CITY OF SEATTLE

SITE INVESTIGATION REPORT
FOR
630 WESTLAKE AVENUE UST SITE

Prepared for:

City of Seattle
Department of Administrative Services
618 2nd Avenue, 14th Floor
Seattle, Washington 98104

Prepared by:

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May 1991

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May 21, 1991
File No. 48921.02

Mr. Paul Berry
Seattle Dept. of Administrative Services
618 2nd Avenue, 14th Floor
Seattle, Washington 98104

Subject: Site Investigation Report,
630 Westlake Avenue, Seattle, Washington

Dear Mr. Berry:

Enclosed are three copies of our Site Investigation Report for property located at 630 Westlake Avenue, Seattle, Washington. The report provides documentation of subsurface petroleum hydrocarbon contamination in soils and groundwater.

The scope of this investigation included the installation of five groundwater monitoring wells, one soil boring, sampling and testing of soil and groundwater, determining the extent of contamination, and evaluating the direction and rate of groundwater movement at the site.

Our findings provide supporting evidence that the site has been impacted by contaminant sources upgradient of the site. The Unocal property to the south is a likely source of the contamination because of the occurrence of a massive gasoline spill at the site in 1980 and recent (March 1991) observations of free product in one of the Unocal monitoring wells.

The extent of contamination appears to be widespread- from Mercer Street, south of the site to across Valley Street, north of the site. Petroleum hydrocarbon contamination exeeded Washington State Department of Ecology Method A Compliance Cleanup Levels (Model Toxics Control Act) at each well site sampled during this investigation- both on and off-site.

We recommend providing notification to the Washington State Department of Ecology (WDOE) of the results of this investigation in accordance with reporting requirements for contaminated sites. We also suggest that immediate steps be initiated to remove free product from the water table on the Unocal property, immediately south of the site. In addition, potential remedial actions should be reviewed with WDOE to determine the most feasible approach to proceed with clean-up actions.

If you have any questions regarding the enclosed report, please do not hesitate to contact either of the undersigned.

Respectfully yours,

Richard C. Alvord, C.P.G.
Project Manager
SCS ENGINEERS

David E. Roberson, CHMM
Vice President
SCS ENGINEERS

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SECTION 1

INTRODUCTION

PURPOSE AND SCOPE

This report was prepared by SCS Engineers in response to a request by the City of Seattle to conduct an investigation to evaluate the magnitude of petroleum hydrocarbon contamination discovered during the removal of five USTs at 630 Westlake Avenue, Seattle, Washington. The location of the site is illustrated in Figure 1.

The purpose of this investigation is to provide documentation of existing site conditions and to delineate the extent of petroleum hydrocarbon contamination in the soil and groundwater. The scope of this investigation included installing five groundwater monitoring wells, one soil boring, collecting soil and groundwater samples for analytical testing, determining the extent of contamination, and evaluating the direction of groundwater movement near the site.

In February 1990, significant levels of petroleum hydrocarbon contamination were detected at the site during the removal of several underground storage tanks. The tanks consisted of four gasoline tanks ranging from 2,000-gallons to 5,000-gallons, and one 500-gallon waste oil tank. The contamination appeared to be widespread in extent and beyond the property boundaries. No obvious damage or holes were observed in the fuel tanks or fuel lines that were excavated from the site. Although the source of contamination was not specifically identified, previous on-site fueling stations and upgradient sources could have impacted the property.

An historical review indicated that the Unocal Station immediately south of the site was the source of a major underground gasoline spill in 1980. The effects of this spill probably impacted the City's property and was a primary consideration in preparing a plan to proceed with this investigation.

The following sections of this report include a description of the site, a summary of previous site investigations, documentation of existing site conditions, and an evaluation of our findings.

SITE DESCRIPTION

The Westlake site is located at 630 Westlake Avenue, approximately 300 feet south of Lake Union in Seattle, Washington. The site is bordered on the north by Valley Street, on the south by Union 76 Service Station, on the east by a marine/boat sales and service yard, and on the west by Westlake Avenue.

The site has been owned by the City of Seattle since 1972 and operated primarily by a private auto service business. The current tenant uses the site for vehicle maintenance, including oil changes, brake work, tune-ups, steam cleaning, engine degreasing, etc.

The property is occupied by two permanent one story concrete block buildings as illustrated in Figure 2. The office building now stands where the original gasoline station at the site was constructed. The auto service garage is an "L" shaped structure with four car bays and a small store room. A temporary skid-mount trailer and wash rack for cleaning automobiles is located on the north side of the service garage. A catch basin serving this part of the property is located adjacent to the wash rack on Valley Street. Five abandoned underground tanks were removed from the site in February 1990 under the direction of SCS Engineers as requested by the City of Seattle.

The property is paved with asphalt in the driveway areas between the two existing buildings, and ramp entries to the service garage are constructed of concrete. City sidewalks, sewer and storm systems, and water lines bound the north and west perimeter of the property. Main storm and sewer lines near the site are identified in Figure 2.

FIGURE 1 WESTLAKE AVENUE UST SITE

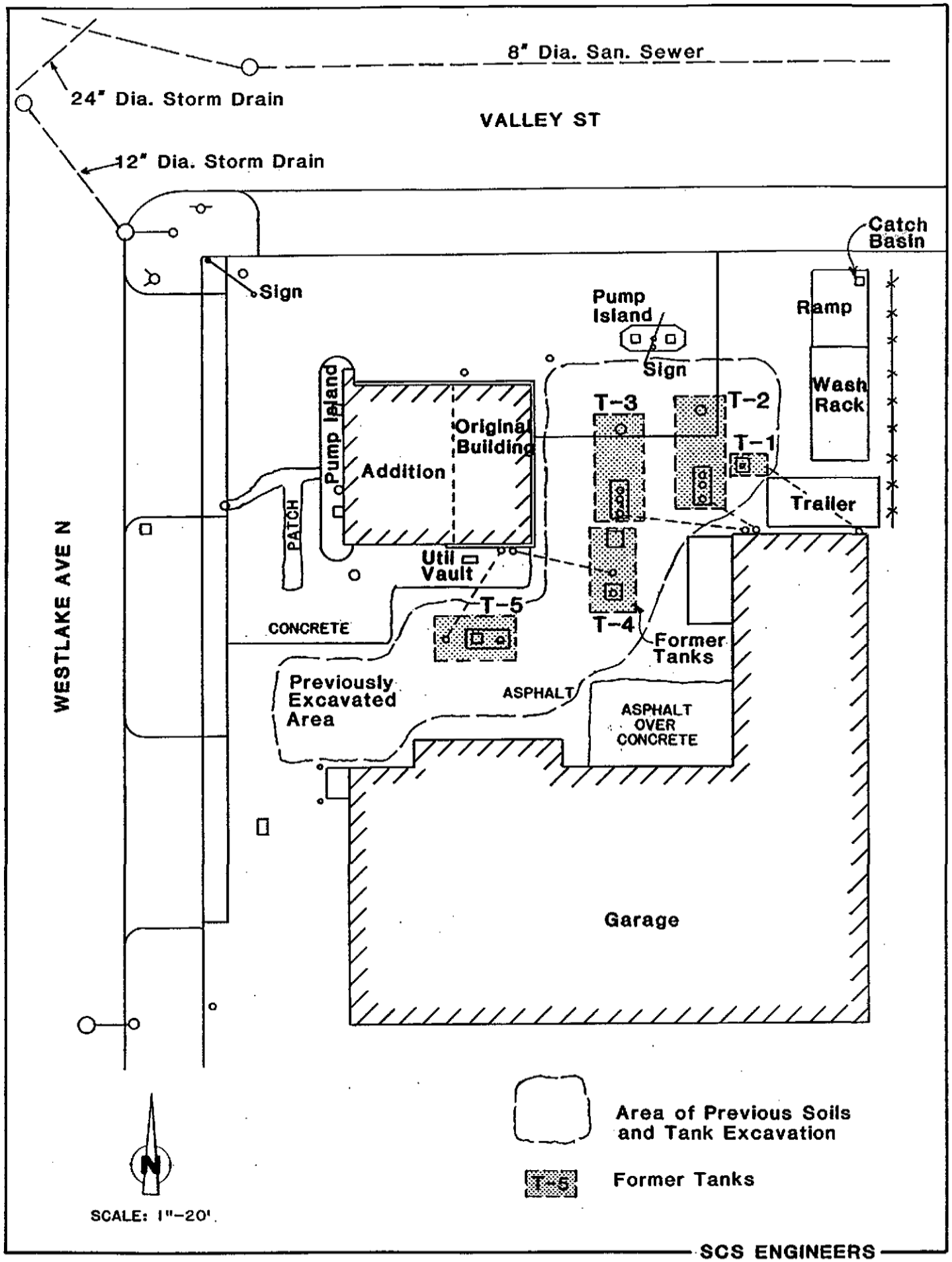


FIGURE 2 WESTLAKE SITE PLAN MAP

SECTION 2

PREVIOUS SITE INVESTIGATIONS

Based on information available at the time of this report, the only known previous investigations for contamination at the site were conducted in 1990 and 1991 by SCS Engineers, under contract to the City of Seattle. However, during the last ten years, subsurface investigations at the Unocal property immediately to the south included free product recovery efforts, monitoring, and installation of a vapor extraction system. A brief summary of these previous investigations is provided below.

UNDERGROUND TANK INVESTIGATION

In early 1990, the City of Seattle retained SCS Engineers to provide engineering services for the removal of several underground storage tanks at 630 Westlake Avenue, and to conduct an investigation of subsurface soils for site closure, in accordance with State and Federal requirements. The results of the investigation were reported (report entitled "Underground Tank Investigation Summary Report, Westlake Avenue") to the City of Seattle and Washington State Department of Ecology in June 1990.

In February 1990, five underground storage tanks were removed from the Westlake site. No holes or obvious signs of leaks were observed in any of the tanks or fuel lines. The tanks appeared to be in fair condition, having only some areas of surface rust; however, the fill pipes and fuel lines generally exhibited a greater degree of surface rust and more extensive pitting.

During tank removal activities, it was discovered that three of the abandoned tanks (T-2, T-3, and T-5) contained water, and fill pipes for these tanks were plugged with concrete. The fact that these tanks contained water indicated that they probably were not leaking when they were in use.

High levels of petroleum hydrocarbon contamination (TPH and BTEX) were detected in soil at the site. Subsequently, about 800 cubic yards of petroleum hydrocarbon contaminated soil was excavated and transported to another site for future treatment. An undetermined amount of contaminated soil was left in place, primarily under existing buildings and possibly beyond the property boundaries. Preliminary testing indicated that groundwater at the site was also contaminated with excessive levels of petroleum hydrocarbons and possibly lead.

The results of the investigation indicated a likely occurrence of off-site migration of contamination. Migration of contamination onto the Westlake site from up-gradient sources (from properties south of the Westlake site)

also appeared to be a possibility, based on detected and observed contamination in the tank excavations on the south end (upgradient) of the site.

The fact that contaminated soil was observed to be extensive throughout the site, including at the upgradient property boundary, suggested that an upgradient (off-site) source of contamination may have contributed to the petroleum hydrocarbon contamination detected at the Westlake site. Based on the findings of the initial investigation, additional work was recommended to determine the extent of contamination at the site.

In January 1991 SCS Engineers conducted an investigation of two existing monitoring wells installed at the Westlake Site and seven other monitoring wells previously installed in the area by Unocal. Free petroleum hydrocarbon product was observed in one well on the Unocal property and a sheen of product was observed in a well at the City's Westlake site. Combustible gas levels up to 25% in air and petroleum hydrocarbon vapors up to 300 ppm were also detected in several wells. A letter report of the monitoring well investigation was forwarded to the City of Seattle on January 9, 1991. A copy of this report is provided in Appendix A.

ADJACENT PROPERTY

In May 1980 a large underground gasoline spill occurred at the Unocal property, south of the site. According to local newspapers, the spill was estimated to be more than 80,000-gallons and occurred over a six month period. The spill affected several City blocks around the service station and resulted in the closure of local streets and businesses during recovery operations.

Wells and trenches were constructed on the property and in the streets to recover the gasoline. Explosive vapors were detected in sewer lines along Westlake, Valley, and Mercer Streets. Approximately 15,000-gallons of gasoline was recovered from the wells and trenches during the initial cleanup.

According to a memorandum from Geo Engineers to the Department of Ecology, dated November 26, 1990 (see Appendix A), the lost product was reportedly leaded premium gasoline. The memorandum indicates that by October 1982, a total of 41,900 gallons of gasoline had been recovered and that the program was terminated because of slow recovery response.

During 1985 to 1988, free product was discovered in "numerous on-site and off-site wells" according to the memorandum. Maximum product thickness ranged from 0.23 feet (about 3 inches) to 0.41 feet (about 5 inches). Unocal subsequently installed a vapor extraction system on their northern property boundary and has operated the system periodically during 1988 to 1991.

SECTION 3

SITE CHARACTERIZATION

SUBSURFACE INVESTIGATION

During January 1991, five groundwater monitoring wells (MW-1 to MW-5) and one soil borehole (BH-1) were constructed on and off-site in an attempt to delineate the extent of petroleum hydrocarbon contamination in the soil and groundwater, and to determine the direction of groundwater movement. The monitoring wells were installed at depths ranging from 15 to 20 feet and the borehole was drilled to depth of eight feet. Figure 3 illustrates the location of each monitoring well and borehole.

Monitoring well MW-1 was installed south of the Unocal property to serve as an upgradient and background monitoring well based on the initial assumption that shallow groundwater near the site discharges into Lake Union, to the north. Monitoring wells MW-4 and MW-5 were constructed on the north (downgradient) and south (upgradient) property boundaries, respectively, of the Westlake Site. Monitoring wells MW-2 and MW-3 were installed northwest and north of the site, respectively, to investigate the northern extent of a possible plume of petroleum hydrocarbon contamination and to collect additional water level information for determining direction of groundwater movement. Borehole BH-1 was intended to be converted to an off-site groundwater monitoring well, but drilling was terminated after discovering the well location would interfere with the owner's plans for the site.

Drilling

Drilling was performed by Hokkaido Drilling (Graham, Washington), under the direction of SCS Engineers. Drilling and well installation was conducted using a Mobil B-61 drill rig equipped with 6.25-inch inside diameter hollow stem auger.

Soil cuttings from each boring were collected and placed into 55-gallon drums for future disposal. The drill augers were steam cleaned at a staging area near the south end of the site prior to drilling each borehole. Plastic sheeting was placed on the ground to contain the decontamination water and to prevent infiltration into surface soils. The decontamination water was placed in 55-gallon drums and stored on-site to await proper disposal at the completion of this investigation.

Soil Sampling

Approximately three soil samples were collected from each boring- one at about 5 feet, one immediately above the water table, and one at the bottom of the borehole. Soil samples were collected by driving a split-spoon

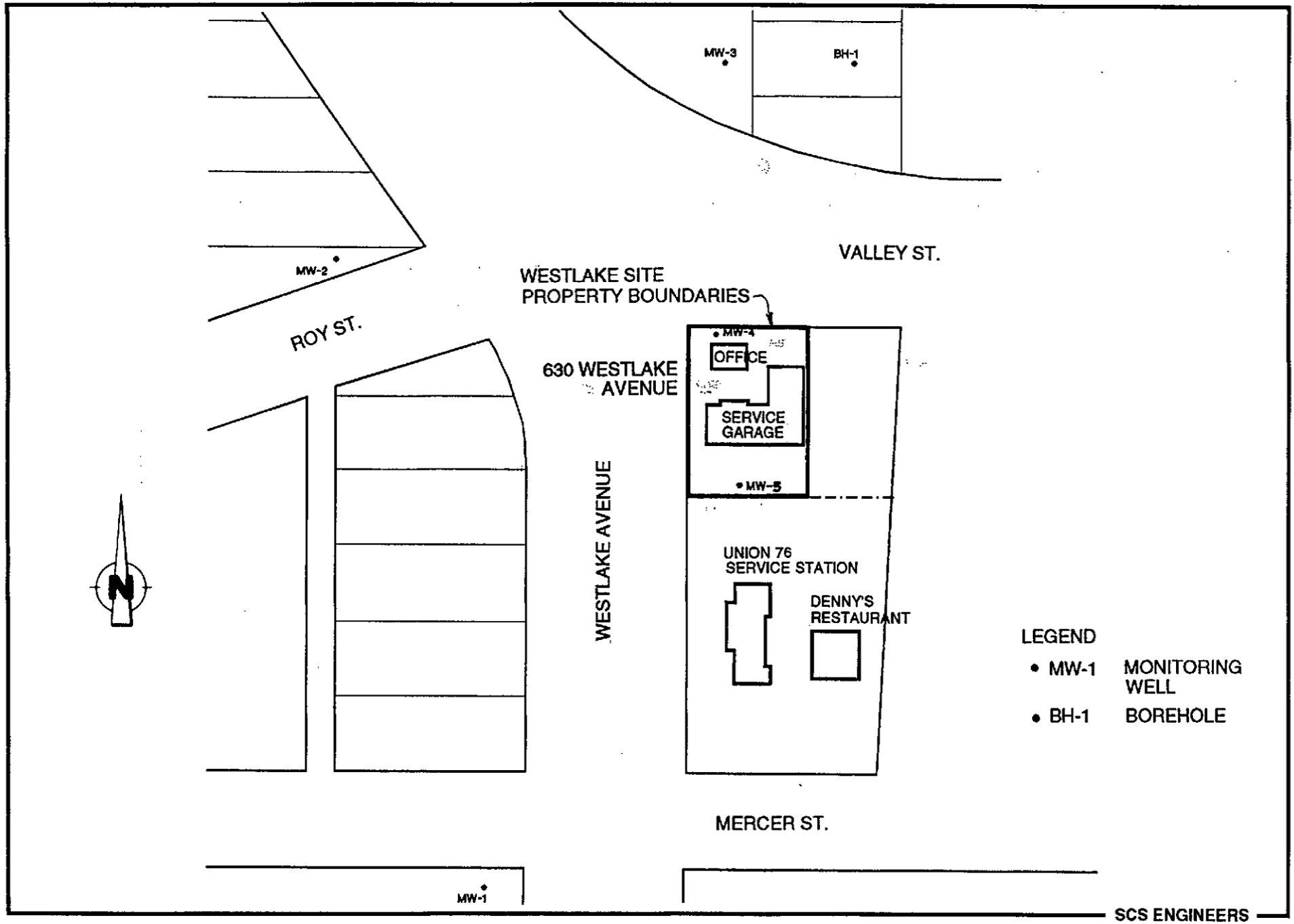


FIGURE 3 LOCATION OF MONITORING WELLS AND BOREHOLE INSTALLED DURING THIS INVESTIGATION

sample barrel into the undisturbed soil beneath the lead hollow-stem auger section. Each sample was inspected visually for signs of contamination and then tested for volatile organic vapors using a photoionization analyzer (HNu meter, Model 101). Samples were placed into labelled glass jars, capped with Teflon-lined lids, and then placed into an ice cooler prior to transport to the analytical laboratory.

To prevent cross-contamination of soil samples during drilling and sampling activities, the split-spoon sampler and drill augers were decontaminated prior to each use. The sampler was scrubbed with a brush in TSP detergent, and then rinsed with distilled water.

Monitoring Well Construction

The groundwater monitoring wells were constructed of two-inch diameter Schedule 40 PVC with 10 feet of screen. Each well was constructed such that the screen intercepted the water table surface, in order to allow direct measurement and observation of free floating product. The annular space around the outside of each well was backfilled with clean sand filter pack to a height of approximately two to three feet above the top of the screen, and then sealed with bentonite to within one to two feet of the ground surface. A flush-mounted traffic cover was cemented into place at the surface of each well. All monitoring wells were installed in accordance with Washington State Department of Ecology well construction standards.

After installation, the wells were developed to provide a good hydraulic connection to the water bearing formation. Well development procedures consisted of surging, bailing, and pumping to remove sediment from each well, and to settle the filter pack around the screen. The wells were considered reasonably developed after removing approximately 15 to 20 gallons of water from each well and observing improved clarity (less sediment) in the water.

A summary of well installation data is provided in Table 1, and borehole logs and monitoring well construction details are provided in Appendix B.

Groundwater Sampling

Groundwater samples were collected from the monitoring wells during March 1991, approximately four weeks after well installation. The depth to the water surface was measured and recorded at each site prior to sampling. Water samples were then collected from the water table surface using a clear plastic rigid tube (referred to as a "Sludge Judge" by the manufacturer) to inspect for the presence of immiscible product.

Water samples were first collected at the water table surface without removing any water in each of the wells. Since the water table intercepted the well screen at each site, these samples were representative of actual site conditions and did not require evacuation of any "stagnant" water from the wells prior to sampling. Water samples for analytical testing were collected using a two-foot long Teflon bailer after inspecting for the presence of immiscible product.

For a comparison of test results and a determination of the presence of product below the water table surface, additional water samples from wells

TABLE 1. GROUNDWATER MONITORING WELL DATA

MONITORING WELL	DATE OF INSTALLATION	DEPTH (feet)	SCREENED INTERVAL (feet)	MEASURING POINT [1] (elev.)
MW-1	01/28/91	20	9.0 - 19.0	29.31
MW-2	01/30/91	15	4.0 - 14.0	25.75
MW-3	01/29/91	17.5	6.5 - 16.5	25.76
MW-4	01/29/91	15	4.0 - 14.0	24.52
MW-5	01/31/91	17	6.5 - 16.5	25.48

Notes: 1 The measuring point is located on the top edge of the well casing and is used as a reference for determining groundwater elevation (feet above MSL).

MW-5 and U-2 were collected after removing approximately 10 gallons of water from the wells. The water was removed using a PVC bailer and then samples were collected using a Teflon bailer.

Water samples from each well were collected in VOA vials (40 ml glass vials) for BTEX analysis and in one liter amber colored glass containers for TPH and total lead analysis. No head space was allowed in the VOA vials in accordance with standard sample collection procedures for volatile organic analysis.

On April 9, 1991 four additional samples were collected (results discussed in Section 5) from wells MW-1 and MW-5 for verification of previous total lead test results and evaluation of the soluble fraction of the total lead. One sample from each well was filtered and acidified in the field. The other sample was not filtered or acidified. These samples were collected after pumping both wells dry and allowing approximately 75 percent full recovery.

Aquifer Testing

During April 1991, aquifer testing was conducted at selected monitoring well sites (MW-1, MW-3, MW-4, MW-5) to determine the approximate hydraulic conductivity of the water table aquifer materials. Hydraulic conductivity refers to the ability of a formation to transmit water through a porous material. This numerical value is one variable used in calculating groundwater flow velocity.

Aquifer testing consisted of simple bail and pump tests in which the rate of water level recovery was observed after removing a certain volume of water from the well. An electric sounding tape (E-tape) was used to measure water level response.

An analysis of bail test data indicated hydraulic conductivity ranged from about 3.6×10^{-5} ft/min at MW-4 to 9.0×10^{-5} ft/min at MW-1, and up to 7.5×10^{-3} ft/min at MW-3. Bail test data was analyzed by methodology of Ferris and Knowles, 1963 (presented in McWhorter and Sunada, 1977) and Hvorslev, 1953 (presented in Freeze and Cherry, 1979). Additional details regarding the analysis of test data using these two procedures is provided in Appendix C, and a discussion of groundwater flow rates at the site is provided below.

Water level recovery was too rapid to accurately measure with an E-tape in monitoring well MW-5, indicating that the aquifer is very permeable at this location. The estimated hydraulic conductivity of subsurface materials at MW-5 may approach 1.0×10^{-2} to 1.0×10^{-3} ft/min, based on the rapid rate of water level recovery and the nature of sediment occurring at this location.

SITE HYDROGEOLOGY

Subsurface soils in the vicinity of the site consist of approximately 10 to 15 feet of fill material underlain by gray plastic clay. The fill material generally consists of an assortment of sand, gravel, cobbles, clay, wood

chips, and occasional concrete and brick construction debris. The underlying clay is gray, sandy to silty in texture, plastic, and moist to wet. Figure 4 illustrates a cross-sectional view of our interpretation of subsurface conditions at the site, based on borehole log data and water level information.

Shallow groundwater occurs at the site under water table conditions at a depth of about eight to nine feet, based on water level measurements in on-site monitoring wells during March and April 1991. A summary of water level information collected during this investigation is provided in Table 2.

A groundwater level contour map was prepared from data in Table 2 and is provided in Figure 5. The map is based on water level information collected in March 1991 and illustrates a predominant groundwater flow direction to the north from the Westlake site. Water level elevations and hydraulic gradients indicate that groundwater west of the site maintains an east-northeast component of flow and groundwater south of the site maintains a northerly component of flow. The data suggests that the Westlake site is in the path of groundwater discharge for areas directly west and south of the site.

Based on groundwater level information and local topography, the shallow groundwater flow system appears to discharge into Lake Union to the north. The aquifer system is likely recharged from precipitation and upgradient sources.

The rate of groundwater movement across the site was calculated to range from less than 1 foot per year to 58 feet per year, assuming a hydraulic conductivity between 3.6×10^{-5} ft/min to 1.0×10^{-2} ft/min, a hydraulic gradient of 0.005 ft/ft, and a porosity of 45% in subsurface materials. A higher gradient (0.025 ft/ft) between wells MW-2 and MW-3 resulted in an estimated groundwater flow rate ranging from about 1 to 220 feet per year to the northeast in this area of the site. A discussion regarding the determination of groundwater velocity, hydraulic conductivity, hydraulic gradient, and porosity is provided in Appendix C.

Based on the interpretation of the groundwater flow system at the site, a point source of contamination could possibly move from the southern to northern property boundary, a distance of 150 feet, in about 5.0 years, assuming an average flow rate of about 30 feet per year. Several factors which could affect the estimated rate and direction of movement of a plume of contamination in the vicinity of the site include heterogeneous subsurface materials, variable hydraulic gradients, subsurface storm lines, sewers, or other buried structures, and characteristics of contaminants (for example, quantity of contaminant, rate of previous leak or spill, solubility, dispersion, etc.).

TABLE 2. SUMMARY OF GROUNDWATER ELEVATIONS AT SELECTED MONITORING WELL LOCATIONS

MONITORING WELL	DATE	DEPTH TO GROUNDWATER (feet)	ELEVATION OF GROUNDWATER (feet)
City of Seattle Wells:			
MW-1	03/06/91	11.65	17.66
	04/09/91	11.58	17.73
MW-2	03/06/91	4.25	21.50
MW-3	03/06/91	11.49	14.27
	04/09/91	10.77	14.99
MW-4	03/06/91	8.87	15.65
	04/09/91	8.55	15.97
MW-5	03/07/91	9.11	16.37
	04/16/91	9.05	16.43
Unocal Wells:			
U-1	03/07/91	9.53	16.40
	01/07/91	9.95	15.98
U-2	01/02/91	10.45	15.61
U-3	03/07/91	8.73	16.50
	01/02/91	9.50	15.73
	01/07/91	9.02	16.21
U-11	01/07/91	8.85	16.85
U-14	03/07/91	9.04	16.18
U-15	03/07/91	10.26	16.08
U-16	03/07/91	10.70	16.40
U-19	03/07/91	10.67	16.09
U-27	01/07/91	10.70	16.19
U-29	01/02/91	8.52	16.06
	01/07/91	9.10	15.48
	03/07/91	8.44	16.14
U-32	01/02/91	3.90	15.40
	01/07/91	3.45	15.85
	03/07/91	2.97	16.33

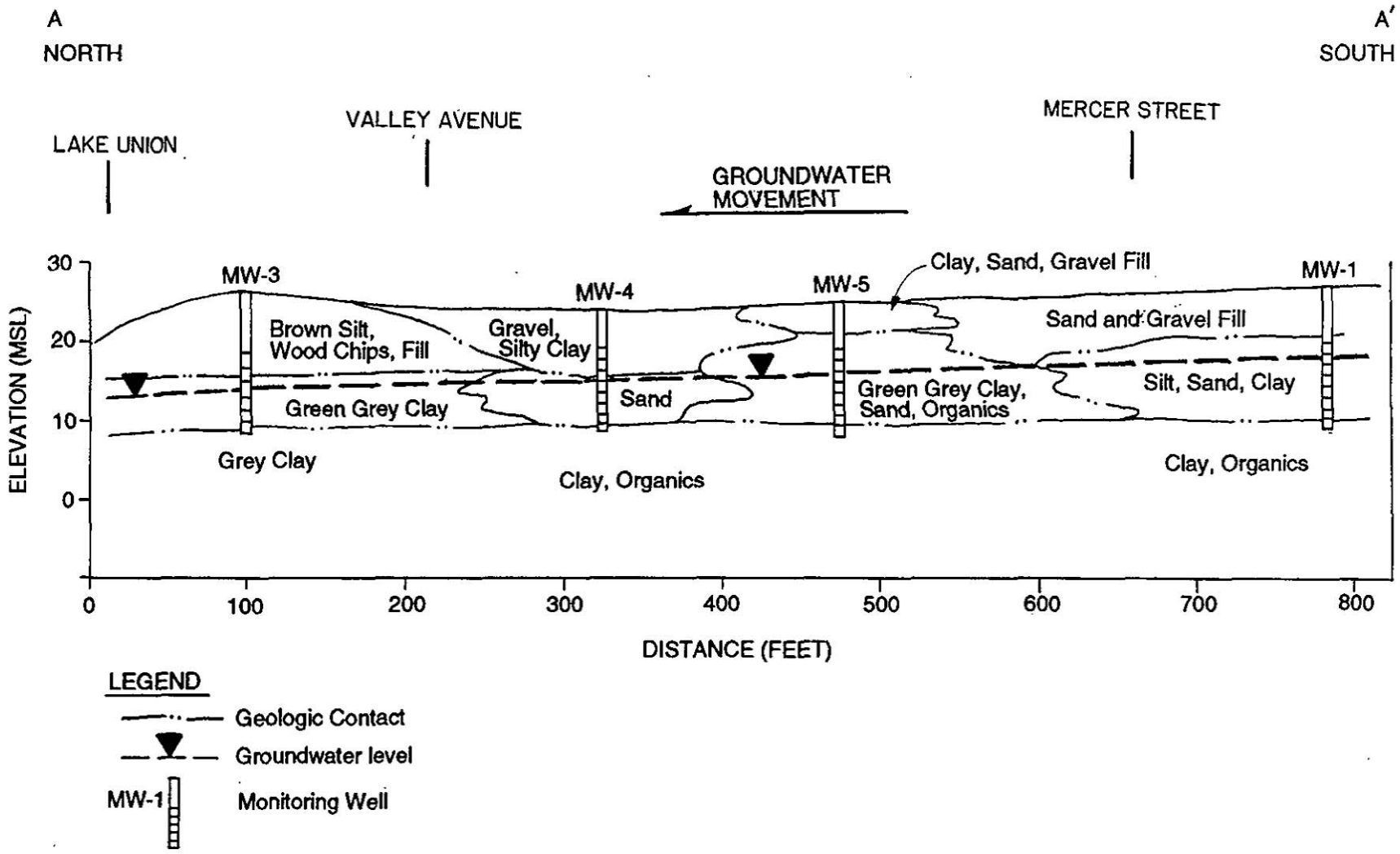


FIGURE 4 CROSS SECTION A-A'

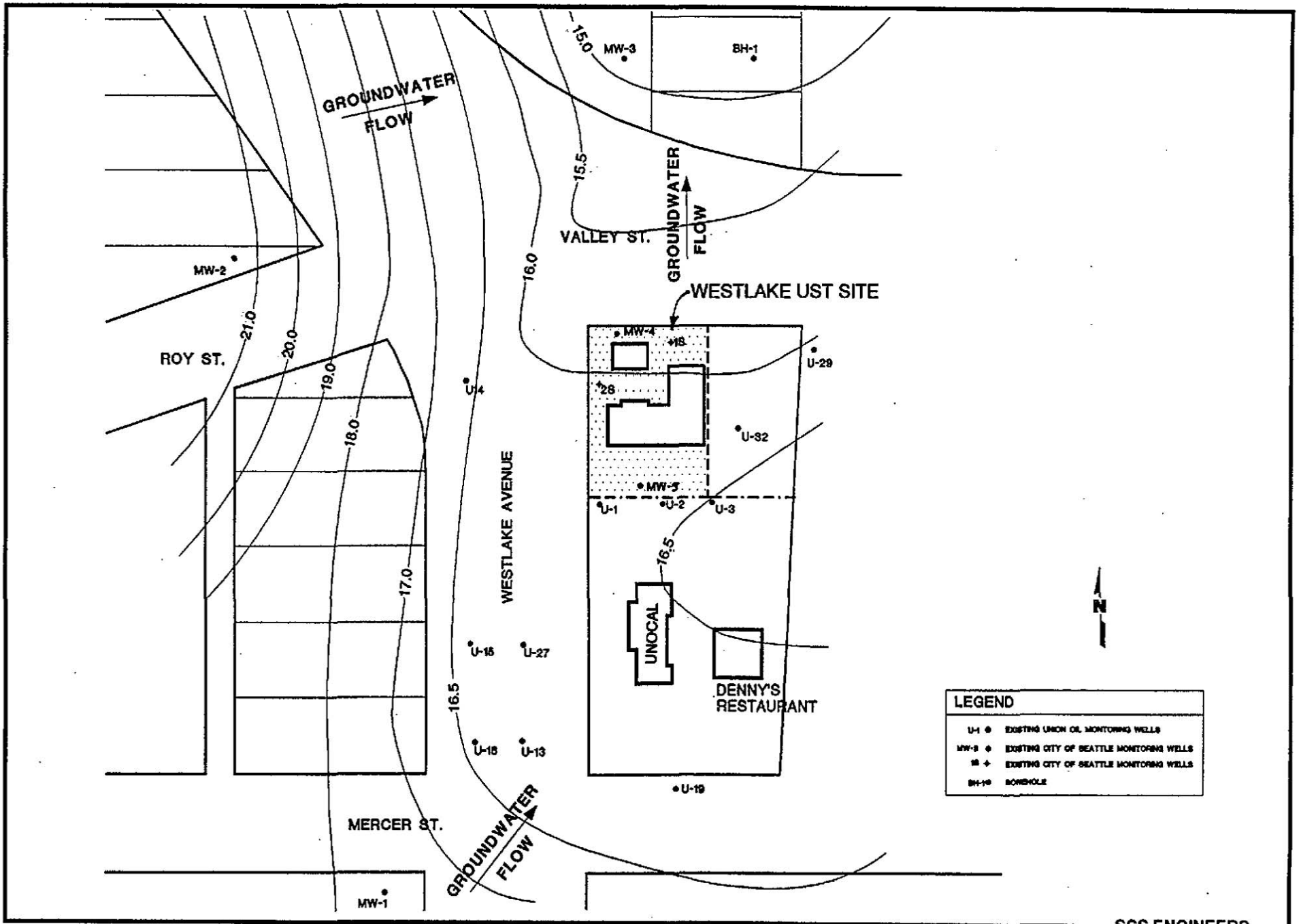


FIGURE 5 GROUNDWATER CONTOUR MAP

SECTION 4

FINDINGS

Analytical test results for this investigation were compared to soil and groundwater cleanup levels referenced in the State's new Model Toxics Control Act (MTCA). A copy of "Method A Compliance Levels" for soil and groundwater has been excerpted from MTCA and is provided in Appendix D. Analytical Laboratory Reports for soil and groundwater samples, and Chain of Custody Records are provided in Appendix E for reference. Our findings are discussed below.

SOIL CONTAMINATION

Soil samples collected from each monitoring well location were tested for TPH, and BTEX by Alden Analytical Laboratories, Inc. (Seattle, Washington). Table 3 includes a summary of testing protocol for these samples.

Soil contaminated with total petroleum hydrocarbons (TPH) was detected above Washington State Department of Ecology soil cleanup levels of 200 ppm at each well and borehole location except for MW-1. Analytical test results indicated that TPH levels in the upper five feet of soil ranged from 38 ppm in MW-1 (background well site) to 750 ppm in MW-3 (across Valley Street north of the site). TPH was detected at 290 ppm (MW-4) and 390 ppm (MW-5) in the upper five feet of soil on site. TPH contamination did not exceed soil cleanup levels below a depth of five feet at any of the well or borehole locations. A summary of analytical test results for TPH in soil at each well site is provided in Table 4.

Soil contaminated with benzene, toluene, and xylene was detected above soil cleanup levels at a depth of ten feet at MW-5, and benzene and toluene exceeded soil cleanup levels at a depth of ten feet at MW-4. Soil cleanup levels for BTEX were not exceeded at MW-1, MW-2, MW-3, or BH-1. A summary of analytical test results for BTEX contamination is provided in Table 5.

GROUNDWATER CONTAMINATION

Groundwater samples were collected for inspection and analytical testing from City of Seattle wells MW-1, MW-2, MW-3, MW-4, MW-5, 1s, and 2s and Unocal wells U-1 and U-2. Figure 3 illustrates the location of these monitoring wells.

During March and April 1991 an iridescent sheen of petroleum hydrocarbon product was observed in each well located on site (MW-4, MW-5, 1s, and 2s). During this same period, approximately one inch of black oily product was observed in Unocal well U-2, located immediately south (upgradient) of the

site and a sheen of product was observed in Unocal well U-1. No other wells on the Unocal property were sampled during this investigation.

Groundwater samples collected during this investigation were tested for TPH, purgeable volatile organics (including BTEX) and total lead. Alden Analytical Laboratories, Inc. provided analytical testing services for petroleum hydrocarbons, and Sound Analytical (Fife, Washington) and SCS Analytical (Long Beach, California) provided testing services for total lead analysis. Table 3 includes a summary of testing protocol for groundwater samples collected during this investigation.

TPH Contamination in Groundwater

Total petroleum hydrocarbon contamination (TPH) was detected above Ecology cleanup levels in groundwater at each monitoring well site sampled during this investigation. Table 6 provides a summary of analytical test results for TPH.

TPH contamination ranged from 2.2 ppm in monitoring well MW-2 to 8,000 ppm in Unocal well U-2. TPH was detected in the background well (MW-1) at 3.1 ppm. The level of TPH contamination in on-site groundwater monitoring wells ranged from 5.2 ppm (MW-4) to 960 ppm (1s) near the northern (downgradient) property boundary. TPH was detected at 6.2 ppm (MW-5) near the southern property boundary (upgradient). TPH was detected at 58 ppm in well 2s, which is located near the center of the site.

It should be noted that wells 1s and 2s were installed in excavations of the former underground tanks at the site, prior to backfilling with clean imported sand and gravel. The wells were originally intended to provide a rough indication of the level of groundwater contamination to be expected at the site. Since these wells were not constructed or installed according to Ecology well construction standards, groundwater samples collected from these wells may not be considered representative samples.

Purgeable Volatile Organic Contamination in Groundwater

Analytical testing for BTEX was conducted on groundwater samples collected from the following monitoring wells: MW-1, MW-2, MW-3, MW-4, MW-5, 1s, 2s, U-1, and U-2. In addition, a complete scan of purgeable hydrocarbons (U.S. EPA Method 624, see analytical test results for list of compounds) was conducted on samples collected from MW-4 and U-2 to investigate for the possible presence of solvents and other volatile organics. Tables 7 and 8 provide a summary of these analytical test results.

BTEX was detected in groundwater samples collected from each monitoring well. Benzene was detected above Ecology cleanup levels in each well with the possible exception of MW-3. The analytical detection limit used for benzene in MW-3 was 0.050 ppm (50 ppb) and the cleanup level for benzene in groundwater is 0.005 ppm (5 ppb). Therefore, since the laboratory reported benzene less than the detection limit used for this analysis, benzene could actually be over the cleanup level at MW-3.

Benzene was detected over ten times (0.063 ppm) it's cleanup level of

0.005 ppm in MW-1, upgradient of the site. Benzene was detected on-site at levels ranging from 1.4 ppm (well 2s) to 7.9 ppm (MW-4). These levels are approximately 300 to 1,500 times over Ecology cleanup levels for benzene in groundwater. Benzene was detected immediately upgradient of the site in Unocal wells U-1 and U-2, ranging from 5.4 ppm to 5.9 ppm.

Ethylbenzene was detected above Ecology cleanup levels in each well sampled on site (MW-4, MW-5, 1s, 2s) and both wells (U-1, U-2) sampled on Unocal property. Ethylbenzene was not detected in off-site monitoring wells MW-1, MW-2, and MW-3 above the laboratory detection limit of 0.050 ppm for this analysis. However, it should be noted that Ecology's cleanup level for ethylbenzene in groundwater is 0.030 ppm, and it is possible that ethylbenzene could actually exceed its cleanup level but be less than the laboratory detection limit.

Toluene and xylene exceeded Ecology cleanup levels at each monitoring well location. Toluene was detected up to 4 ppm (well 1s) on site, which is 100 times its cleanup level of 0.040 ppm. Toluene was detected at 28.0 ppm (700 times its cleanup level) at Unocal well U-2, immediately upgradient of the site. Xylene was detected on site at levels ranging from 0.40 ppm (MW-1) to 14.00 ppm (well 1s). These levels are about 20 to 700 times cleanup levels for xylene in groundwater. Xylene exceeded its cleanup level of 0.020 ppm by over 1500 times in Unocal well U-2, upgradient from the site.

A laboratory analytical scan for purgeable volatile organics (EPA Method 624) conducted on groundwater samples collected from wells MW-5 and U-2 indicated the presence of acetone and carbon disulfide in MW-5 and methylene chloride in U-2 (see Table 8). These contaminants may have been introduced during the laboratory analytical procedure because they are commonly used in analytical extractions for organic analysis. Considering the type of contamination detected in the groundwater at the site, it is unlikely that these constituents are actually present in groundwater at the site.

Total Lead Contamination in Groundwater

Groundwater samples were tested for the presence of total lead, in accordance with Ecology's requirement for analytical testing ("Guidance for Site Checks and Site Assessments for Underground Storage Tanks", dated February 1991) at UST sites.

Analytical test results for unfiltered groundwater samples collected on March 6, 1991 indicated total lead exceeded Ecology's cleanup level of 0.005 ppm in all wells sampled during this investigation. Total lead ranged from 0.06 ppm (MW-5) to 0.86 ppm (well 1s) on site and up to 15.4 ppm in Unocal well U-2, upgradient of the site. Total lead was also detected in MW-1 ("background well") at a level of 0.80 ppm, which is over Ecology's cleanup level of 0.005 ppm in groundwater by 160 times.

A second sampling effort was conducted on April 9, 1991 to collect additional groundwater samples for confirmation and further evaluation of test results for total lead. Filtered and unfiltered groundwater samples were collected from MW-1 and MW-4 in an attempt to distinguish the fraction of total lead absorbed to sediment particulates from that dissolved in the

groundwater. No lead was detected in any of these samples using a detection limit of 0.50 ppm. However, it should be noted that the analytical test procedure for "second round" samples used a detection limit of 0.50 ppm and "first round" samples were tested using a detection limit of 0.005 ppm. Total lead may not have been detected in second round samples because of this higher detection limit. At the time of this report, the laboratory was in the process of re-testing second round samples using a lower detection limit.

Laboratory Chromatographs

A series of chromatographs are provided in Appendix F for groundwater samples collected from wells MW-4, MW-5, U-1, and U-2. The graphs illustrate a similar pattern for the detection of lighter fraction petroleum hydrocarbons in an elution range approximately less than 10 minutes and similar characteristics for heavier fractions of hydrocarbons near an elution range of 20 minutes. According to Alden Analytical Laboratory (personal communication, April 29, 1991) these chromatographs likely represent a common fuel type.

TABLE 3. SUMMARY OF ANALYTICAL TESTING PROTOCOL
FOR SOIL AND GROUNDWATER SAMPLES

MATRICE	ANALYTICAL TEST PROCEDURE
Soil	Total Petroleum Hydrocarbons (TPH) - U.S. EPA Method 418.1
Soil	Benzene, Ethylb., Toluene, Xylene - U.S. EPA Method 8240
Groundwater	Total Petroleum Hydrocarbons (TPH) - U.S. EPA Method 418.1
Groundwater	Benzene, Ethylb., Toluene, Xylene - U.S. EPA Method 624
Groundwater	Purgeable Aromatics - U.S. EPA Method 624
Groundwater	Total Lead - U. S. EPA 7421/ 200.7

TABLE 4. SUMMARY OF ANALYTICAL TEST RESULTS FOR TPH IN SOIL

SAMPLE NO.	LOCATION	DEPTH (feet)	DATE OF COLLECTION	TEST PARAMETER[1]	SOIL (ppm)	CLEANUP LEVEL[2] (ppm)
19631	MW-1	5	01/28/91	TPH	38	200
19633	MW-1	10	01/28/91	TPH	8.6	200
19637	MW-4	10	01/28/91	TPH	290	200
19639	MW-4	15	01/28/91	TPH	33	200
19642	MW-3	5	01/28/91	TPH	750	200
19644	MW-3	10	01/28/91	TPH	73	200
19280	BH-1	5	01/30/91	TPH	500	200
19282	BH-1	8	01/30/91	TPH	29	200
19285	MW-2	5	01/30/91	TPH	450	200
19287	MW-2	8	01/30/91	TPH	77	200
19290	MW-5	5	01/30/91	TPH	390	200
19292	MW-5	10	01/30/91	TPH	17	200

Notes: 1 TPH is Total Petroleum Hydrocarbons.

2 Model Toxics Control Act, 1991, Washington State Department of Ecology.

TABLE 5. SUMMARY OF ANALYTICAL TEST RESULTS THAT EXCEEDED SOIL CLEANUP LEVELS FOR BTEX

SAMPLE NO.	LOCATION	DEPTH (feet)	DATE OF COLLECTION	TEST PARAMETER[1]	SOIL (ppm)	CLEANUP LEVEL[2] (ppm)
19289	MW-5	5	01/30/91	Benzene	0.56	0.5
19291	MW-5	10	01/30/91	Benzene	11.0	0.5
				Toluene	57.0	40.0
				Xylenes	87.0	20.0
19636	MW-4	10	01/29/31	Benzene	4.3	0.5
				Toluene	40.0	40.0

Notes: 1 Test parameter for BTEX includes benzene, toluene, ethylbenzene, and xylene.

2 Model Toxics Control Act, 1991, Washington State Department of Ecology.

TABLE 6. SUMMARY OF ANALYTICAL TEST RESULTS FOR TPH IN GROUNDWATER

SAMPLE NO.-	LOCATION	DATE OF COLLECTION	TEST PARAMETER[1]	TEST RESULTS (ppm)	CLEANUP LEVEL[2] (ppm)
19654	MW-1	03/06/91	TPH	3.1*	1.0
19658	MW-2	03/06/91	TPH	2.2*	1.0
19663	MW-3	03/06/91	TPH	3.0*	1.0
19677	1s	03/06/91	TPH	960.0*	1.0
19683	2s	03/06/91	TPH	58.0*	1.0
19669	MW-4	03/13/91	TPH	5.2*	1.0
19689	U-2	03/13/91	TPH	8,000.0*	1.0
19696	U-1	03/13/91	TPH	66.0*	1.0
19696	MW-5	03/13/91	TPH	6.2*	1.0

Notes: * Exceed Ecology Cleanup Standards, MTCA 1991, 173-340 WAC.

1 TPH is total petroleum hydrocarbons.

2 Model Toxics Control Act, 1991, Washington State Department of Ecology.

TABLE 7. SUMMARY OF ANALYTICAL TEST RESULTS THAT EXCEEDED GROUNDWATER CLEANUP LEVELS FOR BTEX

SAMPLE NO.	LOCATION	DATE OF COLLECTION	TEST PARAMETER	TEST RESULTS (ppm)	CLEANUP LEVEL[1] (ppm)
19650	MW-1	03/06/91	Benzene	0.063*	0.005
			Toluene	0.077*	0.040
			Xylenes	0.400*	0.020
19655	MW-2	03/06/91	Benzene	0.094*	0.005
			Toluene	0.120*	0.040
			Xylenes	2.100*	0.020
19660	MW-3	03/06/91	Benzene	< 0.050[2]	0.005
			Toluene	0.060*	0.040
			Xylenes	0.360*	0.020
19665[3]	MW-4	03/06/91	Benzene	7.000*	0.005
			Ethylb.	0.610*	0.030
			Toluene	3.200*	0.040
			Xylenes	7.300*	0.020
19667[4]	MW-4	03/06/91	Benzene	7.700*	0.005
			Ethylb.	0.410*	0.030
			Toluene	3.900*	0.040
			Xylenes	7.900*	0.020
19673[5]	MW-4	03/06/91	Benzene	7.900*	0.005
			Ethylb.	0.990*	0.030
			Toluene	4.500*	0.040
			Xylenes	6.600*	0.020
19699	MW-5	03/07/91	Benzene	3.500*	0.005
			Ethylb.	0.180*	0.030
			Toluene	2.900*	0.040
			Xylenes	4.200*	0.020
19704[5]	MW-5	03/07/91	Benzene	4.900*	0.005
			Ethylb.	0.520*	0.030
			Toluene	8.900*	0.040
			Xylenes	8.600*	0.020
19675	ls	03/06/91	Benzene	1.700*	0.005
			Ethylb.	3.000*	0.030
			Toluene	4.000*	0.040
			Xylenes	14.000*	0.020

(continued on next page)

TABLE 7. SUMMARY OF ANALYTICAL TEST RESULTS THAT EXCEEDED GROUNDWATER CLEANUP LEVELS FOR BTEX

(continued from previous page)

SAMPLE NO.	LOCATION	DATE OF COLLECTION	TEST PARAMETER	TEST RESULTS (ppm)	CLEANUP LEVEL[1] (ppm)
19680	2s	03/06/91	Benzene	1.400*	0.005
			Ethylb.	1.400*	0.030
			Toluene	1.800*	0.040
			Xylenes	13.100*	0.020
19688[3]	U-2	03/07/91	Benzene	5.400*	0.005
			Ethylb.	6.600*	0.030
			Toluene	28.000*	0.040
			Xylenes	31.400*	0.020
19692[5]	U-2	03/07/91	Benzene	5.800*	0.005
			Ethylb.	1.400*	0.030
			Toluene	1.000*	0.040
			Xylenes	7.600*	0.020
19694	U-1	03/07/91	Benzene	5.900*	0.005
			Ethylb.	1.400*	0.030
			Toluene	1.000*	0.040
			Xylenes	7.400*	0.020

Notes: * Exceeds Ecology Cleanup Standards, MTCA 1991, 173-340 WAC.

1 Model Toxics Control Act, 1991, Washington State Department of Ecology.

2 Test result less than detection limit of 0.050 ppm.

3 Test results are from complete 624 scan of sample collected from water table surface.

4 Partial 624- BTEX, sample collected from water table surface. Compare to 19665.

5 Sample collected after removing 10-gallons of water.

TABLE 8. SUMMARY OF OTHER VOLATILE ORGANIC COMPOUNDS REPORTED IN GROUNDWATER SAMPLES[1]

SAMPLE NO.	LOCATION	DATE OF COLLECTION	TEST PARAMETER	TEST RESULTS (ppm)	CLEANUP LEVEL[2] (ppm)
19665	MW-5	03/06/91	Acetone	0.017	---
			Carbon Disulfide	0.0049	---
19688	U-2	03/07/91	Methylene Chloride	1.200	---

Notes: 1 Volatile organic compounds other than BTEX.

2 No cleanup standards presently exist for acetone, carbon disulfide, or methylene chloride.

TABLE 9. SUMMARY OF ANALYTICAL TEST RESULTS FOR TOTAL LEAD IN GROUNDWATER

SAMPLE NO.	LOCATION	DATE OF COLLECTION	TEST PARAMETER	TEST RESULTS (ppm)	CLEANUP LEVEL[1] (ppm)
19654	MW-1	03/06/91	Total Lead[2u]	0.80*	0.005
19659	MW-2	03/06/91	Total Lead[2u]	1.30*	0.005
19664	MW-3	03/06/91	Total Lead[2u]	0.04*	0.005
19671	MW-4	03/06/91	Total Lead[2u]	0.15*	0.005
19679	1s	03/06/91	Total Lead[2u]	0.86*	0.005
19671	2s	03/06/91	Total Lead[2u]	0.15*	0.005
19698	U-1	03/06/91	Total Lead[2u]	1.00*	0.005
19691	U-2	03/06/91	Total Lead[2u]	15.40*	0.005
19703	MW-5	03/06/91	Total Lead[2u]	0.06*	0.005
19715	MW-1	04/09/91	Total Lead[3u]	ND	0.005
19716	MW-1	04/09/91	Total Lead[3f]	ND	0.005
19717	MW-4	04/09/91	Total Lead[3u]	ND	0.005
19718	MW-4	04/09/91	Total Lead[3f]	ND	0.005

Notes: * Exceed Ecology Cleanup Standards, MTCA 1991, 173-340 WAC.

1 Model Toxics Control Act, 1991, Washington State Department of Ecology.

2 Total lead tested using EPA Method 7421; "u" is unfiltered.

3 Total lead tested using EPA Method 200.7; "f" is filtered, "u" is unfiltered.

SECTION 5

CONCLUSIONS

This investigation provides supporting evidence that the City's property located at 630 Westlake Avenue has been impacted by contaminant sources upgradient of the site. Petroleum hydrocarbon contamination was detected in the soil and groundwater on and offsite. The extent of contamination appears to be widespread- extending from Mercer Street, south of the site (upgradient) to across Valley Street, to the north of the site.

TPH, BTEX, and total lead contamination in groundwater exceeded Ecology cleanup levels at each well site sampled during this investigation. The highest levels of contamination were detected in wells on the Unocal property, immediately south (upgradient) of the site.

Excessive levels of petroleum hydrocarbon contamination detected in on-site wells 1s and 2s during this investigation, provides evidence that the City's Westlake Site continues to be significantly impacted by an upgradient source of groundwater contamination. This is based on the determination of the direction of groundwater flow and the fact that in February 1990, wells 1s and 2s were installed in imported clean sand and gravel backfill after removing all underground tanks and contaminated soil (no soil was excavated below existing building foundations at the site) from the site.

Based on our interpretation of the groundwater flow system at the site, any sources of groundwater contamination to the south and west could environmentally impact the City's Westlake site since the site appears to be in the path of local groundwater discharge. However, based on similar characteristics of a series of laboratory analytical chromatagraphs for groundwater samples collected from the Westlake Site and the Unocal property, the source of groundwater contamination discovered at the Westlake site is likely from the Unocal property to the south.

High concentrations of petroleum hydrocarbons in well upgradient well MW-1 may indicate that the well is within the area of influence of the 1980 Unocal spill or that the contamination represents another source of contamination upgradient of MW-1. However, the fact that the hydraulic gradient is very low in this area, petroleum hydrocarbon contamination in MW-1 could be a result of contaminant dispersion even in an upgradient direction.

The data presented in this report does not provide a quantitative indication of the age of product discovered at the site. In addition, there is no conclusive evidence at this time that correlates this product with the Unocal spill in 1980. Therefore, in the absence of any leak detection test records of Unocal's fuel system, it is not known if existing

site contamination is a result of the 1980 fuel spill or possibly current problems that may exist at the Unocal facility.

High concentrations of petroleum hydrocarbon contamination were also detected in shallow subsurface soil and groundwater at well MW-2, which indicates the possibility of one or more additional sources of contamination contributing to the existing problem near the Westlake site, since MW-2 is located hydraulically upgradient of the site. Local groundwater gradients suggest that any sources of groundwater contamination directly to the west could also impact the Westlake Site (see Figure 5).

Total lead detected in the groundwater at and near the site could be a result of natural background levels in the groundwater or sediments, fuel spills, or other upgradient sources of contamination. No conclusive evidence is available at this time which relates the detected total lead to any organic lead which may be present in petroleum hydrocarbon contamination at the site.

Based on an interpretation of water level information at the site, the predominant direction of groundwater flow at the site is to the north at a rate ranging from less than 1 foot per year to 58 feet per year. A higher gradient between wells MW-2 and MW-3 resulted in an estimated groundwater flow rate ranging from about 1 to 220 feet northwest of the site.

Based on the present interpretation of the groundwater flow system at the site, a point source of contamination could possibly move from the southern to northern property boundary (a distance of 150 feet) in about 5.0 years, assuming an average flow rate of about 30 feet per year. Very low hydraulic gradients at the site are likely to result in slow contaminant transport.

Several factors which could affect the estimated rate and direction of movement of a plume of contamination in the vicinity of the site include heterogeneous subsurface materials, variable hydraulic gradients, subsurface storm lines, sewers, or other buried structures, and characteristics of contaminants (for example, quantity of contaminant, rate of previous leak or spill, solubility, dispersion, etc.).

TPH contamination in soil exceeded Ecology cleanup levels at each well site installed during this investigation except for MW-1. TPH contamination above 200 ppm was not detected below a depth of five feet at these well locations. Benzene, toluene, and xylene contamination in soil exceeded Ecology cleanup levels in only on-site wells MW-4 and MW-5. No analytical test results for soil were available for wells drilled previously on the Unocal property immediately north of the Westlake Site.

SECTION 6

RECOMMENDATIONS

Based on the results of this investigation, we recommend the following:

- Submit this Site Investigation Report to WDOE in accordance with 90-day reporting requirements of The Model Toxics Control Act for releases at UST sites.

- Follow-up earlier reports to WDOE to confirm that free product was recently (March 1991) observed in a well on Unocal Property to the south (upgradient) and that a sheen of product was visible in all wells located on City property located at 630 Westlake Avenue.

- Additional characterization of subsurface contamination west of the site is necessary to determine the possibility of an additional source of contamination impacting the site and other property downgradient of MW-2. We recommend installing one or two additional monitoring wells to investigate for contamination and to further characterize the direction of groundwater flow.

- Clean-up of free product on the Unocal property to the south should be the first step in attempting to remediate contamination discovered on the City's property on Westlake Avenue.

- Since groundwater contamination (free product) was detected at the site, the Department of Ecology may require a State Remedial Investigation and Feasibility Study, in accordance with The Model Toxics Control Act.

- The results of this investigation and potential remedial options should be reviewed with WDOE to determine the most feasible approach to clean up the site.

APPENDIX A

Investigation of Monitoring Wells at the Westlake Site
January 9, 1991

Environmental Consultants

2950 Northup Way
Bellevue, WA 98004

206 822-5800
FAX 206 889-2267

SCS ENGINEERS

January 9, 1991
File No. 48921.02

Mr. Paul Berry
City of Seattle
Dept. of Administrative Services
618 2nd Avenue, 14th Floor
Seattle, Washington 98104

Subject: Investigation of Monitoring Wells at Westlake Site

Dear Mr. Berry:

This letter includes a summary of information collected on January 2 and 7, 1991 from existing monitoring wells at the Unocal Station, located at Mercer Street and Westlake Avenue, and Seattle's Westlake site at 630 Westlake Avenue, in Seattle. The purpose of our site investigation was to determine the possible presence of free gasoline product, which could be a potential hazard and source of contamination to the area.

BACKGROUND

Unocal installed more than 30 monitoring and recovery wells on and around their facility in 1980 as a result of an underground release of gasoline. According to a memorandum, dated November 26, 1990 from GeoEngineers to the Department of Ecology (Appendix A), more than 80,000 gallons of leaded premium gasoline was released at the site. By October 1982, a total of about 41,900 gallons of product was recovered. As recent as May 1990, free product was identified in three of the wells.

In February 1990, five abandoned underground fuel storage tanks were removed from City of Seattle property located at 630 Westlake Avenue, immediately north of the Unocal property. An investigation conducted by SCS Engineers (Underground Tank Summary Report, dated June 1990) indicated that subsurface soil and groundwater was contaminated with petroleum hydrocarbons. Approximately 800 cubic yards of contaminated soil was excavated from the site after the tanks were removed from the ground. The source of contamination discovered on the property was not specifically identified, although the gasoline spill that occurred at Unocal in 1980 was one suspected source. SCS recommended an additional investigation to determine the source and extent of contamination.

SITE INVESTIGATION

On January 2, 1991, representatives from the City of Seattle and SCS Engineers investigated several existing wells at the site to determine the possible presence of free product. Additional well information was obtained on January 7, 1991. Table 1 presents a summary of data collected from these wells.

Only wells located near property at 630 Westlake Avenue (see Figure 1) were investigated. These wells included Unocal Wells 1, 2, and 3, on the north side of the service station; Unocal Wells 11 and 27 in the middle of Westlake Avenue; and Unocal Wells 29 and 32, northeast of the service station. Unocal Well 6 was reportedly installed on City property immediately north of the recovery wells but could not be located during this investigation. Two City of Seattle monitoring wells (1s and 2s) at 630 Westlake Avenue were also inspected.

During our site investigation, the wells were checked for the presence of free product using a teflon bailer and gas-finding paste; the water level in each well was measured; and a natural gas meter and HNu meter was used to test for combustible gases and volatile organic vapors, respectively. The teflon bailer and water level probe were thoroughly decontaminated with detergent to avoid cross-contaminating the wells.

Approximately one inch of free, oily, gasoline product was observed in Unocal Well No. 2 (See Figure 1). Free product was not identified in any other wells that were accessed. However, an oily sheen was observed in City of Seattle Well No. 2s, located near the south side of City property, (Figure 1). In addition, volatile organic vapors were detected in City of Seattle Well 2s and Unocal Wells 3 and 32 using an HNu Meter, calibrated to benzene as a standard.

Combustible gas was detected in several wells using a D-15 Gastester, which may confirm earlier reports of methane gas (GeoEngineers, November 26, 1990). However, the D-15 Gastester instrument is sensitive to methane gas and lighter fraction petroleum hydrocarbon vapors. Therefore, laboratory analytical testing is needed to determine specific gas types and respective concentrations.

During this investigation, combustible gas levels were detected up to 25% volume in air in the wells. Petroleum hydrocarbon vapors were detected up to 300 ppm (.03%) using the HNu meter. Methane is considered explosive at levels ranging from 5% to 15% in air, and is flammable above 15%. Petroleum hydrocarbon vapors are considered flammable between a range of 1% to 10% volume in air.

Volatile organic vapor readings may have been on the low side because the HNu meter tends to be less sensitive in the presence of moisture. Water condensation in the wells could have affected these readings. HNu readings were not obtained during the site inspection on January 7, 1991 because the meter was affected by rain. A summary of our findings is provided in Table 1.

CONCLUSIONS

Based on the results of this investigation, it appears that gasoline product floating on the water table at the Unocal facility could be a

continuing source of contamination to adjacent property, including City of Seattle property, located at 630 Westlake Avenue.

Additional investigation is needed to determine the magnitude and direction of movement of groundwater contamination at the site. Gas vapors detected in the wells are most likely related to the fuel contamination, but additional investigation is needed for confirmation.

RECOMMENDATIONS

On January 2, 1991, the City of Seattle reported the discovery of free product at the north property boundary of the Unocal facility, to the Department of Ecology. The Seattle Fire Department should also be informed of these findings.

Based on the discovery of free product in May 1990, as reported by GeoEngineers, and free product in one well during this investigation, the fueling system at Unocal should be tested to determine the possibility of any existing leaks that may be contributing to the current problem. Because of the nature of potentially hazardous conditions at the site, efforts to clean up free product should commence immediately.

We also recommend proceeding with an investigation to determine the magnitude of contamination, path of migration, and impact of the contamination to City of Seattle property. Any additional information such as spill cleanup records, construction details of Unocal monitoring and recovery wells, borehole logs, water level measurement records, previous reports and documentation, and fuel system tightness test records would be helpful to this investigation.

The presence of combustible gas is a potential safety hazard. Therefore, we recommend collecting gas (vapor) samples from several of the wells to confirm the type and concentration of specific gases. Based on laboratory analytical test results, appropriate recommendations can then be addressed.

If you have any questions regarding this report, please do not hesitate to contact us.

Respectfully yours,

Richard C. Alvord, C.P.G.
Project Manager
SCS ENGINEERS

David E. Roberson, CHMM
Project Director
SCS ENGINEERS

G:/jobs/4892102/watlev1

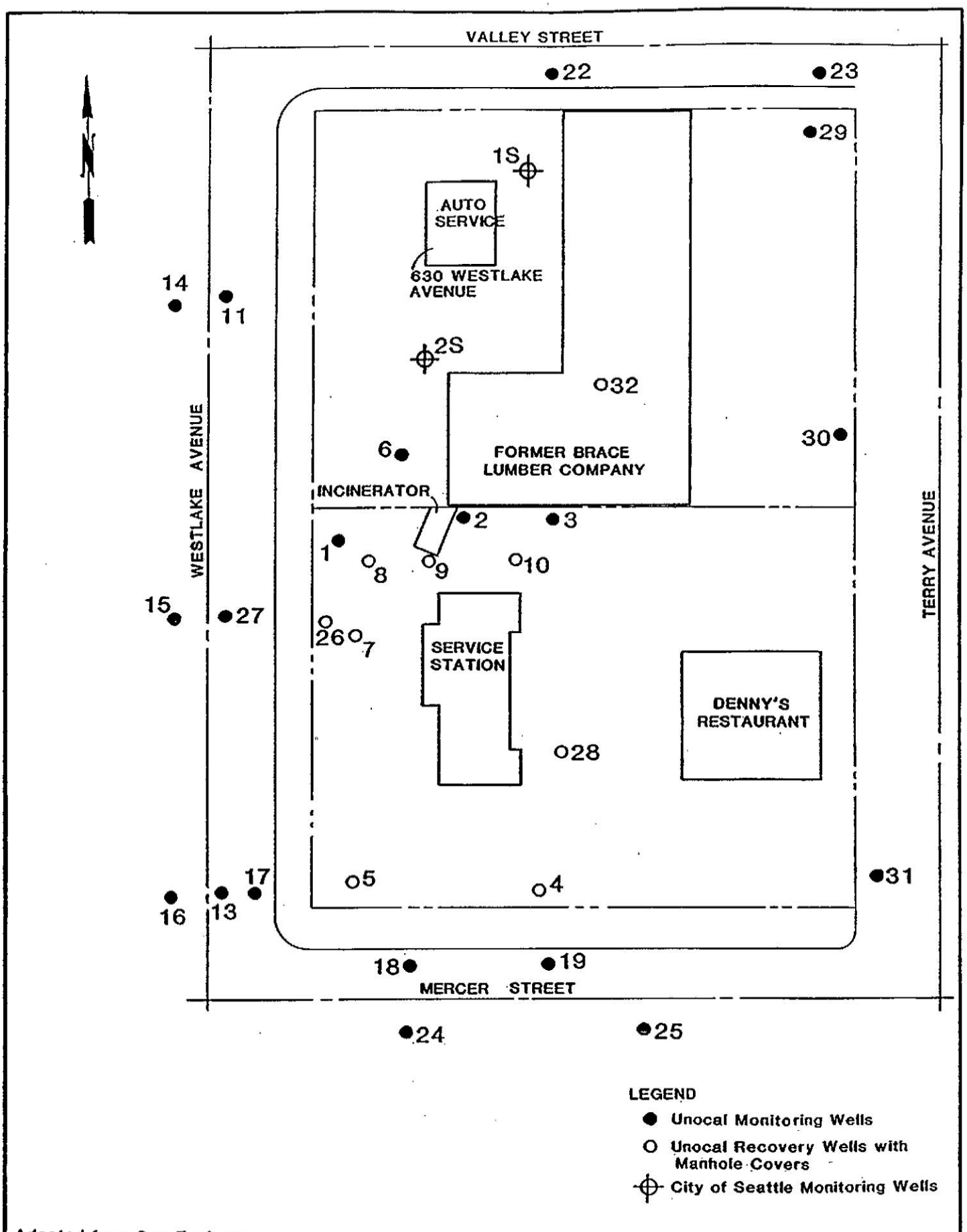
TABLE 1. SUMMARY OF INFORMATION COLLECTED FROM UNOCAL AND CITY OF SEATTLE GROUNDWATER MONITORING WELLS

DATE	WELL ID (In.)	DEPTH OF WELL (Feet)	WELL DIAM. (In.)	DEPTH TO WATER (Feet)	OBSERVED PRODUCT THICKNESS	COMBUSTIBLE GAS (%)	DETECTED ORGANIC VAPORS
UNOCAL WELLS:							
1/2/91	1*1						
1/7/91	1	15	2	9.95	0	<1	
1/2/91	2	~15	2	10.45	~1-in.	10-15	Strong odor
1/7/91	2*1						
1/2/91	3	14.5	2	9.50	0	15	+100 ppm*2
1/7/91	3			9.02	0	25	
1/7/91	11	9.6	1.5	8.85	0	4	
1/7/91	27	17	1.5	10.70	0	0	
1/2/91	29	57	1.5	8.52	0	0	
1/7/91	29			9.10	0	1-2	
1/2/91	32	15.3	1.5	3.90	0	5-10	20-200 ppm*2
1/7/91	32			3.45	0	10	
CITY OF SEATTLE WELLS:							
1/2/91	1s*3	15	2				
1/2/91	2s	15	2	9.15	sheen	5-10	300 ppm*2
1/7/91	2s			8.85		4	

Unocal Wells Not Measured:

4-5, 12-13, 16-21, 24-25, 28, 31, (see note *4)
6, 22-23, 30, (see note *5)
8-10, (see note *6)
7, 14, 15, 26, (see note *7)

Notes:
*1 Vehicle parked over well cover prevented access to well.
*2 HNu Meter results calibrated to benzene as a standard.
*3 Did not measure; pipe extension needed to prevent infiltration of surface runoff.
*4 Did not attempt to locate or access well.
*5 Could not locate well.
*6 Locked cover prevented access to well.
*7 Located well but did not attempt to gain access.



Adapted from Geo Engineers

SCS ENGINEERS

FIGURE 1 LOCATION OF MONITORING WELLS

APPENDIX A

GeoEngineers Memorandum
November 26, 1990

RECEIVED
NOV 27 1990
DEPT. OF ECOLOGY Bellevue

GeoEngineers

MEMORANDUM

TO: Gary Gunderson, Unocal and
Annette Petri, Washington Department of Ecology

FROM: Stephen Perrigo, GeoEngineers sep

DATE: November 26, 1990

FILE: 0161-013-B04

SUBJECT: Historical Summary of Activities at Unocal Station 5353, Located at Westlake & Mercer in Seattle, WA

RECEIVED
DAS
DEC 28 1990
[illegible]

This memorandum describes the chronology of main events that have taken place as a result of the release of gasoline prior to 1980 at Unocal Station 5353. The station is located at the northeast corner of the intersection of Westlake and Mercer in Seattle, Washington. A response to Ecology's letter of October 26, 1990 is also attached.

CHRONOLOGY OF EVENTS

May 1980
Gasoline leak detected at Service Station 5353. Loss of more than 80,000 gallons of leaded premium gasoline. Seven on-site gasoline recovery wells and an extensive network of monitor wells were installed in June and July.

June 1980
Free product recovery commenced.

October 1980
Recovery well installed in Brace Lumber Yard.

November 1980
Gasoline recovery totals 33,000 gallons, recovery rates decline. Additional monitor wells installed.

December 1980
Gasoline recovery totals 34,500 gallons.

February 1981
Pilot studies of the use of surfactents are conducted by Roger Lowe Associates for possible site application.

January 1982
Alternative cleanup methods including biodegradation, surfactants and venting are evaluated for the site by Harding Lawson Associates.

CHRONOLOGY OF EVENTS - (continued)

October 1982
Gasoline recovery totals 41,900 gallons. Recovery program terminated due to slow recovery.

October 1985
GeoEngineers measures ground water levels, product thickness and vapor concentrations in monitor wells. Free product was found in numerous on-site and off-site wells. Maximum free product thickness was 0.41 feet.

February 1988
GeoEngineers measures ground water levels, product thickness and vapor concentrations in monitor wells. Free product was found in numerous on-site and off-site monitor wells. Maximum product thickness was 0.23 feet.

April 1988
GeoEngineers recommends a subsurface vapor extraction program utilizing components of the existing free product recovery system.

June 1988
Vapor recovery initiated with thermal destruction of vapor effluent (02-90 through 05-90 vapor recovery terminated to evaluate site conditions under non-operational conditions).

February 1990
Well monitoring does not detect the presence of free product in any monitor wells.

May 1990
Well monitoring detects free product in three wells which had no measurable free product in February 1990.

August 1990
Vapor recovery terminated pending review of system operation.

October 1990
Ecology requests site information due to the discovery of subsurface contamination on adjoining property

CHRONOLOGY OF SITE REPORTS

Consultation services and reports of site-related activities have been prepared by the following consulting firms for Unocal:

Roger Lowe Associates, Inc.	(RLAI)
Harding Lawson Associates	(HLA)
GeoEngineers, Inc.	(GEI)

Reports prepared for Unocal are summarized below by date, general subject content and with identification of the consulting firm preparing the report:

Initial Site Characterization and Free Product Recovery Phase: 1980-1982

08/12/80	Initial site characterization report	(RLAI)
10/23/80	Progress Report #1, through #16 (07/23/81)	(RLAI)
08/07/81	Progress Report #17 through #45 (10/27/82)	(HLA)

Study of Alternatives

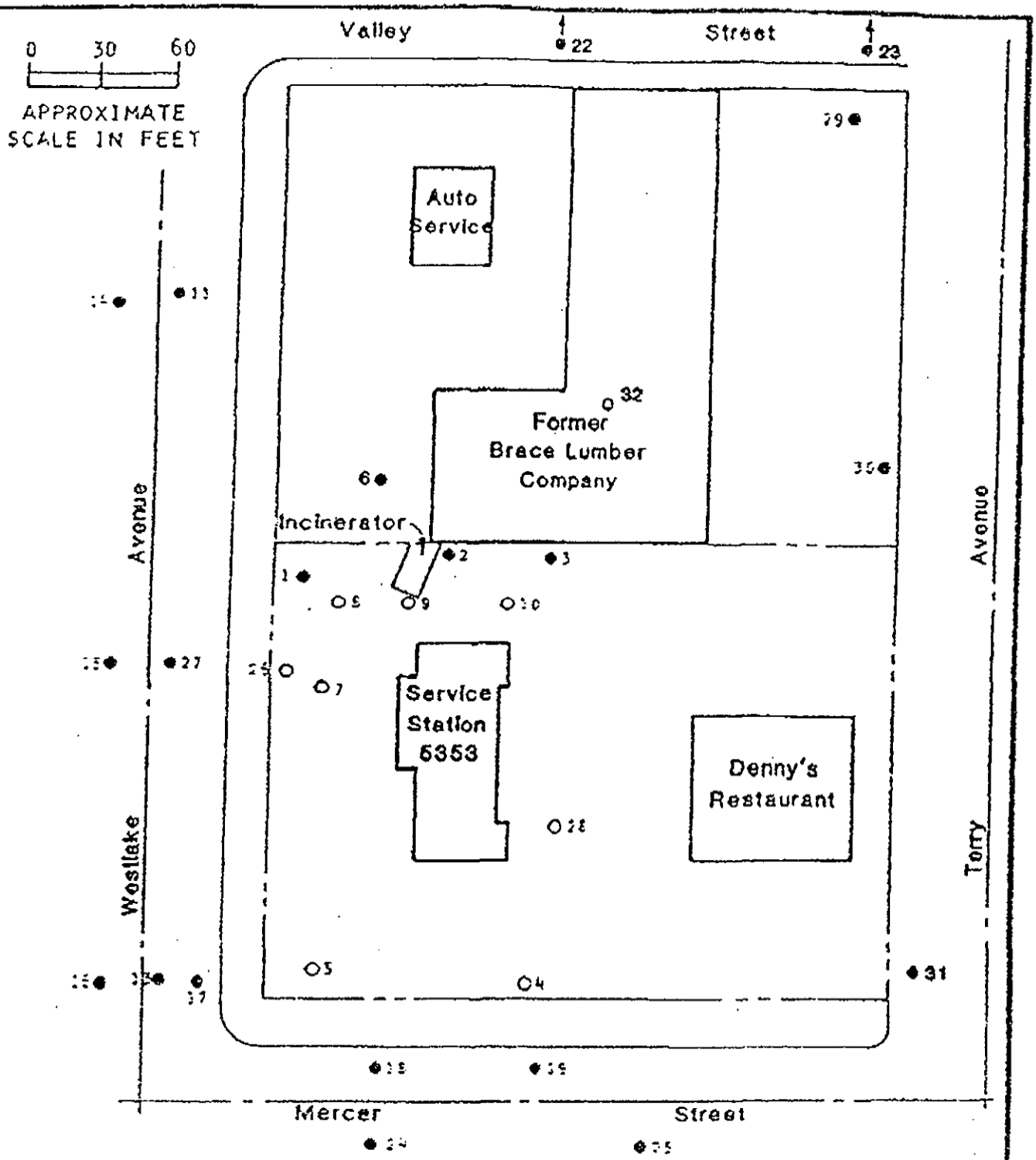
03/23/81	Degreasing (surfactant) agent evaluation	(RLAI)
01/26/82	Recovery method assessment study	(HLA)

Monitoring Activities

11/14/85	Results of site monitoring (October 1985)	(GEI)

Active Vapor Recovery (Withdrawal & Destruction) at Site: 1988-1990

06/08/88	Vapor extraction system overview	(GEI)
07/27/88	Progress Report #1	(GEI)
10/03/88	Interim Status Report	(GEI)



A-10 SITE PLAN

GeoEngineers

RESPONSE TO ECOLOGY'S LETTER OF OCTOBER 26, 1990

Unocal has provided information to Ecology regarding the past activities and monitoring of the site. Attached are copies of correspondence between Unocal and Ecology that describe the proposal for implementation of the vapor recovery system and reporting on its operation. Ecology's representative during the initial response to the release in 1980 was Mr. Craig Baker of the Northwest Regional Office. We understand that Mr. Baker has recently accepted a transfer within the Department. It may be appropriate at this time for Unocal and GeoEngineers to meet with Ecology so that a new representative of Ecology can be briefed on past, current, and planned actions at the site.

If any of the reports cited on the previous page are required by Ecology for evaluation, please contact Stephen Perrigo at GeoEngineers (746-5200).

The site has not been evaluated relative to the draft cleanup standards contained in the Model Toxics Controls Act Regulation. We recognize that such an evaluation, including testing of soil and ground water conditions, is appropriate at this time. No chemical testing of soil or ground water has been performed at this site. All of the existing monitor wells were installed in 1980. No additional subsurface explorations have occurred since that date.

The on-going site cleanup activities by vapor extraction have been hindered somewhat by the presence of methane gas in the subsurface environment. The methane would not be generated as a result of the gasoline leak and likely represents an off-site source relative to the Unocal site. The source of the methane gas has not been ascertained but it is expected that it is being generated within sawdust fill which is present in the general area. However, the possibility of the methane being derived from leaks from buried natural gas distribution lines has not been ruled out. The concentrations of methane gas measured on and around the site exceed Ecology's current reporting criteria which are outlined in Ecology's policy document POL 102 (May 25, 1990). Unocal has directed GeoEngineers to provide Ecology with data regarding subsurface methane gas which is gathered as part of our studies and cleanup activities at the Station 5353 site.

Unocal Refining & Marketing Division
Unocal Corporation
3131 Elliott Avenue, P.O. Box 78
Seattle, Washington 98111
Telephone (206) 281-7666

GeoEngineers

UNOCAL 76

JUN 14 1988

Routing [illegible]

File 161-13

June 13, 1988

Mr. Craig S. Baker
Washington Dept. of Ecology
Northwest Regional Office
4350 - 150th Avenue Northeast
Redmond, Washington 98052-5301

Dear Mr. Baker:

Re: SERVICE STATION 5353
Remedial Operations

UNOCAL is presently planning to resume remedial operations at the site of a leak of gasoline from our Service Station 5353 at Westlake and Mercer Street in Seattle, Washington. The spill occurred prior to May, 1980. Your department was involved at that time. From 1980 through October, 1982 a recovery system was able to recover about 41,000 gallons of fuel. Recovery efforts were terminated in 1982 with Washington Department of Ecology's concurrence.

As we all know, environmental standards have changed considerably since 1982. Based on UNOCAL's current corporate policies, we feel that it is necessary to return to the site and implement further remedial measures. We plan to install and operate a vapor extraction/incineration system to remove and treat hydrocarbon vapors that are present in the soil beneath the site. The duration of the vapor extraction program is not known at this time, but we are tentatively planning on operating such a system for up to two years.

We have contacted GeoEngineers, Inc., to assist with the design, operation and monitoring of the vapor recovery system. Attached to this letter is a brief overview of the design and operation of the system planned for this site. We expect to begin system operation during mid to late June.

We will keep Ecology informed of the operation and effectiveness of this sytem. Regular progress reports submitted by GeoEngineers will be forwarded to Ecology.

We request that you review this proposed program to determine if it satisfies the requirements of Ecology for remediation at this site. If you have any further questions about our plans for this vapor recovery system, please contact Mr. Steve Perrigo of GeoEngineers at 746-5200. Please concur with our plans by executing and returning one copy of this letter to UNOCAL.

Yours very truly,

V. L. CARLSON
Construction Engineer

VLC:ct

Attachment

cc: J. L. Ashlock
A. L. Barone
J. Miller, GeoEngineers, Inc. (w/attach)

Proposal accepted this _____ day of _____, 1988

_____
Department of Ecology

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4350-150th Ave. N.E. • Redmond, Washington 98052-5301 • (206) 867-7000

V.L. CARLSON
GeoEngineers JUN 23 1988

JUN 27 1988
Routing OCD
File 0161-13-7

June 22, 1988

Mr. V. L. Carlson
Unocal Corporation
3131 Elliott Avenue
P.O. Box 76
Seattle, Washington 98111

Dear Mr. Carlson:

On June 14, 1988, we received your proposal for vapor recovery and incineration at service station 5353, located at Westlake and Mercer.

Upon review of the subject document, our approval has been given.

Sincerely,

Craig S. Baker

Craig S. Baker
Spill Response Manager
Environmental Quality

CSB:cs

RECEIVED
JUN 23 1988
MAINT. & CONT.

Unocal Refining & Marketing Division
Unocal Corporation
3131 Elliott Avenue, P.O. Box 76
Seattle, Washington 98111
Telephone (205) 281-7666

GeoEngineers

UNOCAL 76

SEP 1 1988

Routing SCI

File

August 31, 1988

Craig S. Baker
Department of Ecology
4350 150th Ave. NE
Redmond, Wa. 98052-5301

Dear Mr. Baker

Re: STATION 5353
WESTLAKE & MERCER
SEATTLE, WASHINGTON

The attached Progress Report No. 1 for the vapor extraction program at Station 5353, Westlake and Mercer Streets, is for your review and comment.

Please contact Mr. Steve Perrigo at GeoEngineers (746-5200) or myself at 443-7523 if you have any questions.

Yours very truly,

V. L. CARLSON
Construction Engineer

VLC:ct

Attachment

cc: S. Perrigo, GeoEngineers, Inc.
J. L. Ashlock
A. L. Barone
J. E. Mason

APPENDIX B

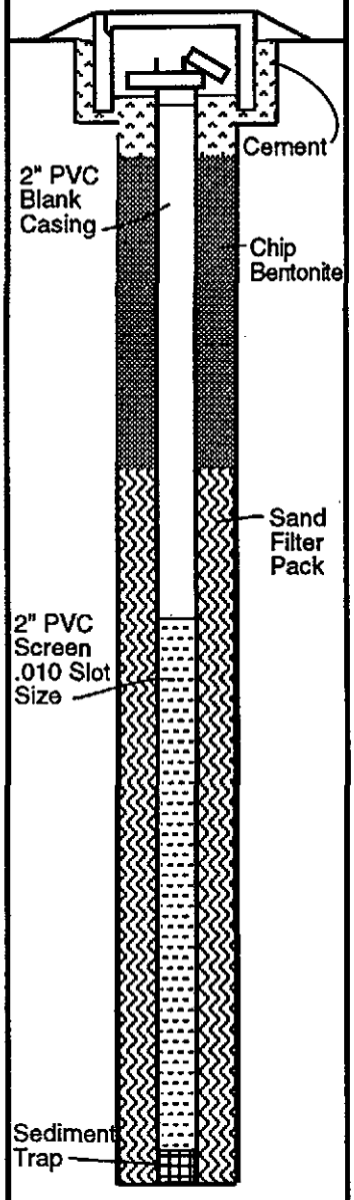
Borehole Logs and Monitoring Well Construction Details

BORING LOG

SCS ENGINEERS
Environmental Consultants
2950 Northup Way
Bellevue, Wa 98004
(206) 822-5800
FAX (206) 889-2267

PROJECT: CITY OF SEATTLE
LOCATION: WESTLAKE
JOB NUMBER: 0489021.02
GEOLOGIST/ENGINEER: D. VENCHIARUTTI
DRILLER: HOKKAIDO
DRILL RIG: MOBIL B - 61
DRILLING METHOD: HOLLOW STEM AUGER

HOLE/WELL #: MW-1
DIAMETER: 6 1/4" I.D.
TOTAL DEPTH: 19' 10"
DATE STARTED: 1/28/91
DATE COMPLETED: 1 / 28 / 91
SAMPLING DEVICE: SPLIT SPOON
PAGE: 1 OF: 1

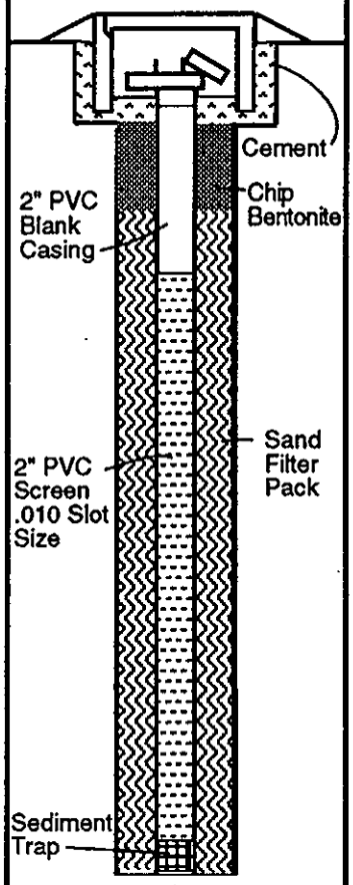


DEPTH (FEET)	SAMPLE #	BLOW COUNTS/ 18"	USCS SYMBOL	DESCRIPTION
0				Asphalt
2			Gm	Gravel fill, 1/2" - 1" gravel, brown silt.
5	19630 19631	14	Gm	Sandy gravel, 1/2" - 1" gravel, silty brown soil, some grey clay. HNu 0 ppm.
10	19632 19633	11	SC	Silty grey clay, with med. coarse sand. HNu 0 ppm.
12				Water level
13			SC	Sand, med. coarse, silty with grey clay. Wet. HNu 0 ppm.
17			SC	Medium coarse sand with some clay, grey, plastic. HNu 0 ppm.
19	19634 19635	-	OH	Grey plastic clay. Decomposed wood and peat. HNu 0 ppm.
20				

BORING LOG

SCS ENGINEERS
Environmental Consultants
2950 Northup Way
Bellevue, Wa 98004
(206) 822-5800
FAX (206) 889-2267

PROJECT: CITY OF SEATTLE
HOLE/WELL #: MW-2
LOCATION: WESTLAKE
DIAMETER: 6 1/4" I.D.
JOB NUMBER: 0489021.02
TOTAL DEPTH: 14' 4"
GEOLOGIST/ENGINEER: D. VENCHIARUTTI
DATE STARTED: 1/30/91
DRILLER: HOKKAIDO
DATE COMPLETED: 1/30/91
DRILL RIG: MOBIL B - 61
SAMPLING DEVICE: SPLIT SPOON
DRILLING METHOD: HOLLOW STEM AUGER
PAGE: 1 OF: 1

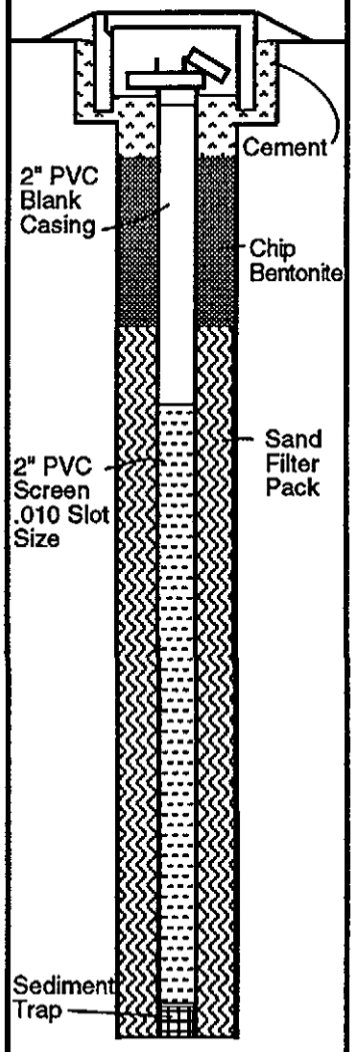


DEPTH (FEET)	SAMPLE	SAMPLE #	BLOW COUNTS/ 18"	USCS SYMBOL	DESCRIPTION
0					Asphalt
1				Gm	Silty gravel soil, cobbles to 1". Some organic debris.
2					
3					
4					
5		19284 19285	30	Gm	Dark green silt, with cobbles and assorted debris. Dry. HNu 0 ppm
6					
7					Water level
8		19286 19287	35	Sm	Wet, clay rich green silt with some coarse sand. Concrete debris occur.
9					
10					
11					
12					
13					
14		19288	25	SC	Concrete debris still present. Less sandy, more clay rich, plastic. Very wet. HNu 0 ppm
15					
16					
17					
18					
19					
20					

BORING LOG

SCS ENGINEERS
Environmental Consultants
2950 Northup Way
Bellevue, Wa 98004
(206) 822-5800
FAX (206) 889-2267

PROJECT: CITY OF SEATTLE
HOLE/WELL #: MW-3
LOCATION: WESTLAKE
DIAMETER: 6 1/4" I.D.
JOB NUMBER: 0489021.02
TOTAL DEPTH: 17'
GEOLOGIST/ENGINEER: D. VENCHIARUTTI
DATE STARTED: 1/29/91
DRILLER: HOKKAIDO
DATE COMPLETED: 1 / 29 / 91
DRILL RIG: MOBIL B - 61
SAMPLING DEVICE: SPLIT SPOON
DRILLING METHOD: HOLLOW STEM AUGER
PAGE: 1 OF: 1

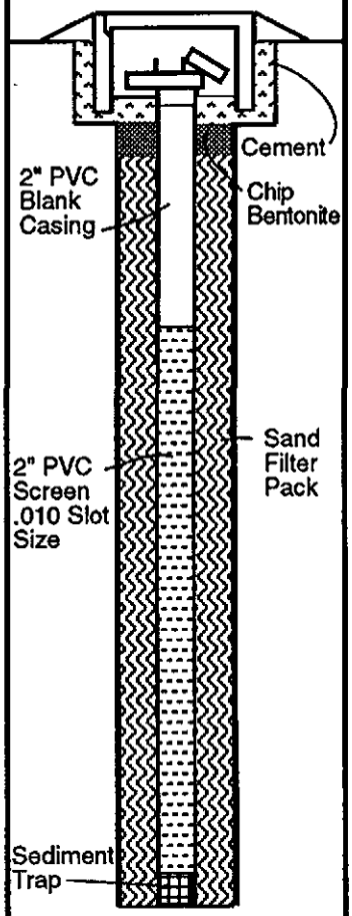
DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ 18"	USCS SYMBOL	DESCRIPTION
0					OL	Grass; on brown clayish silt. 10% gravel to 1".
5			19641 19642	17	OL	Green brown silt with some gray clay. Wood chips. 10% pebbles to 1". HNu 0 ppm.
8						Green-grey plastic clay, with minor silt. Wet. HNu 0 ppm.
10			19643 19644	11	OH	Water level
17			19645	19	OH	Wet green, gray plastic clay. HNu 0 ppm.

BORING LOG

SCS ENGINEERS
Environmental Consultants
2950 Northup Way
Bellevue, Wa 98004
(206) 822-5800
FAX (206) 889-2267

PROJECT: CITY OF SEATTLE
LOCATION: WESTLAKE
JOB NUMBER: 0489021.02
GEOLOGIST/ENGINEER: D. VENCHIARUTTI
DRILLER: HOKKAIDO
DRILL RIG: MOBIL B - 61
DRILLING METHOD: HOLLOW STEM AUGER

HOLE/WELL #: MW-4
DIAMETER: 6 1/4" I.D.
TOTAL DEPTH: 15'
DATE STARTED: 1/29/91
DATE COMPLETED: 1 / 29 / 91
SAMPLING DEVICE: SPLIT SPOON
PAGE: 1 OF: 1

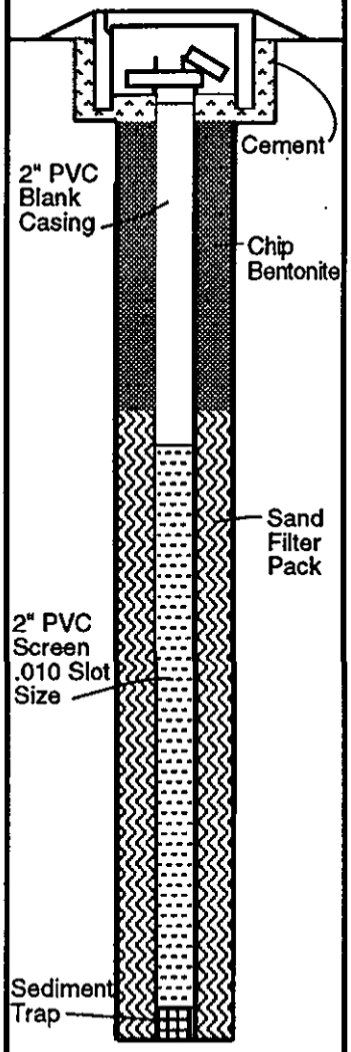
DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ 18"	USCS SYMBOL	DESCRIPTION
0						Concrete
1					GC	Grey silty clay, some gravel. Petro hydrocarbon vapors. HNu 20 - 25 ppm.
2						
3						
4						
5			19636	14	GC	Gravel and cobbles to 6", with grey silty clay. Strong gas odor. HNu 50 -100 ppm.
6						
7						
8					SC	▽ Water level
9						Grey, silty medium sand. Wet. HNu 300 ppm.
10			19637 19638	6		
11						
12						
13						
14						
15			19639 19640	4	OH	Plastic, grey silty clay. Some decomposed wood. Wet. HNu<5 ppm.
16						
17						
18						
19						
20						

BORING LOG

SCS ENGINEERS
Environmental Consultants
2950 Northup Way
Bellevue, Wa 98004
(206) 822-5800
FAX (206) 889-2267

PROJECT: CITY OF SEATTLE
LOCATION: WESTLAKE
JOB NUMBER: 0489021.02
GEOLOGIST/ENGINEER: D. VENCHIARUTTI
DRILLER: HOKKAIDO
DRILL RIG: MOBIL B - 61
DRILLING METHOD: HOLLOW STEM AUGER

HOLE/WELL #: MW-5
DIAMETER: 6 1/4" I.D.
TOTAL DEPTH: 17' 4"
DATE STARTED: 1/31/91
DATE COMPLETED: 1 / 31 / 91
SAMPLING DEVICE: SPLIT SPOON
PAGE: 1 OF: 1



DEPTH (FEET)	SAMPLE	SAMPLE #	BLOW COUNTS/ 18"	USCS SYMBOL	DESCRIPTION
0					Asphalt
2				CL	Green clay rich fill. Sand, silt and gravel mix. HNu 10 ppm.
5		19289 19290	38	OH	Green-grey clay, very plastic. Some organic debris. Dry, some petro hydrocarbon vapors. HNu 5 - 7 ppm.
10		19291 19292	8	OH	Green/grey plastic clay. Some cand. Organics present. Dry. HNu 250 ppm.
11					Water level
17		19294	11	OH	Very wet. Residual sand, with clay washed away. Smell of petroleum hydrocarbons. Wood debris common.

BORING LOG

SCS ENGINEERS
Environmental Consultants
2950 Northup Way
Bellevue, Wa 98004
(206) 822-5800
FAX (206) 889-2267

PROJECT: CITY OF SEATTLE
LOCATION: WESTLAKE
JOB NUMBER: 0489021.02
GEOLOGIST/ENGINEER: D. VENCHIARUTTI
DRILLER: HOKKAIDO
DRILL RIG: MOBIL B - 61
DRILLING METHOD: HOLLOW STEM AUGER

HOLE/WELL #: BH-4
DIAMETER: 6 1/4" I.D.
TOTAL DEPTH: 8'
DATE STARTED: 1 /30 / 91
DATE COMPLETED: 1 /230 / 91
SAMPLING DEVICE: SPLIT SPOON
PAGE: 1 OF: 1

DEPTH (FEET)	SAMPLE	COMPLETION DETAIL	SAMPLE #	BLOW COUNTS/ 18"	USCS SYMBOL	DESCRIPTION
0						Asphalt
1					Gm	Brown silty soil with 1" - 2" gravel.
2						
3						
4						
5			19279 19280	25	OL	Green clay rich silt with cobbles and some organics. HNu 0 ppm.
6						
7						
8			19281 19282	29	OL	▽ Water level Same as above, but with more sandy silt, less clay. Some organics. HNu 0 ppm.
9						
10						T.D. = 8'
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

APPENDIX C

Determination of Groundwater Flow Parameters

APPENDIX C

DETERMINATION OF GROUNDWATER FLOW PARAMETERS

Groundwater Flow Velocity

The average linear velocity of groundwater flow is generally defined as:

$$V = \frac{K\,(dh/dl)}{n}$$

where,

V = average linear velocity in unit length per unit time

k = hydraulic conductivity (permeability) in unit length per unit time

dh/dl = hydraulic gradient, dimensionless

n = porosity

The average linear velocity of flow in the water table aquifer was calculated across the site using hydraulic conductivity (k), hydraulic gradient (ft/ft), and porosity (n). The rate of groundwater movement to the north was estimated to range from less than 1 foot per year to 58 feet per year at monitoring wells MW-1, MW-3, MW-4 and MW-5. A low hydraulic gradient (0.005 ft/ft) at the site appears to be the limiting factor in the rate of groundwater flow. A higher gradient (0.025 ft/ft) between wells MW-2 and MW-3 resulted in an estimated groundwater flow rate ranging from about 1 to 220 feet per year to the northeast in this area of the site.

Table C-1 provides a summary of groundwater velocities calculated at each monitoring well site. The variables used in the calculation of groundwater flow at the site are discussed below.

Hydraulic Conductivity

Hydraulic conductivity refers to the ability of water to move through a porous material. The hydraulic conductivity of the water table aquifer materials at the Westlake Site was estimated to range from 3.6×10^{-5} ft/min to 1.0×10^{-2} ft/min. This range in values is typical for fill materials. It is also common to have a variation in results such as this when analyzing bail or slug test data.

Hydraulic conductivity of a formation may be determined by several methods, depending upon the aquifer type, aquifer response, and design

and spacing of test wells. Time recovery data was analyzed at the Westlake Site using the Ferris and Knowles method (McWhorter and Sunada, 1977) and the Horslev Method (Freeze and Cherry, 1979). An analysis of the data for the determination of hydraulic conductivity values by both procedures is provided below.

Hydraulic Gradient

The hydraulic gradient (dh/dl) of a water bearing formation is calculated by determining the difference in water level elevations (dh) at two points and the distance (dl) between these two points.

The average hydraulic gradient of the water table aquifer during March 1991 was calculated to be 0.005 ft/ft across the site. The predominant flow direction is towards the north, from the Westlake site. A gradient of 0.025 ft/ft was calculated between wells MW-2 and MW-3, which indicates a northeasterly component of flow northwest of the site.

Porosity

The porosity of a formation is the ratio of the volume of the interstices or void space to the total bulk volume. Porosity is influenced by particle shape, degree of compaction and cementation, and particle size distribution. In general, poorly sorted gravels, sands, and silts have lower porosities than well sorted deposits.

An estimated porosity of 45% was assumed in the groundwater velocity equation discussed previously. This porosity is representative of observed subsurface materials occurring at the site based on porosity values provided for sand, silt, and clay.

TABLE C-1. SUMMARY OF GROUNDWATER VELOCITY ESTIMATES

LOCATION	CONDUCTIVITY (ft/min)	GRADIENT (1) (ft/ft)	POROSITY	VELOCITY ft/min	VELOCITY ft/yr
MW-1	4.5×10^{-5} (2)	0.005	0.45	5.0×10^{-7}	0.3
	9.0×10^{-5} (3)	0.005	0.45	1.0×10^{-6}	0.5
MW-2	3.6×10^{-5} (2)	0.025	0.45	2.0×10^{-6}	1
	7.5×10^{-3} (2)	0.025	0.45	4.2×10^{-4}	220
MW-3	7.5×10^{-3} (2)	0.005	0.45	8.3×10^{-5}	43
	1.9×10^{-3} (3)	0.005	0.45	2.1×10^{-5}	11
MW-5	3.6×10^{-5} (2)	0.005	0.45	4.0×10^{-7}	0.2
	5.2×10^{-5} (3)	0.005	0.45	5.8×10^{-7}	0.3
MW-6	1.0×10^{-2} (4)	0.005	0.45	1.1×10^{-4}	58

Notes: 1 - Average hydraulic gradient from MW-1 to MW-3 is 0.005 ft/ft. Hydraulic gradient from MW-2 to MW-3 is 0.025 ft/ft.

2 - Value determined using Ferris and Knowles Methodology; Hydraulic conductivity values assumed for MW-2 are based on values determined for MW-3 and MW-5.

3 - Value determined from Hvorslev methodology.

4 - Estimated value based on higher permeable materials.

TWO METHODS OF DETERMINING HYDRAULIC CONDUCTIVITY

A) HVORSLEV METHOD (1951)

$$K = \frac{r2 \ln (L/r)}{2L \ To}$$ (Freeze & Cherry, 1979)

where:
- K = hydraulic conductivity
- r = radius of well casing
- L = length of screen
- To = time corresponding to normalized recovery of 0.37
- H = water level prior to test
- Ho = water level at start of test
- h = water level during test at time (t)

B) FERRIS AND KNOWLES METHOD (1963)

$$T = \frac{v}{(4)\ (3.14)\ (t)\ (-s)}$$

where:
- T = transmissivity
- v = volume of water removed for test
- t = time
- s = recovery at time (t)

then:

$$K = \frac{T}{\text{Saturation thickness}}$$

HYDRAULIC CONDUCTIVITY VALUES
CALCULATED USING TWO METHODS

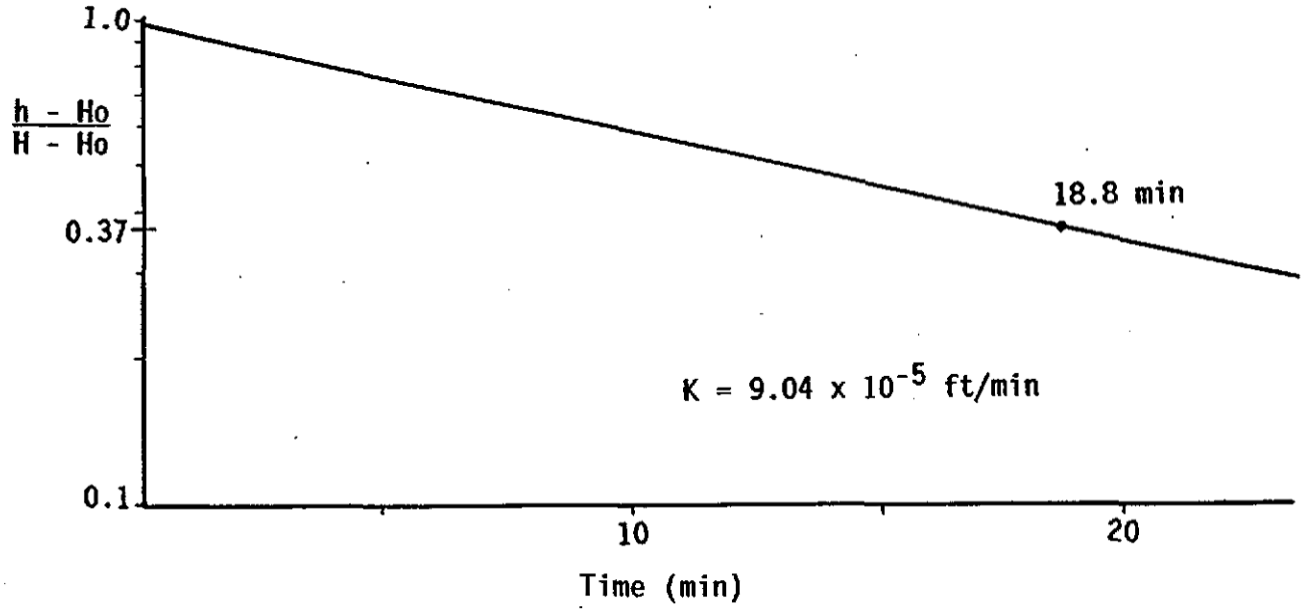
WELL #	FERRIS AND KNOWLES METHOD	HVORSLEV METHOD
MW-1	4.5×10^{-5} ft/min	9.04×10^{-5} ft/min
MW-3	7.5×10^{-3} ft/min	1.87×10^{-3} ft/min
MW-5	3.57×10^{-5} ft/min	5.23×10^{-5} ft/min

DETERMINATION OF HYDRAULIC CONDUCTIVITY AT MW-1

Hvorslev Method, 1951

DATA:

Time (min)	h (ft)	h - Ho (ft)	$\frac{h - Ho}{H - Ho}$	
0.0	17.82	6.24	1.0	Ho = 11.58 ft
0.5	17.08	5.50	0.88	
1.0	16.90	5.32	0.85	H = 17.82 ft
1.5	16.78	5.20	0.83	
2.0	16.65	5.07	0.81	H - Ho = 6.24 ft
2.5	16.54	4.98	0.79	
3.0	16.42	4.84	0.76	
3.5	16.31	4.73	0.75	
4.0	16.20	4.62	0.74	
4.5	16.12	4.54	0.73	
5.0	16.00	4.42	0.71	
6.0	15.84	4.26	0.68	
7.0	15.64	4.06	0.65	
8.0	15.48	3.90	0.62	
9.0	15.30	3.72	0.60	
11.0	14.89	3.31	0.53	
13.0	14.59	3.01	0.48	
15.0	14.30	2.72	0.43	
20.0	13.76	2.18	0.35	



DETERMINATION OF TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY AT MW-1

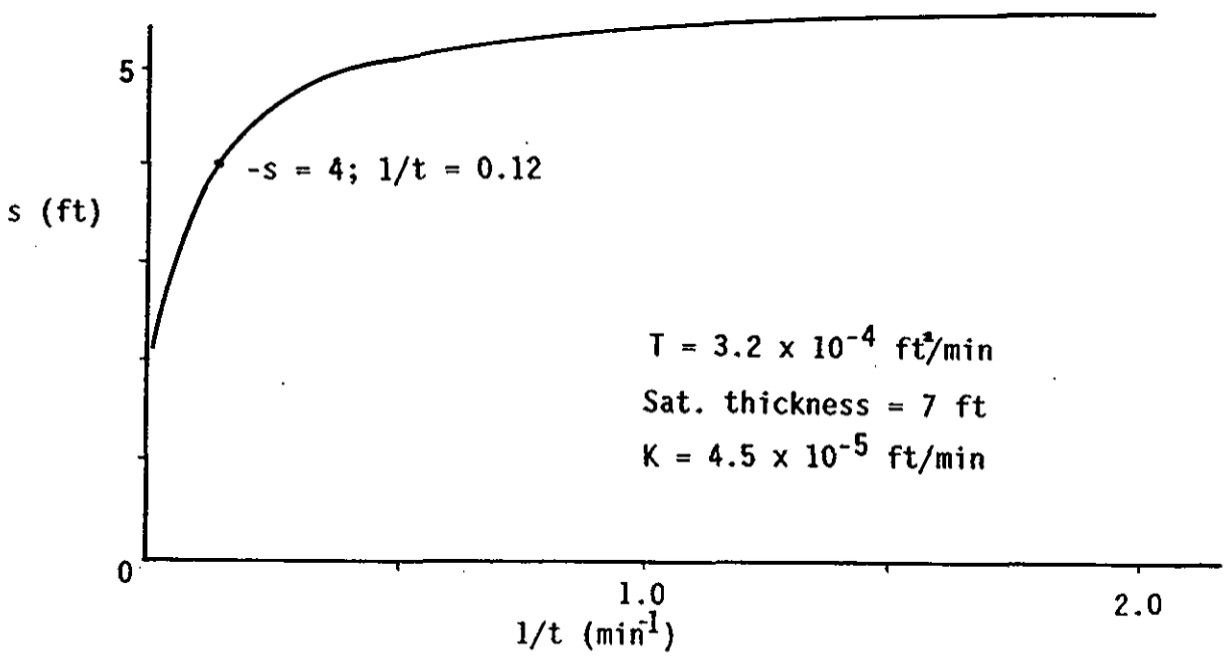
Ferris and Knowles Method, 1963

DATA:

Time (min)	1/t	h (ft)	s (ft)
0.0	0.0	17.82	0.0
0.5	2.0	17.08	5.50
1.0	1.0	16.90	5.32
1.5	0.67	16.78	5.20
2.0	0.5	16.65	5.07
2.5	0.4	16.54	4.98
3.0	0.33	16.42	4.84
3.5	0.28	16.31	4.73
4.0	0.25	16.20	4.62
4.5	0.22	16.12	4.54
5.0	0.20	16.00	4.42
6.0	0.16	15.84	4.26
7.0	0.14	15.64	4.06
8.0	0.13	15.48	3.90
9.0	0.11	15.30	3.72
11.0	0.09	14.89	3.31
13.0	0.07	14.59	3.01
15.0	0.06	14.30	2.72
20.0	0.05	13.76	2.18

h = 17.82 ft at start of test.

v = 0.136 ft^3 removed to conduct test



$T = 3.2 \times 10^{-4}$ ft^2/min

Sat. thickness = 7 ft

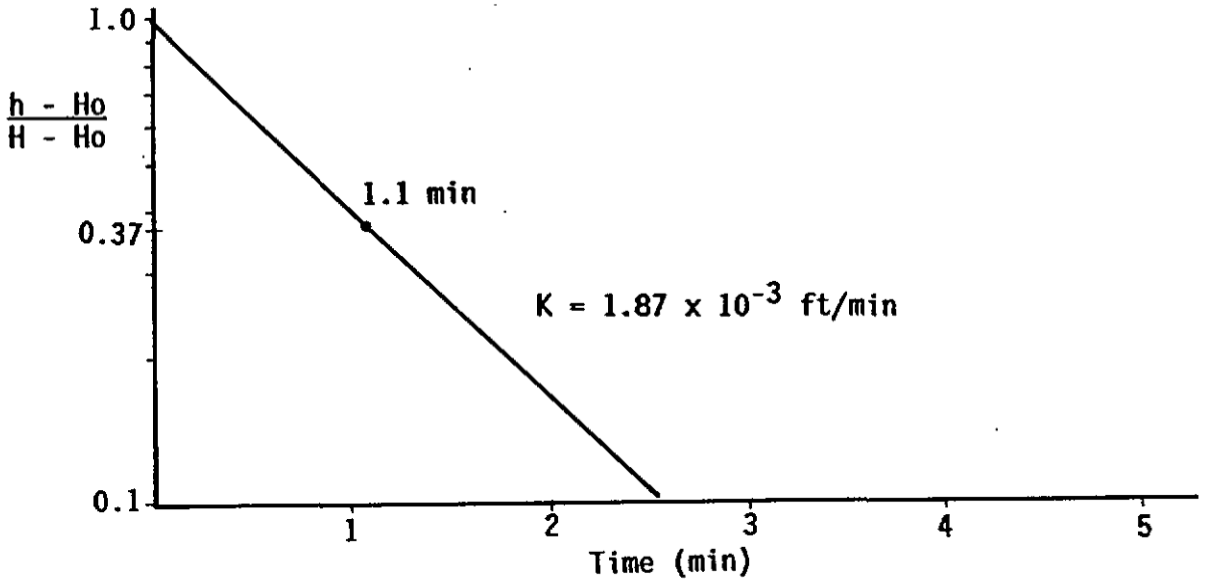
$K = 4.5 \times 10^{-5}$ ft/min

DETERMINATION OF HYDRAULIC CONDUCTIVITY AT MW-3

Hvorslev Method, 1951

DATA:

Time (min)	h (ft)	h - Ho (ft)	$\frac{h - Ho}{H - Ho}$	
0.0	10.96	0.19	1.0	Ho = 10.77 ft
0.5	10.88	0.11	0.58	
1.0	10.85	0.08	0.42	H = 10.96 ft
1.5	10.82	0.05	0.26	
2.0	10.80	0.03	0.16	H - Ho = 0.19 ft
2.5	10.79	0.02	0.11	
3.0	10.79	0.02	0.11	
4.0	10.78	0.01	0.05	



DETERMINATION OF TRANSMISSIVITY
AND HYDRAULIC CONDUCTIVITY AT MW-3

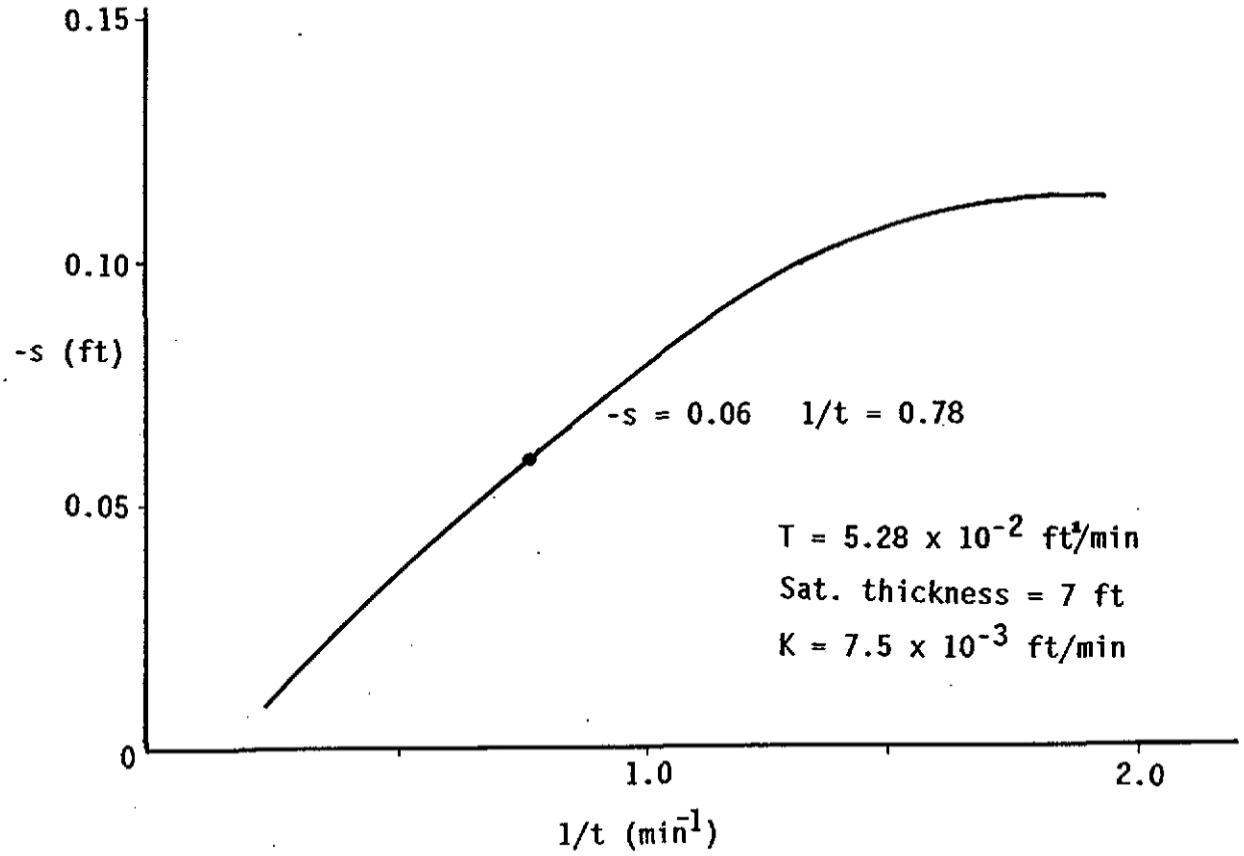
Ferris and Knowles Method, 1963

DATA:

Time (min)	1/t	h (ft)	s (ft)
0.0	0.0	10.96	0.0
0.5	2.0	10.88	0.11
1.0	1.0	10.85	0.08
1.5	0.67	10.82	0.05
2.0	0.5	10.80	0.03
2.5	0.4	10.79	0.02
3.0	0.33	10.79	0.02
4.0	0.25	10.78	0.01

h = 10.96 ft at start of test

v = 0.051 ft^3 removed to conduct test



DETERMINATION OF TRANSMISSIVITY AND HYDRAULIC CONDUCTIVITY AT MW-4

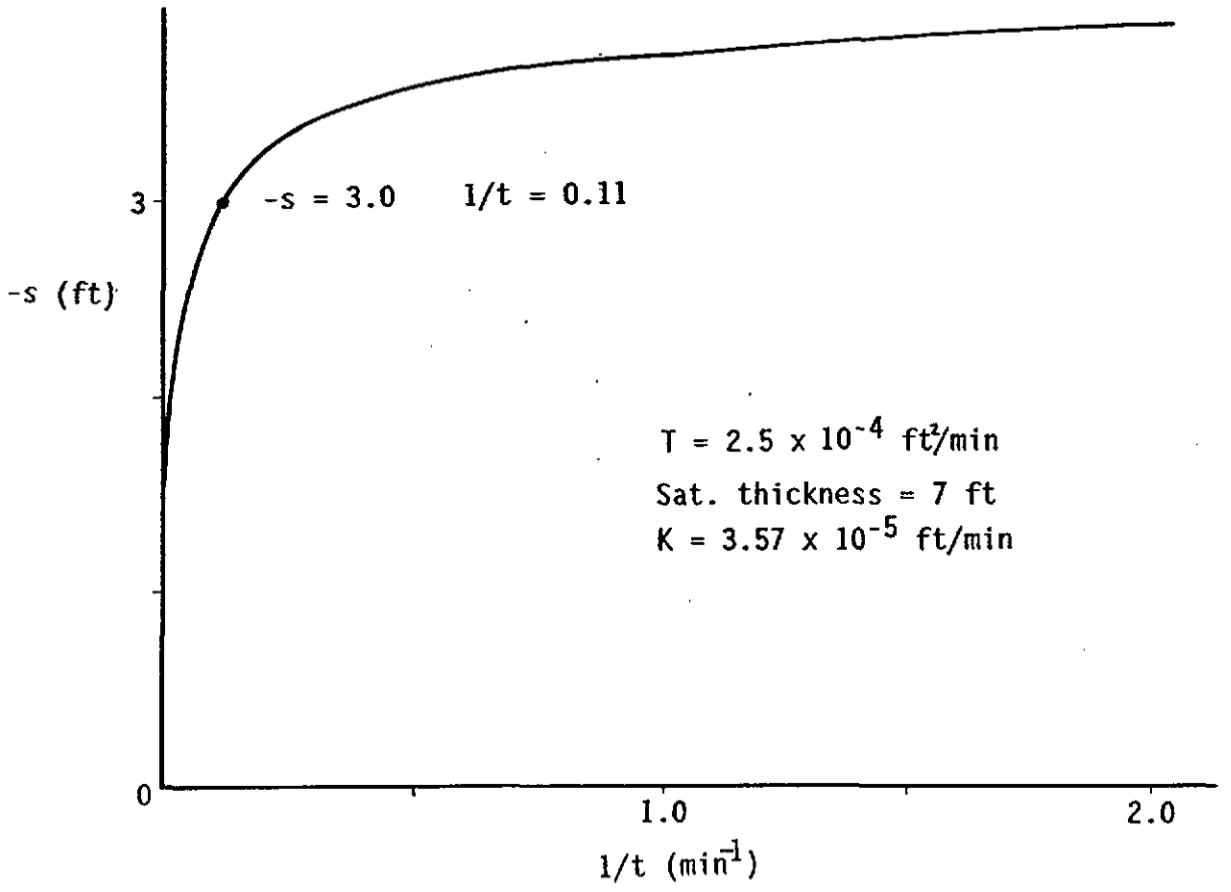
Ferris and Knowles Method, 1963

DATA:

Time (min)	1/t	h (ft)	s (ft)
0.0	0.0	12.50	0.0
0.5	2.0	12.12	3.87
1.0	1.0	12.27	3.72
1.5	0.67	12.21	3.66
2.0	0.5	12.14	3.59
2.5	0.4	12.03	3.48
3.0	0.33	12.04	3.47
4.0	0.25	11.90	3.35
5.0	0.20	11.82	3.27
6.0	0.16	11.74	3.19
7.0	0.14	11.65	3.10
8.0	0.13	11.58	3.03
10.5	0.09	11.40	2.85
15.0	0.06	11.05	2.50

h = 12.50 ft at start of test

v = 0.086 ft^3 removed to conduct test

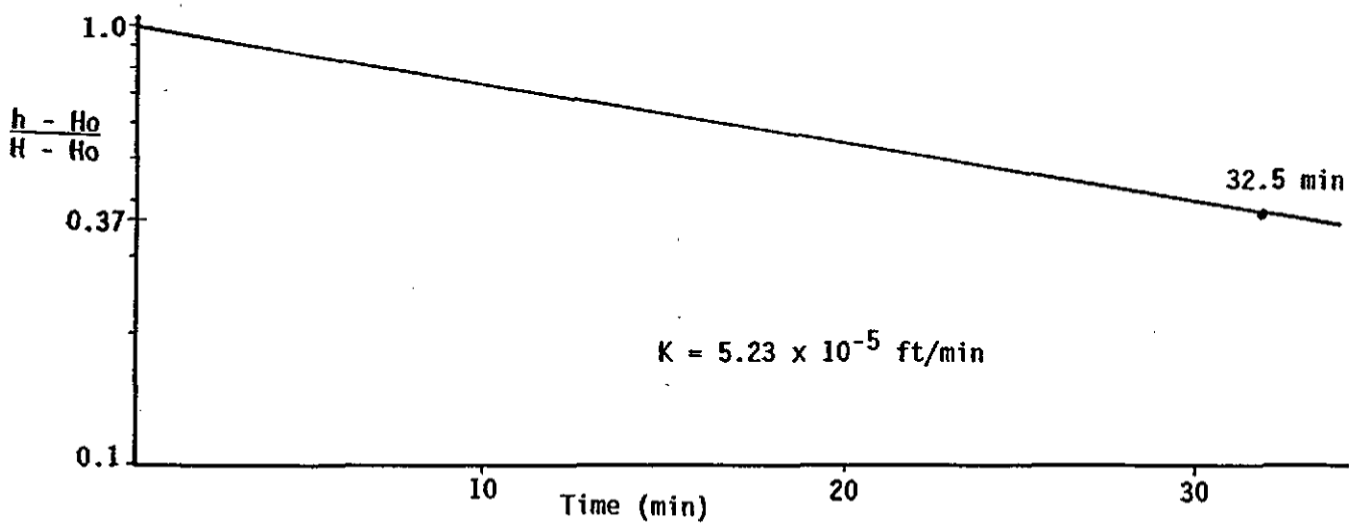


DETERMINATION OF HYDRAULIC CONDUCTIVITY AT MW-4

Hvorslev Method, 1951

DATA:

Time (min)	h (ft)	h - Ho (ft)	$\frac{h - Ho}{H - Ho}$	
0.0	12.50	3.95	1.0	Ho = 8.55 ft
0.5	12.12	3.87	0.98	
1.0	12.27	3.72	0.94	H = 12.50 ft
1.5	12.21	3.66	0.93	
2.0	12.14	3.59	0.91	H - Ho = 3.95 ft
2.5	12.03	3.48	0.88	
3.0	12.04	3.47	0.87	
4.0	11.90	3.35	0.85	
5.0	11.82	3.27	0.82	
6.0	11.74	3.19	0.81	
7.0	11.65	3.10	0.78	
8.0	11.58	3.03	0.77	
10.5	11.40	2.85	0.72	
15.0	11.05	2.50	0.63	



APPENDIX D

MTCA Cleanup Levels for Soil and Groundwater

(2) Method A cleanup levels.

(a) Where the ground water is a current or potential future source of drinking water, method A cleanup levels shall be at least as stringent as all of the following:

(i) Concentrations listed in Table 1:

Table 1

Method A Cleanup Levels - Ground Water [a]

Hazardous Substance	CAS Number	Cleanup Level
Arsenic	7440-38-2	5.0 ug/liter [b]
Benzene	71-43-2	5.0 ug/liter [c]
Cadmium	7440-43-9	5.0 ug/liter [d]
Chromium (Total)	7440-47-3	50.0 ug/liter [e]
DDT	50-29-3	0.1 ug/liter [f]
1,2 Dichloroethane	107-06-2	5.0 ug/liter [g]
Ethylbenzene	100-41-4	30.0 ug/liter [h]
Ethylene dibromide	106-93-4	0.01 ug/liter [i]
Gross Alpha Particle Activity		15.0 pCi/liter [j]
Gross Beta Particle Activity		4.0 mrem/yr [k]
Lead	7439-92-1	5.0 ug/liter [l]
Lindane	58-89-9	0.2 ug/liter [m]
Methylene chloride	75-09-2	5.0 ug/liter [n]
Mercury	7439-97-6	2.0 ug/liter [o]
PAHs (carcinogenic)		0.1 ug/liter [p]
PCB mixtures		0.1 ug/liter [q]
Radium 226 and 228		5.0 pCi/liter [r]
Radium 226		3.0 pCi/liter [s]
Tetrachloroethylene	127-18-4	5.0 ug/liter [t]
Toluene	108-88-3	40.0 ug/liter [u]
Total Petroleum Hydrocarbons		1000.0 ug/liter [v]
1,1,1 Trichloroethane	71-55-6	200.0 ug/liter [w]
Trichloroethylene	79-01-5	5.0 ug/liter [x]
Vinyl chloride	75-01-4	0.2 ug/liter [y]
Xylenes	1330-20-7	20.0 ug/liter [z]

[a] Caution on misusing method A tables. Method A tables have been developed for specific purposes. They are intended to provide conservative cleanup levels for sites undergoing routine cleanup actions or those sites with relatively few hazardous substances. The tables may not be appropriate for defining cleanup levels at other sites. For these reasons, the values in these tables should not automatically be used to define cleanup levels that must be met for financial, real estate, insurance coverage or placement, or similar transactions or purposes. Exceedances of the values in these tables do not necessarily trigger requirements for cleanup action under this chapter.

[b] Arsenic. Cleanup level based on background concentrations for state of Washington.

[c] Benzene. Cleanup level based on applicable state and federal law.

(e) Soil cleanup levels shall be established at concentrations which do not directly or indirectly cause violations of ground water, surface water, sediment, or air cleanup standards established under this chapter or applicable state and federal laws.

(2) Method A cleanup levels.

(a) Method A cleanup levels shall be at least as stringent as all of the following:

(i) Concentrations in the following table; and

Table 2

Method A Cleanup Levels - Soil [a]

Hazardous Substance	CAS Number	Cleanup Level
Arsenic	7440-38-2	20.0 mg/kg [b]
Benzene	71-43-2	0.5 mg/kg [c]
Cadmium	7440-43-9	2.0 mg/kg [d]
Chromium	7440-47-3	100.0 mg/kg [e]
DDT	50-29-3	1.0 mg/kg [f]
Ethylbenzene	100-41-4	20.0 mg/kg [g]
Ethylene dibromide	106-93-4	0.001 mg/kg [h]
Lead	7439-92-1	250.0 mg/kg [i]
Lindane	58-89-9	1.0 mg/kg [j]
Methylene chloride	75-09-2	0.5 mg/kg [k]
Mercury (inorganic)	7439-97-6	1.0 mg/kg [l]
PAHs (carcinogenic)		1.0 mg/kg [m]
PCB Mixtures		1.0 mg/kg [n]
Tetrachloroethylene	127-18-4	0.5 mg/kg [o]
Toluene	108-88-3	40.0 mg/kg [p]
TPH (gasoline)		100.0 mg/kg [q]
TPH (diesel)		200.0 mg/kg [r]
TPH (other)		200.0 mg/kg [s]
1,1,1 Trichloroethane	71-55-6	20.0 mg/kg [t]
Trichloroethylene	79-01-5	0.5 mg/kg [u]
Xylenes	1330-20-7	20.0 mg/kg [v]

[a] Caution on misusing method A tables. Method A tables have been developed for specific purposes. They are intended to provide conservative cleanup levels for sites undergoing routine cleanup actions or those sites with relatively few hazardous substances. The tables may not be appropriate for defining cleanup levels at other sites. For these reasons, the values in these tables should not automatically be used to define cleanup levels that must be met for financial, real estate, insurance coverage or placement, or similar transactions or purposes. Exceedances of the values in these tables do not necessarily trigger requirements for cleanup action under this chapter.

[b] Arsenic. Cleanup level based on background concentrations in the state of Washington.

[c] Benzene. Cleanup level based on protection of ground water.

APPENDIX E

Analytical Laboratory Reports and Chain of Custody Records

CROSS REFERENCE RECORD FOR SAMPLE ID

Sample ID	Location	Matrice	Protocol
19631	MW-1 @ 5′	Soil	418.1
19633	MW-1 @ 10	Soil	418.1
19634	Archive		
19637	MW-4 @ 10′	Soil	418.1
19639	MW-4 @ 15′	Soil	418.1
19642	MW-3 @ 5′	Soil	418.1
19644	MW-3 @ 10′	Soil	418.1
19645	Archive		
19280	BH-1 @ 5′	Soil	418.1
19282	BH-1 @ 8′	Soil	418.1
19285	MW-2 @ 5′	Soil	418.1
19287	MW-2 @ 8′	Soil	418.1
19288	Archive		
19290	MW-5 @ 5′	Soil	418.1
19292	MW-5 @ 10′	Soil	418.1
19630	MW-1 @ 5′	Soil	BTEX
19632	MW-1 @ 10′	Soil	BTEX
19635	Archive		
19636	MW-4 @ 5′	Soil	BTEX
19638	MW-4 @ 10′	Soil	BTEX
19640	MW-4 @ 15′	Soil	BTEX
19641	MW-3 @ 5′	Soil	BTEX
19643	MW-3 @ 10′	Soil	BTEX
19279	BH-1 @ 5′	Soil	BTEX
19281	BH-1 @ 8′	Soil	BTEX
19284	MW-2 @ 5′	Soil	BTEX
19286	MW-2 @ 8′	Soil	BTEX
19289	MW-5 @ 5′	Soil	BTEX
19291	MW-5 @ 10′	Soil	BTEX
19294	MW-5 @ 17.5′	Soil	BTEX
19653	MW-1 - DUP	GW	418.1
19654	MW-1	GW	418.1
19657	MW-2 - DUP	GW	418.1
19658	MW-2	GW	418.1
19662	MW-3	GW	418.1
19663	MW-3 - DUP	GW	418.1
19677	MW-1s	GW	418.1
19678	MW-1s - DUP	GW	418.1
19683	MW-2s	GW	418.1

(continued on next page)

(continued)

CROSS REFERENCE RECORD FOR SAMPLE ID

Sample ID	Location	Matrice	Protocol
19669	MW-4	GW	8015-m
19672	MW-4 - DUP	GW	8015-m
19689	U-2	GW	8015-m
19690	U-2 - DUP	GW	8015-m
19696	U-1	GW	8015-m
19697	U-1 - DUP	GW	8015-m
19701	MW-5	GW	8015-m
19702	MW-5 - DUP	GW	8015-m
19650	MW-1	GW	BTEX
19651	MW-1 - DUP	GW	BTEX
19655	MW-2	GW	BTEX
19656	MW-2 - DUP	GW	BTEX
19660	MW-3	GW	BTEX
19661	MW-3 - DUP	GW	BTEX
19667	MW-4	GW	BTEX
19668	MW-4 - DUP	GW	BTEX
19673	MW-4 - Below Surf.	GW	BTEX
19674	MW-4 - DUP 19673	GW	BTEX
19675	MW-1s	GW	BTEX
19676	MW-1s - DUP	GW	BTEX
19680	MW-2s	GW	BTEX
19681	MW-2s	GW	BTEX
19685	Bailer		
19686	Sludge Judge		
19692	U-2	GW	BTEX
19693	U-2 - DUP	GW	BTEX
19694	U-1	GW	BTEX
19695	U-1 - DUP	GW	BTEX
19699	MW-5	GW	BTEX
19700	MW-5 - DUP	GW	BTEX
19704	MW-5 - Below Surf.	GW	BTEX
19705	MW-5 - DUP 19704	GW	BTEX
19665	MW-4	GW	624
19666	MW-4 - DUP	GW	624
19688	U-2	GW	624
19687	U-2 - DUP	GW	624
19654	MW-1	GW	Total Lead
19659	MW-2	GW	Total Lead
19664	MW-3	GW	Total Lead
19671	MW-4	GW	Total Lead
19679	MW-1s	GW	Total Lead
19683	MW-2s	GW	Total Lead
19691	U-2	GW	Total Lead
19698	U-1	GW	Total Lead
19703	MW-5	GW	Total Lead

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9101020/1
Client Sample Number: See below	Alden Sample Number: See below
Date of Sample Receipt: 1/29/91	Analysis Method: 418.1
Date of Sample Extraction: 2/12/91	Matrix: Soil
Date of Sample Analysis: 2/13/91	Reporting Units: mg/kg

Client Sample ID	Alden Sample Number	Total Petroleum Hydrocarbons
19631	6398	78
19633	6400	8.6
19637	6404	290
19639	6406	33
19642	6409	750
19644	6411	73

Note: Results are reported to two significant figures.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9101023/1
Client Sample Number: See below	Alden Sample Number: See below
Date of Sample Receipt: 1/31/91	Analysis Method: 418.1
Date of Sample Extraction: 2/19/91	Matrix: Soil
Date of Sample Analysis: 2/19/91	Reporting Units: mg/kg

Client Sample ID	Alden Sample Number	Total Petroleum Hydrocarbons
NA	Blank	9.9
19280	6424	500
19282	6425	29
19285	6426	450
19287	6427	77
19290	6428	390
19292	6429	17
19292	6429 Duplicate	15

Note: Results are reported to two significant figures.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19630 MW-1 @ 5'
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/5/91

Alden Job Number: 9101020/1
Alden Sample Number: 6397
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	90	76 - 114
Toluene-d_8	110	88 - 110
Bromofluorobenzene	86	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19632 MW-1 @ 10'
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/5/91

Alden Job Number: 9101020/1
Alden Sample Number: 6399
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	92	76 - 114
Toluene-d_8	100	88 - 110
Bromofluorobenzene	90	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19636 (MW-4 @ 5')
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/5/91

Alden Job Number: 9101020/1
Alden Sample Number: 6403
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	5.0	170
Toluene	108-88-3	5.0	< 5.0
Ethylbenzene	100-41-4	5.0	600
m,p-Xylene*	1330-20-7	5.0	38
o-Xylene	1330-20-7	5.0	< 5.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	85	76 - 114
Toluene-d_8	100	88 - 110
Bromofluorobenzene	97	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: N/A
Date of Sample Receipt: N/A
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/5/91

Alden Job Number: 9101020/1
Alden Sample Number: Blank 1
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	110	76 - 114
Toluene-d_8	100	88 - 110
Bromofluorobenzene	92	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19638 (MW-4 @ 10')
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101020/1
Alden Sample Number: 6405
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	100	4300
Toluene	108-88-3	100	4000
Ethylbenzene	100-41-4	100	7800
m,p-Xylene*	1330-20-7	100	12000
o-Xylene	1330-20-7	100	4100

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	87	76 - 114
Toluene-d_8	110	88 - 110
Bromofluorobenzene	100	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19640 (MW-4 @ 15')
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101020/1
Alden Sample Number: 6407
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	2.4
Ethylbenzene	100-41-4	1.0	2.6
m,p-Xylene*	1330-20-7	1.0	7.5
o-Xylene	1330-20-7	1.0	2.9

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	90	76 - 114
Toluene-d_8	100	88 - 110
Bromofluorobenzene	94	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9101020/1
Client Sample Number: N/A	Alden Sample Number: Blank 2
Date of Sample Receipt: N/A	Analysis Method: EPA 8240
Date of Sample Extraction: N/A	Matrix: Soil
Date of Sample Analysis: 2/6/91	Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	85	76 - 114
Toluene-d_8	96	88 - 110
Bromofluorobenzene	89	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers MW-3
Client Sample Number: 19641 @ 5'
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101020/1
Alden Sample Number: 6408
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	1.5
m,p-Xylene*	1330-20-7	1.0	9.7
o-Xylene	1330-20-7	1.0	4.8

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	87	76 - 114
Toluene-d_8	100	88 - 110
Bromofluorobenzene	87	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19643 MW-3 @ 10'
Date of Sample Receipt: 1/29/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101020/1
Alden Sample Number: 6410
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	89	76 - 114
Toluene-d_8	110	88 - 110
Bromofluorobenzene	90	86 - 115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers BH-1 @ 5'
Client Sample Number: 19279
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101023/1
Alden Sample Number: 6417
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	88	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	91	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19281 BH-1 @ 8'
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101023/1
Alden Sample Number: 6418
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	91	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	92	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers MW-2
Client Sample Number: 19284 @ 5'
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101023/1
Alden Sample Number: 6419
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	89	70 - 121
Toluene-d_8	110	81 - 117
Bromofluorobenzene	84	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19286 MW-2 @ 8'
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101023/1
Alden Sample Number: 6420
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery*	Advisory Limits
1,2-Dichloroethane-d_4	91	70 - 121
Toluene-d_8	120	81 - 117
Bromofluorobenzene	76	74 - 121

* Matrix interference present during purge.

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19289 (MW-5 @ 5 Ft)
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101023/1
Alden Sample Number: 6421
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	5.0	560
Toluene	108-88-3	5.0	590
Ethylbenzene	100-41-4	5.0	84
m,p-Xylene*	1330-20-7	5.0	360
o-Xylene	1330-20-7	5.0	150

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	87	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	96	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: N/A
Date of Sample Receipt: N/A
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/6/91

Alden Job Number: 9101023/1
Alden Sample Number: Blank 1
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	85	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	89	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19291 (MW-5 @ 10')
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/11/91

Alden Job Number: 9101023/1
Alden Sample Number: 6422
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	100	11000
Toluene	108-88-3	500	57000
Ethylbenzene	100-41-4	100	17000
m,p-Xylene*	1330-20-7	500	63000
o-Xylene	1330-20-7	500	24000

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	84	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	94	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19294 (MW-5 @17.5')
Date of Sample Receipt: 1/31/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/11/91

Alden Job Number: 9101023/1
Alden Sample Number: 6423
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	430
Toluene	108-88-3	50	780
Ethylbenzene	100-41-4	50	430
m,p-Xylene*	1330-20-7	50	1700
o-Xylene	1330-20-7	50	540

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	85	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	93	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: N/A
Date of Sample Receipt: N/A
Date of Sample Extraction: N/A
Date of Sample Analysis: 2/11/91

Alden Job Number: 9101023/1
Alden Sample Number: Blank 2
Analysis Method: EPA 8240
Matrix: Soil
Reporting Units: ug/kg as received

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	89	70 - 121
Toluene-d_8	100	81 - 117
Bromofluorobenzene	94	74 - 121

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: See below
Date of Sample Receipt: 3/7/91
Matrix: Water

Alden Job Number: 9103006/1
Alden Sample Number: See below
Analysis Method: 8015-Modified
Reporting Units: mg/L

Client Sample ID	Alden Sample Number	Extraction Date	Analysis Date	Total Extractable Hydrocarbons
N/A	Blank	3/13/91	3/15/91	<0.05
19669	6680	3/13/91	3/18/91	5.2
19689	6692	3/13/91	3/15/91	8000
19696	6696	3/13/91	3/18/91	66
19701	6699	3/13/91	3/18/91	6.2

Note: Results are reported to two significant figures.

Alden Analytical Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9103006/1
Client Sample Number: See below	Alden Sample Number: See below
Date of Sample Receipt: 3/7/91	Analysis Method: 418.1
Date of Sample Extraction: 3/14/91	Matrix: Water
Date of Sample Analysis: 3/14/91	Reporting Units: mg/L

Client Sample ID	Alden Sample Number	Total Petroleum Hydrocarbons
N/A	Blank	2.6
MW-1 19654	6671 Split	3.1
MW-2 19658 (Archive)	6673 Dup	2.2
MW-3 19663	6676 Dup Split	3.0
19663	6676 Dup Split Duplicate	3.9
MW-1S 19677	6684 Dup	960
MW-2S 19683	6688	58

ılts are reported to two significant figures.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19650 MW-1
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6669
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	63
Toluene	108-88-3	50	77
Ethylbenzene	100-41-4	50	< 50
m,p-Xylene*	1330-20-7	50	280
o-Xylene	1330-20-7	50	120

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	95	76-114
Toluene-d_8	97	88-110
Bromofluorobenzene	93	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

MW-2

Client: SCS Engineers
Client Sample Number: 19655
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6672
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	94
Toluene	108-88-3	50	120
Ethylbenzene	100-41-4	50	< 50
m,p-Xylene*	1330-20-7	50	400
o-Xylene	1330-20-7	50	1700

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	96	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	86	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19660 MW-3
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6675
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	< 50
Toluene	108-88-3	50	66
Ethylbenzene	100-41-4	50	< 50
m,p-Xylene*	1330-20-7	50	250
o-Xylene	1330-20-7	50	110

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	110	88-110
Bromofluorobenzene	99	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19667 mw-4
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6679
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	7700
Toluene	108-88-3	50	3900
Ethylbenzene	100-41-4	50	410
m,p-Xylene*	1330-20-7	50	5500
o-Xylene	1330-20-7	50	2400

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	89	76-114
Toluene-d_8	98	88-110
Bromofluorobenzene	93	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers MW-4
Client Sample Number: 19673
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6682
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	7900
Toluene	108-88-3	50	4500
Ethylbenzene	100-41-4	50	990
m,p-Xylene*	1330-20-7	50	4700
o-Xylene	1330-20-7	50	1900

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	95	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19675 MW-1S
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6683
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	1700
Toluene	108-88-3	50	4000
Ethylbenzene	100-41-4	50	3000
m,p-Xylene*	1330-20-7	50	9600
o-Xylene	1330-20-7	50	4400

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	95	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers MW-2S
Client Sample Number: 19680
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6686
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	100	1400
Toluene	108-88-3	100	1800
Ethylbenzene	100-41-4	100	1400
m,p-Xylene*	1330-20-7	100	9200
o-Xylene	1330-20-7	100	3900

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	110	88-110
Bromofluorobenzene	95	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9103006/1
Client Sample Number: N/A	Alden Sample Number: Blank 1
Date of Sample Receipt: N/A	Analysis Method: EPA 624
Date of Sample Extraction: N/A	Matrix: Water
Date of Sample Analysis: 3/13/91	Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	110	76-114
Toluene-d_8	110	88-110
Bromofluorobenzene	98	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19685
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6689
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	< 50
Toluene	108-88-3	50	< 50
Ethylbenzene	100-41-4	50	< 50
m,p-Xylene*	1330-20-7	100	< 100
o-Xylene	1330-20-7	50	< 50

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	110	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	98	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19686 sludge S. Distilled
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6690
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	1.0	15
Toluene	108-88-3	1.0	16
Ethylbenzene	100-41-4	1.0	5.7
m,p-Xylene*	1330-20-7	1.0	40
o-Xylene	1330-20-7	1.0	17

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	97	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers U-2
Client Sample Number: 19692
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6694
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	100	5800
Toluene	108-88-3	100	1000
Ethylbenzene	100-41-4	100	1400
m,p-Xylene*	1330-20-7	200	5700
o-Xylene	1330-20-7	100	1900

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	96	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19694 U-1
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6695
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	5900
Toluene	108-88-3	50	1000
Ethylbenzene	100-41-4	50	1400
m,p-Xylene*	1330-20-7	100	5500
o-Xylene	1330-20-7	50	1900

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	100	76-114
Toluene-d_8	100	88-110
Bromofluorobenzene	94	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19699 MW-5
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6698
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	3500
Toluene	108-88-3	50	2900
Ethylbenzene	100-41-4	50	180
m,p-Xylene*	1330-20-7	100	3200
o-Xylene	1330-20-7	50	1000

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	116	76-114
Toluene-d_8	110	88-110
Bromofluorobenzene	110	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers MW-5
Client Sample Number: 19704
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6701
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS Number	Reporting Limit	Result
Benzene	71-43-2	50	4900
Toluene	108-88-3	50	8900
Ethylbenzene	100-41-4	50	520
m,p-Xylene*	1330-20-7	100	6200
o-Xylene	1330-20-7	50	2400

Surrogate	Percent Recovery	Advisory Limits
1,2-Dichloroethane-d_4	110	76-114
Toluene-d_8	110	88-110
Bromofluorobenzene	89	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19665 MW-4S
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6678
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS No.	Reporting Limit	Result
Acetone	67-64-1	10	17
Benzene	71-43-2	50	7000
Bromodichloromethane	75-27-4	1.0	< 1.0
Bromoform	75-25-2	1.0	< 1.0
Bromomethane	74-83-9	1.0	< 1.0
2-Butanone	78-93-3	10	< 10
Carbon disulfide	75-15-0	1.0	4.9
Carbon tetrachloride	56-23-5	1.0	< 1.0
Chlorobenzene	108-90-7	1.0	< 1.0
Chloroethane	75-00-3	1.0	< 1.0
Chloroform	67-66-3	1.0	< 1.0
Chloromethane	74-87-3	1.0	< 1.0
Dibromochloromethane	124-48-1	1.0	< 1.0
1,2-Dichlorobenzene	95-50-1	1.0	< 1.0
1,3-Dichlorobenzene	541-73-1	1.0	< 1.0
1,4-Dichlorobenzene	106-46-7	1.0	< 1.0
1,1-Dichloroethane	75-34-3	1.0	< 1.0
1,2-Dichloroethane	107-06-2	1.0	< 1.0
1,1-Dichloroethene	75-35-4	1.0	< 1.0
cis-1,2-Dichloroethene	156-60-5	1.0	< 1.0
trans-1,2-Dichloroethene	156-60-5	1.0	< 1.0
1,2-Dichloropropane	78-87-5	1.0	< 1.0
cis-1,3-Dichloropropene	10061-01-5	1.0	< 1.0
trans-1,3-Dichloropropene	10061-02-6	1.0	< 1.0
Ethylbenzene	100-41-4	50	610
2-Hexanone	591-78-6	10	< 10
Methylene chloride	75-09-2	30	< 30
4-Methyl-2-Pentanone	108-10-1	10	< 10
Styrene	100-42-5	1.0	< 1.0
1,1,2,2-Tetrachloroethane	79-34-5	1.0	< 1.0
Tetrachlorethene	127-18-4	1.0	< 1.0
Toluene	108-88-3	50	3200
1,1,1-Trichloroethane	71-55-6	1.0	< 1.0
1,1,2-Trichloroethane	79-00-5	1.0	< 1.0
Trichloroethene	79-01-6	1.0	< 1.0
Trichlorofluoromethane	75-69-4	1.0	< 1.0
Vinyl acetate	108-05-4	10	< 10
Vinyl chloride	75-01-4	1.0	< 1.0
o-Xylene	1330-20-7	50	2200
m,p-Xylene*	1330-20-7	50	5100

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19665
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: 6678
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Surrogate	Amount Added	Percent Recovery	Recovery Limits
1,2-Dichloroethane-d_4	250 ng	92	76-114
Toluene-d_8	250 ng	110	88-110
Bromofluorobenzene	250 ng	98	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9103006/1
Client Sample Number: N/A	Alden Sample Number: Blank 1
Date of Sample Receipt: N/A	Analysis Method: EPA 624
Date of Sample Extraction: N/A	Matrix: Water
Date of Sample Analysis: 3/13/91	Reporting Units: ug/L

Surrogate	Amount Added	Percent Recovery	Recovery Limits
1,2-Dichloroethane-d_4	250 ng	110	76-114
Toluene-d_8	250 ng	110	88-110
Bromofluorobenzene	250 ng	98	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: N/A
Date of Sample Receipt: N/A
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/13/91

Alden Job Number: 9103006/1
Alden Sample Number: Blank 1
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS No.	Reporting Limit	Result
Acetone	67-64-1	10	< 10
Benzene	71-43-2	1.0	< 1.0
Bromodichloromethane	75-27-4	1.0	< 1.0
Bromoform	75-25-2	1.0	< 1.0
Bromomethane	74-83-9	1.0	< 1.0
2-Butanone	78-93-3	10	< 10
Carbon disulfide	75-15-0	1.0	< 1.0
Carbon tetrachloride	56-23-5	1.0	< 1.0
Chlorobenzene	108-90-7	1.0	< 1.0
Chloroethane	75-00-3	1.0	< 1.0
Chloroform	67-66-3	1.0	< 1.0
Chloromethane	74-87-3	1.0	< 1.0
Dibromochloromethane	124-48-1	1.0	< 1.0
1,2-Dichlorobenzene	95-50-1	1.0	< 1.0
1,3-Dichlorobenzene	541-73-1	1.0	< 1.0
1,4-Dichlorobenzene	106-46-7	1.0	< 1.0
1,1-Dichloroethane	75-34-3	1.0	< 1.0
1,2-Dichloroethane	107-06-2	1.0	< 1.0
1,1-Dichloroethene	75-35-4	1.0	< 1.0
cis-1,2-Dichloroethene	156-60-5	1.0	< 1.0
trans-1,2-Dichloroethene	156-60-5	1.0	< 1.0
1,2-Dichloropropane	78-87-5	1.0	< 1.0
cis-1,3-Dichloropropene	10061-01-5	1.0	< 1.0
trans-1,3-Dichloropropene	10061-02-6	1.0	< 1.0
Ethylbenzene	100-41-4	1.0	< 1.0
2-Hexanone	591-78-6	10	< 10
Methylene chloride	75-09-2	30	< 30
4-Methyl-2-Pentanone	108-10-1	10	< 10
Styrene	100-42-5	1.0	< 1.0
1,1,2,2-Tetrachloroethane	79-34-5	1.0	< 1.0
Tetrachlorethene	127-18-4	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
1,1,1-Trichloroethane	71-55-6	1.0	< 1.0
1,1,2-Trichloroethane	79-00-5	1.0	< 1.0
Trichloroethene	79-01-6	1.0	< 1.0
Trichlorofluoromethane	75-69-4	1.0	< 1.0
Vinyl acetate	108-05-4	10	< 10
Vinyl chloride	75-01-4	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0
m,p-Xylene*	1330-20-7	1.0	< 1.0

Alden Analytical Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19688 U-2
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6691
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS No.	Reporting Limit	Result
Acetone	67-64-1	500	< 500
Benzene	71-43-2	50	5400
Bromodichloromethane	75-27-4	50	< 50
Bromoform	75-25-2	50	< 50
Bromomethane	74-83-9	50	< 50
2-Butanone	78-93-3	50	< 50
Carbon disulfide	75-15-0	50	< 50
Carbon tetrachloride	56-23-5	50	< 50
Chlorobenzene	108-90-7	50	< 50
Chloroethane	75-00-3	50	< 50
Chloroform	67-66-3	2000	< 2000
Chloromethane	74-87-3	50	< 50
Dibromochloromethane	124-48-1	50	< 50
1,2-Dichlorobenzene	95-50-1	50	< 50
1,3-Dichlorobenzene	541-73-1	50	< 50
1,4-Dichlorobenzene	106-46-7	50	< 50
1,1-Dichloroethane	75-34-3	50	< 50
1,2-Dichloroethane	107-06-2	50	< 50
1,1-Dichloroethene	75-35-4	50	< 50
cis-1,2-Dichloroethene	156-60-5	50	< 50
trans-1,2-Dichloroethene	156-60-5	50	< 50
1,2-Dichloropropane	78-87-5	50	< 50
cis-1,3-Dichloropropene	10061-01-5	50	< 50
trans-1,3-Dichloropropene	10061-02-6500	50	< 50
Ethylbenzene	100-41-450	50	6600
2-Hexanone	591-78-6	500	< 500
Methylene chloride	75-09-2	750	1200
4-Methyl-2-Pentanone	108-10-1	500	< 500
Styrene	100-42-5	50	< 50
1,1,2,2-Tetrachloroethane	79-34-5	50	< 50
Tetrachlorethene	127-18-4	50	< 50
Toluene	108-88-3	500	28000
1,1,1-Trichloroethane	71-55-6	50	< 50
1,1,2-Trichloroethane	79-00-5	50	< 50
Trichloroethene	79-01-6	50	< 50
Trichlorofluoromethane	75-69-4	50	< 50
Vinyl acetate	108-05-45	500	< 500
Vinyl chloride	75-01-4	50	< 1.0
o-Xylene	1330-20-7	500	9400
m,p-Xylene*	1330-20-7	1000	22000

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: 19688
Date of Sample Receipt: 3/7/91
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: 6691
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Surrogate	Amount Added	Percent Recovery	Recovery Limits
1,2-Dichloroethane-d_4	250 ng	97	76-114
Toluene-d_8	250 ng	100	88-110
Bromofluorobenzene	250 ng	95	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers
Client Sample Number: Blank
Date of Sample Receipt: N/A
Date of Sample Extraction: N/A
Date of Sample Analysis: 3/14/91

Alden Job Number: 9103006/1
Alden Sample Number: Blank 2
Analysis Method: EPA 624
Matrix: Water
Reporting Units: ug/L

Compound Name	CAS No.	Reporting Limit	Result
Acetone	67-64-1	10	< 10
Benzene	71-43-2	1.0	< 1.0
Bromodichloromethane	75-27-4	1.0	< 1.0
Bromoform	75-25-2	1.0	< 1.0
Bromomethane	74-83-9	1.0	< 1.0
2-Butanone	78-93-3	10	< 10
Carbon disulfide	75-15-0	1.0	< 1.0
Carbon tetrachloride	56-23-5	1.0	< 1.0
Chlorobenzene	108-90-7	1.0	< 1.0
Chloroethane	75-00-3	1.0	< 1.0
Chloroform	67-66-3	40	< 40
Chloromethane	74-87-3	1.0	< 1.0
Dibromochloromethane	124-48-1	1.0	< 1.0
1,2-Dichlorobenzene	95-50-1	1.0	< 1.0
1,3-Dichlorobenzene	541-73-1	1.0	< 1.0
1,4-Dichlorobenzene	106-46-7	1.0	< 1.0
1,1-Dichloroethane	75-34-3	1.0	< 1.0
1,2-Dichloroethane	107-06-2	1.0	< 1.0
1,1-Dichloroethene	75-35-4	1.0	< 1.0
cis-1,2-Dichloroethene	156-60-5	1.0	< 1.0
trans-1,2-Dichloroethene	156-60-5	1.0	< 1.0
1,2-Dichloropropane	78-87-5	1.0	< 1.0
cis-1,3-Dichloropropene	10061-01-5	1.0	< 1.0
trans-1,3-Dichloropropene	10061-02-6	1.0	< 1.0
Ethylbenzene	100-41-4	10	< 1.0
2-Hexanone	591-78-6	10	< 10
Methylene chloride	75-09-2	15	< 15
4-Methyl-2-Pentanone	108-10-1	10	< 10
Styrene	100-42-5	1.0	< 1.0
1,1,2,2-Tetrachloroethane	79-34-5	1.0	< 1.0
Tetrachlorethene	127-18-4	1.0	< 1.0
Toluene	108-88-3	1.0	< 1.0
1,1,1-Trichloroethane	71-55-6	1.0	< 1.0
1,1,2-Trichloroethane	79-00-5	1.0	< 1.0
Trichloroethene	79-01-6	1.0	< 1.0
Trichlorofluoromethane	75-69-4	1.0	< 1.0
Vinyl acetate	108-05-4	10	< 10
Vinyl chloride	75-01-4	1.0	< 1.0
o-Xylene	1330-20-7	1.0	< 1.0
m,p-Xylene*	1330-20-7	2.0	< 2.0

Alden Analytical
Laboratories, Inc.

REPORT OF ANALYTICAL RESULTS

Client: SCS Engineers	Alden Job Number: 9103006/1
Client Sample Number: Blank	Alden Sample Number: Blank 2
Date of Sample Receipt: N/A	Analysis Method: EPA 624
Date of Sample Extraction: N/A	Matrix: Water
Date of Sample Analysis: 3/14/91	Reporting Units: ug/L

Surrogate	Amount Added	Percent Recovery	Recovery Limits
1,2-Dichloroethane-d_4	250 ng	110	76-114
Toluene-d_8	250 ng	110	88-110
Bromofluorobenzene	250 ng	98	86-115

* m-Xylene and p-xylene cannot be separated and are reported here as a total of the two isomers.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Alden Analytical Labs Date: March 22, 1991

Report On: Analysis of Water Lab No.: 16525

IDENTIFICATION:
Samples Received on 03-15-91
Project: 9103005/1

ANALYSIS:

5 ppb

Lab Sample No.	Client ID	SCS ID		Total Lead, mg/l	ppb
1	6681	19671	MW-4	0.15	150
2	6685	19679	1S	0.86	860
3	6693	19691	U-2	15.4	15,400
4	6697	19698	U-1	1.0	1000.
5	6700	19703	MW-5	0.06	460
6	6671	19654	MW-1	0.80	800
7	6674	19659	MW-2	1.3	1,300
8	6688	19683	2S	32.4	32,400
9	6677	19664	MW-3	0.04	40.

SOUND ANALYTICAL SERVICES

STAN P. PALMQUIST

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 16525
Date: March 22, 1991
Client: Alden Analytical Labs

Client ID: 6681
Matrix: Water
Units: mg/l

Compound	Sample(S)	Duplicate(D)	RPD*
Total Lead	0.15	0.13	14.3

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

RECEIVED

APR 1 9 1991

S.C.S. ENGINEERS

SCS ANALYTICAL LABORATORY
2860 WALNUT AVENUE
LONG BEACH, CALIFORNIA 90806
(213) 595-9324
FAX (213) 595-6709

MEMO

To: Rick Alvord

From: Lam V. Ho

April 16, 1991

Job No.: 0489021.02

LABORATORY REPORT

Samples: Four (4) liquid samples from Seattle UST Westlake, received 04/10/91 and analyzed 04/14/91.

Sample ID	Pb (200.7) -----mg/L------
19715	ND
19716	ND
19717	ND
19718	ND
Detection Limit	0.5

ND = Not Detected

David Sincerbeaux
Chemist

Lam V. Ho PhD, REP
Laboratory Director

seatle1.rep

[redacted]SC[redacted]NG[redacted]S[redacted]

Alden Analytical Laboratories, Inc.
1001 SW Klickitat Way
Seattle, WA 98134
Telephone (206) 623-3660
Facsimile (206) 624-8778

Alden Project Number: ______
Page ___ of ___

Samplers: Rick Alvord (print)
Dan Verchicrutti (print)
______ (print)

Address: 2950 Northup Way
City, State, ZIP: Bellevue, Washington 98004
Project No./PO No.: 48921.02
Contact Name: Rick Alvord
Phone: 822-5800 Fax: 889-2267

TO BE COMPLETED BY SAMPLER											LABORATORY USE ONLY			
			Analysis Requested											
Sample Date/Time	Client Sample ID #	Matrix	BTEX 8020	TPH 418.1						TAT	Alden Lab ID #	Hold Time	Sample Condition	Notes
1/28/91	19630	Soil	X											
/91	19631	"		X										
/91	19632	"	X											
1/28/91	19633	"		X										
1/28/91	19634 (Archive)	"		X										Hold
1/28/91	19635 (Archive)	"	X											Hold
1/29/91	19636	"	X											
1/29/91	19637	"		X										
1/29/91	19638	"	X											
1/29/91	19639	"		X										
1/29/91	19640	"	X											
1/29/91	19641	"	X											
1/29/91	19642	"		X										
1/29/91	19643	"	X											
1/29/91	19644	"		X										
1/29/91	19645 (Archive)	"		X										Hold

E-50

Relinquished By: [signature]
Received By: [signature] Date/Time: 1/29/91
Relinquished By:
Received By: Date/Time

Misc. Notes

TAT Codes
A - Standard (2 weeks)
B - 24 Hour
C - 48 Hour
D - Other (specify):

Alden Analytical Laboratories, Inc.
1001 SW Klickitat Way
Seattle, WA 98134
Telephone (206) 623-3660
Facsimile (206) 624-8778

Alden Project Number: _____
Page 1 of 1

Samplers: Dan Venchiarutti (print)
_____ (print)
_____ (print)

Address: 2950 Northup Way
City, State, ZIP Bellevue WA 980
Project No./ PO No.: 048921.02
Contact Name: Dan Venchiarutti / Rick Alvord
Phone: 822-5800 Fax: 889-2267

TO BE COMPLETED BY SAMPLER | LABORATORY USE ONLY

Sample Date/Time	Client Sample ID #	Matrix	Analysis Requested: BETX 8020	TPH 418.1	Archive					TAT	Alden Lab ID #	Hold Time	Sample Condition	Notes
1/30-31/91	19279		✓							A		14 days	FM	
	19281		✓											
	19284		✓											
	19286		✓											
	19289		✓											
	19291		✓											
	19294		✓											
	19290			✓										
	19282			✓										
	19285			✓										
	19287			✓										
	19290			✓										
	19292			✓										
	19288				✓									

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Relinquished By: Daniel Venchiarutti
Received By: [signature] Date/Time 1:00 PM 1/31/91
Relinquished By:
Received By: Date/Time

Misc. Notes

TAT Codes
A - Standard (2 weeks)
B - 24 Hour
C - 48 Hour
D - Other (specify):

lden Analytical
aboratories, Inc.
001 SW Klickitat Way
eattle, WA 98134
elephone (206) 623-3660
acsimile (206) 624-8778

Alden Project Number:
Page 1 of 3

Samplers: Richard Alvord
(print)
(print)
(print)

Address: 2950 Northup Way
City, State, ZIP Bellevue, WA 98004
Project No./ PO No.: 48921.02 (Westlake)
Contact Name: Rick Alvord
Phone: 822-5800 Fax:

TO BE COMPLETED BY SAMPLER

Sample Date/Time	Client Sample ID #	Matrix	Analysis Requested: BTEX 8020	TPH 418.1	TOT pb 7421					TAT	LABORATORY USE ONLY: Alden Lab ID #	Hold Time	Sample Condition	Notes
3/6/91	x 19650	GW	X											
3/ " /91	x 19651 (Archive)	Dup 19650	X											
3/ " /91	x 19652	GW		X										
3/ " /91	x 19653 (Archive)	Dup 19652		X										
3/6/91	x 19654	GW			X									
"	x 19655	GW	X											
"	x 19656 (Archive)	Dup 19655												
"	x 19657	GW		X										
"	x 19658 (Archive)	Dup 19657		X										
"	x 19659	GW			X									
"	x 19660	GW	X											
"	x 19661 (Archive)	Dup 19660	X											
"	x 19662	GW		X										
"	x 19663	Dup 19662		X										
"	x 19664	GW			X									

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quished By: Richard C Alvord

quished By:

Received By: [signature] Date/Time 3/7/91 1351

Received By: Date/Time

Misc. Notes

TAT Codes
A - Standard (2 weeks)
B - 24 Hour
C - 48 Hour
D - Other (specify):

Alden Analytical
Laboratories, Inc.
10011 SW Klickitat Way
Seattle, WA 98134
Telephone (206) 623-1660
Facsimile (206) 624-8718

Alden Project Number: _____
Page 2 of 3

Samplers: Richard Alvord (print)
(print)
(print)

Address: 2950 NORTHUP WAY
City, State, ZIP BELLEVUE, WA 98004
Project No./ PO No.: 48921.02 (Westlake)
Contact Name: Rick Alvord
Phone: 822-5800 Fax:

TO BE COMPLETED BY SAMPLER

Sample Date/Time	Client Sample ID #	Matrix	Analysis Requested: BTEX 8010/8020	BTEX 8020	TPH 8015 Mod.	Tot Pb 7421	TPH 418.1			TAT
3/6/91	19665	GW	X							
	19666 (Archive)	Dup 19665	X							
	19667 ~~80~~	GW		X						
	19668 (Archive)	Dup 19667		X						
	19669	GW			X					
	19672 (Archive)	Dup 19669			X					
	19671	GW				X				
	19673	GW		X						
	19674 (Archive)	Dup 19673		X						
	19675	GW		X						
	19676 (Archive)	Dup 19675		X						
	19677	GW					X			
	19678 (Archive)	Dup 19677					X			
	19679 ~~(Archive)~~	GW				X	~~X~~			

LABORATORY USE ONLY

Alden Lab ID #	Hold Time	Sample Condition	Notes

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Relinquished By: Richard C Alvord
Relinquished By:

Received By: Date/Time
Received By: 3/7/91 1350
Received By: Date/Time

Misc. Notes

TAT Codes
A - Standard (2 weeks)
B - 24 Hour
C - 48 Hour
D - Other (specify):

lden Analytical
aboratories, Inc.
001 SW Klickitat Way
eattle, WA 98134
elephone (206) 623-3660
acsimile (206) 624-8778

Alden Project Number: _____
Page 3 of 3

Samplers: Richard C. Alvord (print)
_____ (print)
_____ (print)

Address: 2950 Northup Way
City, State, ZIP Bellevue, WA 98004
Project No./ PO No.: 48921.02 (Westlake)
Contact Name: Rick Alvord
Phone: 822-5800 Fax:

TO BE COMPLETED BY SAMPLER

Sample Date/Time	Client Sample ID #	Matrix	Analysis Requested: BTEX 8020	TPH 418.1	Tot. Pb 7421	8010/8020	TPH 8015-mod			TAT	Alden Lab ID #	Hold Time	Sample Condition	Notes
3/6/91	19680	GW	X											
	19681 (Archive)	Dup 19680	X											
	19682	GW		X										
	19683	"			X									
3/7/91	19685	GW	X											
"	19686	GW	X											
"	19687 (Archive) Dup 88	GW				X								
"	19688 (~~Archive~~)	GW				X								
"	19689	GW					X							
"	19690 (Archive)	Dup 19689					X							
"	19691	GW			X									
"	19692	GW	X											
"	19693 Archive	Dup 19692	X											

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LABORATORY USE ONLY

quished By: Richard C Alvord
quished By:

Received By: Jeff Wilson Date/Time 3/7/91 1351
Received By: Date/Time

Misc. Notes

TAT Codes
A - Standard (2 weeks)
B - 24 Hour
C - 48 Hour
D - Other (specify):

lden Analytical
aboratories, Inc.
001 SW Klickitat Way
eattle, WA 98134
elephone (206) 623-3660
acsimile (206) 624-8778

Alden Project Number: _____
Page 1 of 1

Samplers: Richard C. Alvord (prt)
(prt)
(prt)

Address: 2950 Northup Way
City, State, ZIP Bellevue, WA 98004
Project No./ PO No.: 48921.02 (Westlake)
Contact Name: Rick Alvord
Phone: 822-5800 Fax:

TO BE COMPLETED BY SAMPLER

Sample Date/Time	Client Sample ID #	Matrix	Analysis Requested: BTEX 8020	TPH 8015-mod	TOT pb 7421					TAT	LABORATORY USE ONLY: Alden Lab ID #	Hold Time	Sample Condition	Notes
3/7/91	19694	GW	X											
	19695 (Archive)	Dup 19694	X											
	19696	GW		X										
	19697 (Archive)	Dup 19696		X										
	19698	GW			X									
	19699	GW	X											
	19700 (Archive)	Dup 19699	X											
	19701	GW		X										
	19702 (Archive)	Dup 19701		X										
	19703	GW			X									
	19704	GW	X											
	19705 (Archive)	Dup 19704	X											

E-55

Relinquished By: Richard C. Alvord
Relinquished By:

Received By: Date/Time 1351 3/7/91
Received By: Date/Time

Misc. Notes

TAT Codes
A - Standard (2 weeks)
B - 24 Hour
C - 48 Hour
D - Other (specify):

CHAIN OF CUSTODY RECORD REQUEST FOR ANALYSIS

COMPANY NAME: SCS ENGINEERS	CARRIER: FED X	TURNAROUND TIME REQUIRED: ☒ NORMAL ☐ 5-DAY ☐ 3-DAY ☐ 24-HOUR ☐ IMMEDIATE ATTENTION	
ADDRESS: 2950 NORTHUP WAY, BELLEVUE WA	SHIPMENT DATE: 4/9/91		
PHONE NUMBER: 822-5800	SHIPPING NUMBER:		
P.O. NUMBER:	NUMBER OF SAMPLES: 4	PAGE 1 OF 1	
PROJECT NAME: Seattle UST - WESTLAKE			
PROJECT ADDRESS:			
PROJECT NUMBER: 48971.02			
SAMPLER NAME AND SIGNATURE: Rick Alvord			
REPORTS TO BE SENT TO: " "			

SAMPLE I.D. NUMBER	SAMPLE DESCRIPTION	SAMPLE MATRIX	SAMPLE PRESERVATIVE(S)	CONTAINER SIZE / TYPE	DATE / TIME COLLECTED	FIELD TEMP.	FIELD pH	FIELD EC	SPECIAL PROGRAM REQUIREMENTS OR EPA - SOP & QAM REF	ANALYSES REQUIRED: TOTAL LEAD	LAB ONLY: SAMPLE CONDITION UPON RECEIPT
19715	Unfiltered	GW	None	1l	4/9/91	—	—	—		X	Cool
19716	Filtered	"	HCL	1l	"	—	—	—		X	
19717	Unfiltered	"	None	1l	"	—	—	—		X	
19718	Filtered	"	HCL	1l	"	—	—	—		X	

SPECIAL INSTRUCTIONS / COMMENTS:

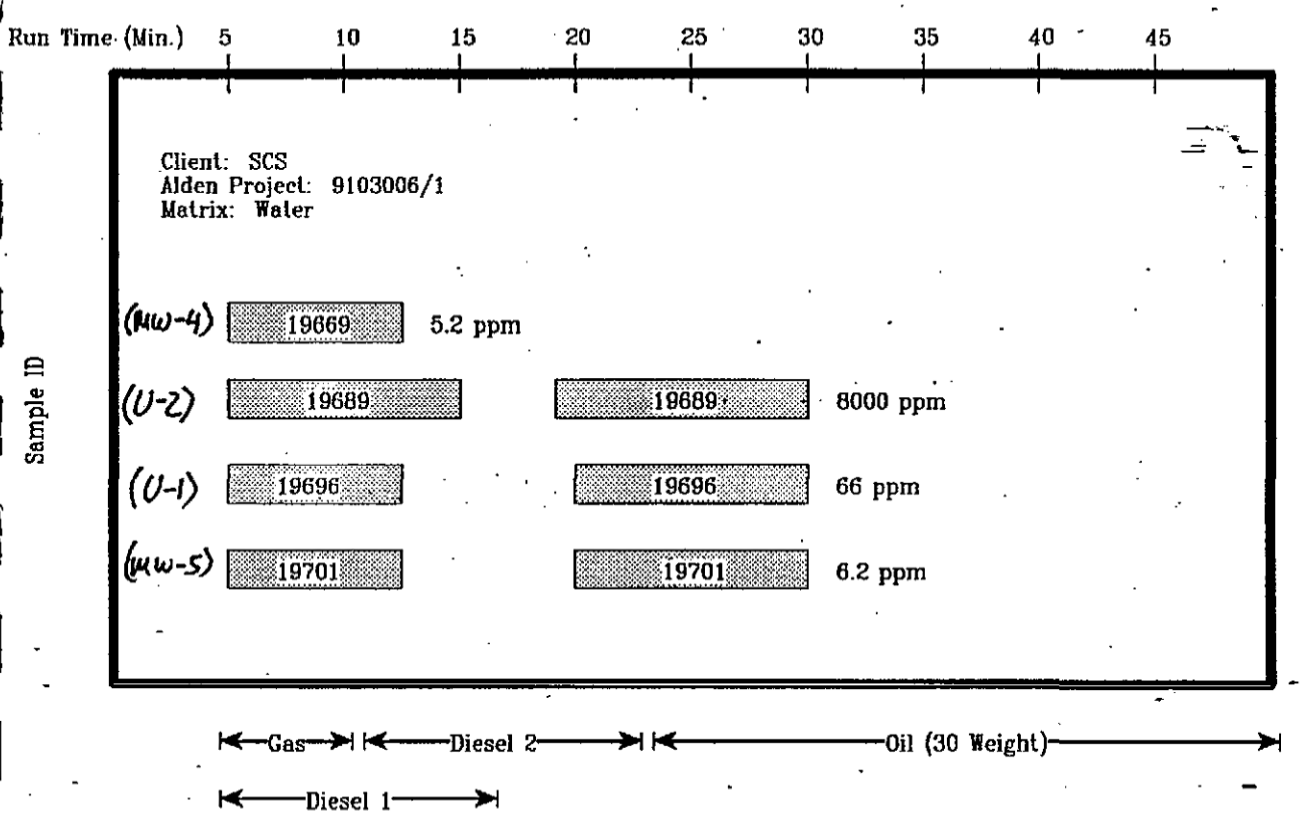
RELINQUISHED BY: (Signature)	DATE: 4/9/91	RECEIVED BY: (Signature) Nancy Stokel 9:15 a.m.	RELINQUISHED BY: (Signature)	DATE:	RECEIVED BY: (Signature)
COMPANY:	TIME:	COMPANY: SCS Lab 4-10-91	COMPANY:	TIME:	COMPANY:

APPENDIX F

Laboratory Analytical Chromatographs

Alden Analytical
Laboratories, Inc.

TPH (8015-Mod) GRAPHICAL SUMMARY*



Elution Ranges: Gasoline 5-10 minutes
Diesel 1 5-17 minutes
Diesel 2 10-22 minutes
Oil (30W) 22-50 minutes

*Note: This graphical representation is intended to provide a qualitative measurement of the elution range of hydrocarbons present in the sample versus known petroleum standards.

ENVIRONMENTAL LABORATORY SAMPLE TRACKING SHEET

n Analytical
rations, Inc.

LYSIS: Total Extractable Petroleum Hydrocarbons
TRIX: WATER

E SAMPLED:
E RECEIVED:
:

SAMPLE I.D.: 19696 (U-1)
LAB I.D.: 6696

MMENTS:

E WGT: 920 ml. (LINE 1)	FINAL EXTRACT VOL: 10 ml. (LINE 2)	COLUMN	RTX-5
E I.D.:		DATE	3/18/91
D:	DATE PREP'D: 3/13/91	DILUTION	1:10
mg/L	DATE ANAL: 3/18/91	WORKER	EB/CA
MDL	ANALYTE(S)	LAB I.D.	
95	Total Extractable Petroleum Hydrocarbons	FINAL	
0	66	66	
	Elution Range > 5 min.		
	< 18 min		
	> 20 min		
	< 30 min		

MAXIMA 820 CUSTOM REPORT

Printed: 19-MAR-1991 9:34:48

SAMPLE: 6696 1:10
U-1
#6 in Method: Total Extractable Hydrocarbons
Acquired: 18-MAR-1991 13:23
Rate: 5.0 points/sec
Duration: 45.000 minutes
Operator:

Type: UNKN
Instrument: PID/NPD
Filename: T0318-6
Index: Disk
Injection Volume: 1.0
Amount: 1.000

DETECTOR: detector 1

PK#	Retention Time (minutes)	Peak Start (minutes)	Peak End (minutes)	Area
1	1.430	0.997	3.920	>15966127
2	4.003	3.920	4.977	2573496
3	4.980	4.977	44.997	14831701
TOTAL				17405198

$17405198 - 2592974 = 14812224$

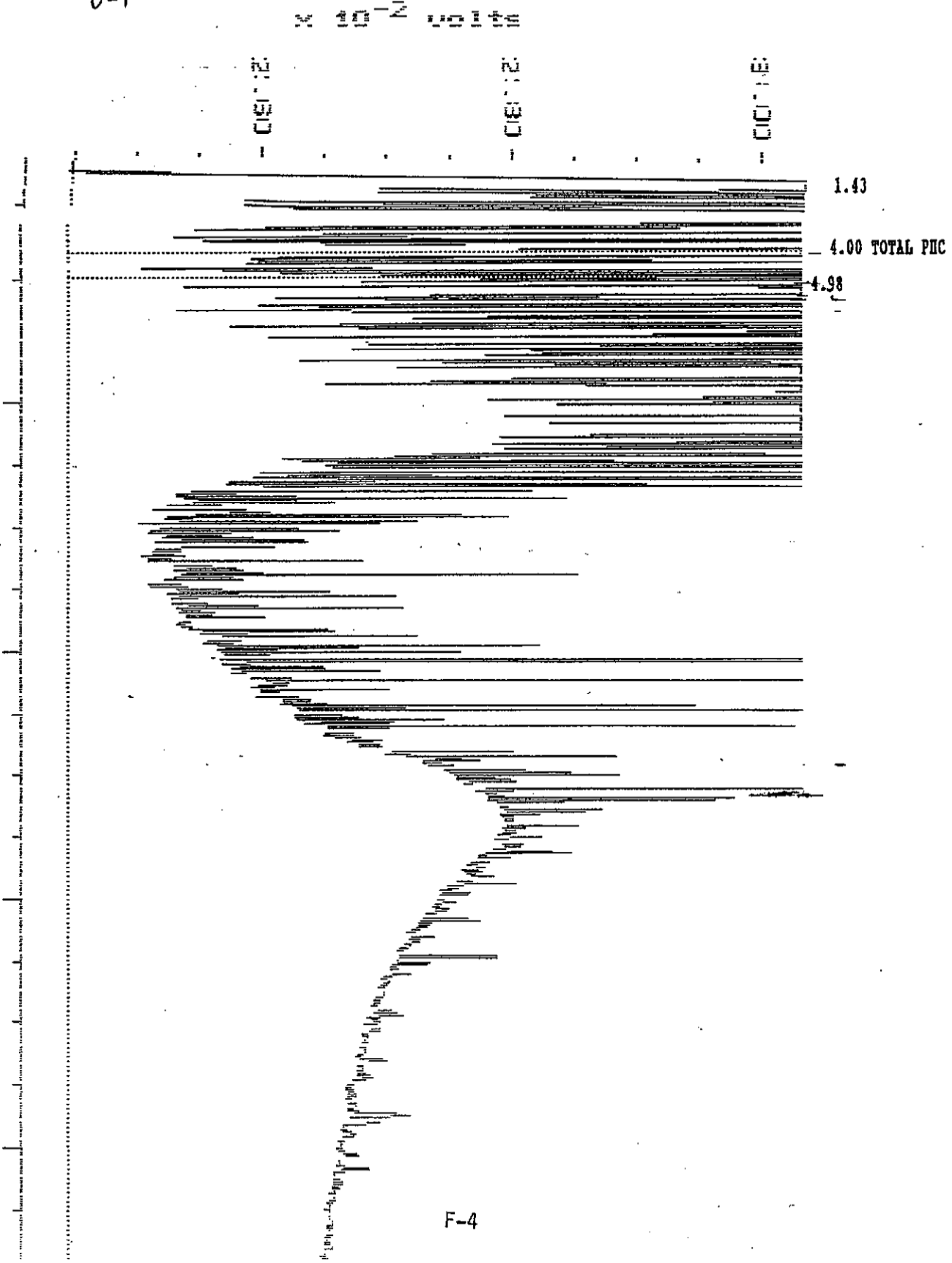
$\frac{14812224}{1025827} \times 51.2\ mg/L \times \frac{0.010L}{0.920L} \times \frac{10}{1} = 80.36\ mg/L$

$14831701 - 2592974 = 12238727$

$\frac{12238727}{1025827} \times 51.2\ mg/L \times \frac{0.010L}{0.920L} \times \frac{10}{1} = 66.4\ mg/L$

Sample: 6696 1:10 Channel: detector 1 Filename: T0318-6
Acquired: 18-MAR-91 13:23 Method: C:\HAX\DATA3\TEH0318 Operator:
Amount: 1.000 Inj Vol: 1.00

U-1



ENVIRONMENTAL LABORATORY SAMPLE TRACKING SHEET

Lab #:

ten Analytical
oratories, Inc.

SAMPLE I.D.: 19689 U-2

LAB I.D.: 6692

ALYSIS: Total Extractable Petroleum Hydrocarbons

TRIX: water

E SAMPLED:

E RECEIVED:

#:

MMENTS:

E WGT: 900 ml (LINE 1)	FINAL EXTRACT VOL: 50 ml (LINE 2)	COLUMN	RTX-5			
LE I.D.:		DATE	3/13/91			
I.D.:	DATE PREP'D: 3/13/91	DILUTION	1:1000			
mg E	DATE ANAL: 3/15/91	WORKER	EB/CA			
MDL	ANALYTE(S)	LAB I.D.				
		FINAL				
05 50	Total Extractable Petroleum Hydrocarbons	8000	8000			
	Elution Range 7 5 min					
	< 15 min					
	19 min					
	< 23 30 min					

MAXIMA 820 CUSTOM REPORT

Printed: 19-MAR-1991 14:37:00

SAMPLE: 6692 1:1000 Type: UNKN
#12 in Method: Total Extractable Hydrocarbons Instrument: FID/WPD
U-2 Acquired: 15-MAR-1991 21:15 Filename: T0315-12
Rate: 5.0 points/sec Index: 12
Duration: 45.000 minutes Injection Volume: 1.0
Operator: Amount: 1.000

DETECTOR: detector 1

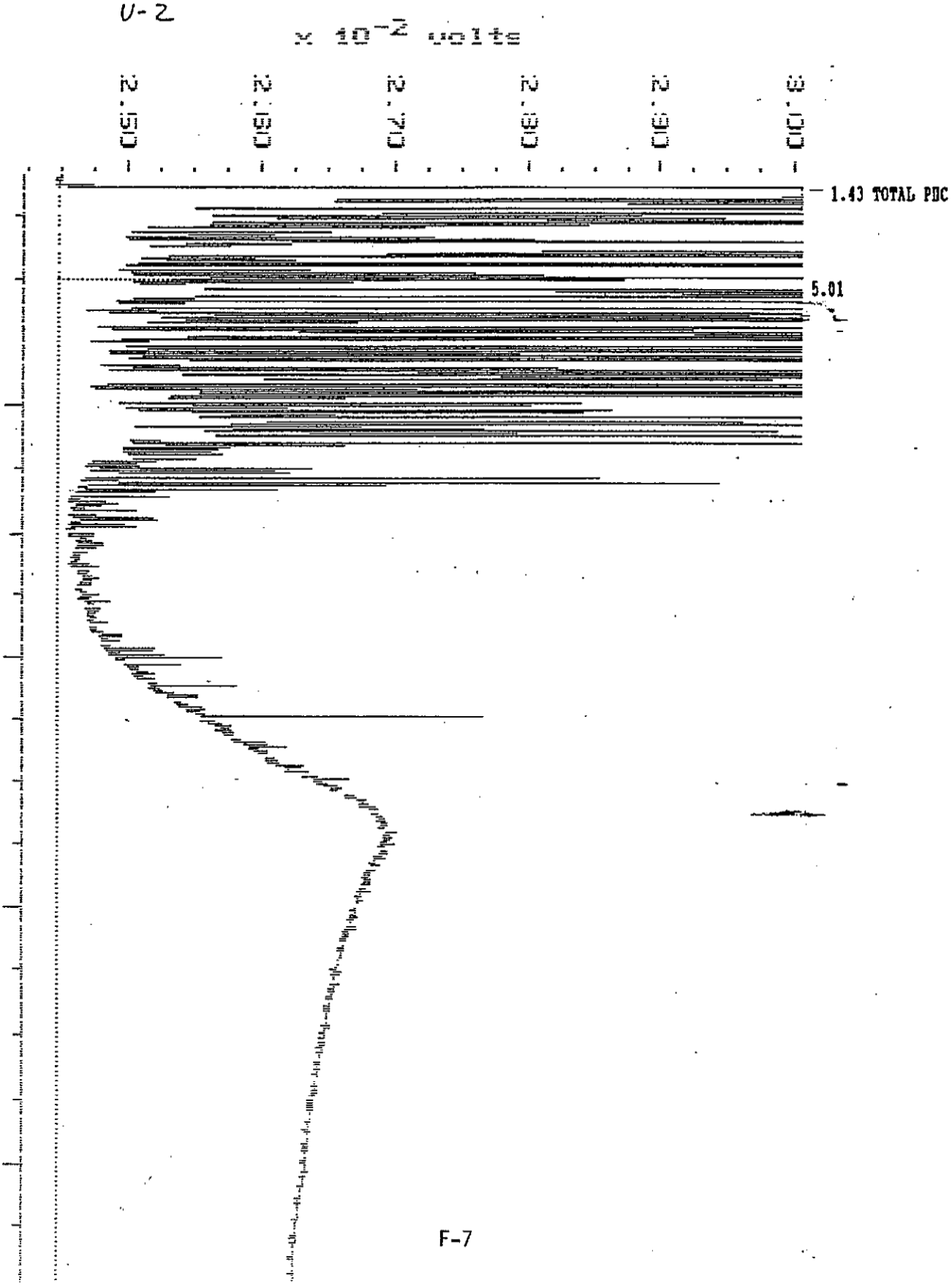
PK#	Retention Time (minutes)	Peak Start (minutes)	Peak End (minutes)	Area
1	1.427	0.997	4.977	>15929356
2	5.007	4.977	44.997	5528592
TAL				5528592

$5528592 - 2570350 = 2958242$

$$\frac{2958242}{1057773} \times 51.2\ mg/L \times \frac{0.050\ L}{0.900\ L} \times \frac{1000}{1} = 795\ mg/L$$

Sample: 6692 1:1000 Channel: detector 1 Filename: T0315-12
Acquired: 15-MAR-91 21:15 Method: C:\MAX\DATAJ\TEH0307 Operator:
Amount: 1.000 Inj Vol: 1.00

U-2



ENVIRONMENTAL LABORATORY SAMPLE TRACKING SHEET

n Analytical
ratories, Inc.

SAMPLER I.D. 19669 LAB I.D. 6680

MW-4

YSIS: Total Extractable Petroleum Hydrocarbons
TRIX: Water

RECEIVED
APR 3 1991
S.C.S. ENGINEERS

SAMPLED:
RECEIVED:

MENTS:

E WGT: 1.000 L	FINAL EXTRACT VOL: 10 ml	COLUMN	RTX-5			
E I.D.: LINE 1	LINE 2	DATE	3/18/91			
D.:	DATE PREP'D: 3/13/91	DILUTION	1:10			
mg/L	DATE ANAL: 3/18/91	WORKER	EB/CA			
MDL	ANALYTE(S)	LAB I.D.				
		FINAL				
.05	Total Extractable Petroleum Hydrocarbons	5.2	5.2			
.50	Elution range >5 min					
	< 12 min					

MAXIMA 820 CUSTOM REPORT

Printed: 19-MAR-1991 9:34:17

SAMPLE: 6680 1:10
MW-4
#5 in Method: Total Extractable Hydrocarbons
Acquired: 18-MAR-1991 12:33
Rate: 5.0 points/sec
Duration: 45.000 minutes
Operator:

Type: UNKN
Instrument: FID/MPD
Filename: T0318-5
Index: Disk
Injection Volume: 1.0
Amount: 1.000

DETECTOR: detector 1

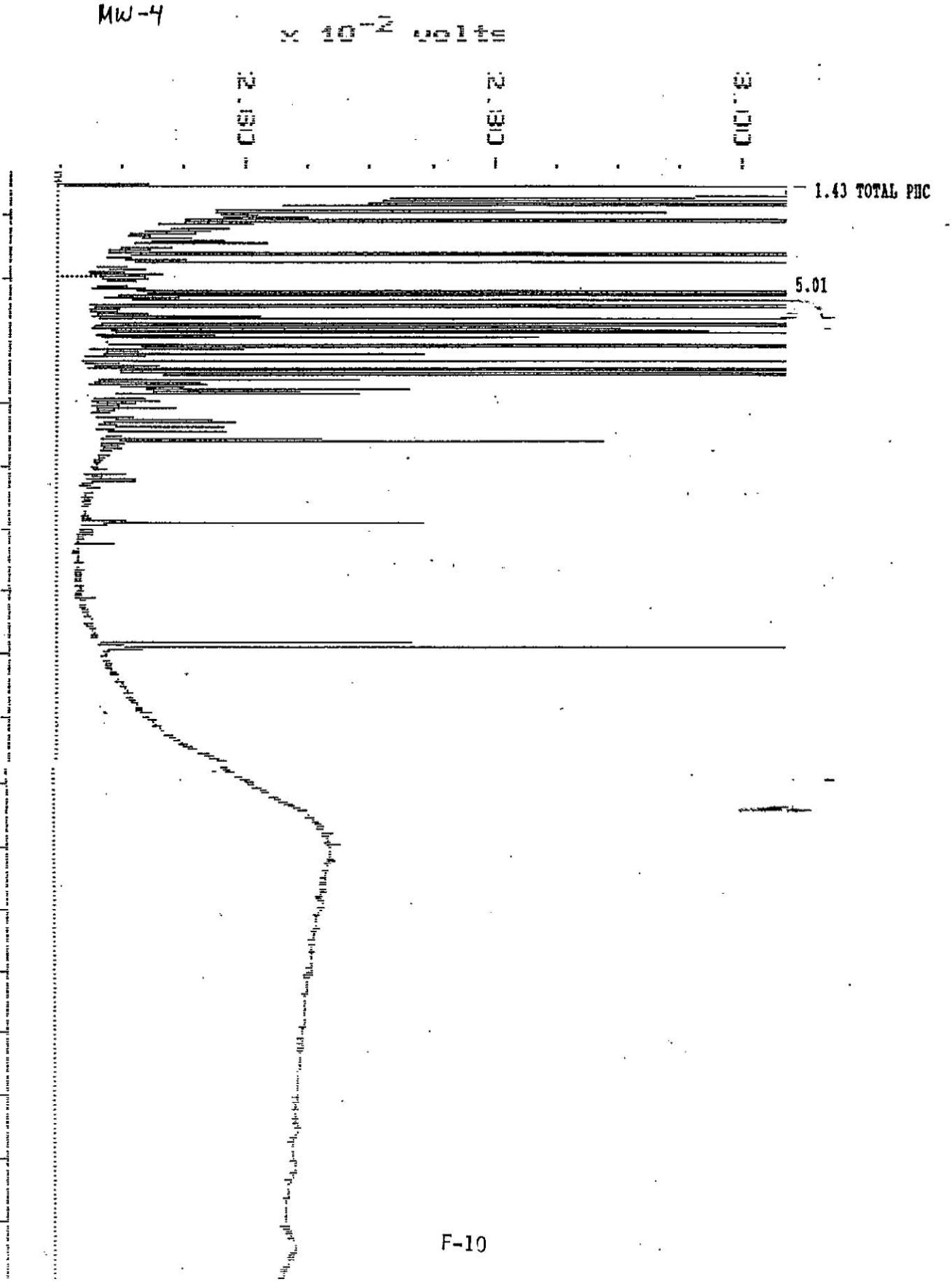
PK#	Retention Time (minutes)	Peak Start (minutes)	Peak End (minutes)	Area
1	1.427	0.997	4.977	>15763913
2	5.007	4.977	44.997	3636472
TAL				3636472

$3636472 - 2592974 = 1043498$

$$\frac{1043498}{1025827} \times 51.2\ mg/L \times \frac{0.010L}{1.000L} \times \frac{10}{1} = 5.21\ mg/L$$

Sample: 6680 1:10 Channel: detector 1 Filename: T0318-5
Acquired: 18-MAR-91 12:33 Method: C:\MAX\DATAJ\TEH0318 Operator:
Amount: 1.000 Inj Vol: 1.00

MW-4



ENVIRONMENTAL LABORATORY SAMPLE TRACKING SHEET

n Analytical
ratories, Inc.

SAMPLER I.D. 19701 MW-5

LAB I.D. ~~6299~~ 6699

YSIS: Total Extractable Petroleum Hydrocarbons
RIX: Water

SAMPLED:
RECEIVED:

MENTS:

COLUMN	RTX-5		
DATE	3/18/91		
DILUTION	1:10		
WORKER	CWA		
LAB I.D.			
FINAL			

E WGT: 995 ml (LINE 1) | FINAL EXTRACT VOL: 5 ml (LINE 2)
E I.D.:
D.: | DATE PREP'D: 3/13/91 | DATE ANAL: 3/18/91

mg/L	ANALYTE(S)	FINAL	
MDL			
05	Total Extractable Petroleum Hydrocarbons	6.2	6.2
50	Elution range > 5 min		
	< 11 min		
	> 20 min		
	< 30 min		

MAXIMA 820 CUSTOM REPORT

Printed: 19-MAR-1991 9:16:45

6699 CA

SAMPLE: ~~6299~~ 1:10 Type: UNKN

MW-5 #7 in Method: Total Extractable Hydrocarbons Instrument: FID/NPD
Acquired: 18-MAR-1991 14:14 Filename: T0318-7
Rate: 5.0 points/sec Index: Disk
Duration: 45.000 minutes Injection Volume: 1.0
Operator: Amount: 1.000

DETECTOR: detector 1

PK#	Retention Time (minutes)	Peak Start (minutes)	Peak End (minutes)	Area
1	1.427	0.997	5.037	>15264904
2	5.097	5.037	44.997	3823641
TAL				3823641

$3823641 - 2592974 = 1230667$

$$\frac{1230667}{1025827} \times 51.2\ mg/L \times \frac{0.010L}{0.995L} \times \frac{10}{1} = 6.17_{mg/L}$$

$= 6.2 mg/L$

6699 CA

Sample: ~~6299~~ 1:10 Channel: detector 1 Filename: T0318-7
Acquired: 18-MAR-91 14:14 Method: C:\MAX\DATA3\TEH0318 Operator:
Amount: 1.000 Inj Vol: 1.00

MW-5