statements are true and correct.

Dated this 12 day of February, 1991 at Livermore, California.

G R Pinks

Gary R. Pinks



LEGEND

Approximate Soil Boring Location ○

Approximate Monitoring Well Location ⊕

Project No. 90C0321A	ARROW RENTALS 187 North L Street Livermore, California	SITE PLAN	NOVEMBER 1990
Woodward-Clyde Consultants			~~FIGURE 1~~

ATTACHMENT TO GARY PINK'S DECLARATION

DECLARATION OF MICHAEL P. COMER

My name is Michael P. Comer.

I have personal knowledge of all the facts stated in this declaration and if called as a witness, I could and would testify competently to them under oath.

I am the owner of Comer Petroleum Equipment. In my business, I frequently assist people in the removal of old underground storage tanks.

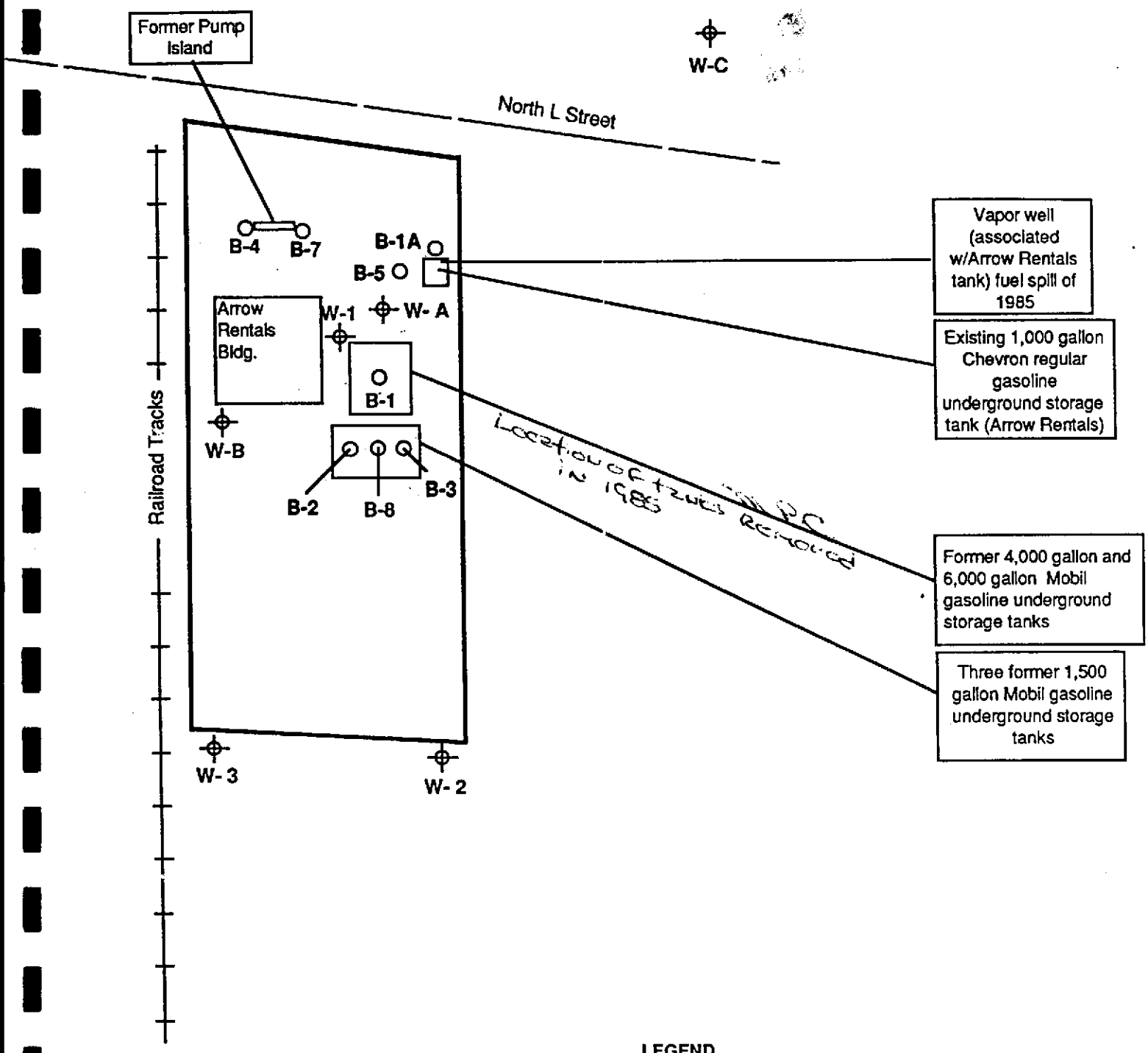
In the spring of 1985 I assisted Tony Sullins in the removal of two underground petroleum tanks (one approximately 4000 gallons and one approximately 6000 gallons) at Arrow Rentals in Livermore (as shown on attached map). When we were disconnecting plumbing going to the tank and the plumbing associated with the fill boxes, there was an odor of gasoline which is normal.

When we pulled the tanks out of the ground there was no noticeable odor of gasoline coming from the soils at the bottom of the tank pit. Nor did the soil in the tank pit have the dark discolored look which is characteristic of a tank which has been leaking underground. Based upon my experience with tank removal, I concluded that the two underground storage tanks which we removed from Arrow Rentals that day had not been leaking.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Dated this 2/12/91 day of February, 1991 at Pleasanton, California.

Michael P. Comer



Project No. 90C0321A	ARROW RENTALS 187 North L Street Livermore, California	SITE PLAN	NOVEMBER 1990
Woodward-Clyde Consultants			~~FIGURE 1~~

ATTACHMENT TO MICHAEL COMER'S DECLARATION