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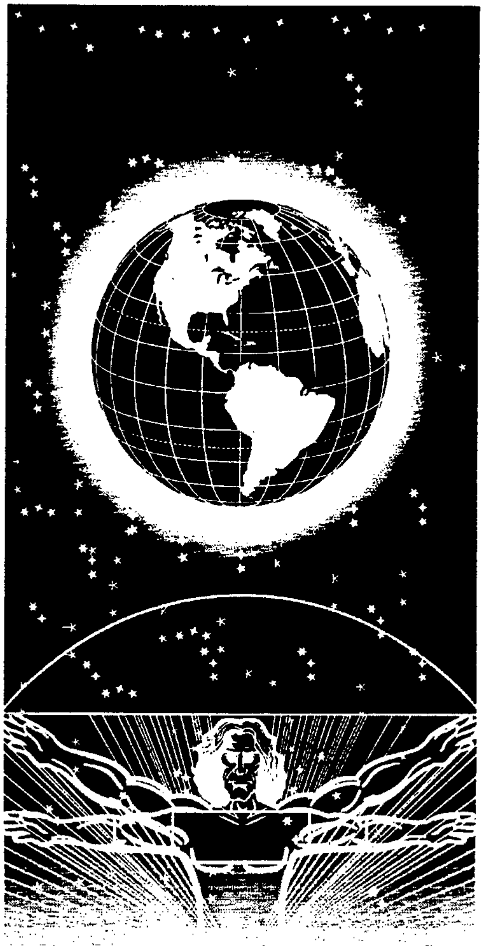

UNITED STATES AIR FORCE RESEARCH LABORATORY

THP CRITERIA WORKING GROUP DEMONSTRATION FIELD SAMPLING REPORT: MARINE CORPS AIR STATION, EL TORO, CA

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October 1998
Final - June 1997 - September 1998

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FOR THE DIRECTOR

STEPHEN R. CHANNEL, Lt Col, USAF, BSC
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A demonstration of the Total Petroleum Hydrocarbon Working Group approach for risk assessment was conducted on two former underground storage tank sites (Sites 380A and 529) at the Marine Corps Air Station in El Toro, CA. Site 380A is impacted by diesel fuel and Site 529 is primarily impacted by heating oil, as well as some lighter fuels. Samples were collected in side-by-side brass sleeves and submitted to different laboratories for fractionation (Direct Method) analysis and conventional total petroleum hydrocarbon (TPH) analysis, specifically EPA Modified 8015. The results of the conventional method were consistently two to three times higher than the results from the fractionation analysis. In addition, the Direct Method yielded volatile aromatic fractions concentrations that differed from the benzene, toluene, ethylbenzene and xylene (BTEX) analyses (EPA Method 8020). The reason for the discrepancies are not clear but may be due to intralaboratory variability. The RBSLs developed for both sites were higher than current state criteria with the exception of the RBSLs for the indoor air pathway. It was found that detection limits, particularly for the lightest aromatic fractions (EC5-8), dramatically affect the RBSLs pathways requiring partitioning. In effect, by using half the detection limit, nondetects in the EC5-8 aromatics contributed 20% of the risk for the indoor air pathway. The effect on the leaching pathway was similar. The sensitivity of the RBSLs to EC5-8 detection limits warrants additional BTEX analysis as part of the protocol for assessing risks.

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PREFACE

This effort was performed by Operational Technologies Corporation (OpTech) and Remediation Technologies, Incorporated (RETEC) under U.S. Air Force Contract Number F41624-94-D-9003/008. OpTech activities were conducted under the Project Management of Mr. Erik Vermulen, 1370 North Fairfield Road, Suite A, Beavercreek OH 45432. RETEC activities were conducted under the management of Dr. Hans Stroo, 1011 SW Klickitat Way, Suite 207, Seattle WA 98134. Major Steve Channel of the Air Force Research Laboratory, Human Effectiveness Directorate, Operational Toxicology Branch (AFRL/HEST), served as contract monitor.

The authors gratefully acknowledge Lynn Hornecker of U.S. Navy, MCAS, El Toro, CA, and Bill Sedlak, Vince Richards, Julie Diebenow and Dwayne Ishida of OHM Remediation Services Corporation (OHM), El Toro, CA, for their assistance in planning and field operations. We also acknowledge Richard Enz and Del Schumaker of Lancaster Laboratories, Lancaster, PA, for analytical results and Hans Stroo and Jill Nordstrom of RETEC, Inc., Seattle, WA, for their technical advice and comprehensive Risk Based Corrective Action analysis.

LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
"J"	estimated amount
ASTM	American Society for Testing and Materials
Avg.	Average
bgs	below ground surface
brn	brown
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
COC	Contaminant Of Concern
dk	dark
EC	Effective Carbon number of chemical molecule
FID	Flame Ionization Detector
fn	fine
ft	feet
GC	Gas Chromatograph
G_S	Specific Gravity
HC	Hydrocarbon
kg	kilogram
L	liter
LOQ	Limit Of Quantification
lt	light
LUFT	Leaking Underground Fuel Tank
MCAS	Marine Corps Air Station
med	medium
mg	milligram
MSL	Mean Sea Level
n-p	nonplastic
NA	Not Applicable
ND	Nondetect
OHM	OHM Remediation Services Corporation
OpTech	Operational Technologies Corporation
PCE	perchloroethylene or tetrachloroethylene
pcf	pounds per cubic foot
PID	Photo-Ionization Detector
ppm	parts per million
pts	points
RBCA	Risk Based Corrective Action
RBSL	Risk Based Screening Level
RETEC	Remediation Technologies, Incorporated
RPD	Relative Percent Difference
sl	slightly
SPLP	Synthetic Precipitation Leaching Procedure
SSTL	Site Specific Target Level
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TPHCWG	Total Petroleum Hydrocarbon Criteria Working Group
TPH-d	Total Petroleum Hydrocarbon - diesel
TPH-g	Total Petroleum Hydrocarbon - gasoline
UST	Underground Storage Tank
VOC	Volatile Organic Carbon
yel	yellow

TPH CRITERIA WORKING GROUP DEMONSTRATION
FIELD SAMPLING REPORT:
MARINE CORPS AIR STATION, EL TORO, CA

1.0 INTRODUCTION

The Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG or Working Group) has developed an approach for establishing risk based criteria for weathered petroleum hydrocarbon contaminated sites. The approach varies from standard total petroleum hydrocarbon (TPH) assessments in the petroleum hydrocarbon analyses performed on the samples and in the risk analyses undertaken to assess the requirements for cleanup of the site. The Working Group approach utilizes TPH fractionation analysis and assesses additive risk of the TPH fractions, using toxicity values assigned to each fraction based on representative chemicals within the fractions. It is consistent with the current scientific practice of assessing complex mixtures of chemically related constituents. This approach results in development of human health Risk Based Screening Levels (RBSLs) specific to the site and contaminant composition (TPHCWG, 1998a, b, c and d).

Operational Technologies Corporation (OpTech) is contracted by the U.S. Air Force Research Laboratory, Operational Toxicology Branch (AFRL/HEST, formerly Armstrong Laboratories, Toxicology Division) to conduct field demonstrations utilizing the Working Group approach for sample analysis and risk assessment. The purpose of the program is to demonstrate the risk-based hydrocarbon fractionation methodology and to collect data necessary to compare the Working Group approach to current state methods. This approach, if accepted by the regulatory community, could assist government and private industry in focusing remediation efforts on those sites which pose a significant risk to human health and the environment.

Two former Underground Storage Tank (UST) sites with residual TPH contamination were chosen for the Demonstration Program. These sites are located on the Marine Corps Air Station (MCAS), El Toro, California. Field sampling operations for the demonstration were conducted from August 27 through September 4, 1997.

The purpose of this report is to describe the sampling activities involved in this demonstration project and to report and evaluate the analytical results. A detailed Risk Based Corrective Action (RBCA) analysis of the fractionation data has been conducted by Remediation Technologies, Inc. (RETEC) and is presented in the Appendix.

1.1 Facility Description

The MCAS El Toro (the Station) was established in 1942 as an operational training facility for Marine Corps pilots. The mission of the Station has been to maintain and operate facilities and to provide services and materials to support aviation activities for the units of the Marine Corps operating forces. The Station is planning for closure and disposal by July 1999 in accordance with the Base Closure and Realignment Act.

The MCAS El Toro is located in Central Orange County, California, approximately 45 miles southeast of Los Angeles. The Station comprises approximately 4,738 acres, of which approximately 800 acres are designated for agricultural out lease. Geographically, the Station is located on the southeastern edge of the Tustin Plain. Sloping gently to the west-southwest, the Station crosses the Tustin Plain and extends into the Santa Ana Mountains. Land surface elevations at the Station are approximately 215 feet above mean sea level (MSL) at the western corner and rise to approximately 800 feet MSL at the eastern corner. The topography in the immediate area of the two former UST sites is relatively flat (Bechtel National, Inc., 1996).

1.1.1 Site 529 Description and History

Site 529 is located in the southeastern quadrant of the base. The site is northeast of Building 529. On the eastern side, L Street borders the site; 14th Street borders the northern side. Building 529 was originally constructed in 1944 as the Station Laundry Boiler Plant. Historical data indicate the tank was an underground 25,000 gallon rectangular concrete tank used for heating oil to supply the laundry boiler. Historical data are incomplete for this UST and the contamination at the site had not been fully delineated at the time of the OpTech field operations.

The UST and associated piping at Site 529 were removed in June, 1997 by OHM Remediation Services Corporation (OHM) (Figure 1). An Orange County Health Care Agency Field Inspector was present during the UST removal and sampling activities. The site was excavated to a depth of approximately 19 feet. Soil sampling within the excavation resulted in TPH-diesel (TPH-d) concentrations ranging from non-detectable to a maximum of 53,000 mg/kg. TPH-Motor Oil concentrations ranged from non-detectable to a maximum of 20,000 mg/kg. Low levels of benzene, toluene, ethylbenzene and xylene (BTEX) constituents were detected from the center of the site to the northeast end of the building at depths of 8 to 19.5 feet below ground surface (bgs). TPH of charcoal-like consistency was detected at several soil sampling locations within the tank excavation at the site. This highly carbonized form of TPH may be the result of a former heating line which ran along the fuel tank, essentially baking the leaked fuel.

The Station laundry was located near the site in Building 24A. Soil gas analyses near the building identified perchloroethylene (PCE) levels of 1.1 µg/L at 20 feet bgs. Soil PCE concentrations of 8 "J" to 120 "J" µg/kg at 12 and 28 feet bgs, respectively, were detected in 1994. "J" indicates an estimated value (Jacobs, 1994).

1.1.2 Site 380A Description and History

Site 380A is in the northeastern quadrant of MCAS El Toro. The site is located west of Building 380 within a storage yard area (Figure 2). Historical records for Site 380A indicate that a UST and associated piping were installed at the site in 1954 as part of the site emergency power generation system. The 10,000 gallon UST was cylindrical in shape, constructed of carbon steel and was laid in the ground horizontally. No spill-containment system was installed in conjunction with the tank (Bechtel National, Inc., 1996).

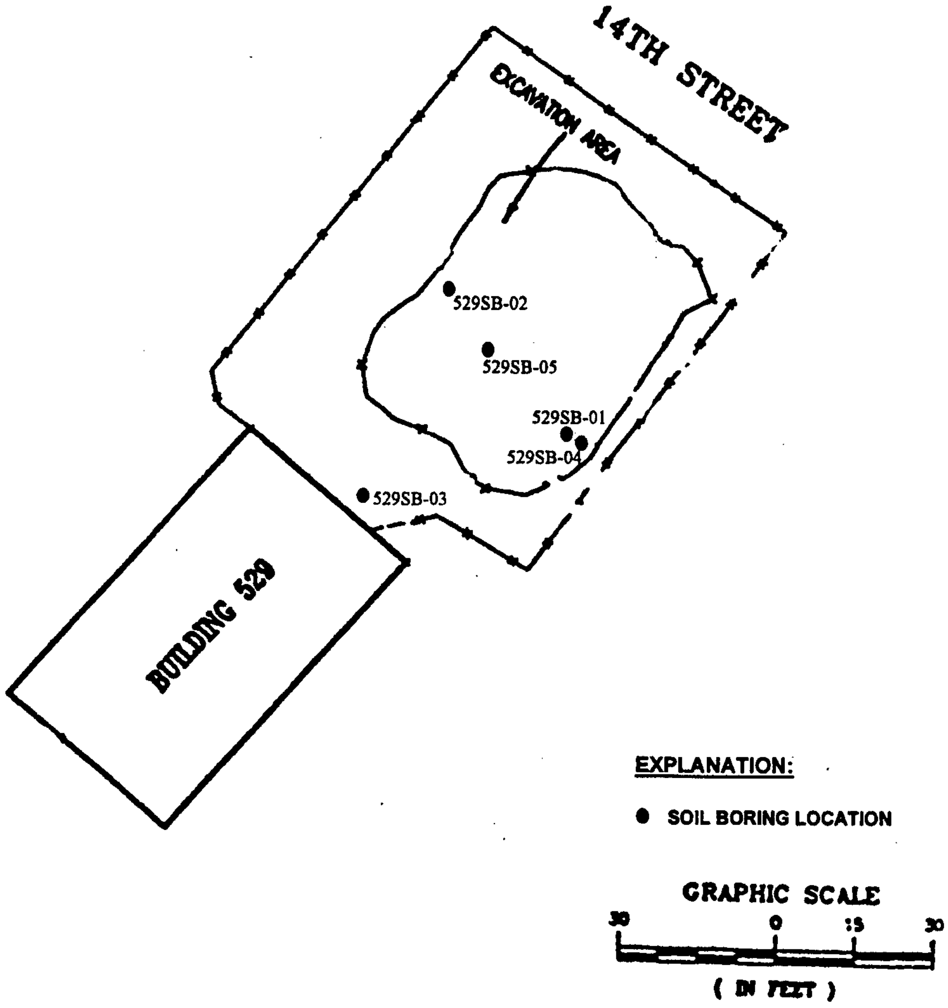

Figure 1. Site 529

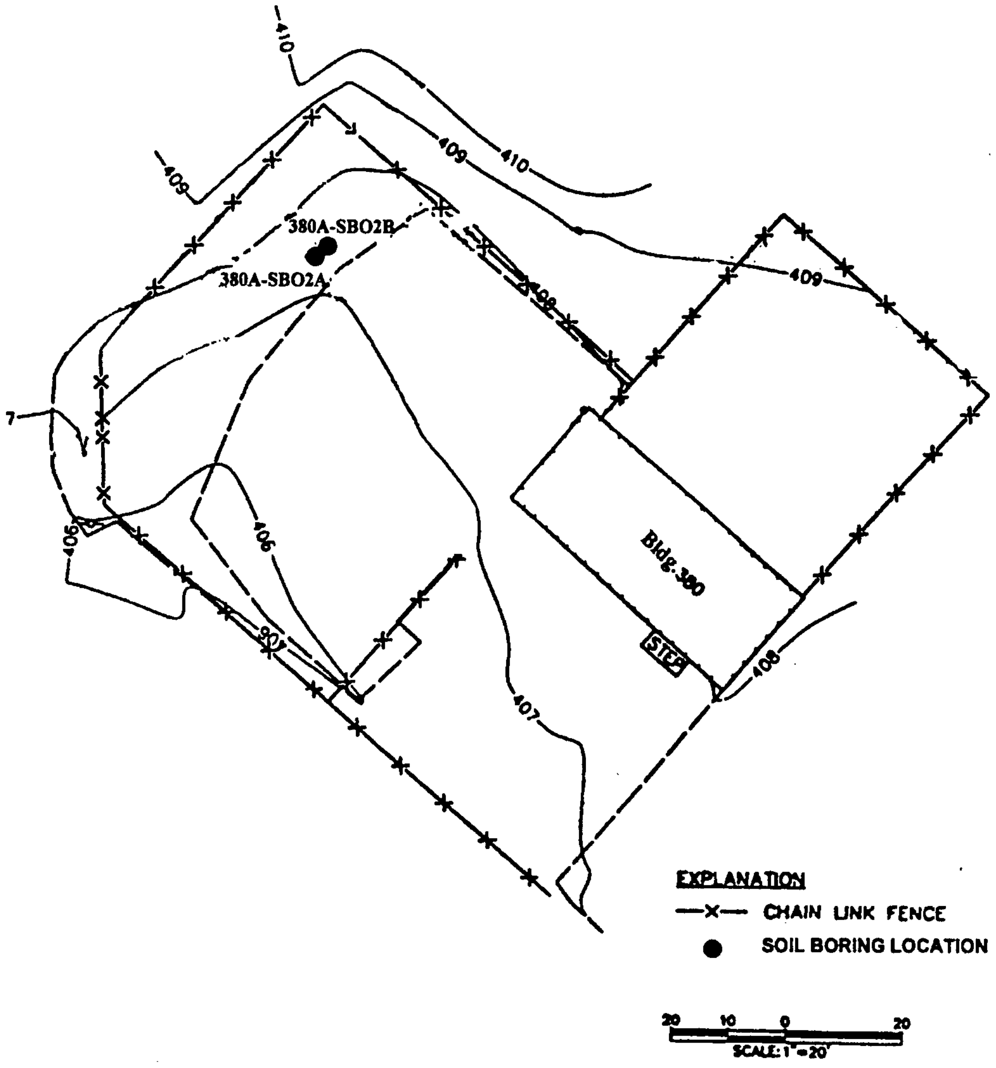

Figure 2. Site 380A

The UST and associated piping at Site 380A were removed in 1993 by American Processing, Inc. An Orange County Health Care Agency Field Inspector was present during the UST removal and sampling activities. The total depth of the excavation for the UST is believed to be 14 feet. Five samples were collected from the UST excavation and spoils pile at the time of removal. Based on the results from the first round of samples, two additional samples were collected from the piping trench at a later date and analyzed for TPH and BTEX. TPH contamination was identified at the north end of the UST excavation (15,000 mg/kg TPH at 14 feet bgs) and at the north end of the piping trench (4,100 mg/kg TPH at 5 feet bgs). TPH and toluene contamination was also found in samples from the spoils pile corresponding to the material removed from the north end of the excavation (320 mg/kg TPH and 0.01 mg/kg toluene). Bechtel National, Inc., took two soil borings at Site 380A in 1996 as part of the site assessment. Samples from those borings showed TPH contamination at a reported maximum of 13,000 mg/kg at 26 feet bgs (Bechtel National, Inc., 1996).

2.0 OBJECTIVES OF THE DEMONSTRATION PROJECT

The main objectives of the demonstration project are listed below:

- To apply the Working Group approach in a field situation.
- To compare the analytical results from the direct fractionation method with those from conventional methods and to evaluate their interchangability.
- To compare and contrast the RBSLs developed using the Working Group approach to the state mandated LUFT (Leaking Underground Fuel Tank) clean-up criteria.
- To assess the Working Group approach for consistency and effectiveness in evaluating similar weathered sites and to identify sources of variability in RBSLs.

As stated earlier, the primary purpose of this report is to describe the sampling and analytical procedures involved in this particular demonstration project and to evaluate the analytical data. A Tier 1 RBCA analysis of the fractionation data and a comparison of analytical techniques are presented in the Appendix entitled "TPH Criteria Working Group Field Demonstration" by RETEC. RBSLs were also calculated by OpTech as a quality control measure on the data and spreadsheets used for the assessment.

3.0 SAMPLING APPROACH

OHM was the Naval Facilities Engineering contractor for the MCAS El Toro UST Program at the time this demonstration field sampling program was undertaken (i.e., August 25th through September 4th, 1997). OHM had contracted with BC^2 Environmental Drilling Company to perform drilling operations at Sites 380A and 529 for the demonstration. The soil sampling program was designed to provide screening levels of TPH concentrations prior to specifying which samples would be submitted for the TPH fractionation analysis. The first three soil borings (529SB-01, 529SB-02 and 380ASB-02A) were cored continuously from a depth of 5 feet bgs to total depth (Figures 1 and 2). Hand augering was used to forward the hole to a depth of 5 feet prior to commencing drilling operations. The continuous cores were used to identify discontinuities in lithology that may act as either a retardant or conduit to vertical migration of contaminants through the subsurface and to identify potential areas of contamination through odor and/or discoloration.

Samples from the continuous cores were screened using a photo-ionization detector (PID) in the field. Hydrocarbon staining and odor were noted in the lithologic descriptions as well as PID readings. Based on the field PID values, soil samples from these borings were collected in 18-inch brass sleeves, consisting of three 6-inch samples. The samples were labeled with the date, boring location, depth and analytical procedure and were stored on ice in coolers. The samples were then submitted by OHM to EMAX Laboratories, Inc., Torrance, California, for TPH and BTEX fixed base laboratory analysis with a 24 hour turn around time on results. Therefore, the data on the sample analyses were made available to the field sampling program members within 36 hours of the completion of the soil boring; however due to a holiday weekend and an overload of lab samples, the turn around time for sample results from soil borings 380ASB-02B and 529SB-05 took over five days. The screening data were used to identify zones of TPH impact with greater certainty and to select which corresponding samples (i.e., the adjacent brass sleeve samples which were sent to Lancaster Labs) should have fractionation analysis run.

Soil borings 529SB-03, 529SB-04, 529SB-05 (Figure 1) and 380A SB-02B (Figure 2) were sampled utilizing a split spoon sampler with brass sleeves forwarded through the auger flight. Samples were collected in one and one-half foot increments, filling three six-inch brass sleeves per split spoon. The soil sample in the shoe of the split spoon was collected and placed in a closing plastic bag for PID screening; a lithologic description was taken. The ends of the contiguous brass sleeves from the bottom-most foot of the sampling interval were then closed with Teflon sheets and plastic caps to preserve volatiles within the undisturbed samples. One of the two brass sleeves was submitted by OHM for TPH, BTEX and synthetic precipitation leaching procedure (SPLP) analysis and the other was submitted by OpTech for fractionation analyses. Immediately after being capped, these brass sleeved samples were enclosed in plastic bags and placed on ice in coolers for shipment.

Samples sent to EMAX Laboratories for TPH (M8015) and BTEX analyses were taken from depths identified using PID field screenings and the analyses from the previous continuous core. The samples from the contiguous brass sleeve collected by OpTech were shipped in ice-packed coolers to Lancaster Laboratories, Lancaster, Pennsylvania, via FedEx overnight express, for the fractionation analysis. Additional samples surrounding the primary zone of interest were also shipped to Lancaster for them to hold prior to selection of samples to be analyzed. The samples to be analyzed for hydrocarbon fractionation were chosen based on the results of the TPH analyses from EMAX.

3.1 Geotechnical Samples

Geotechnical analyses of boring samples were obtained to characterize the soils at the two sites. The RBCA standard, used to calculate RBSLs, already provides Tier 1 default geotechnical parameters to conservatively account for cross-media impact. However, site-specific geotechnical data can be used to reduce the uncertainty of contaminant transport modeling in a Tier 2 assessment. As explained later, a Tier 2 assessment was not performed for this demonstration project because the extent of TPH contamination was not fully delineated. The cost of complete characterization was beyond the scope of this project.

Geotechnical analyses completed included: grain size, total organic carbon (TOC), bulk density, particle size, permeability, porosity, hydraulic conductivity and moisture. Ninyo and Moore Laboratories, in Los Angeles, California, performed this analysis. Background soil samples from above and below the contamination were submitted for particle size and TOC analysis. Other geotechnical analyses were performed on samples taken at points of lithologic variation identified by the soil borings.

Data such as porosity, permeability and particle size distribution are used to define the ability of contaminants to be transported through the soil from the source. Having data on the pH of the soil assists in understanding what changes occur to the contaminants as they migrate. TOC data collected through these tests help to define the fate of the contaminants, as organic materials trapped in the soil will adsorb some contaminants.

Moisture content is a prerequisite for other required analyses such as bulk density; therefore it is required to attain results in other tests. Porosity is necessary to calculate the flow velocity of the unsaturated zone. Dry bulk density is a direct input into the transport equations used by the RBCA model. The hydrometer particle size distribution test for particles of clay size is very useful to ascertain the actual clay content of the soil, which had been described in the boring logs as sand and non plastic fines. The soil tended to be cohesive when damp, which indicates the presence of some plastic clay minerals.

Some samples were collected from soil piles. The initial soil samples collected from the borings for the geotechnical analyses (approximately 12 samples in either 24 ounce jars or 2-inch by 6-inch long brass sleeves) were not sufficient for all analyses requested. Therefore, additional samples were taken from the soils piles and the remaining brass sleeved soil samples from the drilling activities. The samples were packed in plastic bags and forwarded to the lab for grain size analyses. The soil generally fell within one of three types: medium to coarse sand, silty fine grained sand and sandy silt. In order to run some of the analyses from the soil pile samples, the laboratory repacked the samples; this was necessary primarily for the permeability analyses. Repacked samples are better for characterizing horizontal rather than vertical conductivity due to the loss of natural stratification.

Moisture content and dry density of relatively undisturbed samples were evaluated in accordance with American Society for Testing and Materials (ASTM) D 2937-94. Gradient analysis tests, including hydrometer analyses of soil passing the No. 200 sieve, were performed on soil samples in general accordance with ASTM D 422-63. Soil pH and specific gravity tests were performed on representative samples in according to California Test Method 643 and ASTM C 128-93, respectively. Total porosity of relatively undisturbed samples was calculated using the moisture, density and specific gravity results. EPA Method 9060 was used to evaluate the total organic carbon content in selected samples.

4.0 ANALYTICAL RESULTS

4.1 Conventional Analytical Results From Site 529

At Site 529, soil samples were collected from five boring locations, 529SB-01, 529SB-02, 529SB-03, 529SB-04 and 529SB-05, identified in Figure 1. Soil samples from soil borings 529SB-01 and 529SB-02 were taken by way of continuous coring with an auger rig. Soil samples from soil borings 529SB-03 through 529SB-05 were taken in brass sleeves within split spoons at five foot intervals from 20 feet bgs to total depth of each boring. Table 1 lists the samples results.

TABLE 1. SITE 529 SOIL ANALYTICAL RESULTS

Lab/ Sample Number	Depth (ft)	Sample Description	PID VOC (ppm) Field	BTEX 8020 (mg/kg) EMAX	TPH 8015M (mg/kg) EMAX	Purge & Trap 5030/8015 (mg/kg) EMAX	SPLP 1312 (mg/L) EMAX	Moisture %
Boring 529SB-01								
18292-529SB-01-563	11	Sand, 90% fine sand to med sand, 10% nonplastic fines, poorly graded, dk olive brn, sl. moist, HC odor.	68	-	ND	-	-	9.8
18292-529SB-01-564	26	Sand, 90% fine sand, 10% n-p fines, poorly graded, olive brn, strong HC odor.	208	B-ND T-ND E-2.1 X-2.3	14000 EC9-28	-	-	4.8
18292-529SB-01-565	55-60	Sand, 90% fine sand, 10% n-p fines, poorly graded, with streaks of silt, yel brn, strong HC odor.	232	-	18000 EC9-29	-	-	10.1
18292-529SB-01-566	65-70	Sand, 90% very fine sand, 10% n-p fines, olive yel, strong HC odor	252	-	15000 EC10-28	-	-	6.9
Boring 529SB-02								
18292-529SB-02-567	47	Silty Sand, 70% very fine sand, 30% n-p fines, dk yel brn, strong HC odor	214	-	22000 EC7-30	-	-	10.5
18292-529SB-02-568	60	Sandy Silt, 60% n-p fines, 40% fine sand, fractured, Calcium carbonate filling voids and along bedding planes, friable	230	-	25000 EC9-29	-	-	11.8
18292-529SB-02-569	78	Sand, med, poorly graded, olive yel, sl moist, loose, strong odor	242	-	28000 EC7-29	-	-	11.5
18292-529SB-02-570	94	Sand with Gravel, med, pea to 1" rounded gravel, HC odor	167	-	9500 EC9-27	-	-	12.2
18292-529SB-02-571	100	Sand, med to coarse, poorly graded, light yel brn, loose, HC odor	175	-	21000 EC9-29	-	-	4.6
18292-529SB02-572	101, hydropunch	Groundwater sample	NA	B-0.53 T-2.6 E-4.8 X-0.28 (mg/L)	0.82 (mg/L) EC10-25	-	-	NA
Boring 529SB-03								
529SB-03-580	5	Sand , 90% fine to med. sand, 10% non plastic fines, dk yel brn, dry to sl moist	0.9	ND	220 EC16-33	ND	-	5
529SB-03-581	20-20.5	Sand, 95% fine to med, 5% n-p fines, yel brn, sl moist	0.9	ND	ND	ND	-	16.2

Lab/ Sample Number	Depth (ft)	Sample Description	PID VOC (ppm) Field	BTEX 8020 (mg/kg) EMAX	TPH 8015M (mg/kg) EMAX	Purge & Trap 5030/8015 (mg/kg) EMAX	SPLP 1312 (mg/L) EMAX	Moisture %
529SB-03-582	35	Silty Sand, 70% fine sand, 30% n-p fines, dark yel brn, sl moist	1.0	ND	ND	ND	-	14
529SB-03-583	40.5	Sandy Silt, 80% n-p fines, 20% v fine sand, dk yel brn, sl moist	0.4	ND	ND	ND	-	18.5
Boring 529SB-04								
18292-584*	20	Sand, 90% fine to med. sand, 10% n-p fines, dk brn, sl moist	127	B-ND T-ND E-1.4 X-1.5	15000 EC9-29	460+	-	12.2
18292-585	30	Silty Sand, 75% fine to med. Sand, 25% n-p fines, dk yel brn, sl moist	17.9	B-ND T -ND E -0.97 X -0.85	4400 EC10-25	200+	-	9.3
18292-586*	60	Silty Sand, 80% fine to med sand, 20% n-p fines, yell brn, sl moist	221	B -ND T -1.5 E -3.6 X-12.5	24000 EC9-29	650+	4.0 EC9-31-	12
18292-587*	80	Silty Sand, 75% fine to med sand, 25% n-p fines, dk yel brn, sl moist, HC odor	269	B-ND T-1.7 E-3.8 X-12.0	13000 EC9-28	700+	-	9.5
18292-588	90	Silt, 100% med. Plastic clay, lt olive brn, very stiff, sl moist	130	B-ND T-0.62 E-2.4 X-7.0	14000 EC9-26	710+	-	11.7
18292-589*	95	Silty Sand, 75% fine to med sand, 25% n-p fines, yel brn	41	B-ND T-ND E-0.44 X-1.2	10000 EC10-25	340+	2.2 EC10-25	5
18292-590	100	Sand, 90% fine to med sand, 10% n-p fines, yel brn, very moist	11.5	B-ND T-ND E-ND X-ND	ND	ND	-	16.7
18292-591	100.5	Water		ND	ND	ND	-	16.7
Boring 529SB-05								
18292-593*	20	Sand, 90% fn to med., 10% n-p fines, dk yel brn, sl moist, loose, strong HC odor	157	B-ND T-ND E-1.36 X-1.9	7400 EC9-34	290+	-	3.9
18292-594*	25	Silty Sand, 60% fine sand, 40% non to low plastic fines, very dk gray brn, loose	175	B-ND T-0.45 E-2.0 X-1.90	20000 EC9-32	440+	-	17.0
18292-595	35	Silty Sand, 70% fine sand, 30% n-p fines, dk yel brn, dk gray at places, strong odor	176	B-ND T-ND E-0.33 X-0.44	1800 EC10-29	110+	-	11.9

Lab/ Sample Number	Depth (ft)	Sample Description	PID VOC (ppm) Field	BTEX 8020 (mg/kg) EMAX	TPH 8015M (mg/kg) EMAX	Purge & Trap 5030/8015 (mg/kg) EMAX	SPLP 1312 (mg/L) EMAX	Moisture %
18292-596*	50	Silty Sand, 80% fn-med sand, 20% n-p fines, dk yel brn, sl moist	358	B-0.42 T-2.2 E-4.4 X-16.8	22000 EC9-28	770+	-	14
18292-614*	75	Silty Sand, 80% fine sand, 20% n-p fines, lt olive brn, sl moist, HC odor	62	B-0.3 T-1.6 E-4.9 X-11.7	19000 EC9-29	620+	5.8 EC7-30	12
529SB05-77*	75-75.5	Field duplicate of above samples	62					
18292-600	84	Sand, 95% fn-med sand, 5% n-p fines, yel brn, sl moist	174	B-0.22 T-1.9 E-0.3 X-12.0	11000 EC10-26	400+	-	4.3
18292-597	85	Same as above	113	B-0.2 T-2.0 E-3.5 X-13.0	13000 EC10-26	500+	-	6.4
18292-598*	100	Sand, 95% fn-med sand, <5% n-p fines, lt olive brn, moist, HC odor	174	B-ND T-1.2 E-2.6 X-7.5	24000 EC10-28	600+	-	4.7

Notes: * indicates fractionation analysis (Direct Method) was also run on this sample
Blanks indicate that the analysis was not run on that sample.
A Hyphen (-) in the cell of the table indicates that analysis was not performed on sample.
brn = brown; dk = dark; HC = Hydrocarbon; lt = light; med = medium; n-p = nonplastic; NA - Not Applicable; sl = slightly; VOC = volatile organic carbon; yel = yellow

The total depth of borings was originally anticipated to be approximately 150 feet bgs for at least the first soil boring; the total depth of subsequent borings was to be determined based on findings from the first soil boring. Soil boring 529SB-02 encountered wet samples in the continuous core from approximately 102 to 105 feet bgs, at which point the boring was halted. The depth of the water level was measured the next morning and was determined to be 101 feet bgs. A water sample was taken from this boring for TPH analysis. TPH (0.82 mg/L in the effective carbon (EC) 10-EC25 range), benzene (0.53 mg/L), toluene (2.6 mg/L), ethylbenzene (4.8 mg/L) and xylene (0.28 mg/L) were detected in the water sample. Subsequent borings were drilled to a total depth of 100 to 100.5 feet bgs, which was estimated to be above the groundwater table based on the findings in boring 529SB-02.

Ten samples, one of which was a field duplicate, and a trip blank were submitted to Lancaster Labs for TPH fractionation analysis based on the Direct Method. From soil boring 529SB-04, samples at 20, 60, 80 and 95 feet bgs were chosen for TPH fractionation analysis. From soil boring 529SB-05, samples at 20, 25, 50, 75 and 100 feet bgs were chosen. Two contiguous samples from 75 feet were submitted to Lancaster as duplicate samples for quality control. A comparison of the duplicates results is discussed in Section 4.5. All samples were shipped within 24 hours of the time of sampling. However, because extra samples were sent, the samples were held at the lab until a final selection was made based on the results of the EPA Method 8015M TPH results.

TPH concentrations ranged from nondetect (ND) to 28,000 mg/kg, detected at boring 529SB-02 from 75 feet bgs. BTEX, primarily ethylbenzene and xylenes, were detected at Site 529. Benzene was detected at boring location 529SB-05, with a maximum concentration of 0.42 mg/kg at a depth of 50 feet bgs. The BTEX concentrations at this boring decreased with depth from 0.20 mg/kg at 85 feet bgs to ND at 100 feet bgs.

Significant levels of purgeable TPH were detected in samples from borings 529SB-04 and 529SB-05, ranging from ND to 770 mg/kg. An explanation for these levels is not clear. Site history, previous investigations and lab analysis indicate a diesel or mid-range fuel mixture which would likely result in lower concentrations from this analysis. Purge and trap analysis was also performed on samples from boring 529SB-03, which resulted in all NDs. This analysis was not performed on samples from borings 529SB-01 and 529SB-02.

4.2 Conventional Analytical Results from Site 380A

At Site 380A, soil samples were collected from two boring locations, 380SB-02A and 380SB-02B (Figure 2). Soil samples from boring 380SB-02A were taken by way of continuous coring with an auger rig. Soil samples from boring 380SB-02B were taken from split spoons at five-foot intervals from 5 to 29 feet bgs, at which time split spoons were driven continuously in 1.5-foot increments to a depth of 35 feet bgs. Five-foot interval split spoon samples were collected from 40 to 55 feet bgs and a final sample was taken at 55.5 to 56.5 feet bgs in the soil boring. Again PID readings and TPH-extraction method (M8015) were used to delineate the vertical extent of contamination. Table 2 lists all analyses and results on the samples from Site 380A.

TABLE 2. SUMMARY OF ANALYTICAL RESULTS FROM SITE 380A

Lab or Sample Number	Depth (ft)	Sample Description	PID VOCs (ppm) Field	BTEX 8020 (mg/kg) EMAX	TPH & Range M8015 (mg/kg) EMAX	TPH Purge &Trap 5030/8015 (mg/kg) EMAX	SPLP 1312 (mg/L) EMAX	Moisture %
Boring 380SB-02A								
18292-573A	19	Sand, poorly graded with gravel, 85% sand, 15% angular gravel, very pale brn.	2.8	-	430 EC14-26	-	-	3.6
18292-574	29	Gravely Sand, poorly graded, 30% coarse sand, 55% fine sand, 15% medium gravel, lt. yel brn, lt acetone-like odor.	13.4	-	23000 EC12-29	-	-	12.2
18292-575	31.5	Sand, decreased gravel content, grades into poorly graded sand, slight odor.	3.5	-	14000 EC11-29	-	-	4.9
18292-577	37	Same as above	8.0	-	ND	-	-	5.3
18292-578	42	Same as above	3.2	-	ND	-	-	5.1
18292-579	43	Same as above	3.0	-	ND	-	-	3.6
18292-576	55	Same as above	5.1	-	ND	-	-	3.3
Boring 380SB-02B								
18292-601	9.5-10	Silty Sand, 75% fine to med., 25% n-p fines, dk yel brn, med density	3.0	ND	41 EC16-26	ND	-	7.7
18292-602*	14.5-15	Sand, fine to med., 95% sand, 5% n-p fines, HC odor.	3.2	ND	2000 EC13-29	ND	-	4.3
380ASB02-20*	20	Sand, 90% fine sand, 10% n-p fines, dk brn.	-	-	-	-	-	
380ASB02-21*	21	Field Duplicate of above sample	-	-	-	-	-	
18292-603	24.5-25	Sand, 90% fine sand, 10% n-p fines, well sorted, brn.	5.2	ND	750 EC11-31	ND	-	3.7
18292-604*	31.5	Sand, 95% fine sand, 5% n-p fines, well sorted, sl moist, loose, brown.	13.6	ND	3300 EC12-26	ND	19 range = EC12-30	9.3
18292-605*	32.5-33	Same as above.	3.1	ND	2500 EC11-29	ND	-	3.1
18292-606	56-56.5	Silty sand, 80% fine to med. sand, 20% n-p fines, dr. yel brn, sl. moist, med. Density	2.0	ND	140 EC11-25	ND	-	6.4

Notes: * indicates fractionation analysis (Direct Method) was also run on this sample
A (+) indicates that chromatograms do not indicate a gasoline pattern, bit rather a diesel range pattern.
A hyphen (-) in the cell of the table indicates that analysis was not performed on sample
brn = brown, dk = dark, HC = Hydrocarbon, lt = light, med = medium, ND = Nondetect; n-p = nonplastic, sl = slightly, VOC = volatile organic carbon; yel = yellow

Five samples from boring 380A-SB-02B , which includes one field duplicate, were submitted to Lancaster Labs for TPH fractionation analysis. Samples from 15, 20, 32 and 33 feet bgs were chosen for TPH fractionation analysis. A sample from 20.5 feet, labeled 380SB-02B-21, was submitted to Lancaster as a field duplicate for quality control. All samples were shipped within 24 hours of sampling. Again, the samples submitted to Lancaster were held in refrigeration at the lab until the M8015 results from EMAX were received and the selection of which samples to run the Direct Method on was made.

The results from the conventional M8015 method yielded TPH concentrations ranging from ND to 23,000 mg/kg at boring 380SB-02A. Detected TPH values from boring 380SB-02B were lower, ranging from 41 mg/kg at 10 feet to 3300 at 32 feet with no detects from the purge and trap analyses. BTEX analyses were performed only on samples from boring 380SB-02B, resulting in all nondetects. PID readings were very low throughout these soil borings; however, there was a relative increase in the PID readings over the most contaminated zone. The large difference in TPH levels (i.e., 23000 vs. 3300 mg/kg at 29 and 31 feet, respectively) suggests that the impacted area at this site is very isolated. Previous investigations also indicated that the zone of contamination was difficult to locate.

4.3 Fraction-Specific Analytical Results from Site 529 and Site 380A

The Direct Method provides results grouped into the 13 fractions specified by the Working Group. This method is performed by first extracting the hydrocarbons from the soil using *n*-pentane. The extract is analyzed using a gas chromatograph (GC) equipped with a flame ionization detector (FID) for separation and identification of the hydrocarbons. Additional separation of the sample into aliphatic and aromatic fractions is performed using alumina column chromatography. The analysis of the separate fractions is again performed by GC/FID.

The average hydrocarbon composition based on effective carbon number is presented in Figure 3. The greatest concentration of hydrocarbons is in the >EC16 to 21 fraction. The largest amount of aliphatics and aromatics is seen in the >EC16 range, reflecting a high degree of weathering. This trend in composition was consistent among all the samples. Most volatiles and semivolatiles were below reportable limits. A breakdown of the fractionation data from both sites is provided in Tables 3 and 4. By assuming half the detection limit for nondetects, each fraction between EC5 and EC8 contributes approximately 0.1% of the total concentration. The high detection limits within these fractions can result in a significant amount of the hypothetical risks being driven by nondetects. A sensitivity analysis on the effect of detection limits (for the lighter hydrocarbon fractions) on RBSLs is presented in the attached report by RETEC (see Appendix).

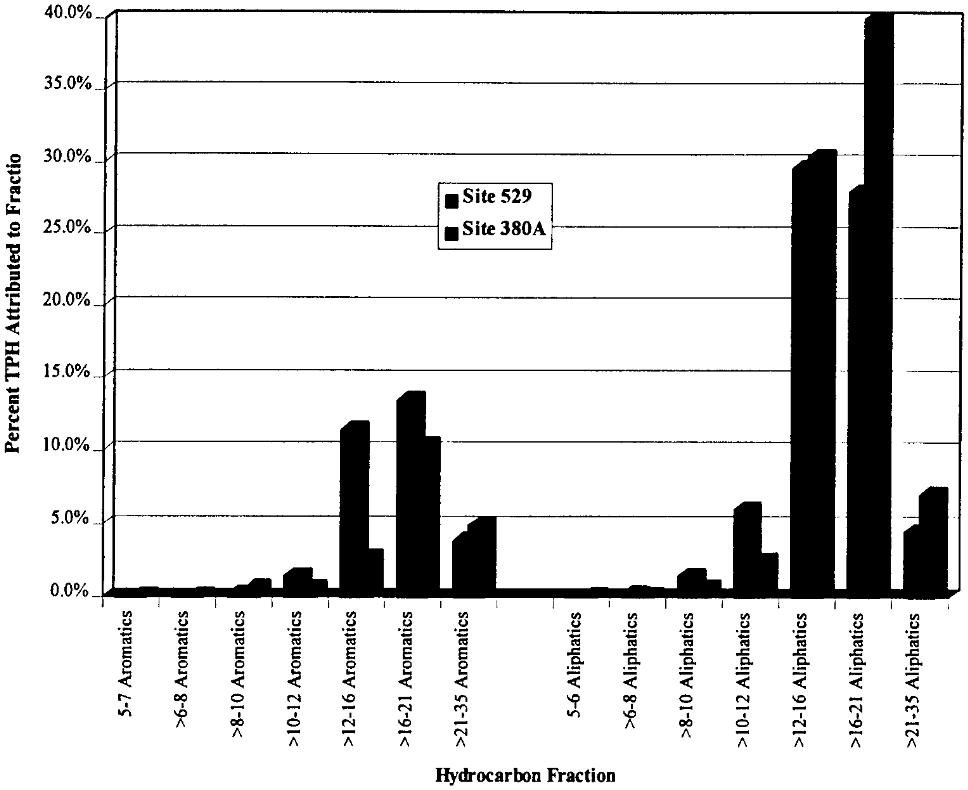

Figure 3. Average Percent Weight Composition at Sites 529 and 380A

TABLE 3. SITE 529 FRACTIONATION DATA

Boring Location:	**529SB-05**							**529SB-04**					
Sampling Depth (ft)	**20**	**25**	**50**	**75**	**77**	**100**		**20**	**60**	**80**	**95**		
HC Fraction	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**Avg. % Wt**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**Avg. % Wt**	**Site-wide Avg. % Wt**
5-7 Aromatics (Benzene)	4	5	5	2	5	4	0.1%	0	4	5	1	0.0%	0.1%
>6-8 Aromatics (Toluene)	4	5	5	2	5	4	0.1%	0	4	5	1	0.0%	0.1%
>8-10 Aromatics	9	9	27	5	5	8	0.2%	5	25	17	4	0.2%	0.2%
>10-12 Aromatics	133	124	138	19	31	81	1.5%	57	105	73	74	1.3%	1.4%
>12-16 Aromatics	958	828	904	164	246	947	11.2%	429	838	609	766	11.5%	11.4%
>16-21 Aromatics	1037	869	1004	180	266	1162	12.5%	569	1158	677	878	14.3%	13.4%
>21-35 Aromatics	767	531	403	29	29	107	5.2%	132	280	69	97	2.5%	3.8%
Total Aromatics	**2913**	**2372**	**2485**	**402**	**586**	**2313**	**30.7%**	**1193**	**2415**	**1453**	**1821**	**30.0%**	**30.4%**
5-6 Aliphatics	4	5	5	2	5	4	0.1%	0	4	5	1	0.0%	0.1%
>6-8 Aliphatics	9	11	22	6	23	22	0.3%	1	25	5	1	0.1%	0.2%
>8-10 Aliphatics	111	115	171	18	26	76	1.4%	58	126	86	52	1.4%	1.4%
>10-12 Aliphatics	501	557	699	65	93	324	6.2%	299	443	279	293	5.7%	6.0%
>12-16 Aliphatics	2187	2129	2519	427	591	2704	29.3%	1142	2047	1585	2093	29.9%	29.6%
>16-21 Aliphatics	1890	1689	1945	428	592	2850	26.1%	1008	2014	1628	2185	29.8%	27.9%
>21-35 Aliphatics	734	588	487	58	57	211	5.9%	178	210	134	171	3.0%	4.5%
Total Aliphatics	**5436**	**5094**	**5847**	**1005**	**1386**	**6191**	**69.3%**	**2687**	**4869**	**3721**	**4797**	**70.0%**	**69.6%**
%Wt Aromatics	**34.9%**	**31.8%**	**29.8%**	**28.5%**	**29.7%**	**27.2%**	**30.7%**	**30.7%**	**33.2%**	**28.1%**	**27.5%**	**30.0%**	**30.4%**
%Wt Aliphatics	**65.1%**	**68.2%**	**70.2%**	**71.5%**	**70.3%**	**72.8%**	**69.3%**	**69.3%**	**66.8%**	**71.9%**	**72.5%**	**70.0%**	**69.6%**
Aromatics/ Aliphatics	**0.54**	**0.47**	**0.42**	**0.40**	**0.42**	**0.37**	**0.44**	**0.44**	**0.50**	**0.39**	**0.38**	**0.43**	**0.44**

Notes: Shaded cells are nondetects (values represent one half of limit of quantitation (LOQ))

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID (mg/kg)

C8 to C35 Hydrocarbons by Pentane Extraction with Aliphatic/Aromatic Separation Performed by Silica Gel Column (mg/kg)

TABLE 4. SITE 380A FRACTIONATION DATA

Boring Location	**380SB-02B**					
Sampling Depth **HC Fractions**	**15** **mg/kg**	**20** **mg/kg**	**21** **mg/kg**	**32** **mg/kg**	**33** **mg/kg**	**Site-wide Avg.** **% Weight**
5-7 Aromatics (Benzene)	0	0	0	1	2	0.1%
>6-8 Aromatics (Toluene)	0	0	0	1	1	0.1%
>8-10 Aromatics	4	4	4	4	4	0.6%
>10-12 Aromatics	4	4	4	4	4	0.6%
>12-16 Aromatics	10	11	10	32	30	2.7%
>16-21 Aromatics	106	11	84	73	81	10.1%
>21-35 Aromatics	61	26	26	26	27	4.7%
Total Aromatics	**186**	**56**	**129**	**141**	**149**	**18.8%**
5-6 Aliphatics	0	0	0	1	1	0.1%
>6-8 Aliphatics	0	0	0	1	1	0.1%
>8-10 Aliphatics	4	4	4	4	4	0.6%
>10-12 Aliphatics	4	4	4	36	16	1.9%
>12-16 Aliphatics	60	11	70	448	449	29.6%
>16-21 Aliphatics	157	57	169	490	599	42.0%
>21-35 Aliphatics	26	26.5	26	80	87	7.0%
Total Aliphatics	**252**	**103**	**273**	**1060**	**1157**	**81.2%**
% Weight Aromatics	**42.4%**	**35.5%**	**32.0%**	**11.7%**	**11.4%**	**18.8%**
% Weight Aliphatics	**57.6%**	**64.5%**	**68.0%**	**88.3%**	**88.6%**	**81.2%**
Aromatics/Aliphatics	**0.74**	**0.55**	**0.47**	**0.13**	**0.13**	**0.23**

Notes: Shaded cells are nondetects (values represent one-half of LOQ)
EC5 to EC8 Hydrocarbons by Purge & Trap GC PID/FID (mg/kg)
EC8 to EC35 Hydrocarbons by pentane extraction with aliphatic/aromatic separation performed by silica gel column (mg/kg)

A decrease in the ratio of aromatic to aliphatic hydrocarbons with sampling depth occurred at both sites. The increase in the aliphatics >EC16 to EC21, especially at Site 380A, suggests reductive reactions possibly from anaerobic activities.

4.4 Comparison of Conventional TPH and Fractionation Results

A wide discrepancy was seen between the Direct Analytical Method results (analyzed by Lancaster Labs) and the EPA modified 8015M results (analyzed by EMAX) (Figure 4). There are several plausible reasons for the discrepancy in the results between conventional analysis and the fractionation data. The samples submitted were not composites, but rather split samples, one brass sleeve (2" diameter, 6" long) being submitted to each lab with the adjacent ends of the split spoons marked to identify from which end to take the sample. This ensured that the results represented side by side samples; however, they were not identical soil samples.

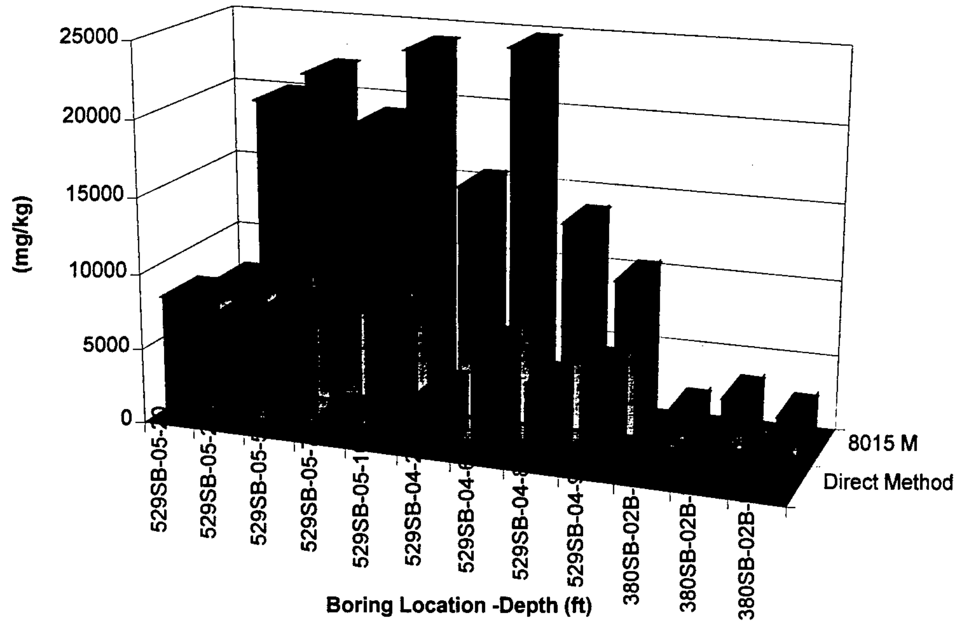

Figure 4. Comparison of Direct Method and 8015 Modified Results

Bruya and Eng (1992) conducted a study using spiked samples and suggested that if the product in the soil is significantly weathered compared with the standard used for calibration, the concentration reported may be inaccurate by as much as ±50%. In this field demonstration there were 13 to 93% differences between the M8015 results and the Direct Method results; the M8015 results were consistently higher. Both laboratories used a diesel #2 fuel as a calibration standard.

The extraction procedures are significantly different. *n*-Pentane was used as the extracting solvent for the fractionation method. *n*-Pentane may result in reduced measurements of the higher weight fractions. The California (M8015) Method used methylene chloride. The fractionation method requires the use of a 10 g sample extracted with 10 ml *n*-pentane in a vortex for 1 to 2 minutes. The procedure prescribed by California (M8015) specifies that a 20 g sample be extracted with 80 ml solvent and shook for at least 4 hours. The protocol specified in the Direct Method prevents the loss of volatile TPH constituents, as present in gasoline. The California method extracts more non-volatile TPH because the solvent is in contact with the sample for a longer time period. Since these sites did not have gasoline, the California method would predictably yield higher results, especially of the larger hydrocarbons.

The calibration standards specified by both methods appear to be the same (in this case, diesel fuel #2); however, the fractionation method uses alumina to separate aliphatics and aromatics. This alumina separation step in the fractionation SOP is not used in the M8015 procedure. The alumina would act similarly to silica gel and would remove the more polar compounds. Anything more polar than methylene chloride will not elute from the alumina column. This might result in lower TPH numbers with the Direct Method.

The two methods are different enough that it is difficult to compare results. However, trends can be identified. In Figure 4, an general increase in TPH concentration at boring 529SB-05, albeit not consistent, is noted with both methods to a depth 50 ft and then a decline. Both analytical methods demonstrate a rise in concentration from 20 to 60 feet bgs at boring 529SB-04, followed by a decrease beyond that depth.

Lastly, it is possible that the results of the Direct Method may have been compromised by a loss of lighter fractions. Samples collected for Direct Method analysis were held at temperatures below 4°C for final selection based on the "screening" M8015 results from the Ninyo and Moore Laboratory. This "screening" approach to selecting samples was used because residual TPH levels at both sites were not fully characterized at the time of sampling and PID readings on several borings were resulting in extremely low levels of contamination. Therefore, as necessitated by the higher cost of the fractionation analysis, samples were held at the laboratory for confirmation based on the M8015 results to ensure the analyses would yield results. Due to a delay period in receiving the M8015 results, two samples from boring 529SB04 exceeded the recommended holding time by two hours. This may have resulted in a loss of highly volatile compounds such as benzene and toluene. Conversely, the BTEX analysis performed on corresponding samples resulted in NDs or very low levels of BTEX, which would not account for the two- to three-fold differences in TPH results. One sample from the next proposed field demonstration will be held beyond the holding time before analysis to evaluate possible impacts on results.

Ideally, if there is a good correlation between the results from the conventional method and those of the fractionation results, one should be able to assume the hydrocarbon fraction composition is representative of the impacted soil contamination. This composition information could then be used as specified in the risk-based methodology proposed by the Working Group for determining acceptable petroleum hydrocarbon concentrations in soil. Unfortunately, a good correlation between the two analytical techniques was not found and therefore it was not appropriate to apply this assumption. Good correlations have been found between the conventional and the Direct Method with other site soils. The effectiveness of combining data from both analytical techniques for assessing impacted sites needs to be evaluated further.

4.5 Evaluation of the Direct Method's Precision

Precision is a measure of mutual agreement among individual measurements of the sample property under prescribed similar conditions. Sampling precision was evaluated by the analysis of a set of field duplicate samples collected from both Site 380A (Samples 380SB-02B-20 and 380SB-02B-21) and Site 529 (Samples 529SB-05-75 and 529SB-05-77). Precision is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured. Based on the results, a measure of bias within the system can be estimated. Precision is calculated in terms of relative percent difference (RPD) between duplicate samples, which is expressed as follows:

$$RPD = \frac{(x_1 - x_2)}{x_{avg}} \times 100$$

where:

RPD = Relative Percent Difference
X_1 = Analyze concentration of first duplicate;
X_2 = Analyze concentration of second duplicate; and
X_{avg} = Average analyte concentration of duplicates one and two.

This equation is taken from OpTech's Quality Assurance Project Plan, which is concurrent with the Federal Register guidance, 44(FR)69533, "Guidelines Establishing Test Procedures for the Analyses of Pollutants, Appendix III: Example Quality Assurance and Quality Control Procedures for Organic Priority Pollutants" (3 December 1979). The QA/QC procedures assume that RPDs less than 35% are acceptable; values of >35% are suspect (OpTech, 1992).

The field duplicates were collected in side-by-side brass sleeves (split samples). Precision of field duplicates depends on sample homogeneity. Field duplicates do not represent lab duplicates and are not identical; however, the distribution of their hydrocarbon fractions is expected to be similar due to the homogenous soil characteristics seen throughout the borings.

The analytical results of the field duplicates and the associated RPDs are presented in Table 5. The RPD between duplicates from Site 529 was acceptable. The fraction-specific RPDs for the duplicates from Site 529 were fairly consistent, although the RPDs for the >EC6 to EC8 aliphatics and >EC10 to EC21 aromatic fractions exceeded the acceptable 35% difference. RPDs are not applicable to fractions with nondetect values.

TABLE 5. ANALYTICAL RESULTS OF DUPLICATE SAMPLES AND CALCULATED RPDS

Lab ID **Sample Location**	**2781273** **529SB-05-75**	**2781274** **529SB-05-77**		**2781282** **380SB-02B-20**	**2781283** **380SB-02B-21**	
Approximate Carbon Fractions	**(mg/kg)**	**(mg/kg)**	**RPD**	**(mg/kg)**	**(mg/kg)**	**RPD**
5-6 Aliphatics	<4.7	<9.2	**NA**	<0.2	<0.2	**NA**
5-7 Aromatics (Benzene)	<4.7	<9.2	**NA**	<0.2	<0.2	**NA**
>6-8 Aliphatics	**5.6**	**23.3**	**122.0**	<0.2	<0.2	**NA**
>6-8 Aromatics (Toluene)	<4.7	<9.2	**NA**	<0.2	<0.2	**NA**
>8-10 Aliphatics	**18.3**	**25.5**	**32.9**	<8.5	<8.4	**NA**
>8-10 Aromatics	<9.3	<9.2	**NA**	<8.5	<8.4	**NA**
Lab ID **Sample Location**	**2781273** **529SB-05-75**	**2781274** **529SB-05-77**		**2781282** **380SB-02B-20**	**2781283** **380SB-02B-21**	
>10-12 Aliphatics	**65.4**	**92.7**	**34.4**	<8.5	<8.4	**NA**
>10-12 Aromatics	**19.3**	**30.6**	**45.5**	<8.5	<8.4	**NA**
>12-16 Aliphatics	**426.9**	**591.0**	**32.2**	<21.2	69.8	**NA**
>12-16 Aromatics	**164.0**	**246.3**	**40.1**	<21.2	<20.9	**NA**
>16-21 Aliphatics	**428.5**	**592.0**	**32.1**	**56.8**	**169.0**	**99.4**
>16-21 Aromatics	**179.8**	**266.4**	**38.8**	<21.2	83.6	**NA**
>21-35 Aliphatics	<58.3	<57.2	**NA**	<52.9	<52.2	**NA**
>21-35 Aromatics	<58.3	<57.2	**NA**	<52.9	<52.2	**NA**
Total	**1377**	**1943**	**34**	**158**	**402**	**87**

Notes: NA - Not Applicable. Raw data value(s) are below reporting limit and therefore not comparable.
RPD - Relative Percent Difference
Totals assume one-half the detection limits for nondetects.
Shaded area indicate fraction which had detectable quantities.

The duplicates for Site 380A both indicate a high degree of weathering with quantifiable detects in the heavier fractions only. However, because these samples are mainly nondetects, the actual values presented in these samples are suspect and are not truly suitable for evaluating sampling precision. Site 380A duplicates differed markedly with a total RPD of 87% and a fraction-specific RPD of 99% for the aliphatics >EC12 to EC16. The large RPD among the aliphatic >EC16 to EC21 fraction suggests either inconsistency in the analytical technique or a significant difference in the composition of the duplicates.

The logs for borings 539SB-05 and 380ASB-02 indicate a fairly homogeneous soil lithology and color (sandy loam) spanning the depths of both sets of duplicate samples. These characteristics would suggest that a relatively consistent amount of contaminant leaching throughout the six inch span between duplicate samples could have occurred; however they do not eliminate the possibility of significant spatial variability.

4.6 Geotechnical Analytical Results

Geotechnical results (Tables 6 through 9) were consistent with the trends reported from the TPH fractionation data (Tables 6 and 7). The average moisture contents at Sites 529 and 380A were 15.9 and 5.8%, respectively. This range was in agreement with the percent moisture reported from the samples submitted for TPH analysis. Density increased slightly with depth, averaging 110 and 102 pounds per cubic foot (pcf) at the two sites, respectively. Organic carbon was slightly higher at Site 529 (average 6700 mg/kg) than at Site 380A (average 1400 mg/kg). This could attribute to the higher TPH levels, especially of the lighter fractions, seen at Site 529 verses Site 380A because TPH will bind with organic materials. Average porosity was 34.7% at Site 529 and 38.0% at Site 380A. Again, the higher porosity at Site 380A would account for a greater loss of the lighter, more soluble TPH fractions than seen at Site 529. The specific gravity (G_s) average of both sites was approximately 2.64. The specific gravity for pure quartz sand is 2.65. Based on the measurement at these sites, other particles such as clay minerals decreased the specific gravity of the samples slightly.

TABLE 6. SUMMARY OF GEOTECHNICAL RESULTS FROM SITE 529

Sample	Depth (ft bgs)	Moisture %	Dry Density (pcf)	pH	G_S	TOC (mg/kg)	Porosity %
529-GT-007	5-5.5			7.7		2400	
529-GT-010	39.5-40.0	24.0	100.0		2.62		38.8
529-GT-010	40.0-40.5	22.4	108.0		2.62		33.9
529-GT-010	44.5-45.0	13.8	107.0		2.67		35.8
529-GT-012	15.0-15.5			7.6			
529-GT-013	64.5-65	24.6	97.0		2.65		41.3
529-GT-013	64.0-65.5	19.2	105.0		2.64		36.3
529-GT-013	69.5-70.0	11.3	116.0		2.64		29.6
529-GT-013	70.0-70.5	7.6	119.0		2.61		26.9
529-GT-014	54.5-55.0	10.3	116.0				
529-GT-014	55.0-55.5	14.9	122.0				
529-GT-014	59.5-60.0	13.5	111.0				
529-GT-014	60.0-60.5	13.2	118.0				
529-GT-015	90.0-90.5			6.7		6600	
529-GT-015	90.5-91.0			8.0		7400	
529-GT-015	94.5-95.0			8.2		7000	
529-GT-015	95.0-95.5			8.2		9900	
Average		**15.9**	**111**	**7.7**	**2.64**	**6700**	**34.7**

TABLE 7. SUMMARY OF GEOTECHNICAL RESULTS FROM SITE 380A

Sample	Depth (ft bgs)	Moisture %	Dry Density (pcf)	pH	G_S	TOC (mg/kg)	Porosity %
380-GT-001	10			7.6		1600	
380-GT-005	29.5-30.0	7.4	103.0	7.8	2.60	2200	36.5
380-GT-005	30.0-30.5	2.3	92.0	7.8	2.65	2600	44.4
380-GT-005	34.0-34.5	4.1	107.0	7.9	2.66	<100	35.5
380-GT-005	34.5-35.0	10.9	101.0	7.8	2.63	200	38.5
380-GT-006	39.5-40.0	6.0	106.0	8.0	2.67	1600	36.4
380-GT-006	40.0-40.5	6.5	104.0	7.9	2.68	1800	37.8
380-GT-006	44.5-45.0	2.8	112.0	7.9	2.65	860	32.2
380-GT-006	45.0-45.5	6.0	96.0	9.2	2.68	510	42.6
Averages		**5.8**	**102.0**	**8.0**	**2.65**	**1400**	**38.0**

Falling head hydraulic conductivity tests were performed on selected remolded soil samples in general accordance with ASTM D 5084-90. The samples were remolded to the dry density and moisture content of other intact samples. Water flow through the soil was sustained using a pneumatically induced head for recording hydraulic gradient. The permeability was then calculated using Darcy's equation. The average coefficients of permeability from Sites 529 and 380A were 3.64×10^{-6} and 4.61×10^{-4} cm/sec, respectively (Tables 8 and 9).

TABLE 8. PERMEABILITY RESULTS FROM SITE 529

	Moisture Content		Dry Density		
Sample	Before Test %	After Test %	Before Test %	After Test %	Coefficient of Hydraulic Conductivity (Avg.) (cm/sec)
529-GT-SP01	20.1	21.9	105.1	106.4	7.58E-08
529-GT-SP04 (gray)	12.9	14.8	117.2	120.3	9.12E-06
529-GT-SP03	20	21.7	105.1	104.3	2.49E-08
529-GT-SP04 (brown)	15.8	18.1	109.2	109.1	8.85E-06
529-GT-SP05	19.9	20.8	105.2	104.8	1.34E-07
Site Average	**17.74**	**19.46**	**108.36**	**108.98**	**3.64E-06**

TABLE 9. PERMEABILITY RESULTS FROM SITE 380A

Sample	Moisture Content Before Test %	Moisture Content After Test %	Dry Density Before Test %	Dry Density After Test %	Coefficient of Hydraulic Conductivity (Avg.) (cm/sec)
380-GT-SP01	6.5	23.6	101.3	99.7	5.89E-06
380-GT-SP02	5.3	21.8	105.1	105.1	9.17E-04
Site Average	**5.9**	**22.7**	**103.2**	**102.4**	**4.61E-04**

Grain size (ASTM Method D-422) distribution at Site 529 ranged from 0.5 to 21.4% gravel, 46.7 to 72.0% sand, 5.6 to 21.8% silt and 11.5 to 36.3% clay. At Site 380A, the distribution ranged from 2.3 to 21.1% gravel, 59.4 to 67.3% sand, 4.2 to 12.2% silt and 7.4 to 26.1% clay. The soil type at both sites ranged with depth from a silty, clayey sand to a clayey sand with gravel. Clay content in the samples varied also with depth. These content changes may indicate clayey permeability boundaries that impede vertical migration of the contaminants.

5.0 RBSLS BASED ON FRACTIONATION DATA

Tier 1 RBSLs were calculated using the ASTM RBCA method and are provided in Table 10 (ASTM, 1995). The critical pathway, which would drive clean-up levels, appears to be volatilization to indoor air. The assumptions used in the ASTM standard for calculating this pathway are extremely conservative. The soil-vapor transport model is based on several very conservative assumptions including a steady chemical concentration in subsurface soils; equilibrium partitioning in the soil between sorbed, dissolved and vapor phases; and steady-state diffusion through the vadose zone and foundation cracks. It also assumes one percent of the foundation area is cracked. RBSLs based on direct contact with soil are the next lowest levels. However, due to the depth at which contamination is seen (greater than 20 feet), both of these are unlikely exposure pathways even for a construction scenario. Soil leaching to groundwater is the most feasible pathway. The leaching model is very conservative since it assumes that no attenuation (e.g., biodegradation, further partitioning onto soil or into vapor) of the leachate occurs from the vadose zone to saturated zone (TPHCWG, 1998c).

TABLE 10. AVERAGE TPH RBSLS FOR WEATHERED DIESEL CONTAMINATION AT SITES 529 AND 380A

	Residential RBSLs		Commercial RBSLs	
Pathway	**(Site 529) (mg/kg)**	**(Site 380A) (mg/kg)**	**(Site 529) (mg/kg)**	**(Site 380A) (mg/kg)**
Soil Leaching to Groundwater	12,900	12,100	80,000	46,000
Volatilization to Outdoor Air	433,000	371,000	568,000	617,000
Volatilization to Indoor Air	900	1,500	3,100	3,700
Direct Contact	6,100	7,700	8,900	10,200

The RBSLs based on leaching are approximately 2000 to 2800 mg/kg higher (for Sites 380A and 529, respectively) than those specified for the MCAS El Toro in OHM's Preliminary Work Plan (i.e., 10,000 mg/kg for diesel and 1,000 mg/kg for gasoline). For an industrial/commercial land use scenario, the RBSLs based on the fractionated data are approximately 30,000 to 70,000 mg/kg higher for Sites 529 and 380A, respectively, than the site criteria. It should be noted that the site criteria are higher than what is actually specified in the LUFT Manual which is based on a scoring system, accounting for distance of contamination to groundwater. For example, the LUFT criteria presented in Table 11 would result in a cleanup level of 100 mg/kg for diesel at site 529, because the TPH was detected at the groundwater surface. A detailed comparison of the site data RBSLs and the California LUFT standards is presented in the attached Appendix.

If a residential scenario was assumed, Site 529 would exceed the RBSLs developed due to the volatilization to indoor air pathway. In this case a Tier 2 assessment using soil gas vapor measurements would be recommended.

5.1 TPH Clean-up Criteria Based on the California LUFT Field Manual

Table 11 was taken from the OHM "Preliminary Draft Work Plan, Remediation of Various Underground Storage Tanks at the MCAS El Toro" (1995). The table is based on the "Leaking Underground Fuel Tank (LUFT) Field Manual: Guidelines for Site Assessment, Cleanup and Underground Storage Tank Closure" (California SWRCB, 1989). It was designed to permit estimation of the concentrations of TPH and BTEX that can be left in place without threatening groundwater. The criteria gives three levels of TPH and BTEX concentrations derived from modeling of sites which fall into categories of low, medium or high leaching potential. To use the table, the appropriate description of each feature is found and each feature is scored using the weighting system shown at the top of each column. The points for each column are then totaled and matched to the allowable BTEX and TPH levels.

TABLE 11. LEACHING POTENTIAL ANALYSIS FOR GASOLINE AND DIESEL USING TPH AND BTEX

Site Feature	Score	Score 10 pts if condition is met	Score	Score 9 pts if condition is met	Score	Score 5 pts if condition is met
Minimum depth to groundwater from the soil sample (ft)	10	>100		51-100		25-50[1,2]
Fractures in subsurface (applies to foothills or mountain areas)	10	None		Unknown		Present
Average annual precipitation (inches)		<10	9	10-25		26-40[3]
Man-made conduits which increase vertical migration of leachate	10	None		Unknown		Present
Unique site features: recharge area, course soil, nearby wells, etc.	10	None		At least one		More than one
Column Totals - Total Points	40	+	9	+		= 49
Range of Total Points	49 pts or more		41-48 pts		40 pts or less	
Maximum Allowable BTEX Levels (ppm)	1/50/50/50		0.3/0.3/1.0/1.0		NA[4]	
Maximum Allowable TPH-d Levels (ppm)	10,000		1,000		100	
Maximum Allowable TPH-g Levels (ppm)	1,000		100		10	

1. If depth is greater than 5 ft. but less than 25 ft., score 0 points.
2. If depth is 5 ft. or less this table should not be used.
3. If precipitation is over 40 inches, score 0 points.
4. Levels for BTEX are not applicable at a TPH concentration of 10 ppm (gasoline) or 100 ppm (diesel)

OHM stated in the Preliminary Draft Work Plan that all remediation activities and site closures will be based upon the clean-up levels developed in accordance with the guidelines of the LUFT Field Manual. The following clean-up criteria have been set for MCAS El Toro: TPH as gasoline (TPH-g) at 1,000 ppm and TPH-d at 10,000 ppm. BTEX levels will generally be inferred from TPH-d levels, with ≤1,000 ppm (TPH-d) inferring an acceptable level of risk to human health and the environment from BTEX. The clean-up goal for BTEX in gasoline or diesel impacted soil is less than or equal to 1 ppm for benzene and less than or equal to 50 ppm for toluene, ethylbenzene and xylene. Based on the LUFT criteria in Table 11, however, these are clean-up levels specified for sites with a distance between contamination and groundwater of 100 feet or more. This has been shown to not be the situation at site 529; however, these levels have been set for the entire base.

6.0 TIER 2 INFORMATION REQUIREMENTS

If Tier 1 RBSLs are exceeded and remediation to these limits is impracticable, a Tier 2 evaluation should be conducted to develop Site Specific Target Levels (SSTLs) for relevant site contaminants and exposure pathways. Tier 1 data requirements may be limited to characterization of on-site land use and determination of maximum contaminant concentrations in the source zone media. For Tier 2, site data must be sufficient to 1) complete Tier 2 SSTLs calculations involving site specific fate and transport parameters and 2) confirm the exceedance or nonexceedance of the SSTLs throughout the full area of affected soil and groundwater. Additional site information required for this includes:

- Source Zone Characterization: Lateral and vertical extents of impacted soil and groundwater zones,
- Hydrogeological Site Conditions: Site stratigraphy, surface soil conditions, rate and direction of groundwater flow, attenuation factors, etc.,
- Relevant Points of Exposure: Distance from source zone to potential receptors, receptor types and exposure factors, and
- Applicable Risk Goals: Human health protection criteria, applicable regulatory exposure limits and ecological protection standards.

A Tier 2 assessment was not conducted as part of this demonstration due to the lack of complete delineation of the impacted zones and specific information regarding the distance to potential receptors. ASTM E-1739 specifies the minimum data requirement for a Tier 2 evaluation (ASTM, 1995). These requirements are summarized in the Table 12. For less sensitive parameters not listed in this table, conservative default values may be employed in place of direct site measurements under Tier 2.

TABLE 12. MINIMUM SITE SPECIFIC DATA REQUIREMENTS FOR TIER 2 EVALUATION

Source Zone Characterization	
Surface Soils (<3 ft bgs)	• Dimensions of affected surface soil zone (depth, length, width) • Constituents of Concern • Representative Concentrations
Subsurface Soil (>3 ft bgs)	• Dimensions of affected surface soil zone (depth, length, width) • Constituents of Concern • Representative Concentrations
Subsurface Fluids	• Dimensions of affected groundwater and/or non-aqueous phase liquid zone (depth, length, width) • Constituents of Concern • Representative Concentrations
Exposure Pathway Information	
Air Pathway	• Area of affected surface soils • Depth interval of affected subsurface soils • Thickness and soil type of unsaturated soil zone • Downwind distance to vapor/dust receptor(s) • Average annual climatic conditions (typical wind speed, etc.)
Groundwater Pathway	• Depth to uppermost water-bearing unit with potentially usable groundwater • Leachate potential through overlying soil zone (rainfall infiltration, etc.) • Hydraulic conductivity of water-bearing unit • Groundwater flow gradient, seepage velocity and flow direction • Attenuation factors (electron acceptors, retardation factors, decay-rate coefficients for contaminants of concern (COCs)) • Distance from plume source point to groundwater receptors
Soil Pathway	• Lateral limits of impacted surface soil • Surface soil type
Surface Water Pathway	• Stormwater drainage pathway from affected surface soil zone to surface water body and estimated COC loading rate • Groundwater to surface water discharge pathway and estimated COC loading rate • Harmonic mean flow in surface water body • Surface water body quality and use classification
Receptor Information	
Land Use	• Land use on-site (current and future) • Land use at off-site points of exposure (current and future)
Receptors	• Anticipated type and location of receptors for each pathway • Applicable site-specific exposure factors

7.0 CONCLUSIONS AND RECOMMENDATIONS

One objective of the Demonstration Program is to identify those actions which led to increased or decreased effectiveness in the field sampling and data analysis. Some of the lessons learned from this effort were:

1) Clear understanding on the parts of all parties of the requirements for sampling and sample analysis is required. A kick-off meeting where all parties who are responsible for the drilling, sampling, analyses and reporting of results is useful to clarify responsibilities. Written guidance on the field effort should be developed as part of the final work plan.

2) Continuous cores are very informational for the initial soil borings and lithologic descriptions. These continuous cores allow the geologist(s) to identify any potential zones of high or low permeability which would transmit contaminants more or less rapidly than the surrounding lithologies. In addition, continuous core information provides the geologist with visual identification of changes in the contaminant staining in the soil. This information is especially important for heavily weathered hydrocarbon contamination.

3) Communication gaps between companies after the field work was completed led to delays in analyses and receipt of analytical results, which may have impacted the validity of data collected from the TPH fractionation analyses. Comparison of the analytical methods and calibration standards used by the two companies may provide additional information on validity of the fractionation analyses.

4) TPH analyses via Method 8015 should be run by the same lab running the fractionation analyses. Both analyses should utilize the same calibration standard (i.e., diesel fuel #2) to develop a comparison between TPH analyses and fractionation data. Variations in the data from analyses by two different labs on this effort have led to many questions about comparison between the "whole TPH" from EPA Method 8015 and the Direct Method.

5) Because multiple analyses are to be run on one sample, samples should be mixed or "composited" from which aliquots can be sent for analysis. Because the demonstration is intended for weathered sites, quickly compositing samples should not result in a significant loss of existing volatiles or semivolatiles. This practice may ensure better duplication of samples for multiple analyses than end-to-end samples collected in brass sleeves.

6) The next demonstration should include the use of a spiked matrix to test the compatibility between different methods, especially if the analyses are performed at different labs.

7) Lower levels of detection for light-end aliphatics and aromatics are needed to improve the effectiveness of the Direct Method for assessing risk.

8.0 SUMMARY

OpTech performed the field sampling phase of the Demonstration Program at former UST Sites 380A and 529, MCAS El Toro, California, from August 24th through September 4th, 1997. The field sampling consisted of continuous coring in three soil borings and split spoon sampling in four other soil borings. Soil samples from the continuous cores were screened in the field with a PID. Based on the PID field screening, certain samples were sent to a fixed base laboratory for TPH and BTEX analyses. Samples from three of the soil borings retrieved with a split spoon sampler were shipped to a different fixed base laboratory for TPH fractionation analyses. These samples were contiguous to samples analyzed for TPH and BTEX.

Soil samples were also collected for geotechnical analyses to characterize the lithologic sequence at the sites and to estimate fate and transport of the contaminants for RBCA analyses. The TPH fractionation data were used in conjunction with toxicity surrogates for each fraction group to estimate RBSLs for the two sites, as specified by the Working Group approach.

The results from the fractionation analysis were consistently lower by nearly two to three times the results from the conventional TPH analysis (EPA Method M8015) and Purge and Trap analysis (EPA Method 5030/M8015). Furthermore, purgeable TPH concentrations were detected from 110 to 770 mg/kg, although the lab reported that the sample did not match a gasoline standard. Those levels would typically not be expected from weathered diesel. Benzene was also detected at Site 529 by the EPA M8015 Method but not by the Direct Method; this may be due to the large detection limits which the Direct Method reported for these fractions. The reason for the large differences is not clear and may also be attributed to spatial and lab variability.
Some samples shipped for fractionation analysis were held a few hours beyond the extent of the recommended holding time. However, the samples were stored at the recommended temperature in air tight sealed brass sleeves. It would seem unlikely that the samples were compromised by a loss of volatiles. In addition, the heavier fractions, as identified by the Direct Method, contributed the greatest percentage of "whole TPH" concentrations. The contribution to total concentration from potentially lost volatiles would not be significant enough to account for the large difference seen in the results between the two methods. The disparity is likely due to differences in analytical technique or spatial variability and not by compromised samples.

The detection limits used for the light <EC5 to EC8 aromatic fractions can have a huge effect upon RBSLs. Approximately 20% of the hypothetical risk from the leaching pathway at Site 380 was attributed to nondetects among these fractions. Interestingly, these fractions only account for less than one percent of the "whole TPH".

The TPH fraction which contributes the greatest amount of risk depends on whether the selected pathways will involved cross-media impacts. The majority of risk at site 380A for the leaching to groundwater pathway came from the aromatic fractions; these fractions only accounted for 12% of the TPH and the lightest fractions were nondetects. Overall, for the leaching and volatilization pathways solubility and volatility tend to dictate which fraction is most responsible for risk. The most soluble fractions account for the most of the risk in the leaching pathway and the most volatile fractions account for the majority of risk in the volatilization pathways.

The RBSLs for the direct contact pathway are not affected by the detection limit of the lighter fractions. Because this pathway is not dependent on partitioning, the risk attributed by each fraction resembles the distribution of TPH. Hence, it is the heavier fractions which account for the majority of the risk due to their greater abundance and relatively low reference doses (TPHCWG, 1998d).

9.0 REFERENCES

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. ASTM Standard E 1739-95. ASTM, West Conshocken, Pennsylvania.

Bechtel National, Inc., 1996. Site Assessment Report, Former Underground Storage Tank Site 380A, MCAS El Toro, California. Bechtel National, Inc., El Toro, CA.

Bruya J and Eng L, 1992. Analytical Techniques for Determining Petroleum Products in Soil and Groundwater. Workshop Handbook, Third Annual West Coast Conference, Hydrocarbon Contaminated Soils and Groundwater. Long Beach, CA, March 11, 1992. (As cited in Michelsen and Boyce, 1993.)

California SWRCB, October, 1989. Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup and Underground Storage Tank Closure. State of California, State Water Resource Control Board (SWRCB).

Jacobs Engineering Group, 1994. Marine Corps Air Station El Toro: Installation Restoration Program Phase II Remedial Investigation/Feasibility Study. Jacobs Engineering Group, El Toro, CA.

Michelsen T and Boyce C, 1993. Cleanup Standards for Petroleum Hydrocarbons. Part 1. Review of Methods and Recent Developments. J Soil Contam 2(2):109-124.

OHM Remediation Services Corp., August 1995. Preliminary Draft Work Plan, Remediation of Various Underground Storage Tanks at the Marine Corps Air Station (MCAS), El Toro, CA. OHM Remediation Services Corp., Irvine, CA.

OpTech, January 1992. Corporate Environmental Quality Assurance/Quality Control Plan. OpTech, San Antonio, TX.

TPHCWG, 1998a. A Risk-based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume 1: Petroleum Hydrocarbon Analysis of Soil and Water in the Environment.

TPHCWG, 1998b. A Risk-based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume 2. Composition of Petroleum Mixtures.

TPHCWG, 1998c. A Risk-based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume 3. Selection of TPH Fractions Based on Fate and Transport Considerations.

TPHCWG, 1998d. A Risk-based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume 4. Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).

Appendix A

TPH Criteria Working Group Field Demonstration, MCAS El Toro, CA

TPH Criteria Working Group Field Demonstration

MCAS El Toro, California

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June 17, 1998

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Executive Summary

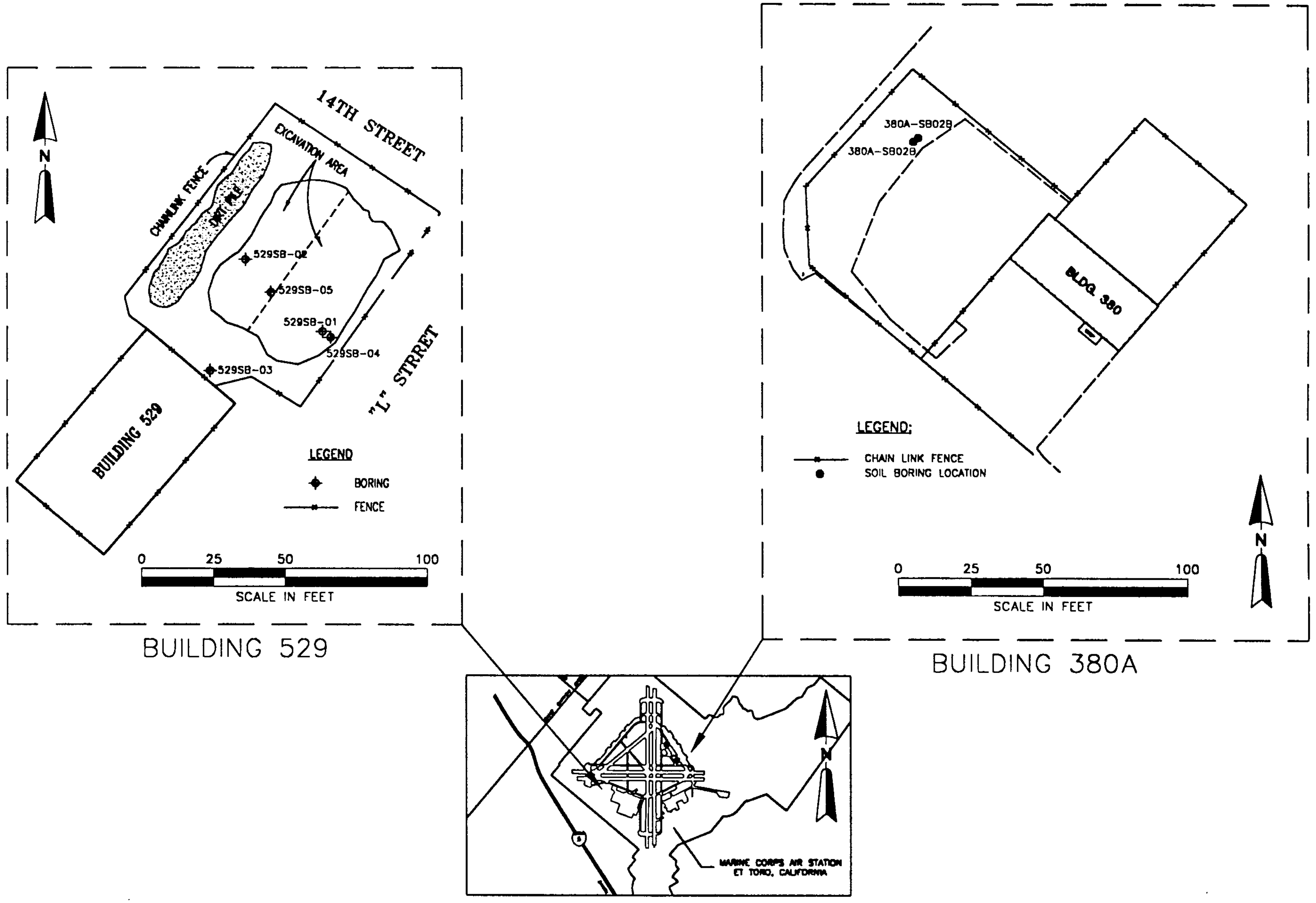
Two sites at the Marine Corps Air Station in El Toro, California (MCAS El Toro), were selected for the second case study of the Total Petroleum Hydrocarbons (TPH) Criteria Working Group's protocol. The Working Group was formed to develop a scientifically defensible approach to calculating human health-based criteria for TPH in soils. The overall objective of the case studies is to assess the usefulness and limitations of the Working Group's approach by evaluating the process and results at several real-world sites.

TPH is difficult to define and to measure. As a result, typical risk-based criteria do not consider the complex chemical nature of TPH, the variations in TPH due to different fuel types and weathering processes, or the mixture effects that largely control the fate and transport of hydrocarbons in the environment. The Working Group approach addresses these issues by separating TPH into 13 separate fractions, and using the best available information on the toxicity and fate and transport characteristics of the fractions in risk calculations. Site-specific risk-based TPH criteria are calculated using the ASTM Risk-Based Corrective Action (RBCA) process (ASTM 1739-95).

Both sites (designated Sites 380A and 529) are locations of former leaking underground storage tanks (LUSTs) that have been removed, and both are known to have residual soil contamination from different fuel mixtures (Figure 1). Site 380A is impacted by a former diesel UST. The UST at Site 529 contained primarily heating oil, although prior testing suggested that lighter hydrocarbons were also present. The soils at both sites are primarily sand and gravel, and groundwater is encountered over 100 feet below ground surface (bgs).

Site 380A was sampled by installing two borings, advanced to approximately 55 feet bgs. Five borings were advanced up to 100 feet bgs at Site 529. Several samples were obtained at various depths from each boring. In all, forty samples were submitted for screening analyses, using Method 8015M for TPH and Method 8020 for BTEX. Fifteen soil samples were submitted for TPH fractionation analysis, using the Direct Method. Additional analyses included geological and chemical information useful for site-specific RBCA assessments.

Risk-based screening levels (RBSLs) were calculated for applicable pathways at both sites. The resulting RBSLs for all of the pathways evaluated (Table 1) were similar for both sites. The lowest RBSLs were for the volatilization to indoor air pathway (average values of 1,500 and 900 mg/kg, respectively). At Site 380A, the TPH concentrations in all of the samples were below both the average and the



TPH WORKING GROUP
DEMONSTRATION PROJECT
5-3267-200

SITE LOCATION MAP
MCAS, EL TORO

RETEC
REMEDIATION TECHNOLOGIES INC

REF DWG	DESC.					
1						
0	E.F.	11/25/199	DRAFT			
NO	DRWN	DATE	REVISION	CHKD	DATE	APPVD	DATE

CURRENT DATE 1/2/98
CAD FILE 32675004
DRAWING NO. FIGURE 1
REV. 0

lowest RBSL calculated for protecting indoor air. At Site 529, several samples exceeded the lowest and average RBSL values, and in fact the average value from all samples tested exceeded the average RBSL.

Table 1 Average RBSL Values for Applicable Pathways at MCAS El Toro

Site	Soil to Indoor Air	Direct Contact	Soil to Groundwater	Soil to Outdoor Air
Residential Scenario 380A	1,500 (560–2,240)	7,700 (5,100–10,500)	12,100 (4,100–18,800)	371,000 (228,000–632,000)
529	900 (730–1,400)	6,100 (5,600–6,600)	12,900 (7,500–20,700)	433,000 (116,000–>100%)
Commercial Scenario 380A	4,300 (1,500–6,300)	10,200 (7,600–15,600)	46,100 (15,400–72,500)	616,900 (271,500–>100%)
529	3,100 (2,000–5,700)	9,000 (8,300–9,600)	80,000 (29,000–202,900)	567,500 (172,500–>100%)

NOTE:
Values are in mg/kg. Ranges are in parentheses.

The next lowest RBSLs at both sites were for the direct contact pathway (averages of 7,700 and 6,100 mg/kg, respectively). Again, several of the Site 529 samples exceeded the lowest and average direct contact RBSLs. The average Hazard Index for all samples from Site 529 was 0.98 (the RBSL is defined as the concentration yielding a HI of 1.00). The average RBSLs for leaching from soil to groundwater were 12,100 and 12,900 mg/kg for Sites 380A and 529, respectively. The highest RBSLs for both sites were for the volatilization to outdoor air pathway (averages of 371,000 and 433,000 mg/kg). RBSLs for a commercial risk exposure scenario were also calculated. These values were also similar for the two samples, although the calculated criteria were considerably higher. The general order of the different pathways remained the same (i.e., the lowest RBSLs were for indoor air, and the highest were for outdoor air exposures).

The RBSLs varied considerably between individual samples. This variability was most pronounced for the volatilization and leaching pathways, while the direct contact RBSLs exhibited very little variability. The variability in the RBSLs for cross-media transport was primarily due to variations in the proportions of TPH accounted for by the lightest aromatic and aliphatic fractions.

The RBSLs were compared to the applicable state criteria for the Los Angeles Region. This area of California has produced guidance for fuel sites that includes a method for deriving maximum soil screening criteria (an approach similar to the "Tier 1" approach). The value used for the entire site has been 10,000 mg/kg, based on protection of groundwater. This value is similar to the RBSLs calculated for the leaching pathway. However, a site-specific analysis under the current regulations would yield much lower cleanup levels for Site 529 and higher values for Site 380A. TPH criteria for volatilization to indoor air are not specifically addressed in the California State regulations. The State does allow the use of fate and transport models to calculate site-specific cleanup levels in an approach similar to RBCA's "Tier 2" values.

One significant finding was that the values used to represent non-detected fractions, particularly the lightest aromatic fractions, affect the RBSLs. Since this value used for non-detect data is generally one-half of the detection limit, the detection limit for these compounds can be an important consideration. For example, the indoor air RBSLs for low TPH (158 to 1,346 mg TPH /kg soil) samples from Site 380A, were governed by the detection limits for the light aromatic fractions (using half the detection limit for non-detected fractions as the concentration in the risk calculations). The importance of these fractions for the leaching pathway is demonstrated by the fact that although the detection limits for the EC5–8 aromatics represented well under one percent of the "total" calculated TPH, these non-detected fractions accounted for up to 20 percent of the total risk.

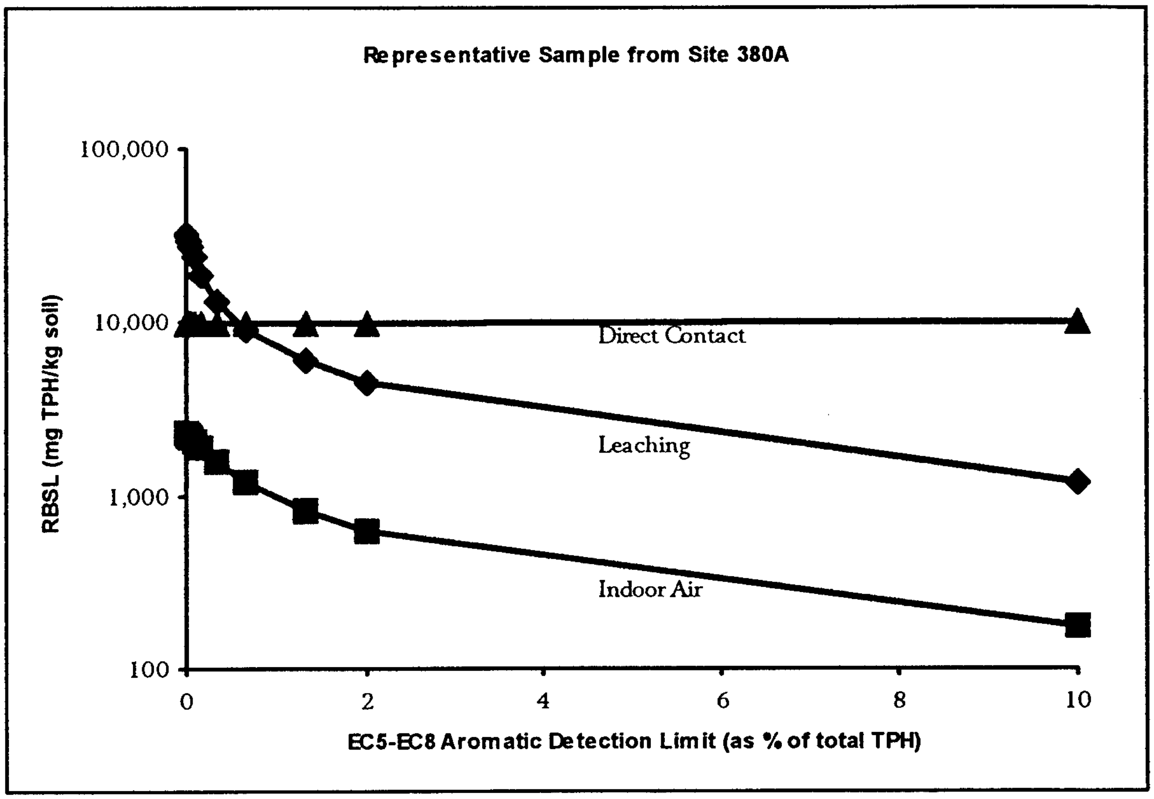
The relative contributions of different fractions to the RBSLs for different pathways were calculated to help determine which fractions need to be measured with the greatest accuracy for different exposure scenarios. Based on these calculations, the values used for non-detect data for the lightest aromatic fractions (EC5–8) were varied and new RBSLs calculated to perform a simple sensitivity analysis. Figure 2 demonstrates how RBSLs for each pathway can be affected by values used for non-detect data for the light aromatic fractions.

This project also demonstrated that it may be difficult to perform Tier 2 assessments using the TPH fractionation approach for cross-media pathways. One factor in this difficulty is the need to consider mixture effects, which complicate the Tier 2 fate and transport modeling. The behavior of mixtures of several interacting fractions is more difficult to model than the fate of specific indicator compounds.

The difficulty of using models for Tier 2 assessments is particularly important when assessing vapor movement through soil. The models used to evaluate the volatilization pathways are conservative in the Tier 1 assessment, and it is difficult to measure the needed site-specific parameters for the Tier 2 analysis.

easier and more accurate to use site-specific vapor monitoring to evaluate the volatilization pathways at a Tier 2 level. Since the indoor air vapor pathway results in the lowest Tier 1 RBSLs, this pathway needs greater attention to develop criteria that are more representative of the actual risk, without the time and expense required for a vapor monitoring program.

Figure 2 RBSL vs. Detection Limit



The Tier 2 evaluation of groundwater leaching is also complicated by the interactions of TPH mixtures. A simplified procedure for performing a Tier 2 assessment is proposed. This process assumes groundwater concentrations at the source area are equal to the effective solubilities of each fraction, and then allows for attenuation (by dispersion only) from the source area to an alternate point of compliance. Incorporation of more complex fate and transport models and/or the inclusion of biodegradation is more difficult due to mixture effects and different characteristics of each TPH fraction. In this case, a Tier 2 assessment would most likely require further groundwater monitoring data.

The analytical methods used to measure the fractions are critical to the Working Group protocol. This demonstration used the Direct Method developed by Shell Development Company (Westhollow, Texas). The method yielded soil TPH concentrations that were on average 2 to 3 times lower than the conventional

TPH analysis used (EPA Method 8015). Further, the results obtained for individual samples by the two methods were not closely correlated. As a result, it may be difficult to retrofit the fractionation data with confidence for sites with existing conventional TPH data. This may be a result of using different laboratories for the different analyses. Further, there is a need for guidance on using fractionation data to set cleanup criteria that will be based on conventional analyses.

The Direct Method also yielded values for the volatile aromatic fractions that differed from the BTEX analyses (EPA Method 8020). The reason for this discrepancy is not clear. However, the demonstration project does suggest that a BTEX analysis by GC/MS-EPA Method 8240 or 8260 (because they are more accurate methods than 8020) should be included in the analytical protocol, and these values should be used for the volatile aromatic fractions. This additional analysis will increase the costs of using the Working Group protocol, but the accuracy and lower detection limits appear warranted, at least for the near future.

In future demonstrations, efforts should be made to obtain sufficient site-specific data to allow a meaningful Tier 2 analysis. The indoor air pathway in particular needs greater attention, because it appears to yield the lowest RBSL values at the Tier 1 level. Criteria for selecting the samples to be used for the fractionation analysis should be developed. More data on the relationship between the results from the Direct Method and the more conventional TPH analyses would also be valuable. Moreover, modifications should be made to spreadsheet models used to calculate RBSLs. These changes should incorporate indoor air calculations and add compatibility with current software versions.

In summary, the Working Group protocol was effective for developing risk-based criteria at a Tier 1 level. The resulting criteria for cross-media transfer pathways are highly variable within a given site. In some cases, low RBSL values were largely determined by non-detectable fractions. Further, the TPH results by the fractionation analysis (the Direct Method) differed significantly from the results of conventional analysis, and the correlation between the two methods was poor.

Major Findings

- ☞ *The Direct Method yielded TPH results that were two to three times lower than the conventional GC method (Method 8015).*
- ☞ *The RBSLs were similar for both fuel mixtures, and were in the order:*

RBSL indoor air < RBSL direct contact < RBSL leaching to groundwater < RBSL outdoor air

- ☞ *One site (Site 529) failed the Tier 1 cleanup criteria for the indoor air and direct contact pathways. All samples from the second site (Site 380A) had TPH concentrations below all RBSLs.*
- ☞ *The RBSLs for all pathways involving cross-media transfer were highly variable, primarily due to differences in the amounts of the lightest aliphatic and aromatic fractions.*
- ☞ *The RBSLs can be largely determined by non-detectable fractions (using half the detection limit in calculations). RBSLs are extremely sensitive to the EC5 to EC8 aromatic fractions.*
- ☞ *The average RBSLs for the leaching pathway slightly exceeded the current state criteria for MCAS El Toro (12,100 and 12,900 mg/kg for the two sites, compared to the state level of 10,000 mg/kg).*

These findings raise questions regarding the use of the protocol to set criteria, and guidance is needed on several issues. Are the lowest RBSL values the criteria to be applied to the site, or are average values appropriate? What types of samples should be analyzed to set criteria (e.g., should product samples be collected, or should samples be taken from the center or fringes of a spill plume)? How should non-detectable fractions be handled in the risk calculations? Should the criteria be based on the Direct Method results, and should this method therefore be used for compliance monitoring (the method can be modified to assess TPH only and not the fraction distribution)? Guidance on these issues will need to be prepared to ensure consistent use of the protocol.

Some suggested recommendations for use of the Working Group protocol are given below, based on the results of this study.

Recommendations

- ☞ *Use the Direct Method, with GC/MS analysis of the lighter volatile fractions, to accurately characterize the soil TPH.*
- ☞ *Ensure detection limits for the light aromatic fractions (and possibly the light aliphatics as well) are below levels that will govern the risk calculations (i.e., a maximum of 1 percent of the "total" TPH recovered).*
- ☞ *Several site samples, preferably with relatively high TPH levels, should be analyzed by the fractionation method to address the variability in fraction distributions.*
- ☞ *If a significant correlation with the conventional method(s) used at the site cannot be demonstrated, use the Direct Method for total TPH to monitor compliance with criteria based on the Working Group protocol.*

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1 Introduction

This report presents the results of a Risk-Based Corrective Action (RBCA) analysis conducted to develop risk-based cleanup goals for total petroleum hydrocarbon (TPH)-impacted soils at two former underground storage tank (UST) sites. The sites are both located at the Marine Corps Air Station (MCAS) in El Toro, California. These areas were chosen as part of a multi-site demonstration of the TPH Criteria Working Group (Working Group) protocol.

The demonstration program is designed to evaluate the Working Group's method for developing risk-based cleanup goals for different types of TPH. The results will then be compared with the approaches currently used in each state. The Working Group protocol, once validated and accepted by the regulatory community, will assist regulators and industry in prioritizing remediation of TPH-impacted sites based on human health risk.

The Working Group was formed in 1993 to find an alternative to the existing standards for cleanup of TPH-impacted soils. The stimulus for its creation was the observation that widely different soil cleanup requirements were being imposed nationwide on TPH sites contaminated with similar hydrocarbon materials. Cleanup levels for these sites ranged from tens to thousands of mg TPH/kg soil in different states. This inconsistency resulted partly from the lack of scientific basis for the criteria. The Working Group therefore established the goal of "developing scientifically defensible information for establishing soil cleanup levels protective of human health at hydrocarbon-contaminated sites."

The objective of this evaluation is to use the Working Group protocol to calculate risk-based screening levels (RBSLs) for TPH at the two MCAS former UST sites. For consistency with previous demonstration projects, the Working Group protocol is evaluated within the American Society of Testing and Materials (ASTM) RBCA framework (E1739-95). An overview of the Working Group protocol and RBCA framework are provided below.

1.1 Overview of the Working Group Protocol

The Working Group protocol focuses only on human health effects, addressing both carcinogenic and non-carcinogenic impacts. This protocol recognizes that TPH is comprised of two basic classes of hydrocarbons—aliphatic and aromatic—that differ in chemical structure. Each of these hydrocarbon classes possesses distinct physical and toxicological characteristics which vary widely with the boiling point of the hydrocarbon and contribute to the overall fate, transport, and toxicological characteristics of the TPH mixture. The basis of the Working Group's approach has been published in a series of documents (TPH Criteria Working Group Vols. 1–6, 1997).

The Working Group methodology relies on the separation of petroleum into 13 fractions (Table 1-1). The separation of these fractions is initially based upon the physical structure of the compounds, i.e., aromatic or aliphatic. Further divisions are made based on order of magnitude differences in fate and transport characteristics, such as water solubility and vapor pressure. Divisions between fractions are made using an equivalent carbon number (EC). The equivalent carbon number is determined by the retention time of TPH constituents on a gas chromatography (GC) column relative to *n*-alkanes (straight-chained aliphatic compounds) of known carbon number. This retention time is closely related to the boiling points of the different hydrocarbons. Thus, the EC is a function of the chemical boiling point and is therefore useful for predicting a compound's fate and transport characteristics.

Table 1-1 Aromatic and Aliphatic Fractions

Aromatic Fraction	Aliphatic Fraction
EC5–7 (Benzene)	EC5–6
EC>7–8 (Toluene)	EC≥6–8
EC>8–10	EC>8–10
EC>10–12	EC>10–12
EC>12–16	EC>12–16
EC>16–21	EC>16–21
EC>21–35	

Because aromatic compounds tend to have slightly higher boiling points than aliphatics composed of the same number of carbon atoms, the EC for an aromatic compound is slightly higher than the actual number of carbons in the aromatic molecule. For example, the EC5-7 aromatic fraction would contain compounds with GC boiling points between *n*-pentane (a 5-carbon *n*-alkane) and *n*-heptane (a 7-carbon *n*-alkane). When normalized to boiling point, the only aromatic which falls in this range is benzene, a 6-carbon aromatic compound with an EC of 6.5. Although toluene is a 7-carbon aromatic compound, it has an EC of 7.6, and is not contained within the EC5–7 aromatic range.

The 13 TPH fractions have been assigned specific toxicological, fate, and transport characteristics which are based upon an extensive review of available data for individual compounds or for petroleum mixtures representative of the fraction. In general, three specific trends are observed for aromatics and aliphatics with similar ECs:

- Aromatics are more water soluble than aliphatics
- Aliphatics are more volatile than aromatics (with the exception of benzene), and
- Aliphatics exhibit a stronger tendency to bind to soil particles than do aromatics

As a result, aromatics pose a greater risk to human health than do aliphatics through pathways such as leaching from soils to groundwater and groundwater ingestion. Light aliphatic hydrocarbons such as hexane, however, exhibit the most risk through volatilization pathways due to their greater tendency to partition into air. A list of fate and transport properties and values for the 13 TPH fractions is provided in Table 1-2.

Table 1-2 Example Hydrocarbon Fractions and Associated Properties Based on an Equivalent Carbon Number Index

	Solubility (mg/L)	**Henry's Constant (dimensionless)**	**Vapor Pressure (atm)**	**log Koc (c/c)**	**PF (soil/water)**	**VF (soil/vapor)**
Aliphatic Fractions						
EC5–6	28	34	0.5	2.8	10	0.3
EC>6–8	4.2	51	0.85	3.5	40	0.9
EC>8–10	0.33	82	0.0081	4.5	300	6
EC>10–12	0.026	130	7.8×10^{-4}	5.4	3,000	50
EC>12–16	5.9×10^{-4}	540	3.5×10^{-5}	6.9	7×10^{4}	1,000
EC>16–21	1.0×10^{-6}	6,400	1.7×10^{-6}	9	1.0×10^{7}	1.0×10^{5}
Aromatic Fractions						
EC5–7 (Benzene)	18	0.23	0.13	1.9	0.9	4
EC>7–8 (Toluene)	520	0.27	0.038	2.4	2	9
EC>8–10	65	0.49	0.0081	3.2	20	50
EC>10–12	25	0.14	7.8×10^{-4}	3.4	20	200
EC>12–16	5.8	0.054	3.5×10^{-5}	3.7	50	2,000
EC>16–21	0.51	0.013	1.7×10^{-6}	4.1	100	4.0×10^{4}
EC>21–35	0.0066	6.8×10^{-4}	7.9×10^{-9}	5	1,000	3.0×10^{7}

NOTES:
Values are based on pure compounds. Behavior may differ in complex mixtures.

Note that in this table, vapor pressures are the same order of magnitude for aliphatic and aromatic hydrocarbons having similar ECs. This relationship reflects the fact that the fractions are defined by their boiling points, which are determined by vapor pressure. Thus, compounds with similar ECs will have similar boiling points and vapor pressures.

Once fate and transport fractions were determined, toxicity values, reference doses (RfDs) and reference concentrations (RfCs) were determined for each fraction by the Working Group. The values were based on the best available toxicity information, which included the measured toxicity of mixtures dominated by given fractions or the measured toxicity of individual indicator compounds contained within a given fraction.

Since reliable toxicity data were largely unavailable for the majority of compounds and for complex TPH mixtures, the same RfD or RfC was in some instances assigned to different fractions. A summary of the fraction-specific RfDs and RfCs calculated by the Working Group is provided in Table 1-3.

Table 1-3 Working Group Toxicology Fraction-Specific RfDs (mg/kg/day)

Carbon Range	Aromatic RfD	Critical Effect	Aliphatic RfD	Critical Effect
EC5–6 EC7–8	0.20 - Oral 0.10 - Inhalation	Hepatoxicity, Nephrotoxicity	5.0 - Oral 5.0 - Inhalation	Neurotoxicity
EC9–10 EC11–12 EC13–16	0.04 - Oral 0.05 - Inhalation	Decreased body weight	0.1 - Oral 0.3 - Inhalation	Hepatic and hematological changes
EC17–21 EC22–34	0.03	Nephrotoxicity	1.00	Hepatic (foreign body reaction) granuloma

The RfDs and RfCs developed are for non-carcinogenic compounds which represent the mass of petroleum constituents remaining for evaluation after carcinogenic indicators have been assessed. The Working Group methodology is not intended to replace evaluation of carcinogenic indicator compounds, which should be assessed prior to evaluating the non-carcinogens. Carcinogenic indicators are always evaluated separately because their presence, even in relatively low concentrations, will usually drive cleanup. The hazard assessment for TPH fractions would only be used in cases where indicator compounds are not present or are present below regulatory action levels. More information on the development of the values shown in Table 1-3 is provided in Working Group's

Document No. 4 "Development of Fraction-Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH)."

In general, aromatic fractions have lower RfDs than aliphatic fractions, and are approximately an order of magnitude more toxic than the corresponding aliphatic fractions. These values are based on chronic effects which include hepatoxicity (liver toxicity), nephrotoxicity (kidney toxicity), and decreased body weight. Note that the approach is conservative, in that additive effects are assumed even though in many cases the target organs may differ.

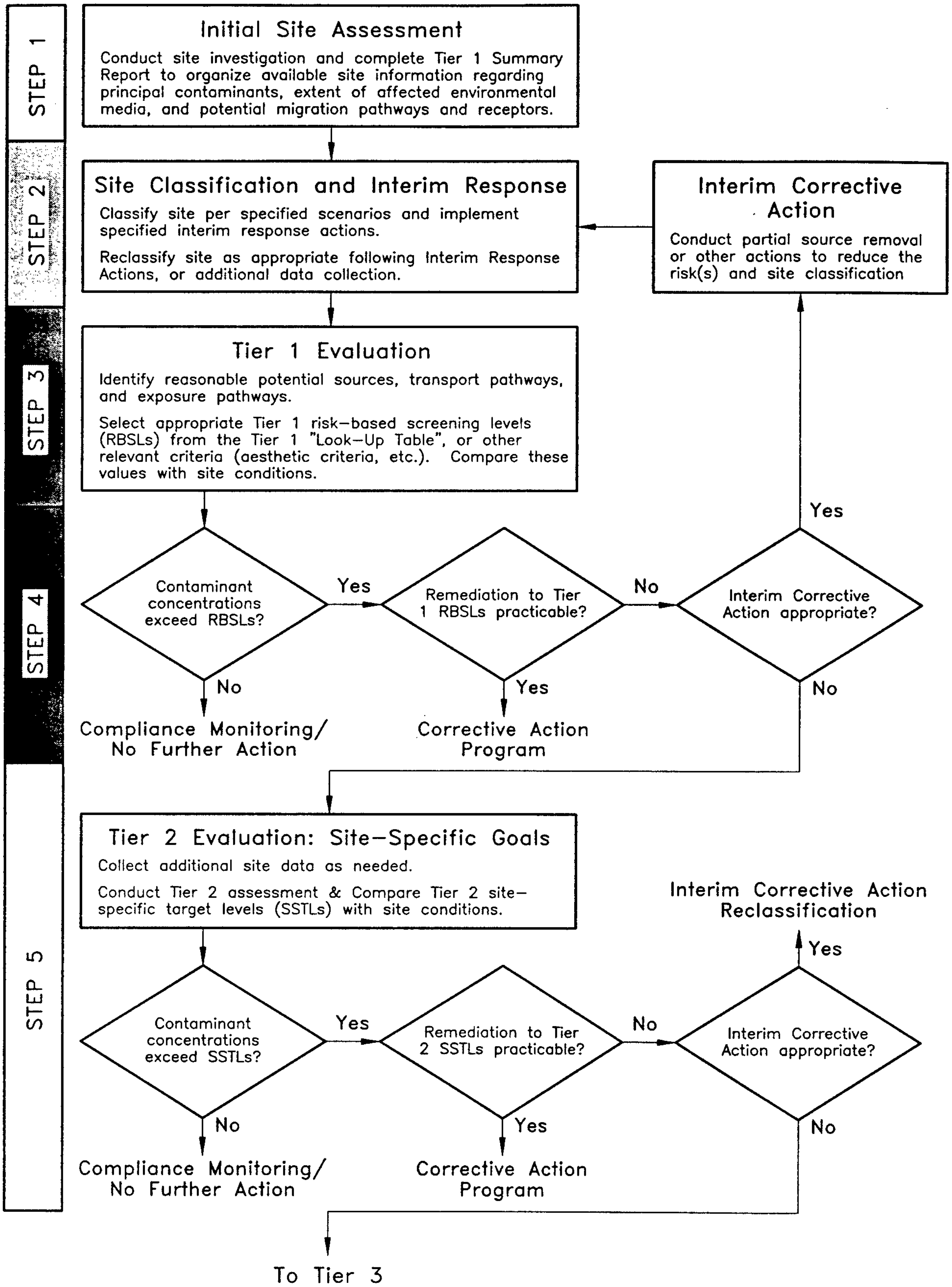
Within a framework such as RBCA, the toxicity, fate, and transport information defined by the Working Group can be used to perform a risk-based analysis of each fraction within the petroleum mixture. This analysis is used to develop soil and groundwater cleanup levels for TPH that are protective of human health. Fraction-specific RBSLs are estimated for each applicable exposure scenario by combining fate and transport information with the RfDs and RfCs for each fraction. The risk that is associated with the TPH mixture as a whole is determined by combining the risks associated with individual fractions in accordance with their composition in the TPH mixture. This methodology is presented in detail in Section 4.2.1 of this document.

1.2 Overview of RBCA Process

The RBCA framework integrates "site assessment, remedial action selection, and monitoring with U.S. EPA-recommended risk and exposure assessment practices" (ASTM, 1995). It is designed to allow the user to make corrective action decisions for different sites in a consistent manner, while remaining protective of human health. Because the RBCA approach is tiered, it is more flexible and therefore more cost-effective than traditional approaches, under which all sites are required to conform to uniform standards and procedures, regardless of site-specific conditions. An overview of the first two tiers of the RBCA approach is shown in Figure 1-1.

The core elements of the RBCA framework are an understanding of:

- The characteristics of the source contamination
- The pathways through which contaminants move in the environment, and
- The existing and potential receptors exposed to the contaminants



Initial Site Assessment

Conduct site investigation and complete Tier 1 Summary Report to organize available site information regarding principal contaminants, extent of affected environmental media, and potential migration pathways and receptors.

Site Classification and Interim Response

Classify site per specified scenarios and implement specified interim response actions.

Reclassify site as appropriate following Interim Response Actions, or additional data collection.

Interim Corrective Action

Conduct partial source removal or other actions to reduce the risk(s) and site classification

Tier 1 Evaluation

Identify reasonable potential sources, transport pathways, and exposure pathways.

Select appropriate Tier 1 risk-based screening levels (RBSLs) from the Tier 1 "Look-Up Table", or other relevant criteria (aesthetic criteria, etc.). Compare these values with site conditions.

Contaminant concentrations exceed RBSLs?

Remediation to Tier 1 RBSLs practicable?

Interim Corrective Action appropriate?

Compliance Monitoring/ No Further Action

Corrective Action Program

Tier 2 Evaluation: Site-Specific Goals

Collect additional site data as needed.

Conduct Tier 2 assessment & Compare Tier 2 site-specific target levels (SSTLs) with site conditions.

Interim Corrective Action Reclassification

Contaminant concentrations exceed SSTLs?

Remediation to Tier 2 SSTLs practicable?

Interim Corrective Action appropriate?

Compliance Monitoring/ No Further Action

Corrective Action Program

To Tier 3

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NO DRWN DATE REVISION CHKD DATE APPVD DATE
SCALE NONE
CAD FILE 32675005

ASTM RBCA
TIER 1 AND TIER 2 PROCESS

RETEC
REMEDIATION TECHNOLOGIES INC
DRAWING NO. REV.
FIGURE 1-1 0

These elements are incorporated into a three-tiered approach which involves increasingly sophisticated levels of data collection and analysis. The initial tier, Tier 1, uses conservative assumptions, some of which are independent of site conditions, and which are replaced in later tiers (i.e., Tiers 2 and 3) by less conservative site-specific assumptions. The soil cleanup goals defined for each tier may be less costly to achieve than those defined by the previous tier. As a result, upon completion, the user can review the results after each tier and decide if the cost of conducting additional site-specific analyses for the next tier are warranted by the potential cost reduction associated with an alternative remedial action.

1.3 El Toro Analysis

The RBCA process begins with an assessment of site conditions, receptors, and pathways to determine the applicable pathways to assess in the Tier 1 analysis. For the two El Toro sites, data on carcinogenic TPH indicators and non-carcinogenic TPH were generated to complete a RBCA Tier 1 analysis of TPH risk associated with these sites. The RBSLs developed in the Tier 1 analysis were then compared to measured TPH concentrations to determine the need for and extent of remedial action required to meet TPH cleanup goals.

2 Site Conditions

Detailed information on site use, geology, hydrogeology, meteorology, lithology and soils is included in the *Draft Final Phase II Remedial Investigation: OU-3A Sites, MCAS El Toro* (OHM, 1997). This section provides a summary of information relevant to the RBCA analysis.

2.1 Facility Description

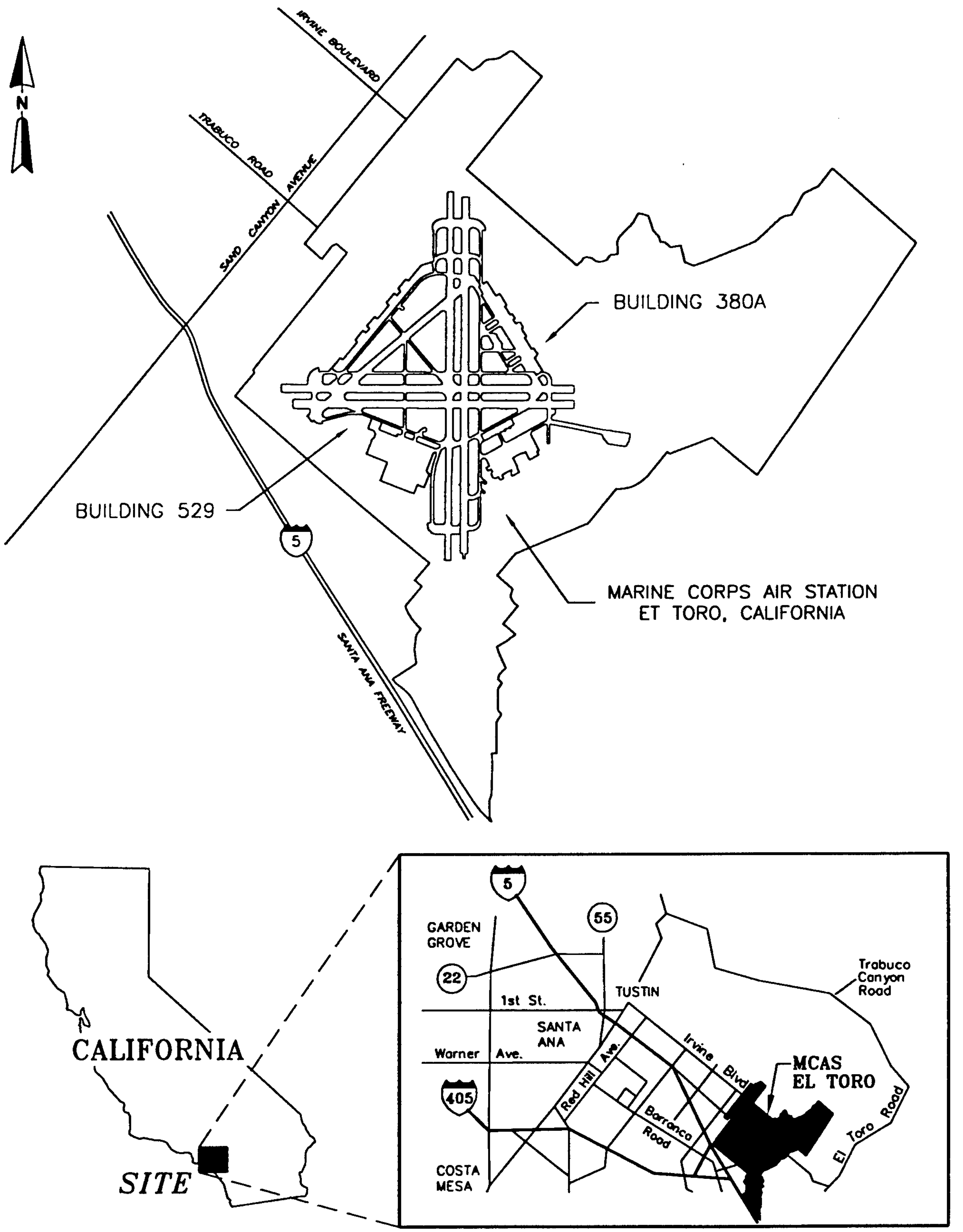
MCAS El Toro is located in central Orange County, California, approximately 45 miles southeast of Los Angeles (Figure 2-1). The site encompasses approximately 4,700 acres, is located on the southeastern edge of the Tustin Plain, and extends into the Santa Ana Mountains. The San Diego Creek, which flows to Upper Newport Bay, is located about 1 mile southwest of the site (OHM, 1997).

MCAS El Toro was established in 1942 as an operational training facility for United States Marine Corps pilots. The station provides services and material to support aviation activities of the Marine Corps and is responsible for operations and maintenance of military aircraft and ground support equipment.

Access to the El Toro facility is limited to four gates in the boundary fence which surrounds the station. The runways, two running north-south and two running east-west, divide the site into four quadrants (Figure 2-1). Land use in these areas is described below (OHM, 1997).

- **Northwest Quadrant:** primarily administrative services
- **Northeast Quadrant:** Marine Aircraft Group activities, family housing, community services and storage
- **Southeast Quadrant:** administrative services, maintenance facilities, storage and golf course
- **Southwest Quadrant:** maintenance facilities, supply and storage and limited administrative services

MCAS El Toro has approximately 400 UST sites, including approximately 60 with active tanks. Approximately 200 inactive tanks have been removed and the Station is in the process of remediating and closing impacted sites (OHM, 1996). Two of these inactive UST sites, located in the NE and SE quadrants, have been selected as demonstration sites for the Working Group's TPH methodology.



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TPH WORKING GROUP DEMONSTRATION PROJECT
5-3267-200

CUR. DATE: 11/24/1997

SITE LOCATION MAP

MCAS, EL TORO

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REMEDIATION TECHNOLOGIES INC

FIGURE 2-1 0

These are former UST sites 380A and 529, shown on Figure 2-1 and in more detail on Figures 2-2 and 2-3.

2.1.1 UST Site 380A

Site 380A is located in the northeastern quadrant of the MCAS El Toro facility, within a storage yard area (Figure 2-2). A 10,000-gallon diesel UST was installed in 1954 as part of the site emergency power generation system. No secondary containment system was installed in conjunction with the tank. The tank was removed in 1993 by American Processing. The total depth of the tank excavation was 14 feet (OHM, 1995). Diesel-range TPH and toluene were detected in samples taken during the excavation at depths of up to 31 feet below ground surface (bgs). Groundwater is reported to be approximately 200 feet bgs (OHM, 1996). Current land use in the vicinity of Building 380A is predominantly light industrial and research and development. Approximately one-half to one mile to the east lie some residential and recreational areas as well as a habitat reserve.

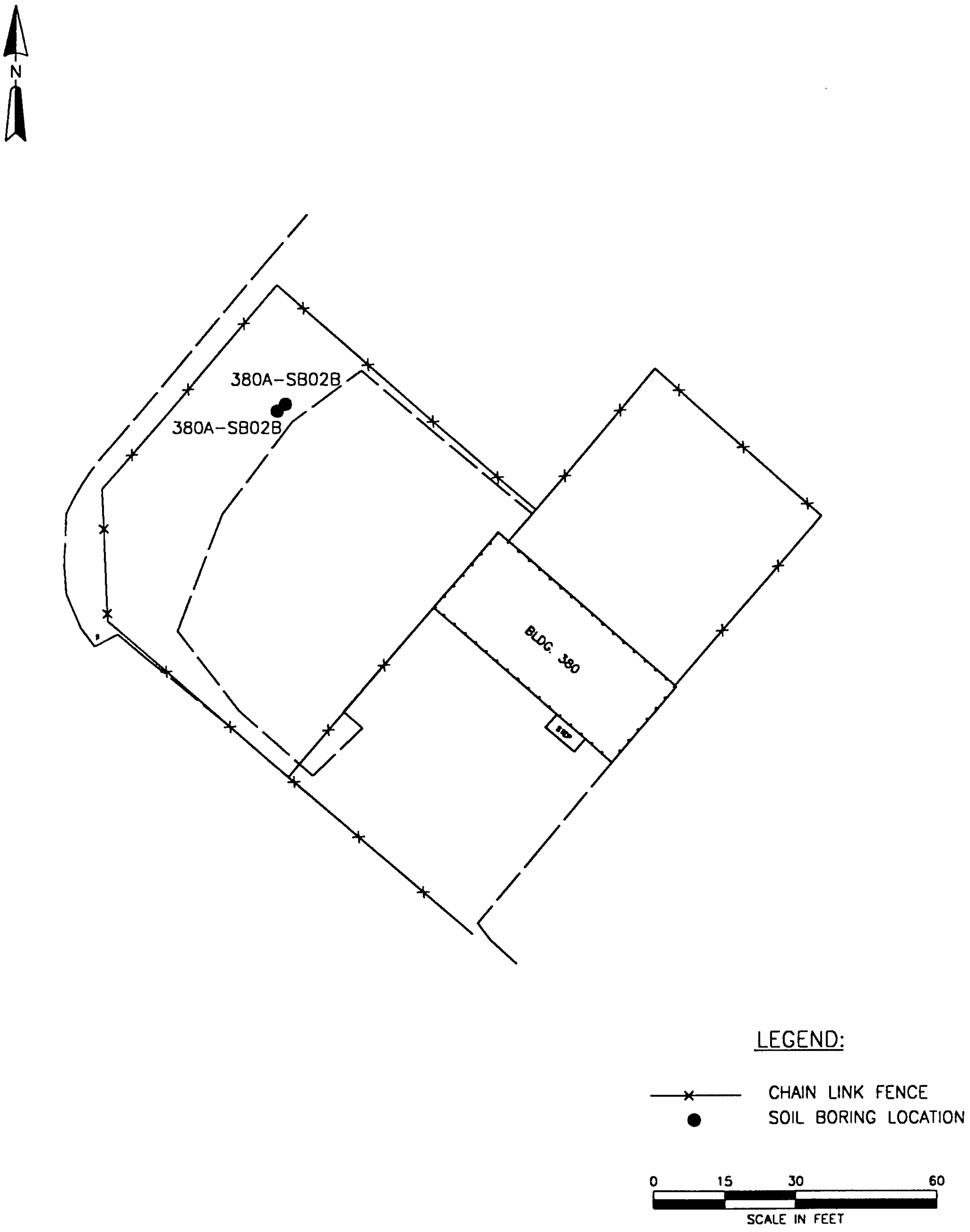
2.1.2 UST Site 529

Site 529 is located in the southwestern quadrant of MCAS El Toro, near a former laundry boiler plant (Figure 2-3). An underground 25,000-gallon rectangular concrete tank (originally used for heating oil for the base laundry) and associated piping were removed in June 1997 by OHM. The site was excavated to a depth of approximately 19 feet. Diesel and motor oil range hydrocarbons were detected as well as low levels of BTEX constituents (benzene, toluene, ethylbenzene, and xylenes). Moreover, charcoal-like consistency TPH has been detected at several boring locations at this UST. This highly carbonized form of TPH may be the result of a former heating line which ran along the fuel tank. The area surrounding Building 529 is used predominantly for cargo. Some airport support and restricted areas are adjacent to the main cargo area.

2.2 Site Geology and Hydrogeology

MCAS El Toro is located on the southeastern edge of the Tustin Plain, which is comprised of alluvial fan deposits derived from the Santa Ana Mountains. These deposits consist of "isolated coarse-grained, stream-channel deposits contained within a matrix of fine-grained overbank deposits that range in thickness up to 300 feet" (OHM, 1997). Silts and clays predominate in the central and northwestern portion of the site. Near the foothills, coarse to fine poorly sorted sands containing some clays are encountered.

Soil borings from Site 380A contained silty, poorly graded sands with some gravels to depths of approximately 50 feet bgs. In general, sands become slightly



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CUR. DATE: 11/24/1997

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SITE PLAN
BUILDING 380A
MCAS, EL TORO

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REMEDIATION TECHNOLOGIES INC

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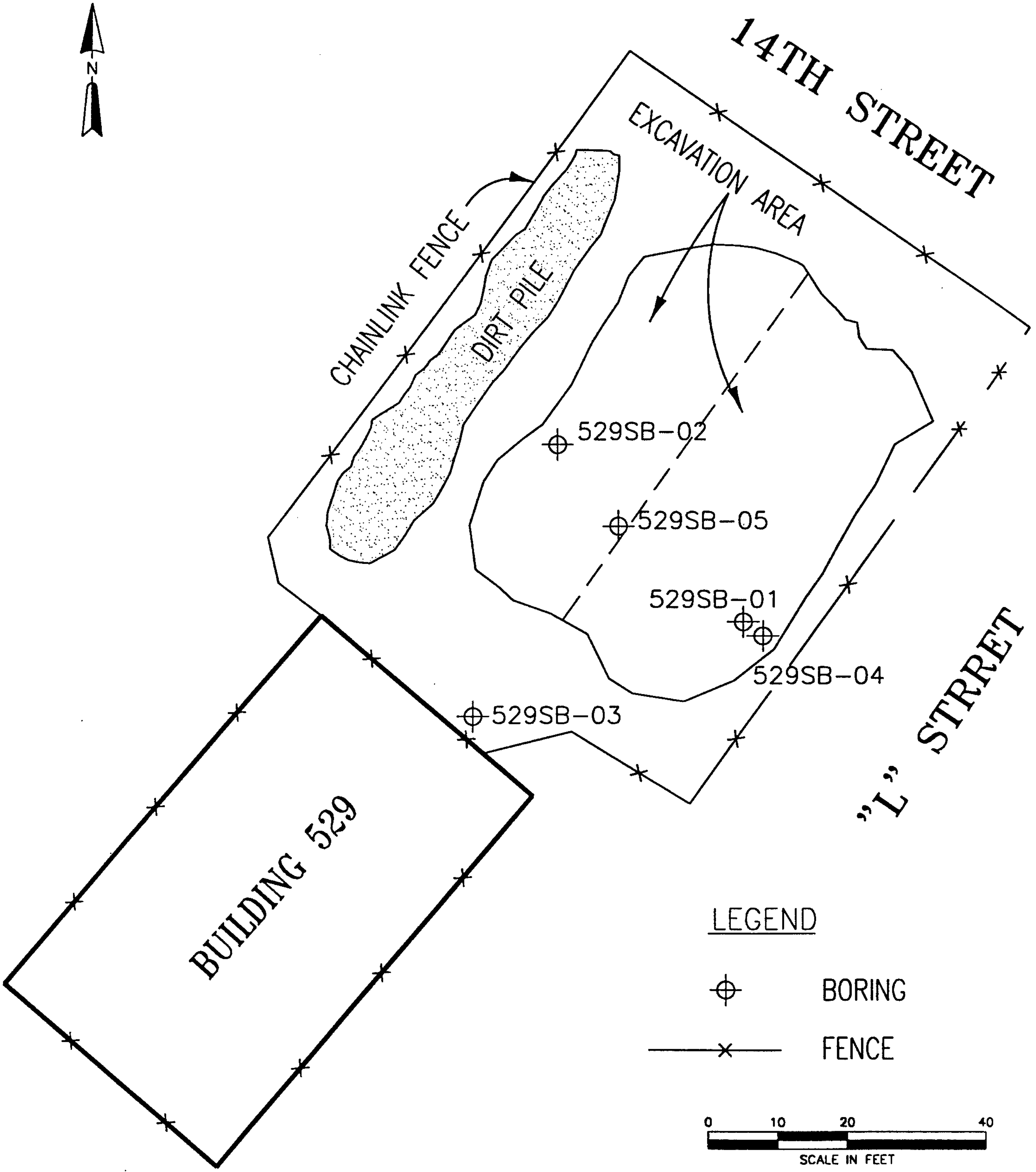

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SITE PLAN
BUILDING 529
MCAS, EL TORO

RETEC REMEDIATION TECHNOLOGIES INC

FIGURE 2-3 0

coarser with depth and gravels become more evident. Groundwater was not encountered in these borings, which extended to depths of approximately 55 feet bgs.

Soil borings from Site 529 contained predominantly poorly graded sands with some silts and fine sands. Some gravels were encountered at depths greater than 80 feet bgs. Groundwater was encountered in one boring at a depth of 104 feet bgs, but was not observed in four additional borings, three advanced to 100 feet bgs, and one to 40 feet bgs.

Regionally, groundwater flow is assumed to be unconfined in this area, discharging to irrigation wells or westward to the Main Orange County Basin. The Phase II RI concluded that, based on water level and water quality data, there exist two aquifer zones, separated by finer-grained, lower permeability material. The shallow aquifer zone consists primarily of sediments, while the deeper, principal aquifer zone is comprised of interbedded fine grained silts and coarse gravels. The shallow aquifer correlates with the alluvial deposits described above.

At the northeastern boundary of the MCAS El Toro facility, groundwater is encountered at a minimum depth of 240 feet bgs. However, along the southwestern boundary, groundwater is encountered approximately 85 feet bgs (OHM, 1997). This is consistent with observations from soil borings described above and previous site investigations. Groundwater was encountered at 104 feet bgs in a boring near Building 529, located in the southwestern portion of the site. Borings from the area near Building 380A were not advanced to the water table, however, previous investigations report groundwater at a depth of approximately 200 feet bgs (OHM, 1996). Water level data from 1989 indicate that groundwater flows generally to the northwest at a gradient of 0.0066 ft/ft (OHM, 1997). Phase I RI data indicate northwestern flow at a gradient of 0.008 ft/ft.

2.3 Physical Characteristics of Site Soils

Soil samples obtained from borings in the demonstration sites were submitted for geotechnical laboratory analysis. The analytical reports are included in Appendix A-1.

The soil samples from both sites were generally coarse-textured sands and silty sands. Total porosities ranged from 0.27 to 0.41 in samples from Site 529, with an average porosity of approximately 0.35. The samples were taken from 40 to 70 feet bgs, and boring logs indicated silty sands to sands at these depths. Porosities in samples from Site 380A were slightly higher, ranging from 0.32 to

0.44 at depths of 30 to 45 feet bgs, corresponding to silty sands and sands with silts.

The dry densities and specific gravities were approximately 100 to 120 pounds/cubic foot and 2.6 to 2.7, respectively, for samples obtained from each location. Moisture content ranged from 2.3 to 10.9 percent in the samples from Site 380A and from 7.6 to 24.6 percent in the samples from Site 529. The pH of these samples ranged from 6.7 to 9.2.

Permeability tests yielded values ranging from 2.5×10^{-8} to 9×10^{-6} cm/sec at Site 529 and 5.9×10^{-6} to 9.2×10^{-4} cm/sec at Site 380A. These values were derived from bagged samples which are generally repacked for analysis. This repacking procedure tends to eliminate the natural bedding of the soils and, therefore, the derived values are most likely representative of horizontal conductivity rather than vertical conductivity.

Hydraulic conductivity (K) can also be estimated from grain size analysis results where K (in cm/sec) is equal to the D_{10} grain size (in mm) squared (Freeze and Cherry, 1979). Most of the results of the grain size analyses did not include a D_{10} value, although in these cases it can be assumed that the D_{10} value is less than 0.001 mm, based on the graphical representation of the grain size distribution. This assumption would yield a hydraulic conductivity of less than 1×10^{-6} cm/sec, consistent with the permeability testing results. One sample from Site 380A had a D_{10} of 0.0661 mm, yielding a hydraulic conductivity of 4.4×10^{-3} cm/sec and one sample from Site 529 had a D_{10} of 0.0032 mm, yielding a hydraulic conductivity of 1×10^{-5} cm/sec. These results are one to three orders of magnitude higher than those derived in the permeability testing.

3 Analytical Methods and Results

3.1 Sampling Procedures

Soil borings at the MCAS El Toro facility were drilled using a hollow stem auger drill rig and soil samples were collected with a high-carbon steel California-style sampler, using standard sampling techniques. Soil samples for geotechnical and chemical analyses were collected with a California-style sampler with brass sleeves. Sampling was performed using the surface drop hammer system. This system utilizes an 18- to 24-inch-long California-style sampler to collect soil samples. When employing an 18-inch (or 24-inch) sampler, three (or four) 6-inch brass sleeves were used to collect soil samples. The sleeve selected for geotechnical and chemical analyses was the one with the most representative, cohesive, and undisturbed soil core as determined by observation by the on-site geologist.

Figure 2-2 shows boring locations near Building 380A. Two borings, 380SB-02A and 380SB-02B, were advanced to depths of approximately 55 feet bgs. Soil samples were collected at various depths from each boring. Figure 2-3 shows boring locations near Building 529. Five borings, 529SB-01 to 529SB-05, were advanced to depths of approximately 100 feet bgs, with the exception of 529SB-03, which was advanced to approximately 40 feet bgs. Several samples were obtained at various depths from each boring. Forty samples were submitted for screening analyses, using Method 8015M for TPH and Method 8020 for BTEX analysis. Fifteen soil samples were submitted for TPH fractionation analysis, using the Direct Method.

3.2 Direct Method

3.2.1 Analytical Approach

In the Direct Method, aliphatics and aromatics are separated prior to analysis. This separation procedure is done using either alumina (modified EPA Method 3611B) or silica gel (modified EPA Method 3630B or C), which can be used to fractionate petroleum materials into saturates, aromatics, and polars. In the Direct Method, a shorter column is used to minimize dilution, and *n*-pentane is used for extraction and to elute the aliphatics. Methylene chloride is used to elute aromatics from alumina and a mixture of methylene chloride and acetone is used for elution of aromatics from silica gel.

Following separation of the aromatics and aliphatics on the alumina or silica gel column, the two separate extracts are analyzed by GC/FID. In cases where light-end constituents (i.e., <EC9) are observed, GC/mass spectrometry (MS) may be performed, especially to quantify the BTEX compounds.

3.2.2 Results

Fifteen soil samples from the two sites chosen for demonstration were submitted to Lancaster Laboratories (Pittsburgh, Pennsylvania) for fractionation analysis by the Direct Method. The analytical results are summarized in Tables 3-1 and 3-2, and the laboratory reports are included in Appendix A-2. Total TPH concentrations ranged from 150 to over 1,300 mg/kg at Site 380A and from 1,300 to 8,500 mg/kg at Site 529.

3.2.2.1 Site 380A

The source of contamination in this area is a leaking UST which contained diesel fuel for emergency power generation. TPH at this site is composed of approximately 25 percent aromatics and 75 percent aliphatics, with the majority in the EC>12–35 range (Table 3-1). This composition is consistent with that of most middle distillate fuels, which typically contain between 3 and 40 percent aromatic compounds (API, 1994). Figure 3-1 graphically shows the percentage of hydrocarbons attributable to each aromatic and aliphatic fraction quantified using the Direct Method. The EC5–7 and EC7–8 aromatic fractions correspond to benzene and toluene, respectively. From this analysis, benzene was detected in only one sample (380SB-02B-33) at a concentration of 2.11 mg/kg. Toluene was not detected in any of the samples. This result is consistent with the composition of diesel fuels, which generally do not contain BTEX compounds.

3.2.2.2 Site 529

Analytical results for samples taken from two borings (04 and 05) installed at Site 529 are summarized in Table 3-2. Figures 3-2 and 3-3 show the distribution of hydrocarbons in TPH from each of the two borings. The similarity of these distributions is consistent with one contaminant source, assumed to be a leaking heating oil UST. Material from this location is composed of approximately 30 percent aromatics and 70 percent aliphatics, most of which fall in the EC>10–35 range. The distribution is consistent with the composition of heating oil, which typically contains 70 to 80 percent aliphatics and 18 to 30 percent aromatics (API, 1994). Average TPH distributions for samples from the two sites are shown in Figure 3-4. The Site 529 TPH contains slightly lighter hydrocarbons than the TPH encountered near Building 380A, although neither benzene nor toluene (EC5–7 and EC7–8 aromatic fractions) was detected in any of the Site 529 samples.

Table 3-1 Analytical Results--Direct Method: Building 380A

Sample Location: **Sample Depth (feet bgs):** **Sample ID:** **Lab ID:** **TPH Fraction**	**380SB-02B** **15** **380SB-02B-15** **2781281**	**380SB-02B** **20** **380SB-02B-20** **2781282**	**380SB-02B** **21** **380SB-02B-21** **2781283**	**380SB-02B** **32** **380SB-02B-32** **2781284**	**380SB-02B** **33** **380SB-02B-33** **2781285**
Aromatic Fraction					
EC5-7 Aromatic	< 0.2	< 0.2	< 0.2	< 2	2.11
EC>7-8 Aromatic	< 0.2	< 0.2	< 0.2	< 2	< 2
EC>8-10 Aromatic	< 8	< 8	< 8	< 8	< 8
EC>10-12 Aromatic	< 8	< 8	< 8	< 8	< 8
EC>12-16 Aromatic	< 21	< 21	< 21	32	30
EC>16-21 Aromatic	106	< 21	84	73	81
EC>21-35 Aromatic	61	< 53	< 52	< 52	< 53
Total Aromatics	186	55.7	129	141	149
Aliphatic Fraction					
EC5-6 Aliphatic	< 0.2	< 0.2	< 0.2	< 2	< 2
EC>6-8 Aliphatic	< 0.2	< 0.2	< 0.2	< 2	< 2
EC>8-10 Aliphatic	< 8	< 8	< 8	< 8	< 8
EC>10-12 Aliphatic	< 8	< 8	< 8	36	16
EC>12-16 Aliphatic	60	< 21	70	448	489
EC>16-21 Aliphatic	157	57	169	490	599
EC>21-35 Aliphatic	< 52	< 53	< 52	80	87
Total Aliphatics	251	102	273	1,060	1,197
Total TPH	437	158	402	1,201	1,346
% Aromatics	*42.5*	*35.3*	*32*	*11.7*	*11*
% Aliphatics	*57.5*	*64.7*	*68*	*88.3*	*89*

NOTE:
All values in units of mg/kg.

Table 3-2 Analytical Results--Direct Method: Building 529

Sample Location: Sample Depth (feet bgs): Sample ID: Lab ID: TPH Fraction	529SB-04 20 529SB-04-20 2781276	529SB-04 60 529SB-04-60 2781277	529SB-04 80 529SB-04-80 2781279	529SB-04 95 529SB-04-95 2781278	529SB-05 20 529SB-05-20 2781270	529SB-05 25 529SB-05-25 2781271	529SB-05 50 529SB-05-50 2781272	529SB-05 75 529SB-05-75 2781273	529SB-05 77 529SB-05-77 2781274	529SB-05 100 529SB-05-100 2781275
Aromatic Fraction										
EC5-7 Aromatic	< 0.9	< 9	< 9	< 2	< 9	< 9	< 9	< 5	< 9	< 8
EC>7-8 Aromatic	< 0.9	< 9	< 9	< 2	< 9	< 9	< 9	< 5	< 9	< 8
EC>8-10 Aromatic	< 9	25	17	< 9	< 18	< 19	27	< 9	< 9	< 17
EC>10-12 Aromatic	57	105	73	74	133	124	138	19	31	81
EC>12-16 Aromatic	429	838	609	766	958	828	904	164	246	947
EC>16-21 Aromatic	569	1,158	677	878	1,037	869	1,004	180	266	1,162
EC>21-35 Aromatic	132	280	69	97	767	531	403	< 58	< 57	107
Total Aromatics	*1,192*	*2,415*	*1,454*	*1,822*	*2,913*	*2,371*	*2,485*	*402*	*585*	*2,314*
Aliphatic Fraction										
EC5-6 Aliphatic	< 0.9	< 9	< 9	< 2	< 9	< 9	< 9	< 5	< 9	< 8
EC>6-8 Aliphatic	1	25	< 9	< 2	9	11	22	6	23	22
EC>8-10 Aliphatic	58	126	86	52	111	115	171	18	26	76
EC>10-12 Aliphatic	299	443	279	293	501	557	699	65	93	324
EC>12-16 Aliphatic	1,142	2,047	1,585	2,093	2,187	2,129	2,519	427	591	2,704
EC>16-21 Aliphatic	1,008	2,014	1,628	2,185	1,890	1,689	1,945	428	592	2,850
EC>21-35 Aliphatic	178	210	134	171	734	588	487	< 58	< 57	211
Total Aliphatics	*2,686*	*4,870*	*3,721*	*4,796*	*5,437*	*5,094*	*5,848*	*976*	*1,358*	*6,191*
Total TPH	3,879	7,285	5,175	6,618	8,350	7,464	8,333	1,377	1,943	8,505
% Aromatics	*30.7*	*33.2*	*28.1*	*27.5*	*34.9*	*31.8*	*29.8*	*29.2*	*30.1*	*27.2*
% Aliphatics	*69.3*	*66.8*	*71.9*	*72.5*	*65.1*	*68.2*	*70.2*	*70.8*	*69.9*	*72.8*

NOTE:
All values in units of mg/kg.

Figure 3-1 TPH Fraction Distribution - Site 380A

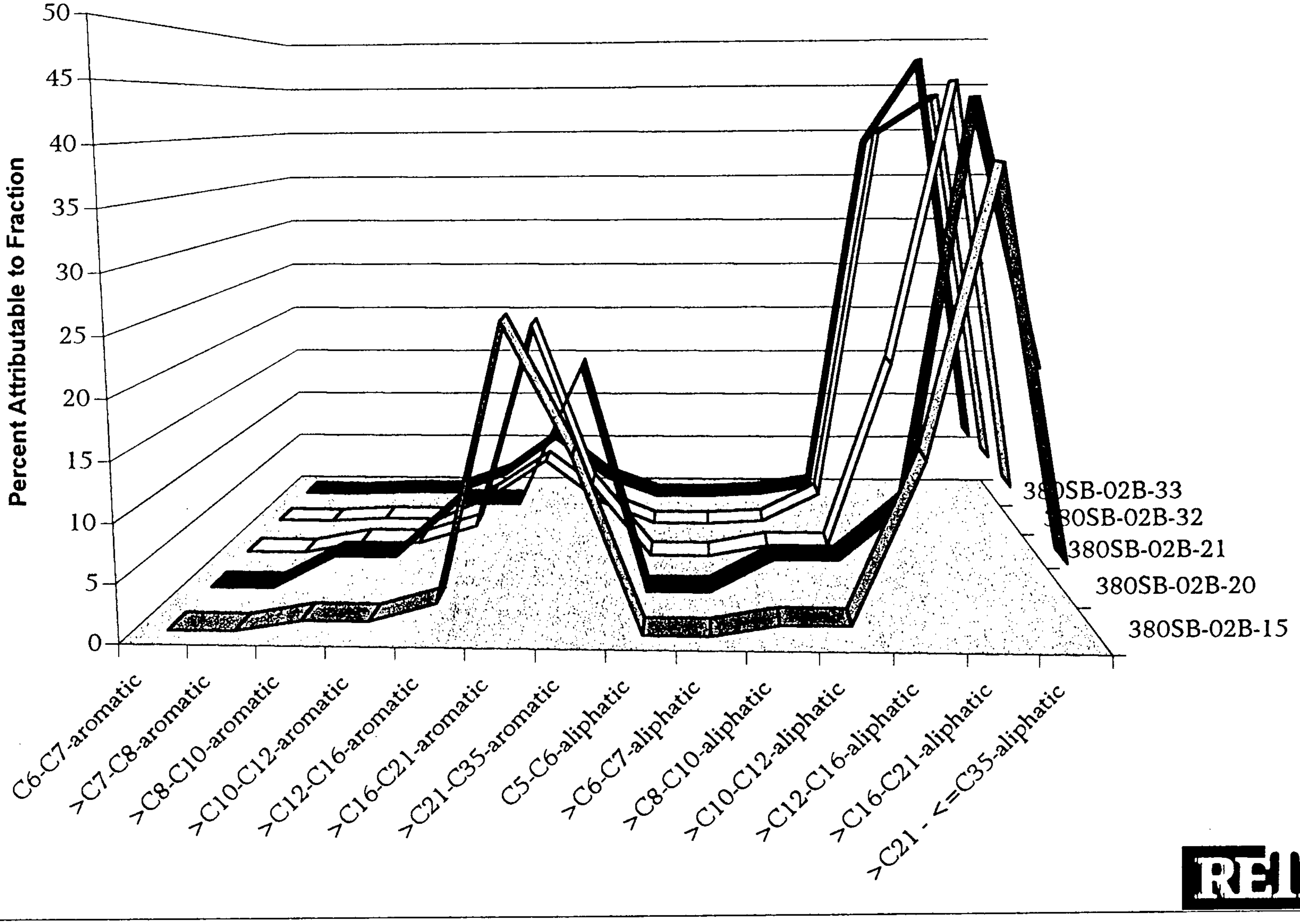


Figure 3-2 TPH Fraction Distribution - Site 529SB04

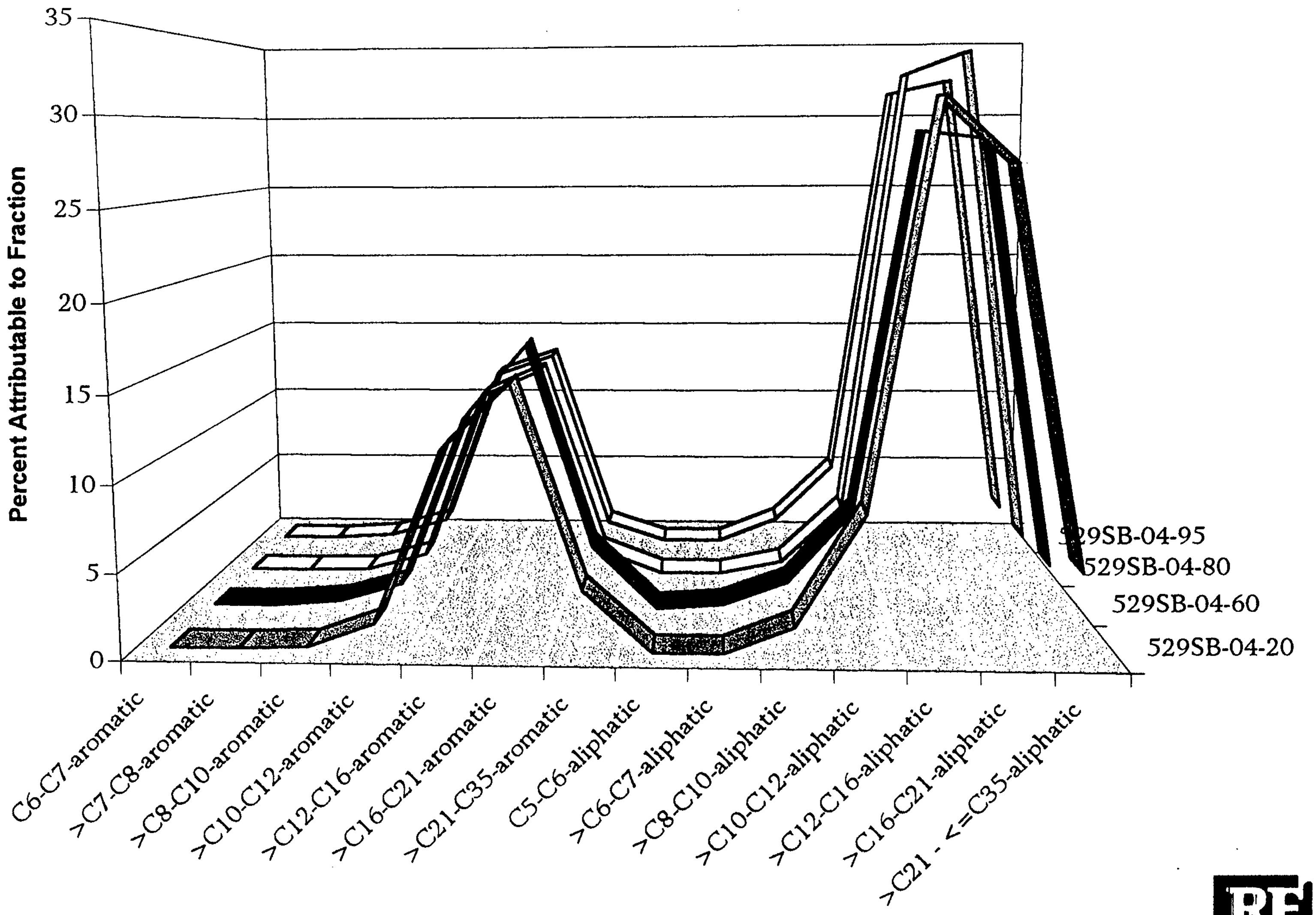


Figure 3-3 TPH Fraction Distribution - Site 529SB05

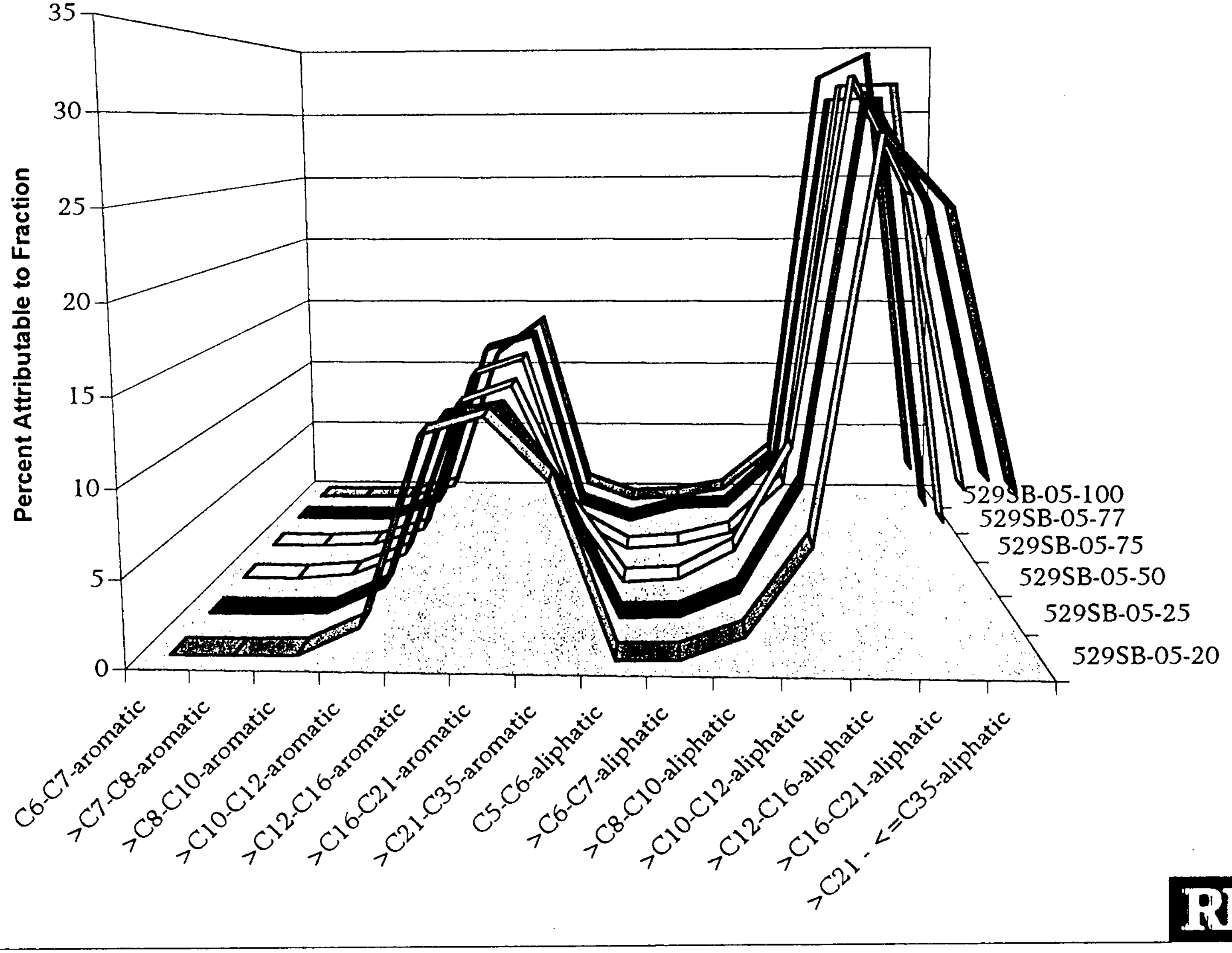
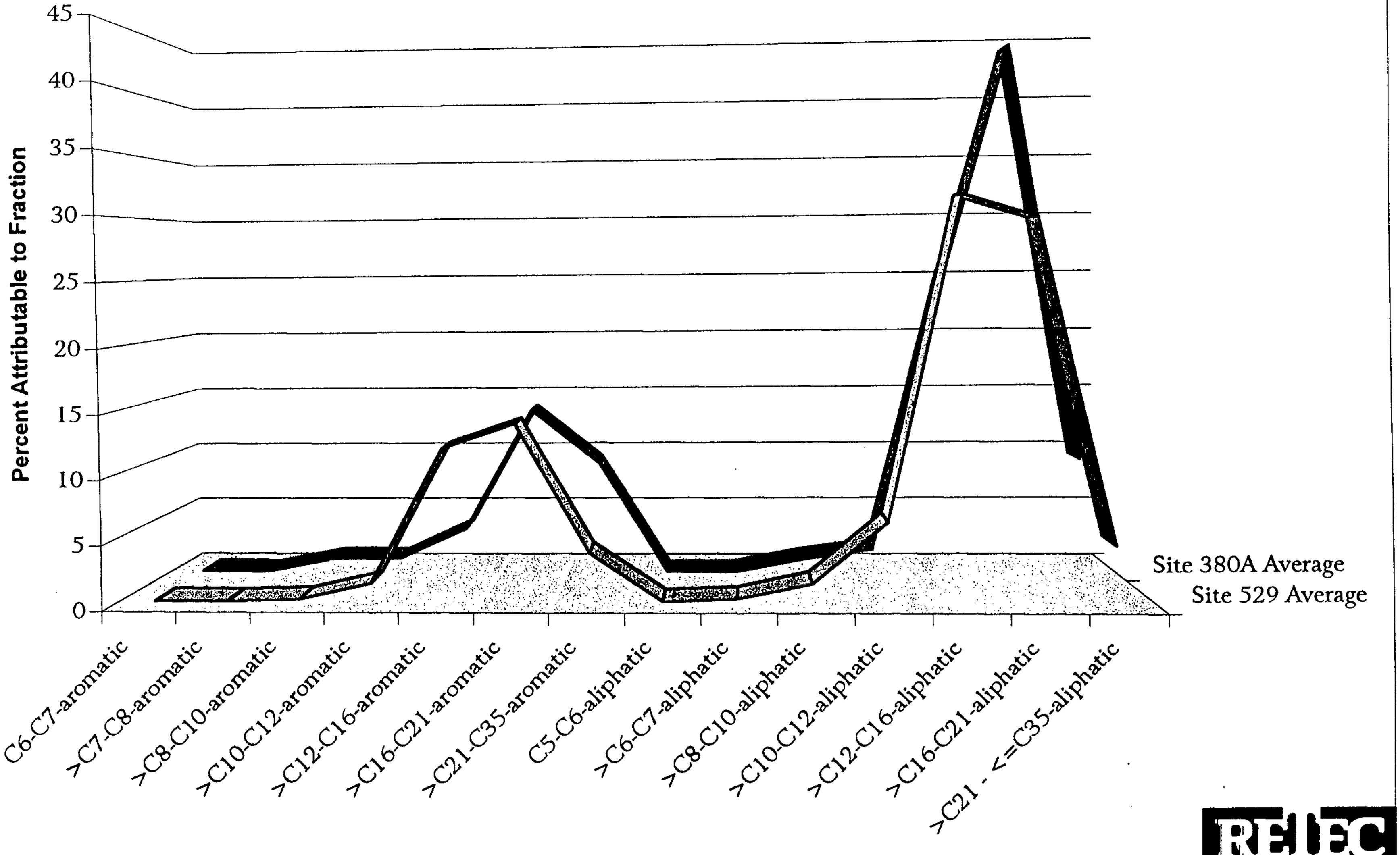


Figure 3-4 TPH Fraction Distribution - Site 380A vs. Site 529



3.3 Conventional Method

3.3.1 Analytical Approach

Conventional methods for TPH analysis, such as EPA 8015, begin with a methylene chloride extraction, followed by gas chromatography (GC) with flame ionization detection (FID) methods to separate petroleum compounds based on molecular weight and/or boiling point. The resulting chromatograms are then compared to those of known mixtures of compounds (such as gasoline or diesel) to quantify the hydrocarbons in given carbon ranges. Numerical results are calculated by integrating the area under the curve over carbon ranges associated with those of known mixtures.

3.3.2 Results

Forty soil samples were submitted to EMAX Laboratories in Torrance, California, for analysis of TPH and BTEX by EPA Methods 8015 and 8020, respectively. The laboratory analytical reports are included in Appendix A-3. Results from soil borings 380SB-02B, 529SB-04 and 529SB-05 (those with samples analyzed by the Direct Method) are summarized in Tables 3-3 and 3-4.

Extractable TPH concentrations ranged from 41 to 3,300 mg/kg in samples from Site 380A. The chromatograms indicate hydrocarbons in the diesel range, primarily C11 to C29. No purgeable TPH or BTEX compounds were detected in any of the six samples submitted for conventional analysis from this site.

Fourteen soil samples were submitted for conventional analysis from Site 529. One sample, taken at 100 feet bgs from soil boring 529SB04 was non-detect for all compounds. For samples with detectable TPH, extractable TPH concentrations ranged from 1,800 to 24,000 mg/kg, with the majority in the C9 to at least C25, and up to C34 range. Moreover, purgeable TPH concentrations in these samples ranged from 110 to 770 mg/kg, although the laboratory reports that the samples do not match a typical gasoline standard. Benzene was detected in three samples, all from soil boring 529SB05, at concentrations from 200 to 420 μg/kg. Toluene, ethylbenzene and xylenes were detected in an additional 10 samples, from both boring locations.

3.4 Comparison of Methods

The term TPH, when used to describe an analytical method, suggests that the combined concentrations of all petroleum-derived hydrocarbons present at a site are measured. Cleanup levels based on TPH assume that a result generated using a conventional TPH method (e.g., EPA 418.1 or EPA 8015) is an accurate

Table 3-3 Analytical Results--Conventional Methods: Building 380A

Sample Location:	**380SB-02B**	**380SB-02B**	**380SB-02B**	**380SB-02B**	**380SB-02B**	**380SB-02B**
Sample Depth (feet bgs):	**9.5-10**	**14.5-15**	**24.5-25**	**31-31.5**	**32.5-33**	**56-56.5**
Sample ID:	**18292-601**	**18292-602**	**18292-603**	**18292-604**	**18292-605**	**18292-606**
Compound						
EPA Method 8015 (mg/kg)						
TPH-Purgeable	ND	ND	ND	ND	ND	ND
TPH-Extractable	41	2,000	750	3,300	2,500	140
EPA Method 8020 (µg/kg)						
Benzene	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND
Xylenes	ND	ND	ND	ND	ND	ND

Table 3-4 Analytical Results--Conventional Methods: Building 529

Sample Location: Sample Depth (feet bgs): Sample ID: Compound	529SB-04 20-20.5 18292-529SB04-584	529SB-04 30-30.5 18292-529SB04-585	529SB-04 60-60.5 18292-529SB04-586	529SB-04 80-80.5 18292-529SB04-587	529SB-04 90-90.5 18292-529SB04-588	529SB-04 95-95.5 18292-529SB04-589	529SB-04 100-100.5 18292-529SB04-590
EPA Method 8015 (mg/kg)							
TPH-Purgeable	460	200	650	700	710	340	ND
TPH-Extractable	15,000	4,400	24,000	13,000	14,000	10,000	ND
EPA Method 8020 (μg/kg)							
Benzene	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	1,500	1,700	620	ND	ND
Ethylbenzene	1,400	970	3,600	3,800	2,400	440	ND
Xylenes	1,500	850	12,500	12,000	7,000	1,200	ND

Sample Location: Sample Depth (feet bgs): Sample ID: Compound	529SB-05 20-20.5 18292-593	529SB-05 25-25.5 18292-594	529SB-05 35-35.5 18292-595	529SB-05 50-50.5 18292-596	529SB-05 75-75.5 18292-614	529SB-05 85-85.5 18292-597	529SB-05 100-100.5 18292-598
EPA Method 8015 (mg/kg)							
TPH-Purgeable	290	440	110	770	620	500	600
TPH-Extractable	7,400	20,000	1,800	22,000	19,000	13,000	24,000
EPA Method 8020 (μg/kg)							
Benzene	ND	ND	ND	420	300	200	ND
Toluene	ND	450	ND	2,200	1,600	2,000	1,200
Ethylbenzene	1,360	2,000	330	4,400	4,900	3,500	2,600
Xylenes	1,900	1,900	440	16,800	11,700	13,000	7,500

measurement of petroleum-derived contamination. An underlying assumption of conventional TPH methods when these results are used to determine cleanup criteria is that the measured TPH concentration is associated with a known level of risk. In reality, neither of these assumptions is true. The results generated using these methods may, in fact, bear little relationship to the true risk, due to the complex nature of petroleum hydrocarbons, the compositional changes that occur due to weathering, and the potential for complex matrix interferences (a particularly important concern for soil analysis).

There are a variety of analytical techniques available for measuring TPH in the environment. One of the reasons for such a large number of TPH methods is that no single method is preferred for all types of petroleum contamination. Some methods measure more of the TPH present because they use more rigorous extraction techniques or more efficient solvents. However, many of these methods (e.g., those based on infrared [IR], such as EPA Method 418.1) are also subject to interferences from naturally-occurring organic materials including peat moss, dried grass, or humic material present in topsoil. These materials may be recorded as part of the total contamination present and result in higher than expected TPH concentrations that are attributable to this organic material. Given the non-specificity of TPH measurements, it is not surprising that TPH concentrations do not necessarily correlate to risk.

The Direct Method was developed to provide the level of specific information necessary to conduct a risk-based analysis of TPH. As described in Section 1.1, the behavior in the environment of different compounds which comprise TPH is dependent on the structure of the compound (i.e., aromatic or aliphatic) and can generally be correlated to the equivalent carbon number. Thus, the Direct Method's separation of aliphatics and aromatics and quantification of much narrower carbon ranges allows for more detailed characterization of the actual TPH encountered at a site. This detailed characterization can be used to more accurately evaluate risk attributable to TPH at the site.

The conventional and fractionation TPH results from comparable samples are presented in Table 3-5 and Figure 3-5. Total TPH values from conventional methods represent the sum of extractable and purgeable hydrocarbons, while total TPH values from fractionation analysis represent the sum of all fractions. One-half of the detection limit was used for fractions not detected above the reporting limit.

Table 3-5 Comparison of Total TPH Values derived using Conventional and Fractionation Methods

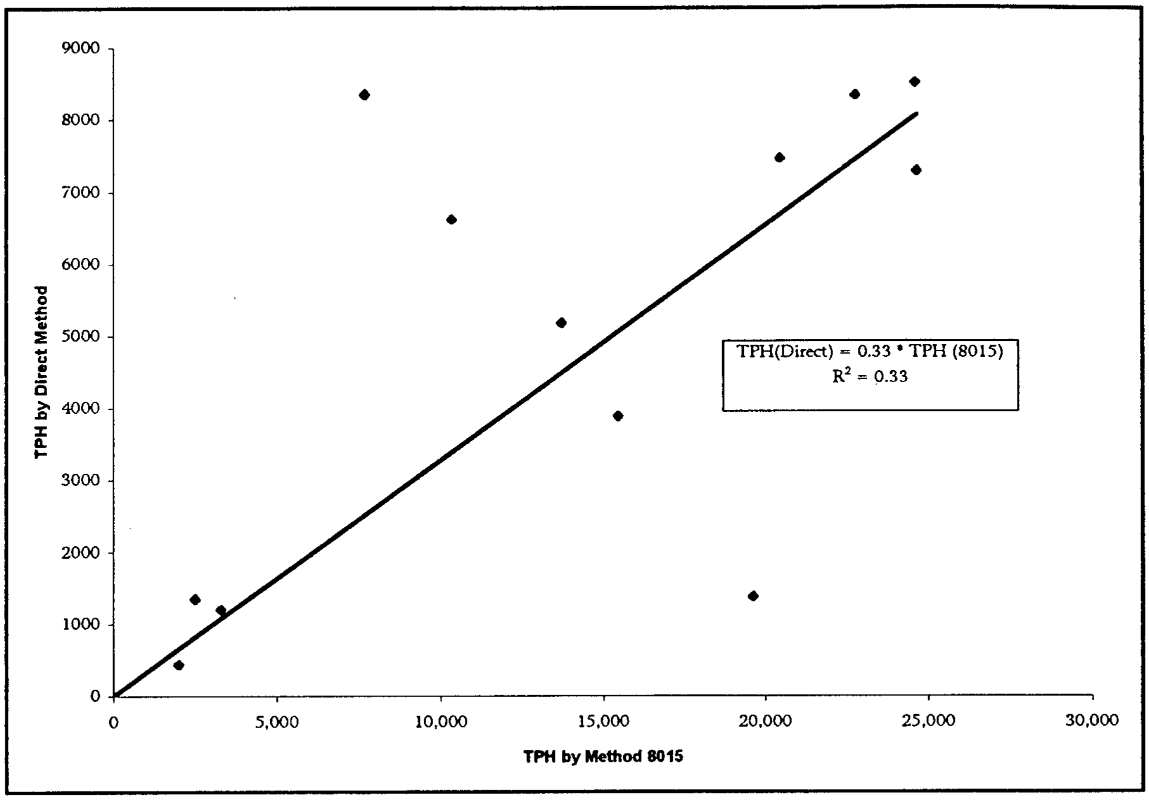
Boring ID	Sample Depth (feet bgs)	Total TPH (mg/kg)	
		EPA Method 8015	Direct Method
Site 380A			
380SB-02B	15	2,005	437
380SB-02B	20	NA	158
380SB-02B	21	NA	402
380SB-02B	32	3,305	1,201
380SB-02B	33	2,505	1,346
Site 529			
529SB-04	20	15,460	3,879
529SB-04	60	24,650	7,284
529SB-04	80	13,700	5,175
529SB-04	95	10,340	6,618
529SB-05	20	7,690	8,349
529SB-05	25	20,450	7,464
529SB-05	50	22,770	8,332
529SB-05	75	19,620	1,377
529SB-05	77	NA	1,943
529SB-05	100	24,600	8,504

NOTES:

NA - not analyzed

½ Detection Limit was used for Non-Detect data

Figure 3-5 Comparison of Results from EPA Method 8015 and Direct Method



In many cases, the results from the two methods differ and there is little apparent correlation between the methods. A trend line fitted to this data set is plotted on Figure 3-5. The R^2 value for this line is 0.33, indicating a poor fit to the data[1]. Higher TPH values from EPA Method 8015 do not necessarily indicate higher total TPH values from the Direct Method. The lack of correlation may be due to the fact that samples were split in the field for analysis at different laboratories. The variation may also reflect the spatial variability of soil quality *in situ*. Figures 3-6 through 3-8 show TPH as a function of sample depth for each of the three borings included in this evaluation. Both 8015 and Direct Method results are plotted for qualitative comparison. It is clear that the conventional analysis tends to report values which are at least twice the values obtained by the Direct Method.

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[1] The correlation coefficient, R^2, is a measure of the goodness-of-fit between the data and the regression line. Values can range from $0 \leq R^2 \leq 1$; a value of 0 indicates no correlation and a value of 1, a perfect correlation.

Figure 3-6 TPH vs. Sample Depth (380SB-02B): Comparison of Conventional/Direct Methods

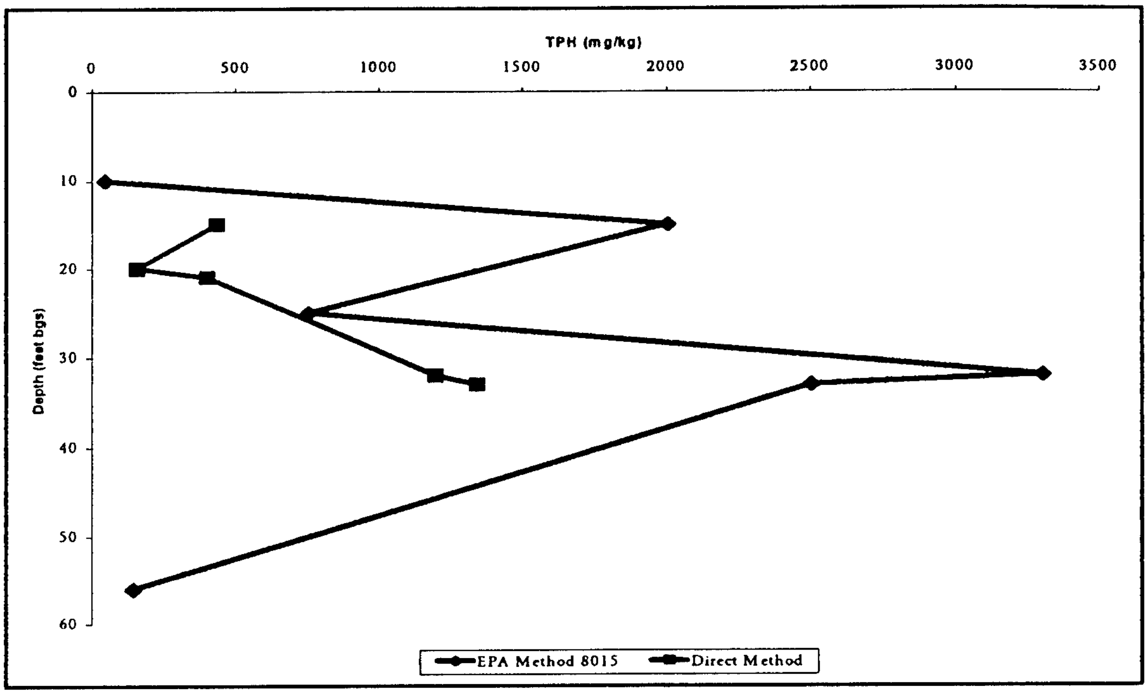


Figure 3-7 TPH vs. Sample Depth (529SB-04): Comparison of Conventional/Direct Methods

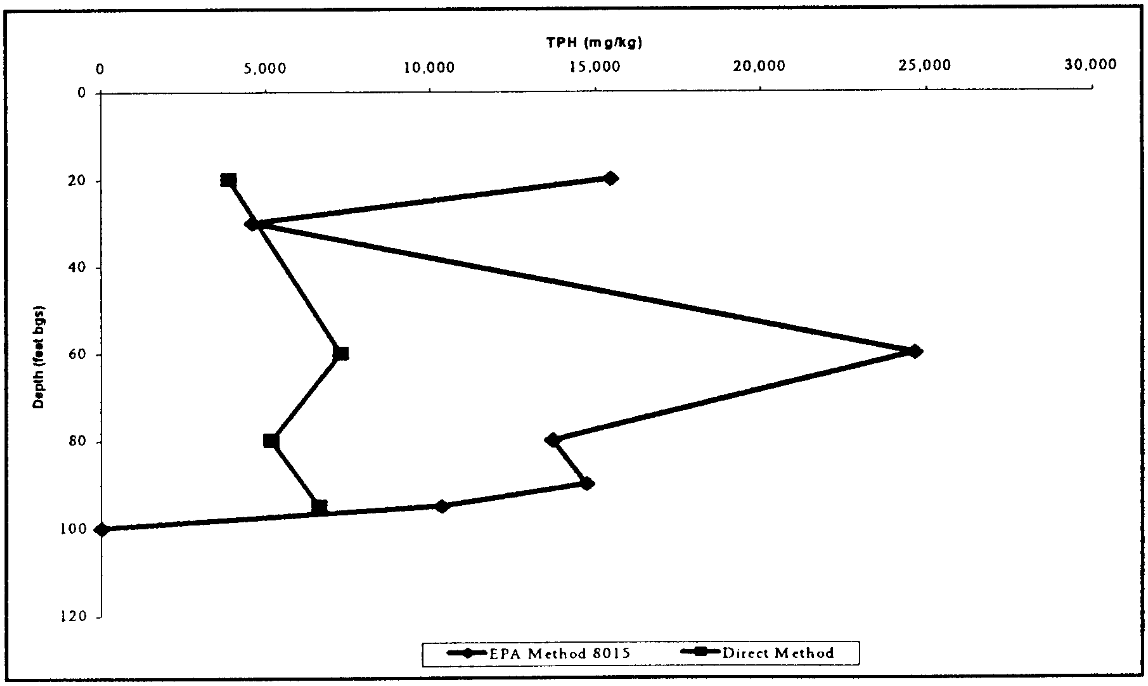
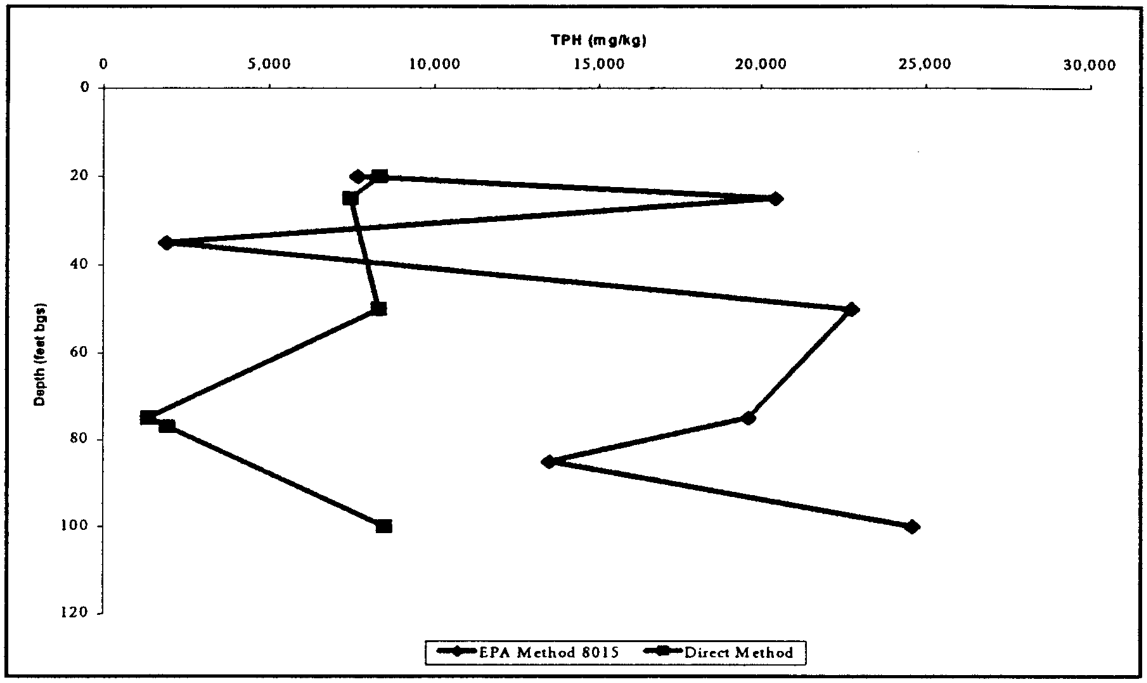


Figure 3-8 TPH vs. Sample Depth (529SB-05): Comparison of Conventional/Direct Methods



There are, however, some comparable general trends in the data obtained by these two analytical methods. For instance, in soil boring 529-SB04, the TPH concentration (as measured by each method) increases between 20 and 60 feet bgs, and decreases at greater depth. Thus, although the actual values obtained from the two methods for specific samples do not correlate well, each method may produce similar general trends in the data sets as a whole.

Finally, although no benzene was detected in samples from Site 380A using Method 8020, benzene was detected in one sample using the Direct Method. Moreover, samples from Site 529 contained benzene and toluene, according to the Method 8020 results, but not according to the Direct Method results. However, the detection limits in the Direct Method were higher than the detected values from the conventional methods. This increased detection limit may "mask" detections at very low concentrations. In some cases, GC/MS analysis (EPA Methods 8240 or 8260) may be used to verify the presence of BTEX compounds following fractionation analysis. However, since BTEX compounds were not detected, the GC/MS method was not used. The effects of these discrepancies in BTEX concentrations will be discussed in more detail during development of RBSLs in the following section.

4 Tier 1 Analysis

4.1 RBCA Evaluation

The first step in a Tier 1 analysis is to identify complete exposure scenarios to be used in calculating RBSLs. A complete exposure scenario requires an identified source, a mechanism for transport, an exposure pathway, and a receptor. Figure 4-1 is an exposure scenario evaluation flowchart provided in the RBCA specification. To graphically portray potential exposure scenarios, boxes corresponding to each element (sources, transport mechanisms, pathways and receptors) present at the site are checked. Complete pathways are those pathways which can be followed from source to receptor.

4.1.1 Source Identification

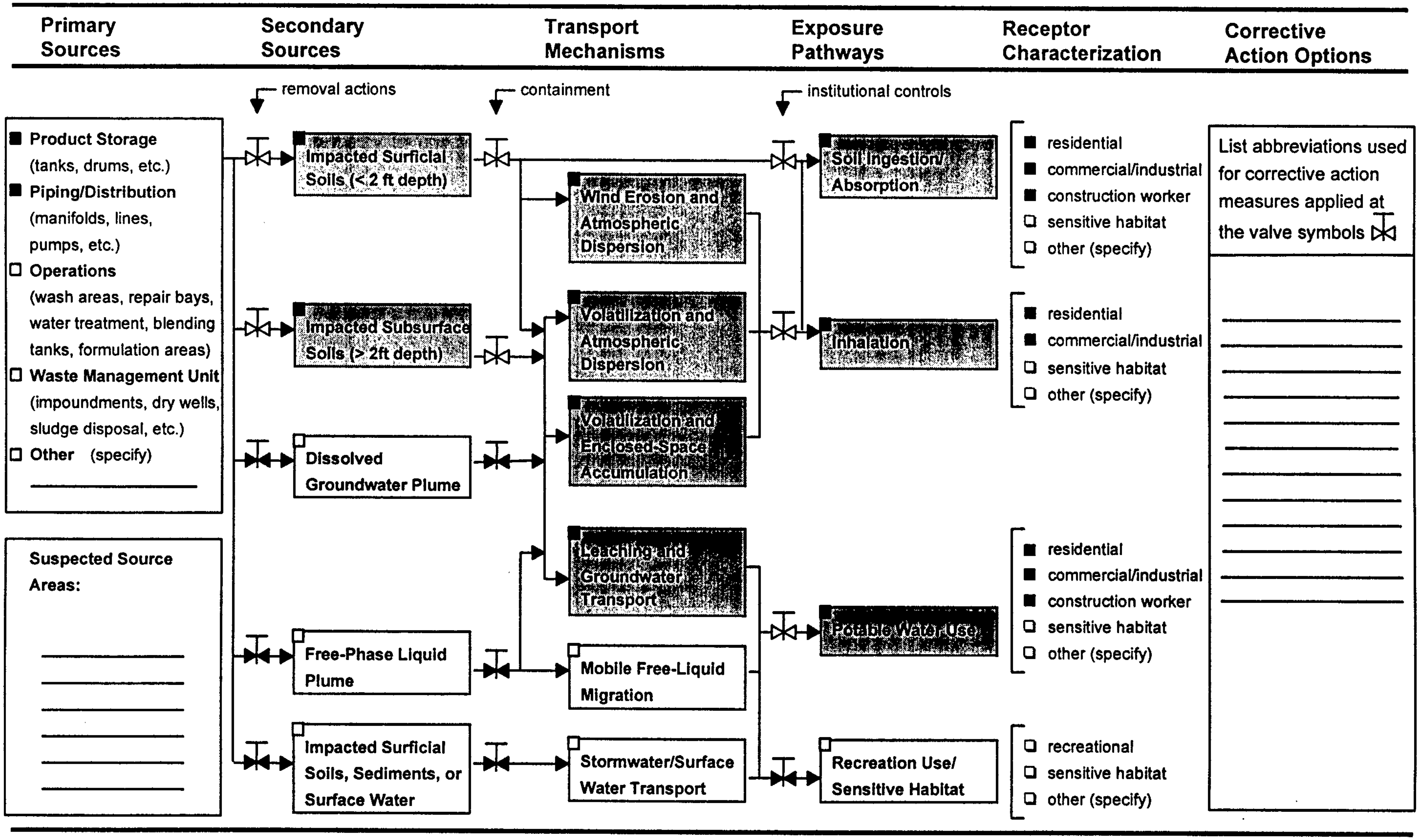
As discussed in Sections 2 and 3, the primary sources of contamination in the two sites chosen for demonstration were materials which leaked from USTs. Near Building 380A, material characteristic of diesel was encountered in vadose zone soils. Near Building 529, heating oil is assumed to be the contaminant of concern in vadose zone soils. At Site 380A, preliminary investigations indicated that TPH concentrations in soil decreased to non-detectable levels at 40 feet bgs and that groundwater is located approximately 200 feet bgs (OHM, 1996). Thus, it is unlikely that groundwater has been impacted at this site. However, at Site 529, impacted soils extend to depths of at least 100 feet bgs, and groundwater was encountered at approximately 104 feet bgs. In this case, it is likely that groundwater has been impacted. However, for purposes of this demonstration, the source area was assumed to be limited to vadose soils and did not include impacted groundwater or free phase product. Furthermore, although no data are available for surface soils (<2 feet bgs) at either location, it was assumed for conservatism and for illustration purposes that both surface and subsurface soils are impacted and act as secondary sources of contamination.

4.1.2 Transport Mechanisms

Contaminants present in surface and subsurface soils may be transported via wind erosion, volatilization to surface air (either indoor or outdoor) and leaching to groundwater. Each of these transport mechanisms is assumed to be viable at the MCAS El Toro site.

Figure 4-1 Potential Exposure Pathways

RETEC



4.1.3 Exposure Pathways

At the MCAS El Toro site, the following exposure pathways are assumed to exist:

- Direct contact with impacted soils in which contaminants may be ingested, inhaled with dust or vapors or absorbed through the skin
- Inhalation of vapors in indoor or outdoor air
- Ingestion of impacted groundwater

Although groundwater in the area is not likely to be used for drinking water purposes, this pathway is often a major pathway of concern. This pathway was therefore included for the purposes of the overall demonstration program.

4.1.4 Receptor Identification

Because the MCAS El Toro site is an active facility which includes both residential and commercial activities, it was assumed that both residential and commercial receptors exist. Although a wildlife habitat exists near the MCAS El Toro site, it is outside the scope of this demonstration project to assess ecological impacts.

4.1.5 Complete Exposure Scenarios

Based on the exposure pathway evaluation, the following scenarios have been selected for evaluation in Tier 1, based on surface and subsurface soils as the only contaminant sources remaining at the site:

- Direct contact with surface soils by residential and commercial receptors
- Inhalation of indoor air by residential and commercial receptors
- Inhalation of outdoor air by residential and commercial receptors
- Ingestion of groundwater by residential and commercial receptors

The procedures used to calculate RBSLs for each pathway and receptor differ from standard RBCA procedures, as is discussed in the following section.

4.2 Calculation of Tier 1 RBSLs

RBSLs are defined by ASTM as "risk-based site-specific corrective action levels for chemical(s) of concern developed under the Tier 1 evaluation." Tier 1 RBSLs were calculated using a procedure developed by the Working Group. This procedure differs from the RBCA framework in that it considers additivity of risk. Additivity of risk is typically not considered in a Tier 1 evaluation, since RBSLs are generally developed for a limited number of constituents. However, because TPH is a mixture, the approach used to calculate TPH RBSLs differs from that used for individual chemicals. Evaluating TPH as a mixture is also important for assessing the interactions between different individual chemicals or fractions that impact fate and transport modeling. The RBSL calculations can use Raoult's Law to more accurately represent the behavior of chemicals in a mixture. For this analysis, mixture effects as defined by Raoult's Law were excluded for conservatism and for consistency with the first demonstration project (RETEC, 1997).

For non-carcinogenic risk, the limit of acceptable risk is defined as "the target hazard quotient (HQ) which is equivalent to a hazard index (HI) of 1.0" (ASTM, 1995). The HI is the ratio of anticipated actual exposure to the exposure which corresponds to a risk level deemed acceptable. The hazard index for non-carcinogenic risk is analogous to the target excess individual cancer risk values of 10^{-4} or 10^{-6} for carcinogenic risk. To incorporate the concept of risk additivity into the calculation of an RBSL for the TPH mixture, hazard quotients[2] are calculated for each TPH fraction. Rather than compare each individual HQ to an acceptable value of 1.0, the sum of all the HQ values is calculated to derive the overall HI. This HI for the entire TPH mixture (i.e., all fractions combined) is compared to the acceptable risk level of 1.0.

It is important to note that the assumption of risk additivity when calculating a mixture RBSL for TPH is highly conservative, because the toxicological information for the target fractions indicates that these fractions often impact different organs. Typically, additivity of risk is appropriate for constituents or constituent classes which impact the same organ.

Another important concept considered in the RBSL calculation is an upper exposure limit for cross media pathways. This upper limit, the chemical saturation concentration (C_{sat}), is the soil concentration at which the sorption limits of the soil particles, the solubility limits of the soil pore water, and the

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[2] A hazard quotient is calculated in the same manner as a hazard index. However, the term "hazard quotient" refers to a risk associated with a portion of the entire risk as expressed by the hazard index.

saturation limit of the soil pore air have been reached. It is important to stress that C_{sat} is not equivalent to the concentration at which free product is observed. Rather, it is an upper limit for transport of petroleum fractions in cross-media pathways, such as soil leaching to groundwater or volatilization to ambient air.

A similar and related term, which is sometimes confused with C_{sat}, is residual saturation (RES). When calculating an RBSL, a value of RES means that the selected risk level (e.g., HI = 1.0) could not be reached or exceeded for the pathway and scenario given the constituents present, regardless of the contaminant concentration. The value of RES is attained at the TPH concentration at which the C_{sat} of the mixture is reached (i.e., each fraction has reached C_{sat}). When calculating a "whole TPH" RBSL, a value of RES indicates that even if the concentration of each fraction is set equal to C_{sat} for that fraction and pathway, the combined risk associated with each fraction still does not yield a HI of 1.0.

The term "residual saturation" is sometimes used to define the soil concentration at which NAPL is mobile. In the context of this report, however, it is only used to indicate the TPH chemical saturation point. In fact, residual saturation represents a range defined by C_{sat} as a lower limit and NAPL mobility (free product) as an upper limit. Within this range, cross-media transport is not affected because C_{sat} limits the concentrations. Therefore, the calculated risk does not increase with an increase in soil contaminant concentration.

However, C_{sat} is not an appropriate constraint for direct exposure pathways such as the direct contact pathway, since the exposure is to the original impacted medium (i.e., contaminated soil), and not to a medium to which the soil contamination has been transferred. Although C_{sat} may limit exposure for this pathway, not using C_{sat} to limit exposure adds further conservatism to the risk calculation.

Methods to integrate additivity and C_{sat} in calculating a mixture TPH RBSL are discussed in the following section. The RBCA framework provides guidance and methodology for performing risk-based assessments of sites. It does not, however, require that a specific approach be adopted such as that outlined in this section. Incorporating concepts such as additivity and C_{sat} is appropriate for increasing the accuracy of a Tier 1 or Tier 2 assessment of TPH at a site.

4.2.1 RBSL Calculation Procedure

RBSLs for each fraction and each pathway are calculated using standard ASTM RBCA default equations, using the fate and transport data presented in Table 1-2 and the toxicity data presented in Table 1-3. A more detailed discussion of the calculation procedures for single fraction RBSLs is included in Appendix B.

Once fraction RBSLs are calculated, a "whole TPH" RBSL must be calculated which takes into account the additivity of risk associated with each fraction. This RBSL is equal to the TPH concentration which would yield a hazard index of 1.0. The procedure for calculating TPH RBSLs for cross-media pathways (such as leaching to groundwater and volatilization) based upon summing the risk from each fraction is complex. Please note that the following procedure is only appropriate for calculating RBSLs for cross-media (or indirect) pathways since it sets C_{sat} as an upper limit for the RBSL. As explained above, C_{sat} does not limit exposure for direct routes such as soil ingestion, dermal exposure, and inhalation of particulates. An additional procedure used to calculate exposure for direct pathways is provided later.

4.2.1.1 Cross-media Pathways

RBSLs for each TPH fraction are first calculated using equations set forth in the ASTM RBCA guidance. These equations and the Tier 1 default parameters used in them are included for reference in Appendix B. Following this step, a whole TPH RBSL is calculated which takes into account additivity of risk from each fraction.

For leaching and volatilization pathways, transport and therefore exposure are maximized at the saturation concentration (C_{sat}) for specific fractions. Using this as a basis, the hazard quotient for each fraction is calculated as the minimum of two values: 1) the weight percentage of the fraction times the whole TPH RBSL, divided by the fraction RBSL, or 2) C_{sat} for the fraction, divided by the fraction RBSL. The hazard index, which must be less than or equal to 1.0, is defined as the sum of the hazard quotients for each fraction. Using these calculations, the whole TPH RBSL can be calculated iteratively, under the constraint that the sum of the weight fractions not exceed one. The equations used to solve for the whole TPH RBSL (C_{TPH}) are shown below:

$$(1) \qquad HI = \sum_{i=1}^{i=n} HQ_i = \sum_{i=1}^{i=n} MIN\left(\frac{f_i\, C_{TPH}}{RBSL_i}, \frac{C_{i\,sat}}{RBSL_i}\right) \leq 1 \quad \textit{given that,}$$

(2) $$\sum_{i=1}^{i=n} f_i = \sum_{i=1}^{i=n} \frac{C_i}{C_{TPH}} = 1 \quad \textit{where,}$$

C_{TPH} = Whole TPH RBSL
f = Weight Fraction of each TPH fraction
RBSL = Tier 1 risk-based screening level for a TPH fraction
C_{sat} = Saturation concentration for each TPH fraction
HI = Hazard Index (typically ≤ 1)
HQ_i = Hazard Quotient for each specific fraction
n = number of fractions (13 total)

The saturation concentration is defined by the following equation:

(3) $$C_{sat} = S * \frac{H_c\theta_{as} + \theta_{ws} + k_s\rho_s}{\rho_s} \quad \textit{where,}$$

S = Fraction effective solubility [mg/L]
H_c = Henry's Constant [dimensionless]
θ_{as} = Soil volumetric air content [cm^3/cm^3]
θ_{ws} = Soil volumetric water content [cm^3/cm^3]
k_s = Soil sorption coefficient (k_{oc}*f_{oc}) [cm^3/g]
ρ_s = Soil density [g/cm^3]

Equations 1 and 2 are iteratively solved for C_{TPH}, which is the additive mixture (or whole TPH) RBSL for the soil sample. Because, as described in Section 4.2, residual saturation represents a range defined by C_{sat} as a lower limit and NAPL mobility (free product) as an upper limit, no increase in risk occurs within this range with an increase in soil contaminant concentration due to limitations on cross-media transport. For purposes of developing RBSLs, Raoult's Law[3] was not used to calculate the RBSLs presented in the following sections.

4.2.1.2 Direct Contact Pathway

For direct exposure routes such as soil ingestion, dermal absorption, and particulates inhalation, exposure is not limited by C_{sat}. This statement applies

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[3] The value obtained for C_{sat} will be considerably lower if the effective C_{sat} of each fraction present in the sample is considered through the use of Raoult's Law.

until the presence of NAPL alters the physical characteristics of the soil. For example, if there is free product in the soil, there is less likelihood of dust being generated. The assumption is made that intake will continue to increase linearly with soil loading beyond C_{sat} for ingestion, dermal, and particulate inhalation pathways. Note that NAPL mobility is not an issue in a direct contact pathway since the receptor is already directly exposed to the contaminated soil.

In this case, the hazard quotient for each fraction is defined as the weight percentage of the fraction times the whole TPH RBSL, divided by the fraction RBSL. The sum of all hazard quotients is equal to the hazard index for the mixture, which must be less than or equal to 1.0 to meet the target risk level. For the direct contact pathway, the following equation is solved:

$$HI = \sum_{i=1}^{i=n} HQ_i = \sum_{i=1}^{i=n} \frac{f_i \, C_{TPH}}{RBSL_i} \leq 1 \qquad (4)$$

Similar to Equation 1, Equation 4 is solved iteratively to find C_{TPH} such that HI = 1 under the constraint of Equation 2.

4.2.2 Calculation of RBSLs from El Toro Site Data

Results from the fractionation analysis were used to calculate the Tier 1 RBSLs. Note that one-half the detection limit was used for all non-detect values. Further, analytical results for the EC>16–21 and EC>21–35 aliphatic fractions were combined for these calculations to represent the heaviest of the Working Group's aliphatic fractions.

For the Tier 1 evaluation, conservative, default values were used for the remaining input parameters. These are summarized in Appendix B.

4.3 Tier 1 Results

The RBSLs developed for the residential scenarios are provided in Tables 4-1 through 4-6, and the model runs are included in Appendix C. Commercial RBSLs are included in Appendix D. At the MCAS El Toro facility, a residential scenario is currently not appropriate even though on-site workers may also live at the facility, because residential areas are located off-base. However, the more conservative approach is to evaluate exposures based on residential assumptions rather than commercial assumptions, if, for example, anticipated future land use included conversion of the base to a residential area. This demonstration focuses on the more conservative, residential scenarios, although the commercial scenarios are included for reference and to illustrate the different values derived for each scenario.

To determine the level of site risk for each of the scenarios evaluated, RBSLs are compared to TPH concentrations at individual locations to calculate a hazard index for each pathway as follows:

$$\text{(5)} \qquad \textit{Hazard Index} = \frac{\textit{TPH Concentration}}{RBSL_{pathway}}$$

It is important to note that the lowest RBSL values do not necessarily provide the highest hazard index values. The hazard index is merely a comparison of the RBSL to the total TPH concentration at that location. A hazard index greater than 1.0 means that the measured TPH concentration at a given location exceeds the allowable concentration based on the Tier 1 assumptions. A hazard index less than 1.0 indicates that the measured TPH concentration is acceptable based on the risk-based calculations using conservative Tier 1 assumptions.

For these scenarios, the target risk level of 1.0 for the hazard index was exceeded for some of the pathways evaluated at Site 529, while none were exceeded at Site 380A.

In most instances, the outdoor air pathway provides the highest RBSL values due to dispersion and mixing with ambient air. In general, volatilization to indoor air provides the lowest values due to default assumptions which lead to accumulation in indoor air. For the material encountered at each location included in this demonstration project, the lowest RBSLs were for the indoor air pathway, followed in order by direct contact, leaching to groundwater and the outdoor air pathways.

4.3.1 Site 380A

4.3.1.1 Soil Leaching to Groundwater Pathway

Table 4-1 presents the RBSLs developed for the soil leaching to groundwater pathway for a residential scenario at Site 380A. RBSLs ranged from approximately 4,000 to almost 19,000 mg TPH/kg soil, with an average value of approximately 12,000 mg/kg. This wide range of RBSLs demonstrates how small variations in TPH distribution can affect calculated RBSLs. For this pathway, the hazard indices are all much less than the target risk level of 1.0.

Table 4-1 Residential Exposure via the Soil Leaching to Groundwater Pathway - Site 380A

Sample ID	Total TPH* (mg/kg)	RBSL (mg/kg)	Hazard Index
380SB-02B-15	437	11,363	0.04
380SB-02B-20	158**	4,107	0.04
380SB-02B-21	402	10,453	0.04
380SB-02B-32	1,201	18,803	0.06
380SB-02B-33	1,346	15,730	0.09
	Average:	12,091	0.05
	Standard Deviation:	5,596	0.02

NOTES:

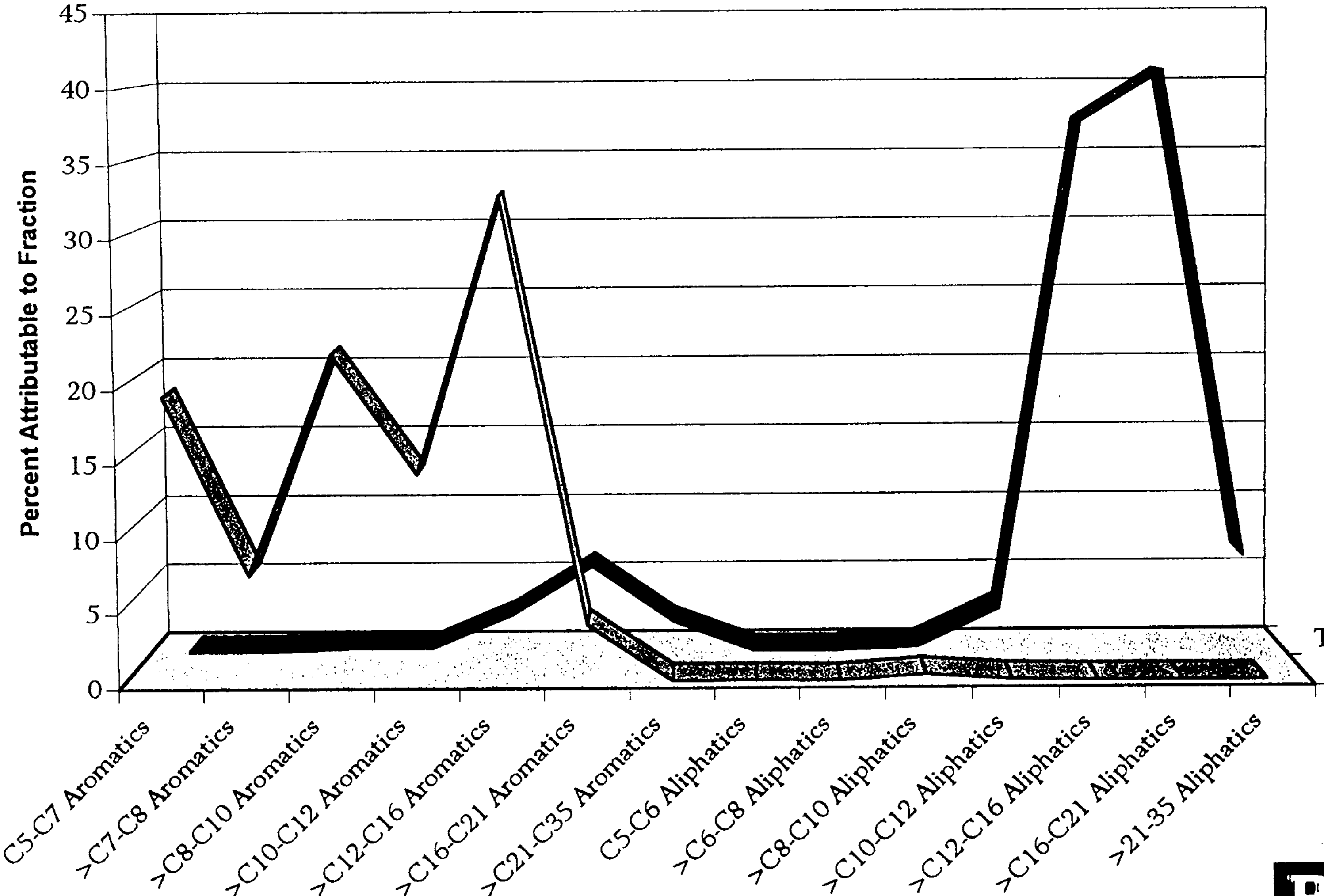
* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

** For this sample, only one fraction was above the detection limit; 101 mg/kg (of the total 158 mg/kg) comes from non-detect results (using ½ detection limits). RBSLs from this sample may not be representative.

Figure 4-2 shows how each TPH fraction contributes to the overall risk. Sample 380SB-02B-32 was selected for illustration purposes because results from most other samples from boring 380SB-02B were largely non-detect. In this graph, the "closer" line indicates the percent of the total hazard index (equal to the hazard quotient for each fraction) attributable to each TPH fraction, while the second line shows the distribution of TPH fractions measured in the sample. Note that although the last two aliphatic fractions were combined for the RBSL calculations, the hazard quotient was split proportionally between these fractions in this figure.

For the leaching to groundwater pathway, it is clear that the majority of the risk (over 99%) comes from the aromatic fractions, while these fractions account for only 12 percent of the total TPH from this sample. Interestingly, the four lightest aromatic fractions were all non-detect in this sample; however, because one-half of the detection limit was used for calculation purposes, these four fractions account for almost 63 percent of the risk. The effects of detection limits, especially for the lighter aromatic fractions, will be discussed further in Section 4.3.4.2. Finally, although the heavier aliphatics (EC>12–35) account for over 85 percent of the total TPH, they account for less than 1 percent of the risk in this pathway. The lower water solubility of the aliphatic fractions and the greater solubility of the lighter aromatics account for this apparent discrepancy in risk apportionment.

Figure 4-2 TPH Fraction vs. Hazard Quotient for Leaching to Groundwater Building 380A - (Sample 380-SB02B-32)



4.3.1.2 Direct Contact Pathway

Table 4-2 presents RBSLs derived for the direct contact pathway in a residential scenario at Site 380A. RBSLs ranged from 5,000 to over 10,000 mg/kg (with an average value of approximately 7,700 mg/kg). The target hazard index of 1.0 was not exceeded for this pathway at this location.

Table 4-2 Residential Exposure via the Direct Contact Pathway - Site 380A

Sample ID	Total TPH* (mg/kg)	RBSL (mg/kg)	Hazard Index
380SB-02B-15	437	5,113	0.09
380SB-02B-20	158**	6,475	0.02
380SB-02B-21	402	6,345	0.06
380SB-02B-32	1,201	9,909	0.12
380SB-02B-33	1,346	10,542	0.13
	Average:	7,677	0.08
	Standard Deviation:	2,397	0.04

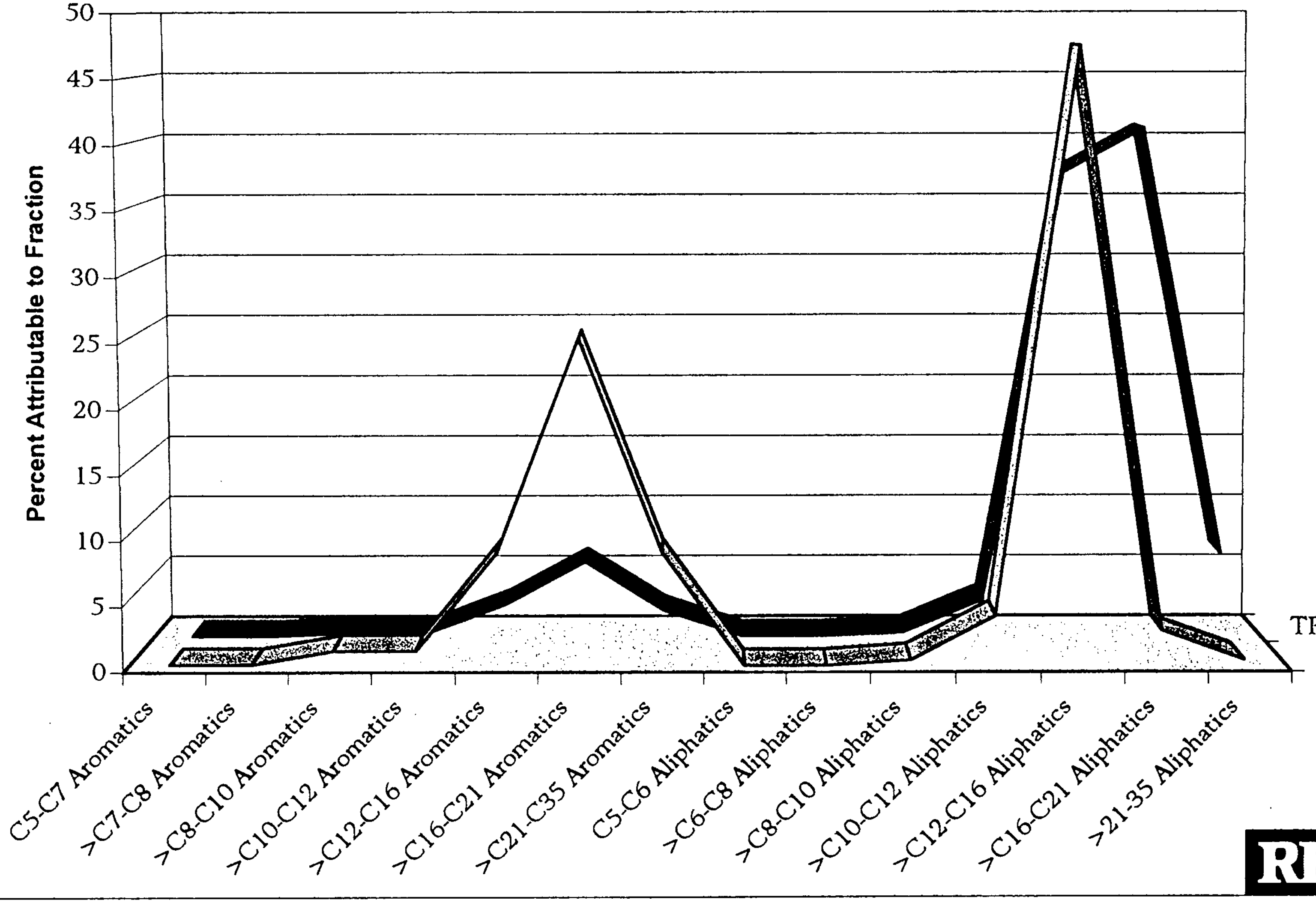
NOTES:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

** For this sample, only one fraction was above the detection limit; 101 mg/kg (of the total 158 mg/kg) comes from non-detect results (using ½ detection limits). RBSLs from this sample may not be representative.

Figure 4-3 illustrates the percentage of total risk attributable to each TPH fraction for the direct contact pathway. Because direct contact with soils does not require cross-media migration, the percentage of risk attributable to each TPH fraction tends to mimic the distribution of TPH. However, the aromatic fractions, which account for 12 percent of the total TPH, account for 45 percent of the total risk and the aliphatics, which account for 88 percent of the total TPH, account for only 56 percent of the risk. Moreover, it is the heavier (EC>12 aromatics and EC>10–21 aliphatics) fractions which contribute the majority (97%) of the overall risk. This result is due to the greater relative abundance and relatively high toxicity (low RfDs) of these fractions. Note that for the direct contact pathway (unlike the leaching pathway), non-detect fractions had little impact on the RBSLs.

Figure 4-3 TPH Fraction vs. Hazard Quotient for Direct Contact with Soils Building 380A - (Sample 380-SB02B-32)



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4.3.1.3 Volatilization Pathways

Table 4-3 presents RBSLs for the volatilization to indoor and outdoor air pathways for residential scenarios at Site 380A. Under these scenarios, corrective action screening levels ranging from approximately 560 to over 630,000 mg/kg TPH were calculated. The lower end of this range represents values determined for the volatilization to indoor air pathway. The upper limit was developed for the volatilization to outdoor air pathway. As in the other pathways evaluated, the target risk level of 1.0 was not exceeded for these scenarios. In fact, the majority of the calculated hazard indices are 0.1 or less, with the greatest hazard indices ranging from 0.28 to 0.64 for the volatilization to indoor air pathway.

Table 4-3 Residential Exposure via Volatilization to Indoor and Outdoor Air - Site 380A

Sample ID	**Total TPH* (mg/kg)**	**RBSL *Indoor* (mg/kg)**	**Hazard Index *Indoor***	**RBSL *Outdoor* (mg/kg)**	**Hazard Index *Outdoor***
380SB-02B-15	437	1,533	0.29	631,700	0.001
380SB-02B-20	158**	557	0.28	228,302	0.001
380SB-02B-21	402	1,410	0.29	581,095	0.001
380SB-02B-32	1,201	1,872	0.64	227,556	0.005
380SB-02B-33	1,346	2,239	0.60	185,952	0.007
	Average:	1,522	0.42	370,921	0.0029
	Standard Deviation:	629	0.19	216,383	0.0031

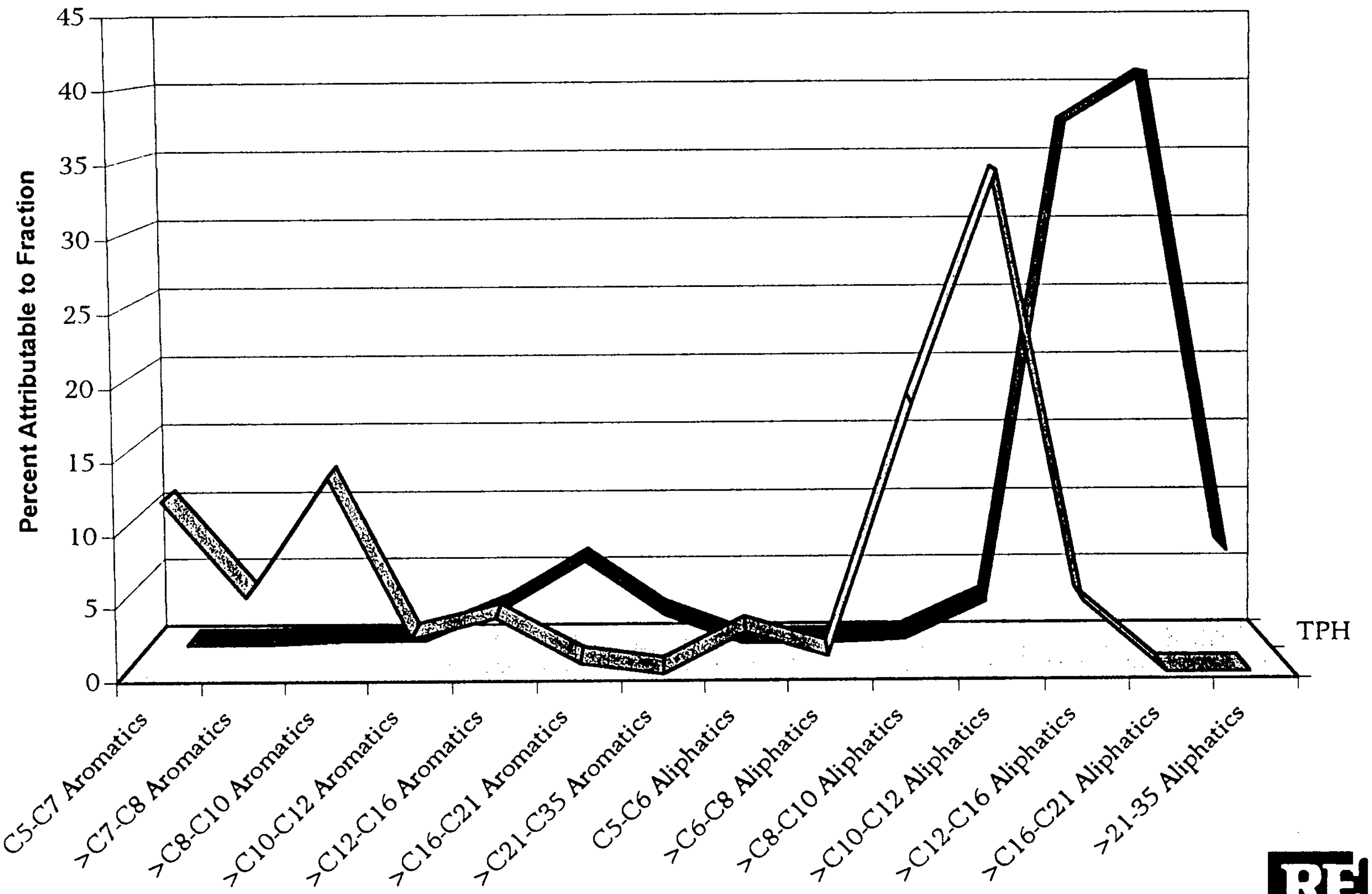
NOTES:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

** For this sample, only one fraction was above the detection limit; 101 mg/kg (of the total 158 mg/kg) comes from non-detect results (using ½ detection limits). RBSLs from this sample may not be representative.

Risk associated with the volatilization to indoor air pathway is illustrated in Figure 4-4. The risk is derived mostly (78%) from the EC>8–16 aromatic and aliphatic fractions, which comprise only 44 percent of the total TPH. This result is due to the greater volatility of the lighter fractions, which allows for increased transfer from soil to the gas phase, and subsequent migration to indoor air. As was true in the leaching pathway, although the lightest aromatic fractions were non-detect, they are responsible for over 17 percent of the risk (using half the detection limit for the RBSL calculations).

Figure 4-4 TPH Fraction vs. Hazard Quotient for Volatilization to Indoor Air Building 380A - (Sample 380-SB02B-32)



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4.3.2 Site 529

Under the residential scenarios evaluated from the Building 529 soil boring data, RBSLs ranged from 660 mg/kg to greater than 100 percent TPH. The trends in RBSLs from this location are similar to those from the Building 380A location. The lowest and highest RBSLs were derived for the volatilization to indoor and outdoor air pathways, respectively, and the RBSLs for each pathway were similar to those developed for Site 380A.

At Site 529, however, the target risk level of a 1.0 hazard index was exceeded in many instances for both the direct contact and indoor air pathways, with the calculated hazard indices ranging up to 12.66. In cases where a hazard index of 1.0 is exceeded, corrective actions would be warranted unless a Tier 2 evaluation using site-specific input parameters showed the observed contaminant levels to be protective of residents under the exposure pathways of concern.

4.3.2.1 Soil Leaching to Groundwater Pathway

Residential RBSLs for the leaching to groundwater pathway for Site 529 are presented in Table 4-4. The RBSLs range from approximately 7,500 to over 25,000 mg TPH/kg soil, with an average value of almost 13,000 mg/kg. None of the hazard indices exceeds the target of 1.0 for this pathway.

Table 4-4 Residential Exposure via the Soil Leaching to Groundwater Pathway - Site 529

Sample ID	Total TPH* (mg/kg)	RBSL (mg/kg)	Hazard Index
529SB-04-20	3,879	15,946	0.24
529SB-04-60	7,284	11,320	0.64
529SB-04-80	5,175	10,727	0.48
529SB-04-95	6,618	20,711	0.32
529SB-05-20	8,350	12,781	0.65
529SB-05-25	7,464	11,967	0.62
529SB-05-50	8,332	10,769	0.77
529SB-05-75	1,377	8,512	0.16
529SB-05-77	1,943	7,496	0.26
529SB-05-100	8,504	18,915	0.45
	Average:	12,914	0.46
	Standard Deviation:	4,315	0.21

NOTES:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

Figure 4-5 shows the percent of total risk for this pathway attributable to each TPH fraction for one sample (529SB-04-20) from Site 529. The distributions from this sample were similar to those of other samples from this site, so it was chosen for illustration purposes. Similar to that of Site 380A, the majority (92%) of the risk for the leaching pathway is derived from the >EC8 to EC16 aromatic fractions, although these fractions comprise approximately 13 percent of the total TPH measured. Unlike the risk distribution from Site 380A (Figure 4-2), however, the non-detect values for the lighter aromatics do *not* contribute in an appreciable way to the overall risk. This is most probably due to the combination of lower detection limits and higher total TPH concentrations; one-half the detection limit for each of these fractions is negligible (approximately 0.01%) compared to the total TPH concentration. The effects of detection limits for the benzene and toluene fractions will be discussed further in Section 4.3.4.2.

4.3.2.2 Direct Contact Pathway

Table 4-5 presents RBSLs for the direct contact residential exposure scenarios for Site 529. The RBSLs range from approximately 5,500 to 6,500 mg/kg, with an average of 6,100 mg/kg. The RBSLs for this pathway at this site are not as variable as those derived for other pathways or at Site 380A. The similar TPH fraction distributions from these samples most likely contribute to this consistency.

For this pathway, six samples exceed the target risk level of a hazard index of 1.0. In these cases, some corrective action or a Tier 2 evaluation would be warranted.

Figure 4-5 TPH Fraction vs. Hazard Quotient for Leaching to Groundwater Building 529 - (Sample 529-SB04-20)

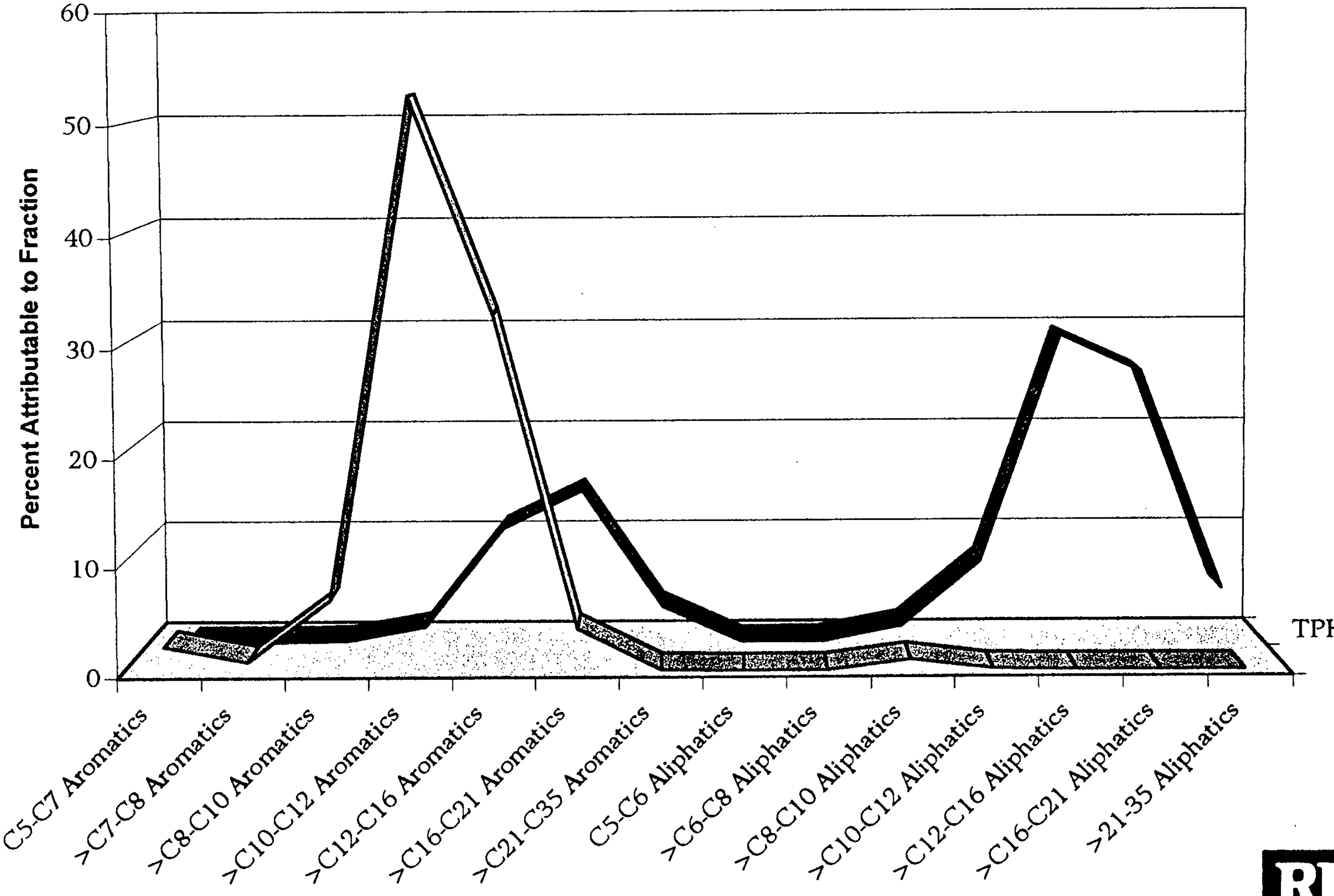


Table 4-5 Residential Exposure via the Direct Contact Pathway - Site 529

Sample ID	Total TPH* (mg/kg)	RBSL (mg/kg)	Hazard Index
529SB-04-20	3,879	5,910	0.66
529SB-04-60	7,284	5,718	***1.27***
529SB-04-80	5,175	6,405	0.81
529SB-04-95	6,618	6,501	***1.02***
529SB-05-20	8,350	5,597	***1.49***
529SB-05-25	7,464	5,844	***1.28***
529SB-05-50	8,332	5,976	***1.39***
529SB-05-75	1,377	6,294	0.22
529SB-05-77	1,943	6,205	0.31
529SB-05-100	8,504	6,564	***1.30***
	Average:	6,101	0.97
	Standard Deviation:	339	0.46

NOTES:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

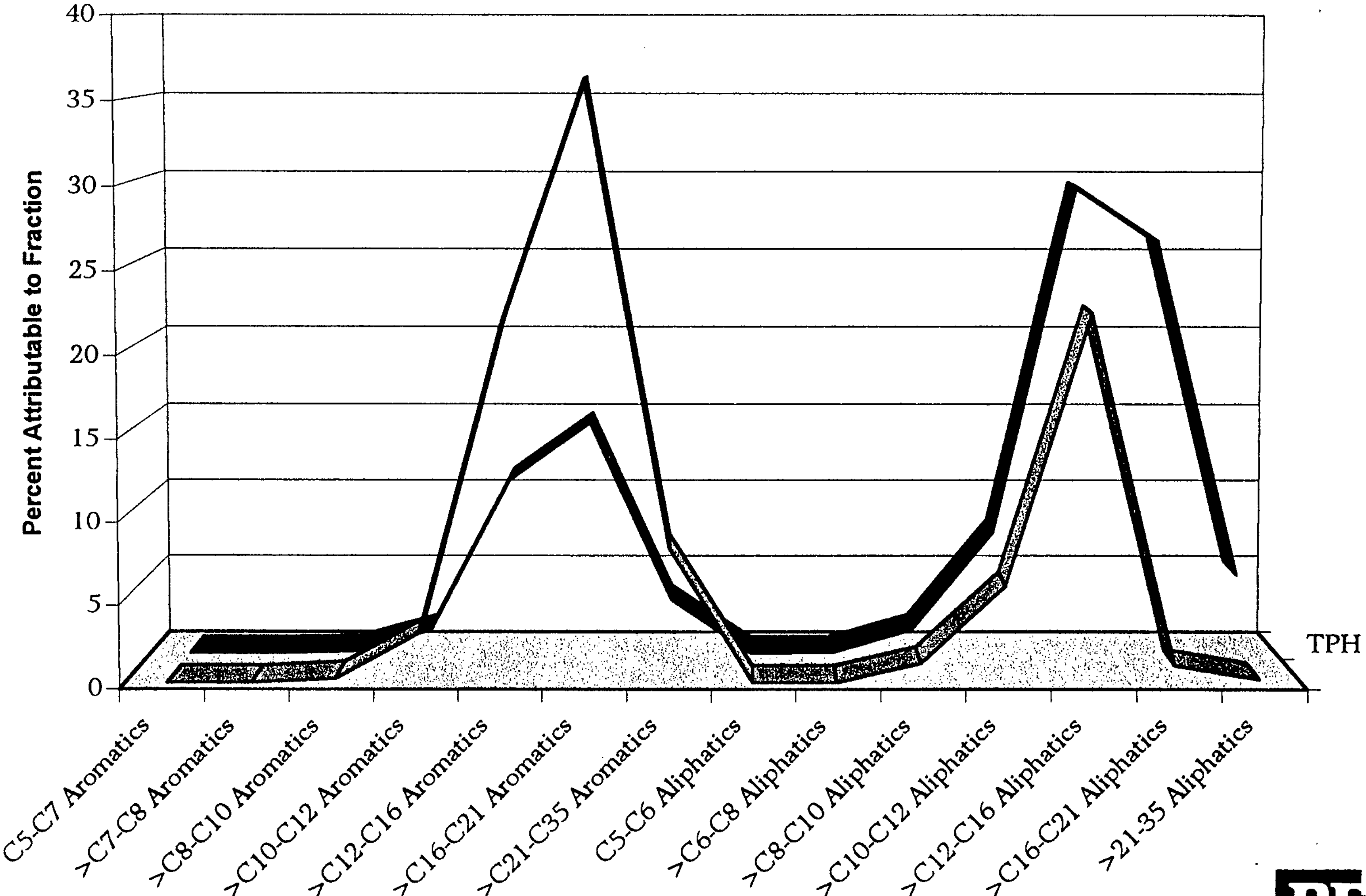
Figure 4-6 shows the risk attributable to each TPH fraction for the direct contact pathway. The distribution of risk is similar (although somewhat exaggerated) to the distribution of TPH for this pathway since there is no cross-media transport affecting exposure under this scenario. As was the case for Site 380A, the majority of the risk (98%) is associated with the heavier (EC>10 aromatics and EC>10–21 aliphatics) fractions. Moreover, 70 percent of the risk is derived from the aromatic fractions alone, which comprise only 30 percent of the total TPH. The proportionally higher risk distribution for these fractions (aromatics over aliphatics and heavier over lighter fractions) arises from their relatively higher toxicity (see Table 1-3).

4.3.2.3 Volatilization Pathways

RBSLs for the volatilization pathways are presented in Table 4-6. These values range from less than 700 mg/kg for indoor air to over 100 percent TPH for outdoor air. Each of these pathways produces a wide range of RBSLs, illustrating the sensitivity of these pathways to variations in TPH distribution.

All hazard indices for indoor air exceed the target value of 1.0 for this site, while none exceed 1.0 for outdoor air at this site. The model for vapor transport is an extremely conservative one (described in more detail in Appendix B), so it is not surprising that this pathway would result in the highest hazard indices (and

Figure 4-6 TPH Fraction vs. Hazard Quotient for Direct Contact with Soils Building 529 - (Sample 529-SB04-20)



lowest RBSLs). Due to the highly conservative nature of this model, a Tier 2 evaluation would most likely be warranted in order to derive more realistic cleanup levels for residential exposures at the site.[4]

Table 4-6 Residential Exposure via Volatilization to Indoor and Outdoor Air - Site 529

Sample ID	Total TPH* (mg/kg)	RBSL *Indoor* (mg/kg)	Hazard Index *Indoor*	RBSL *Outdoor* (mg/kg)	Hazard Index *Outdoor*
529SB-04-20	3,879	855	***4.54***	>100%	NA
529SB-04-60	7,284	777	***9.37***	261,819	0.028
529SB-04-80	5,175	811	***6.38***	222,709	0.023
529SB-04-95	6,618	1,400	***4.73***	>100%	NA
529SB-05-20	8,350	928	***9.00***	434,688	0.019
529SB-05-25	7,464	797	***9.37***	383,217	0.019
529SB-05-50	8,332	658	***12.66***	288,328	0.029
529SB-05-75	1,377	810	***1.70***	132,380	0.010
529SB-05-77	1,943	729	***2.67***	115,757	0.017
529SB-05-100	8,504	1,300	***6.54***	490,372	0.017
	Average:	907	6.70	432,927	0.017
	Standard Deviation:	245	3.42	322,184	0.008

NOTES:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

Figure 4-7 illustrates each fraction's relative contribution to overall risk for the volatilization to indoor air pathway. The majority of the risk (78%) is derived from the EC>8–12 aliphatic fractions, which comprise only 9 percent of the total TPH. These fractions combine relatively high toxicity and volatility, so that they tend to be more important contributors to the risk calculations for volatilization. The aromatic fractions with similar vapor pressure are relatively toxic, but are present in much lower concentrations than the aliphatic fractions.

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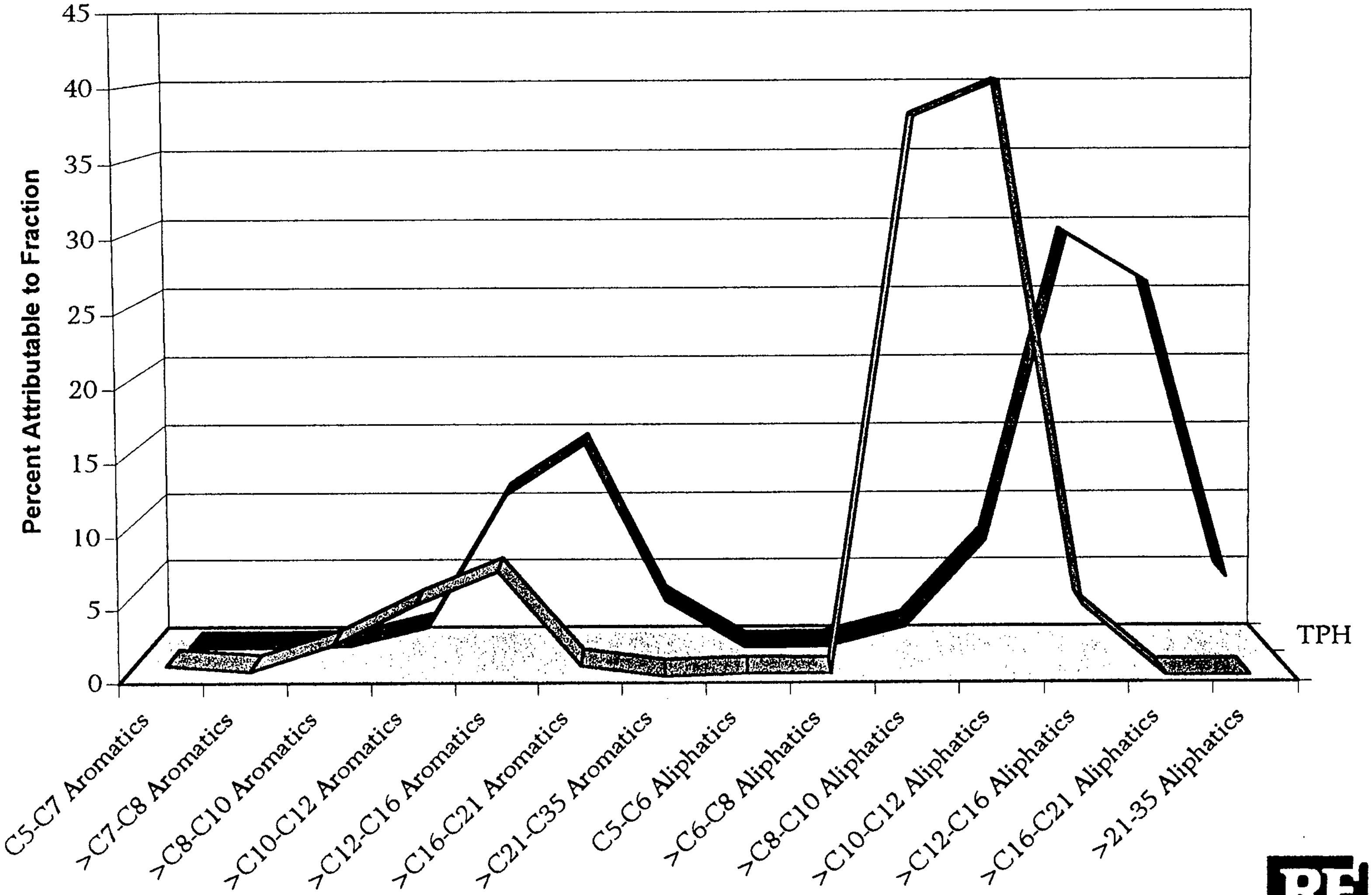
[4] Alternatively, since a commercial exposure scenario is currently the more appropriate one, commercial RBSLs would be used to derive cleanup levels.

Figure 4-7 TPH Fraction vs. Hazard Quotient for Volatilization to Indoor Air Building 529 - (Sample 529-SB04-20)



4.3.3 Commercial RBSLs

RBSLs derived for commercial exposure scenarios are included in Appendix D and are summarized in Table 4-7. These scenarios are currently more appropriate for the El Toro facility, although residential exposures often drive cleanup because they produce lower RBSLs than commercial scenarios.

As expected, commercial RBSLs are higher than residential RBSLs. In general, residential RBSLs are at least three times lower than the commercial RBSLs, due to the different assumptions of exposure frequency for each scenario (see assumptions and default input parameters included in Appendix B). However, the commercial RBSLs do follow the same trends as the residential RBSLs, with the highest and lowest RBSLs generated for the volatilization to outdoor and indoor air pathways, respectively.

Under the commercial scenarios at Site 380A, the RBSLs developed range from 1,486 mg/kg to greater than 100 percent TPH. In these scenarios, the lowest RBSLs were derived for the volatilization to indoor air pathway. The hazard indices ranged from 0.0003 to 0.22, much less than the target risk level of 1.0.

RBSLs for the commercial exposure scenarios at Site 529 ranged from approximately 1,500 mg/kg to greater than 100 percent TPH for the indoor and outdoor air pathways, respectively. In the commercial scenarios, only the volatilization to indoor air pathway provided hazard indices appreciably greater than 1.0. One sample for the direct contact pathway barely exceeded the target risk level, with a hazard index of 1.01.

Table 4-7 Average Commercial RBSL Values for Applicable Pathways at MCAS El Toro

Site	Soil to Indoor Air	Direct Contact	Soil to Groundwater	Soil to Outdoor Air
380A	4,300 (1,500-6,300)	10,200 (7,600-15,600)	46,100 (15,400-72,500)	616,900 (271,500->100%)
529	3,100 (2,000-5,700)	9,000 (8,300-9,600)	80,000 (29,000-202,900)	567,500 (172,500->100%)

NOTE:
Values are in mg/kg. Ranges are in parentheses.

4.3.4 Effects of Detection Limits on RBSLs

As discussed above, when evaluating each TPH fraction's respective contribution to overall risk, it was shown that non-detect results, when entered as one-half the detection limit for calculation purposes, sometimes accounted for a significant portion of the overall risk. For instance, although the EC5–7 aromatic fraction was non-detect in sample 380-SB02B-32, this fraction accounted for almost 20 percent of the overall risk in deriving the RBSL for the leaching to groundwater pathway. This result is unexpected and is clearly an artifact of the use of one-half the detection limit for conservatism in calculations. This result also demonstrates the sensitivity of this pathway to the concentration of the lightest aromatics.

Because non-detect results can greatly affect RBSL values, a qualitative sensitivity analysis was performed to gain some understanding of which fractions appear to have the greatest impact on RBSLs. This analysis can provide guidance in dealing with non-detect values in future analyses. This sensitivity analysis is by no means comprehensive. A more rigorous, statistical analysis of the effects of detection limits on RBSLs may be warranted in future demonstration projects.

4.3.4.1 Risk Apportionment

First, to better understand the relationship between each TPH fraction and risk for different pathways, RBSLs were calculated for a hypothetical sample containing equal concentrations of all TPH fractions. The portion of risk attributable to each fraction for the leaching, volatilization to indoor air, and direct contact pathways are illustrated in Figures 4-8 to 4-10, respectively.

For the leaching to groundwater pathway (Figure 4-8), it is clear that the lighter aromatics can have the largest impact on the RBSL values. This result is not unexpected, because these fractions are by far the most soluble, and therefore partition more easily to groundwater. Moreover, they have higher toxicity values (Table 1-3) than the aliphatics of equivalent carbon numbers. Although the lighter aromatics have slightly lower toxicity (higher RfD values) than the heavier aromatics, the greater mobility (i.e., solubility) of the lighter aromatics causes these fractions to have a much greater impact on the RBSLs for the leaching pathway.

Similar trends are shown for the volatilization to indoor air pathway (Figure 4-9). Because lighter compounds have higher vapor pressures (and equivalent carbon numbers are normalized to this property), they will partition more easily to the vapor phase. Thus, for this pathway, unlike the leaching pathway, the lighter aliphatics can have a significant impact on the RBSL. However, if present in

Figure 4-8 TPH Fraction vs. Hazard Quotient for Leaching to Groundwater

All Fractions Present in Equal Concentrations

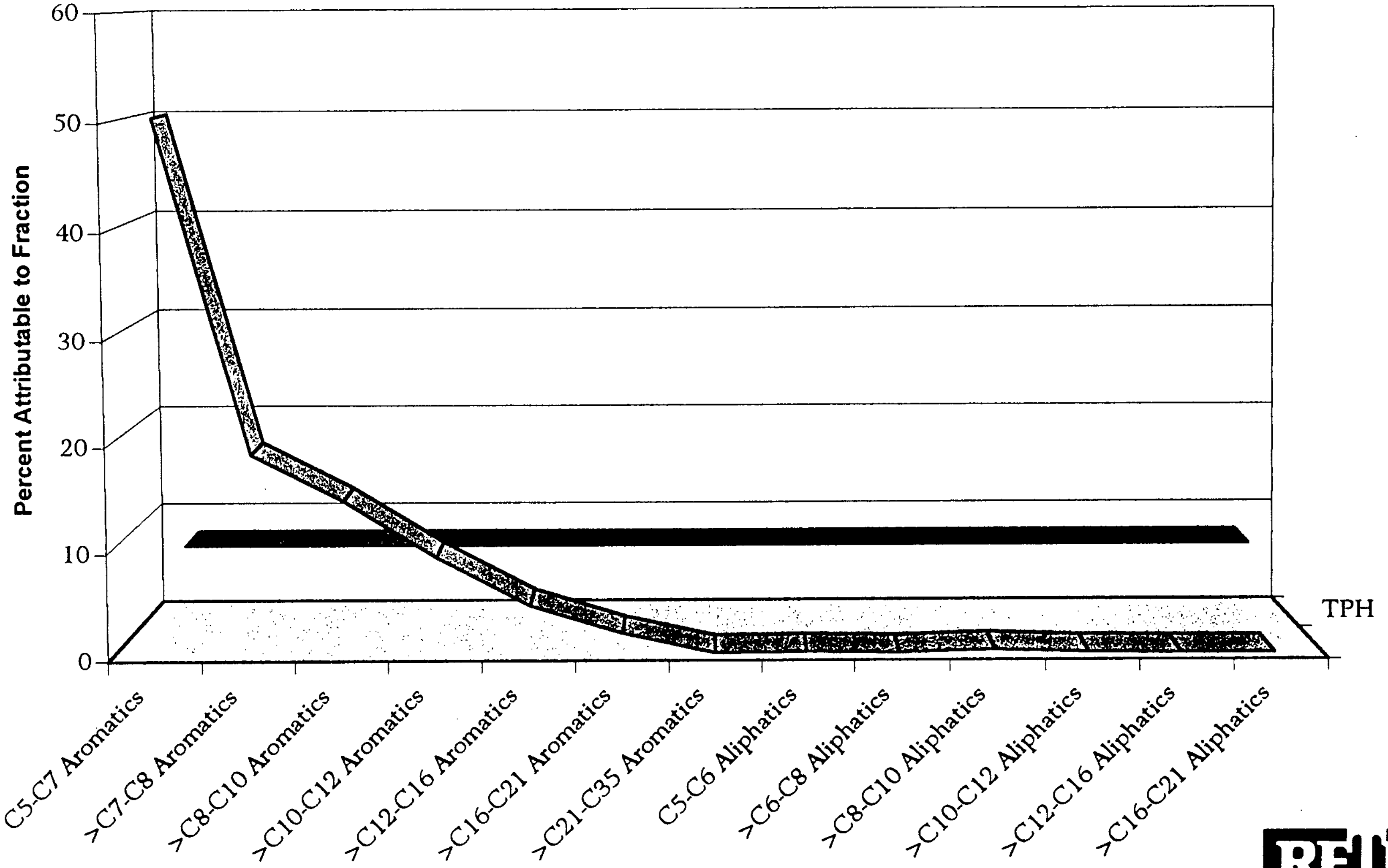


Figure 4-9 TPH Fraction vs. Hazard Quotient for Volatilization to Indoor Air
All Fractions Present in Equal Concentrations

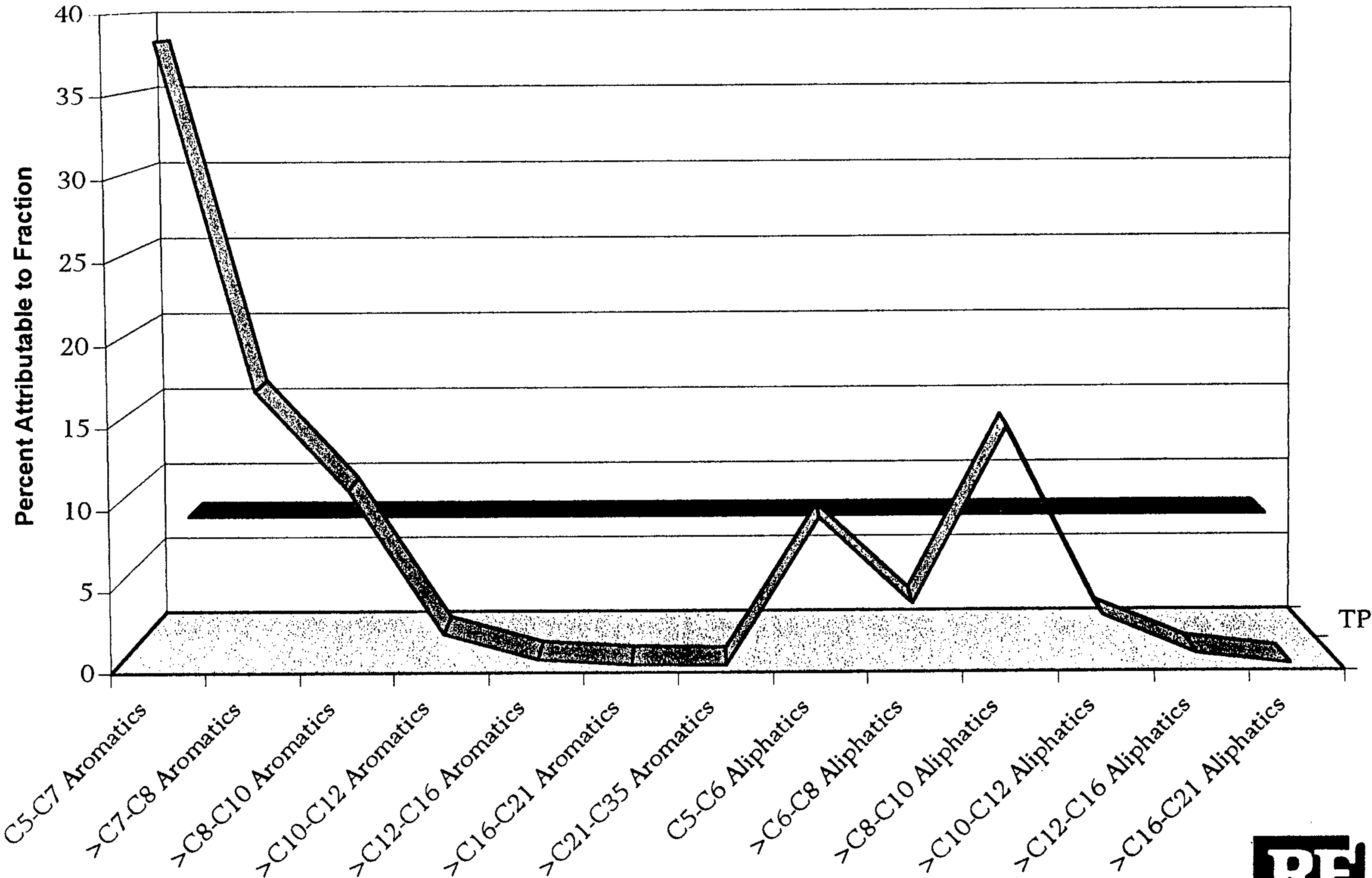
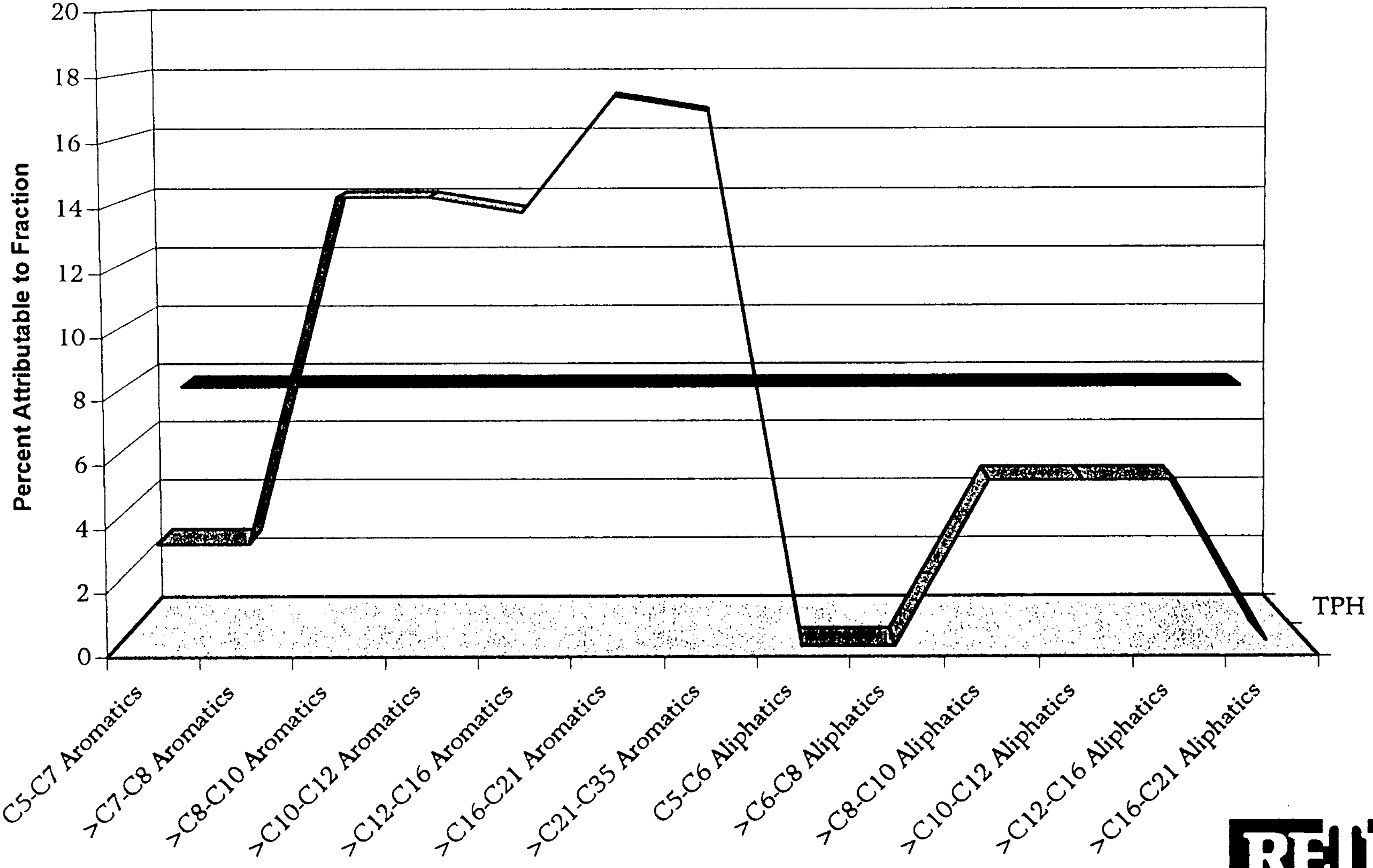


Figure 4-10 TPH Fraction vs. Hazard Quotient for Direct Contact with Soils

All Fractions Present in Equal Concentrations



equal concentrations, the light aromatics can still contribute more risk, overall, than the light aliphatics, as a result of their lower RfC values.

Finally, risk derived for the direct contact pathway is not dependent upon partitioning. The relative risk for each fraction is therefore proportional to its relative toxicity. Thus, for this pathway, the fractions which contribute the most to the overall risk are those with the lowest RfD values (i.e., the middle to heavy aromatics and the middle range aliphatics; Table 1-3).

Thus, the importance of precision in determining the concentration of a specific fraction depends on which pathways are driving cleanup at a particular site. This conclusion has implications for handling non-detect results. For conservatism, one-half the detection limit is generally used for these values. However, for particularly sensitive fractions, using one-half the detection limit when the detection limit is large compared to the total TPH concentration may artificially affect the calculated RBSL. To illustrate the effects of various fractions in more "real world" TPH distributions, rather than the artificial, uniform distribution examined above, two samples, one with a relatively high total TPH concentration (529SB-05-50 with 8,333 mg/kg TPH) and one with a relatively low total TPH concentration (380SB-02B-32 with 1,201 mg/kg), were chosen for further analysis.

4.3.4.2 Effect of Light Aromatic Detection Limits

Because the lighter aromatics appear to have the potential for such dramatic impacts on RBSLs for both volatilization and leaching pathways, and because these fractions are often not detected (either due to the nature of the petroleum mixture or because they are no longer present in weathered products), the effect of the detection limit for the two lightest aromatic fractions (EC5–7 and EC>7–8) was evaluated first. RBSLs for the leaching, volatilization to indoor air and direct contact pathways were calculated using detection limits ranging from 0 to approximately 10 percent of the total TPH concentration for each of the two samples. The resulting RBSLs were plotted versus the detection limit (as a percentage of TPH concentration) and are shown in Figures 4-11 and 4-12.

Figure 4-11 RBSL vs. Detection Limit (Sample 380SB-02B-32)

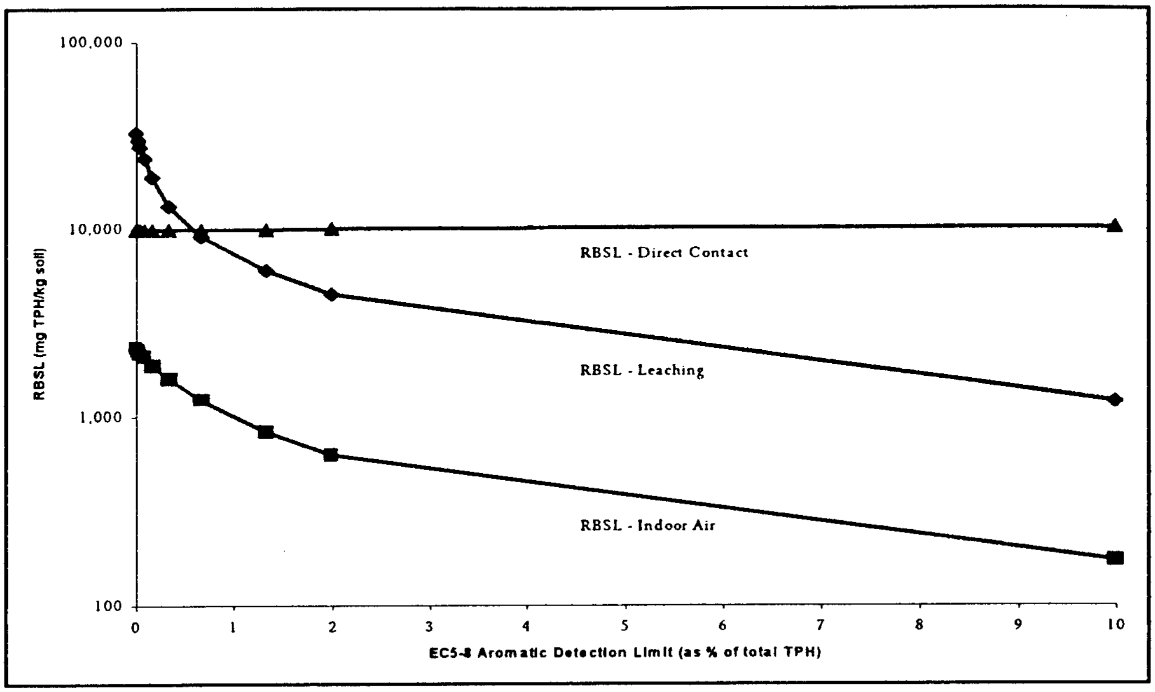
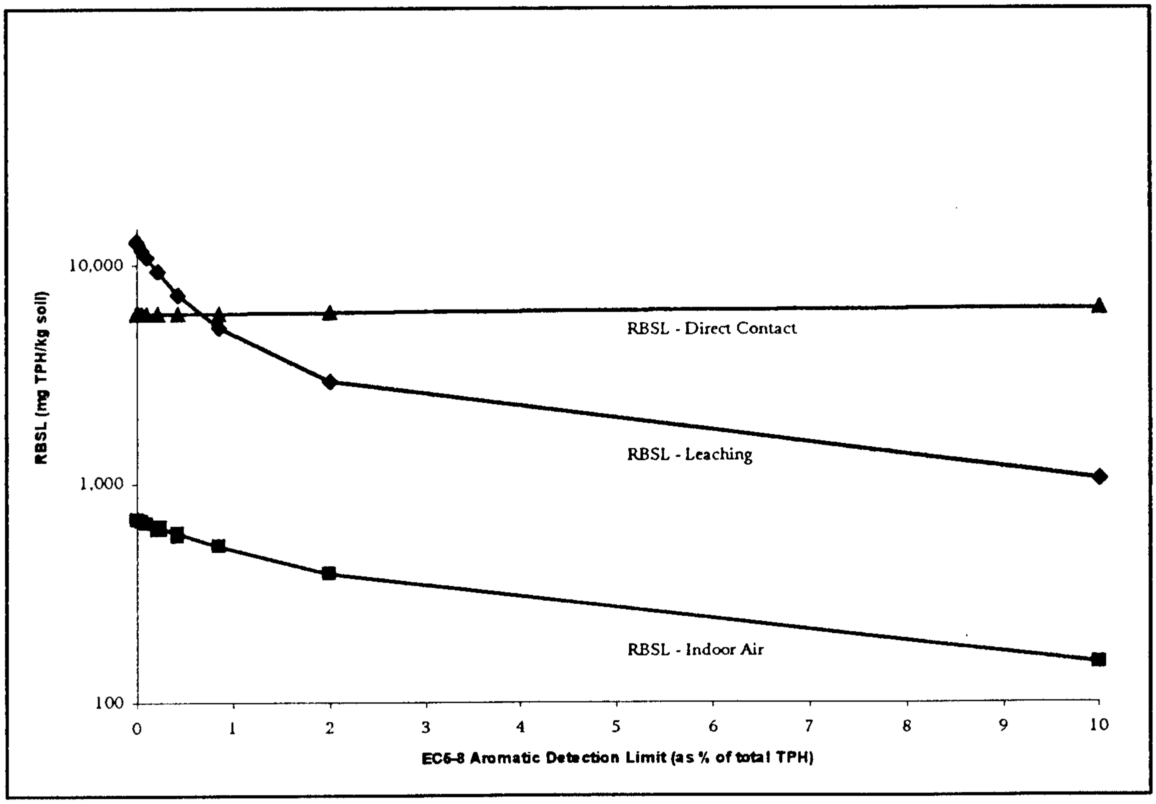


Figure 4-12 RBSL vs. Detection Limit (Sample 529SB-05-50)



Each graph shows similar trends. RBSLs for the leaching and volatilization to indoor air pathways are impacted by changes in the aromatic detection limit, while the RBSL for the direct contact pathway remains largely unchanged with changes in the detection limit used.

The RBSL for the leaching pathway is greatly impacted by the values used for these fractions. For the sample from Site 380A, the RBSL for this pathway ranges from over 30,000 to almost 1,000 mg/kg when values ranging from 0 to 10 percent of the TPH concentration are used as the detection limits[5] for the lightest aromatic fractions. Likewise, the RBSLs for the sample from Site 529 range from over 12,000 to almost 1,000 mg/kg over the same range of detection limits.

RBSLs for the indoor air pathway were similarly impacted. With detection limits ranging from 0 to approximately 10 percent of the TPH concentrations, RBSLs for this pathway range from over 2,000 to less than 200 mg/kg for the sample from Site 380A, and from almost 700 to 150 mg/kg for the sample from Site 529.

In situations where either of these pathways is driving cleanup, the effect on RBSLs of values used to represent non-detect aromatic data can significantly impact cleanup. For instance, order of magnitude differences in calculated RBSLs could greatly affect soil volumes targeted for excavation. It is therefore important to use values which are as accurate as possible. By using a lower detection limit, more precise values can be incorporated into the RBSL calculations. It is not clear at this time precisely how low a detection limit is needed to ensure accurate results. Certainly, light-end aromatic detection limits on the order of 1 percent of the total TPH concentration can produce artificially low RBSLs which may, in fact, be driven by non-detect values. Detection limits on the order of 0.1 percent of the total TPH concentration may be sufficient to avoid this problem. Alternatively, because the lightest two aromatic fractions correspond to benzene and toluene, respectively, GC/MS analysis (EPA Methods 8240 or 8260) could be used to specifically analyze for these compounds.

4.3.4.3 Effect of Light Aliphatic Detection Limits

Because lighter aliphatic compounds appear to contribute to the risk associated with volatilization pathways, a similar evaluation was performed by calculating RBSLs with a range of detection limits for the lightest two aliphatic fractions (EC5–6 and EC>6–8) for samples with non-detect results for these fractions. Figures 4-13 and 4-14 present the RBSLs as a function of aliphatic detection limits (as a percentage of TPH concentration).

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[5] One-half the detection limit was used for the fraction concentrations in calculating RBSLs. Thus, input concentrations ranged from 0 to approximately 5 percent of the TPH concentration.

Figure 4-13 RBSL vs. Detection Limit (Sample 380SB-02B-32)

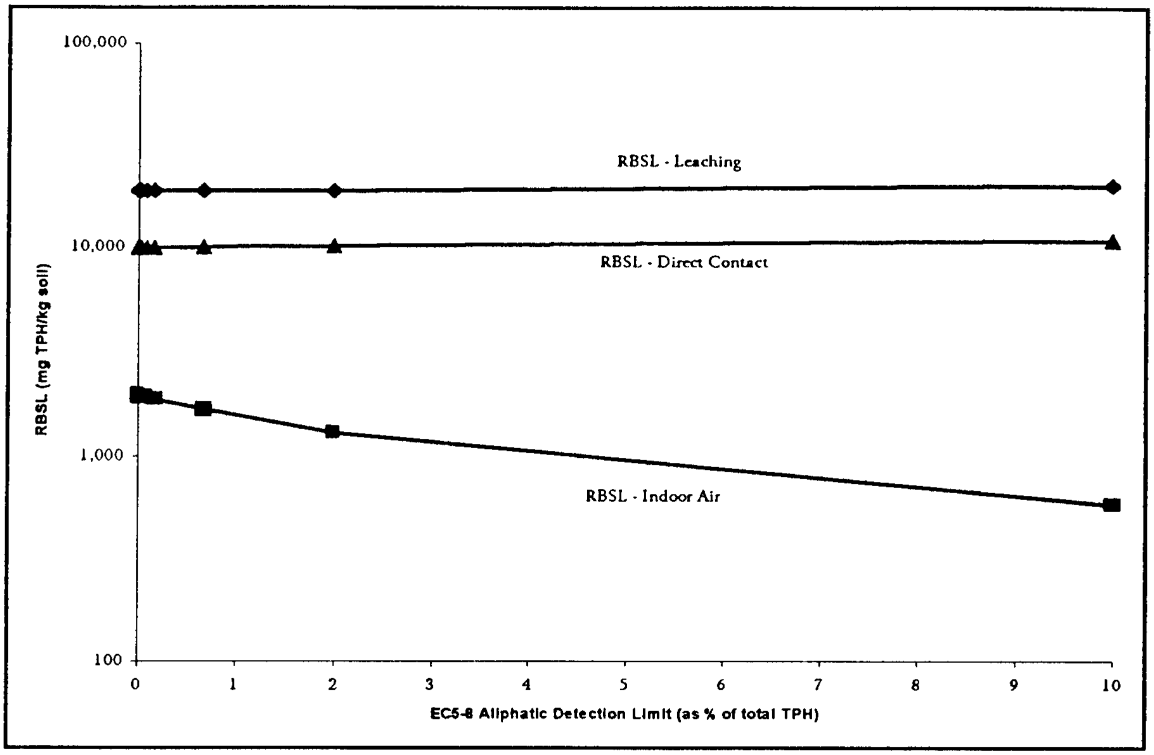
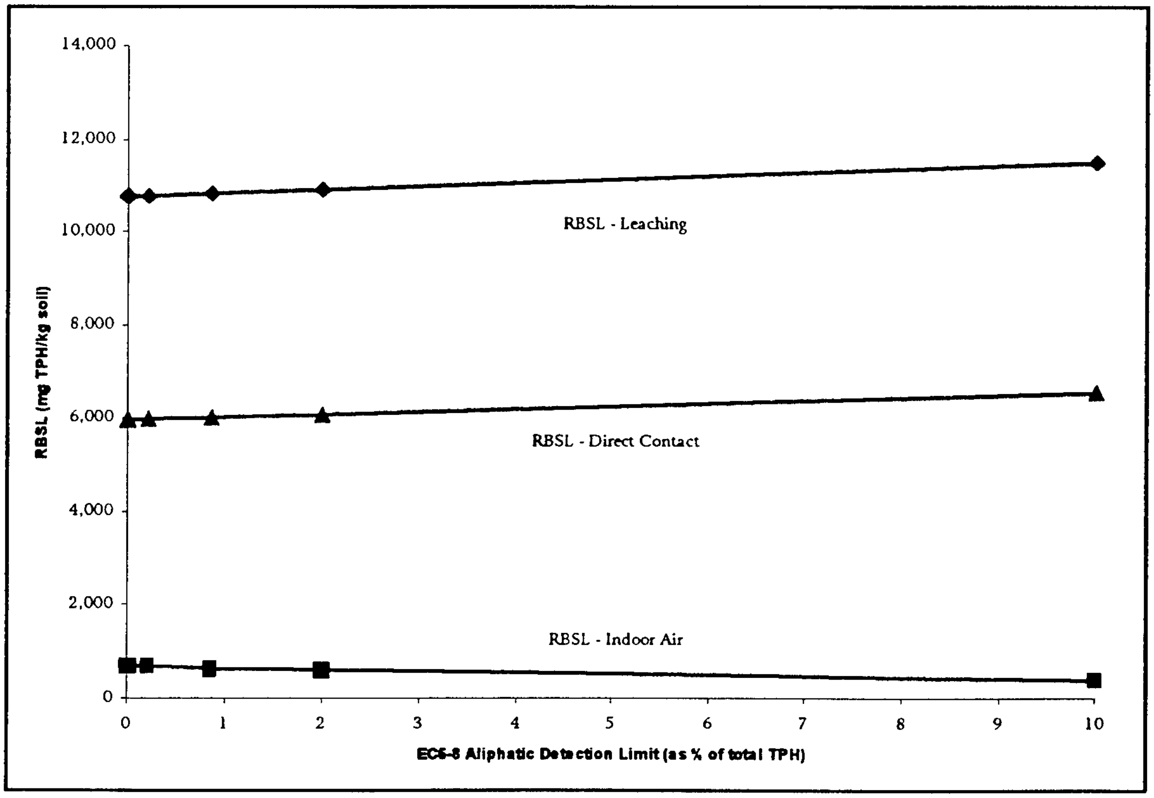


Figure 4-14 RBSL vs. Detection Limit (Sample 529SB-05-50)



For these samples, using detection limits for the lightest aliphatic fractions that ranged from 0 to approximately 10 percent of TPH concentration had little impact on the calculated RBSLs. The RBSL for vapor transport showed some sensitivity to these fractions, but it was much more sensitive to the light aromatic fractions. Thus, in this case, non-detect results for these fractions will not greatly influence cleanup at these sites, regardless of which pathway drives cleanup. This analysis may not apply at all sites; rather, it may be a function of the composition of the material at these sites. For instance, at a site with significantly lower aromatic concentrations, the aliphatic detection limits may have a greater impact on RBSLs.

4.4 Selection of Cleanup Levels

In general, the lowest RBSLs are chosen as cleanup levels at a site. At these locations, the cleanup levels would therefore be 560 and 660 mg/kg at Sites 380A and 529, respectively. These cleanup levels are based on residential exposure via the volatilization to indoor air pathway. If commercial exposures only are considered, the cleanup levels would be 1,500 and 2,000 mg/kg at Sites 380A and 529, respectively.

4.4.1 Site 380A

At Site 380A, the cleanup level based on residential exposure scenarios is derived from sample 380SB-02B-20, which contained only one fraction above detection limits. It could easily be argued that an RBSL based almost entirely on non-detect data is not representative for the site. Disregarding this sample, the cleanup level at Site 380A increases to 1,400 mg/kg. None of the samples submitted for fractionation analysis contains TPH above this level, but some of the samples analyzed by conventional methods contain TPH above this concentration. However, as noted in Section 3.4, a poor correlation was obtained between TPH results from the two methods. Therefore, comparing TPH results by Method 8015 to an RBSL obtained using TPH results by the Direct Method, in this instance, is not appropriate.

The generally poor correlation between methods will pose a problem at any site where historical TPH data are compared to cleanup levels. If a statistically significant correlation between results from the two analytical methods could be demonstrated, cleanup levels based on conventional methods could be inferred. However, in the absence of such a correlation, it is unclear how conventional data should be used to set cleanup levels and to evaluate compliance with those criteria.

4.4.2 Site 529

At Site 529, all of the samples submitted for fractionation analysis exceed the lowest calculated RBSL of 660 mg/kg (for volatilization to indoor air). In fact, most of the samples also exceeded the lowest commercial RBSL of 2,000 mg/kg. At this site, a Tier 2 analysis is most likely warranted to incorporate site-specific parameters and calculate a site-specific target level (SSTL) to be used as a cleanup level. In any event, the issue still remains as to how to evaluate TPH data obtained using conventional analytical methods.

4.5 Comparison with California Regulations

The California Regional Water Quality Control Board (RWQCB) for the Los Angeles Region has issued guidance on remediation of petroleum impacted sites (California EPA, 1996). Although the El Toro facility is located in the Santa Ana Region, the Los Angeles Region's guidance is discussed here for illustration purposes. This document presents screening levels (analogous to Tier 1 RBSL values). In addition, the State of California EPA Department of Toxic Substances Control (DTSC) provides guidance (California EPA, 1992) for performing risk assessments at hazardous waste sites and permitted facilities (analogous to a Tier 2 approach). This guidance is intended to supplement EPA's risk assessment guidance for Superfund sites.

The TPH California RWQCB screening levels are actually a matrix of criteria for three distinct TPH fractions (C4–12, C13–22 and C23–32) and BTEX compounds, with different values based on the distance between contaminated soil and groundwater (Table 4-7). These screening levels are intended to be protective of groundwater and protective of human health via direct contact with soils.

The inclusion of three separate TPH fractions indicates an awareness that different fractions behave differently in the environment and pose different risks. This relatively simple fractionation is consistent with the basis of the Working Group's methodology. However, one major difference between the Working Group protocol and the California RWQCB guidance is that California specifically defines EPA Methods 418.1 and 8015 (DHS Modified) as the appropriate analytical methods for measuring TPH.

Table 4-8 TPH Soil Screening Levels (mg/kg)—California RWQCB Guidance

Distance Above Groundwater	TPH Carbon Range		
	C4–12	C13–22	C23–32
>150 feet	1,000[1]	10,000	50,000
20–150 feet	500	1,000	10,000
<20 feet	100	100	1,000

NOTES:

[1] TPH concentrations in mg/kg, based on EPA 418.1 or 8015 (DHS Modified).

Source: California RWQCB-LA, 1996.

It should also be noted that, in California, all groundwater is assumed to be a potential potable water supply, unless it is excluded under specific criteria as defined by State Water Resources Control Board Resolution 88-63 (e.g., total dissolved solids >3,000 mg/L, production <200 gal/day, or existing contamination that cannot be reasonably treated). Thus, these screening levels are protective of groundwater directly beneath any impacted soil as a potential source of drinking water.

Based on these screening levels, cleanup levels at Site 380A would range from 1,000 to 50,000 mg/kg for various TPH fractions (as measured using conventional methods). Although the purgeable and extractable TPH fractions measured using EPA Method 8015 are not exactly those fractions included in the screening table, they roughly correlate with the C4–C12 and C13–C22 fractions, respectively. Thus, based on the analytical results by EPA Method 8015 (Table 3-3), Site 380A would require no soil remediation (assuming the soils from boring 380SB-02 are indicative of site soil quality).

However, at Site 529, cleanup levels would be significantly lower (100 to 1,000 mg/kg), due to the depth of contamination at that site. These cleanup levels are much lower than the concentrations observed at this site. Thus, further investigation or remedial action would be warranted.

It should be noted that these screening levels are slightly different from those used to develop site-wide cleanup levels for MCAS El Toro, as outlined in the *Preliminary Draft Work Plan* (OHM, 1995). Cleanup levels of 10,000 mg TPH diesel/kg soil and 1,000 mg TPH gasoline/kg soil were derived using guidance provided in the *Leaking Underground Fuel Tank Field Manual*, issued by the State Water Resource Control Board in 1989. This guidance uses a "scoring" table

(Table 4-8) to determine if a site has low, medium or high leaching potential and then defines cleanup levels based on this designation.

Table 4-9 Leaching Potential Analysis for TPH and BTEX

Site Feature	**Score**	**Score 10 Points If Condition is Met**	**Score**	**Score 9 Points If Condition is Met**	**Score**	**Score 5 Points If Condition is Met**
Minimum Depth to Groundwater from the Soil Sample (feet)	*10*	>100		51–100		25–50
Fractures in subsurface	*10*	None		Unknown		Present
Average Annual Precipitation (inches)		<10	*9*	10–25		26–40
Man-made conduits which increase vertical migration of leachate	*10*	None		Unknown		Present
Unique site features: recharge area, coarse soil, nearby wells, etc.	*10*	None		At Least One		More Than One
Column Totals - Total Points	*40*	+	*9*	+	*0*	= *49*
Range of Total Points	**49 points or more**		41–48 points		40 points or less	
Maximum Allowable B/T/X/E Levels (ppm)	**1/50/50/50**		.3/.3/1/1		NA	
Maximum Allowable TPH Levels (ppm) Diesel	**10,000**		1,000		100	
Maximum Allowable TPH Levels (ppm) Gasoline	**1,000**		100		10	

Source: California State WRCB, 1989; OHM Work Plan, 1995.

In developing site-wide cleanup levels, the site was previously given a score of 10 for a depth to groundwater greater than 100 feet. Although this condition is met at many of the UST sites at MCAS El Toro (e.g., Site 380A), it is not true for Site 529. In this instance, since the soil impacts extend to groundwater, this scoring table is not applicable. Even if it were assumed that the soil impacts are 5 feet above groundwater, a score of "0" would be given for this site feature, yielding a total score of 39. This score would change soil TPH cleanup levels from 10,000 to 100 mg/kg for diesel and from 1,000 to 10 mg/kg for gasoline.

Moreover, at Site 529, BTEX compounds were detected by EPA Method 8020. California RWQCB (California EPA, 1996) also dictates specific screening levels for these compounds in soil, based on distance to groundwater as well as soil type. The screening levels are defined for distances of 150, 80 and 20 feet above groundwater. To obtain values for other distances, the guidance allows for interpolation between the given values. However, it is not explicitly stated how to deal with distances less than 20 feet, as would be encountered at Site 529.

5 Tier 2 Issues

5.1 Calculation Procedures

In general, a Tier 2 evaluation is warranted when a site fails the Tier 1 evaluation, and when calculation of Tier 2 values (site-specific target levels, or SSTLs) is cost-effective when compared to potential changes in remedial actions at the site. In a Tier 2 analysis, fate and transport models are used to incorporate site-specific parameters and to model transport of contaminants from the source area to alternate points of compliance, incorporating attenuation via dispersion and, sometimes, biodegradation. Tier 2 provides the framework for back-calculating maximum source area groundwater and soil concentrations based on applicable criteria at the exposure points, while incorporating attenuation effects of fate and transport mechanisms. When considering a mixture such as TPH, the calculations become more complex because each fraction has its own distinct fate and transport characteristics, thus, transport calculations may include changing TPH composition with distance from the source.

5.2 Volatilization to Indoor Air Pathway

The model used to derive indoor air RBSLs assumes a constant chemical concentration in subsurface soils, linear equilibrium partitioning in the soil between sorbed, dissolved, and vapor phases and steady-state vapor- and liquid-phase diffusion through the vadose zone and foundation cracks. In addition, the model assumes that vapors migrate completely and instantaneously into the building, i.e., no attenuation occurs between impacted subsurface soils and the structure foundation. It is important to stress that this is a very conservative assumption since considerable attenuation (including biodegradation and sorption onto clean soil particles) could occur as the vapor migrates through the vadose zone.

Thus, because models evaluating this pathway are quite conservative in their assumptions, any site-specific information about the actual characteristics and behavior of subsurface vapor flow would be valuable in a Tier 2 evaluation. This evaluation would require an empirical determination of attenuation driving vapor transport in the subsurface. Target constituent (e.g., benzene, naphthalene) concentrations from vapor monitoring points at the depth of maximum impact and the base of the building foundation would be compared. The ratio between these values could then be used to determine an actual subsurface attenuation factor. This attenuation factor would be used to calculate acceptable soil concentrations for this pathway.

5.3 Direct Contact Pathway

For the direct contact pathway, it is assumed that the possibility exists for direct exposure to any contaminated site soils. In a Tier 2 evaluation, actual exposure parameters are used to evaluate exposure. Parameters which may be altered include both frequency and duration of exposure as well as the likelihood of actual exposure. For instance, if the majority of a site is paved, it is unlikely that residents will actually be exposed to impacted soils. Moreover, if the shallowest impacted soils are, for instance, 10 feet bgs, it is also unlikely that any resident would ever be exposed to these soils. However, if construction were planned at the site, exposure scenarios involving construction workers, using anticipated exposure frequencies, would be evaluated.

For instance, at the El Toro sites, soil data is all from depths of at least 20 feet bgs. If this pathway were driving cleanup, it could easily be argued that there is no likely residential exposure to these contaminated soils at all, thus eliminating this pathway as a potential concern at the site. However, it would be necessary to collect surface soil samples to obtain soil concentrations from locations more likely to be encountered by residents at the site.

5.4 Leaching to Groundwater Pathway

The leaching to groundwater pathway assumes direct contact between contaminated soils and groundwater. A Tier 2 analysis would incorporate transport of contaminants from impacted soil to groundwater, followed by transport of contaminants in groundwater to a specified receptor. This provides a much more realistic value for concentrations in soil which are still protective of groundwater. Although at the El Toro facility, observed concentrations did not exceed the calculated RBSLs for the leaching to groundwater pathway, this pathway is often important.

The primary difference between a Tier 1 and a Tier 2 analysis for the leaching to groundwater pathway is the consideration of site-specific measurements of constituent attenuation and alternate points of compliance. In the Tier 1 analysis, the point of compliance is the source location, and the RBSLs are therefore compared to the source constituent concentrations. In order to justify "no further action" based on Tier 1 results, the RBSLs must be satisfied at the source itself. In a Tier 2 analysis, consideration of alternate points of compliance is allowed based on the following factors:

- The location of current receptors
- The location of reasonable potential receptors

- The current and projected local and site land use
- The estimated rate of contaminant transport

Thus, for a Tier 2 analysis, attenuation between the source to an actual receptor (e.g., nearest water use well) is evaluated, using simple analytical fate and transport models, such as the Domenico solution (Domenico, 1987). This involves calculation of a whole TPH RBSL for groundwater and then an SSTL which incorporates attenuation to the receptor, as explained below.

In order to calculate whole TPH RBSLs (C_{TPH}) for groundwater, the distribution of TPH fractions in groundwater must first be evaluated. Groundwater fraction distributions can either be measured directly (by collecting groundwater samples for analysis by the Direct Method), or calculated (by calculating the effective solubilities of each fraction, based on the fraction distribution observed in soil or product). Effective solubilities (S_{eff}) are calculated by multiplying the mole fraction (X_i) of a constituent by the solubility (S_i) of the individual constituent, in accordance with Raoult's Law as shown below:

$$(S_{eff})_i = X_i \times S_i \tag{6}$$

To calculate whole TPH RBSLs (C_{TPH}) in groundwater, additive risk must still be considered. Although a standard method for calculating this value has yet to be determined, this could be done in a manner analogous to that used for the direct contact pathway (see Section 4.2.1), since this pathway considers direct exposure to groundwater. The RBSL would therefore be the sum of the hazard quotients for each fraction (defined as the weight percentage of the fraction multiplied by the whole TPH RBSL, divided by the fraction RBSL). This sum would be equal to the hazard index for the mixture, which must be less than or equal to 1.0 to meet the target risk level. In other words, the following equation is solved:

$$HI = \sum_{i=1}^{i=n} HQ_i = \sum_{i=1}^{i=n} \frac{f_i\, C_{TPH}}{RBSL_i} \leq 1 \tag{7}$$

This equation would be solved iteratively to find C_{TPH} such that HI is equal to 1.0 under the constraint of Equation 2 (Section 4.2.1.2). The whole TPH RBSL would then be compared to the actual groundwater concentration or the concentration derived using the effective solubility calculations discussed above. If the hazard index is greater than 1.0, attenuation of the groundwater plume to the actual receptor should be evaluated as allowed in a Tier 2 assessment.

Neglecting biodegradation, and assuming dispersion as the only mechanism responsible for attenuation, all fractions would attenuate equally, given an infinite source and sufficient time to reach steady-state conditions (as is generally assumed in these calculations). Thus, fate and transport parameters for one fraction could be used, in conjunction with site-specific parameters (such as hydraulic conductivity) to calculate a conservative attenuation factor at the point of exposure. If this attenuation factor is equal to (or greater than) the calculated hazard index, then the groundwater plume will attenuate sufficiently to be protective of the downgradient receptor. In other words, the SSTL or concentration in groundwater allowable at the source, would equal the groundwater RBSL multiplied by the attenuation factor. Groundwater with TPH concentrations greater than the SSTL would require remedial action.

As an example, assuming a calculated whole TPH RBSL of 2 mg/L and an actual groundwater concentration of 10 mg/L, the hazard index would equal 10 divided by 2, or HI = 5. If the attenuation factor at the point of exposure is 5, the SSTL (at the source area) is 10 mg/L and the groundwater concentration will decrease by a factor of 5, to 2 mg/L, which is an acceptable concentration at the point of exposure. However, if the attenuation factor were 4, the SSTL would be 8 mg/L and the plume would attenuate to 2.5 mg/L (10 ÷ 4), which is not an acceptable concentration at the point of exposure. In this case, remedial action would be required.

5.5 El Toro Tier 2 Considerations

A Tier 2 evaluation may be appropriate at the El Toro facility for Site 529, since all data from samples submitted for fractionation analysis exceeded the RBSL for residential exposure via the volatilization to indoor air pathway. In this case, soil vapor analyses would be performed in order to determine a site-specific vapor attenuation factor to be used in calculating an SSTL for the site.

6 Summary and Conclusions

6.1 Summary of Results

Using the Working Group methodology for calculation of Tier 1 RBSLs, appropriate alternative cleanup goals were developed for the MCAS El Toro facility. These values range from 557 mg/kg for the indoor air pathway, to over 18,000 mg/kg for the leaching to groundwater pathway and over 100 percent TPH for the outdoor air pathway, given a residential use scenario. These RBSLs represent alternative cleanup goals which result directly from a site-specific analysis of risk for the material present at the two MCAS El Toro facility sites included in this demonstration.

At Site 380A, the TPH concentrations in all of the samples were below both the average and the lowest[6] RBSL calculated for protection of indoor air. At Site 529, several samples exceeded the lowest and average RBSL values. In fact, the average value from all samples tested exceeded the average RBSL.

In general, the lowest RBSLs developed were for the volatilization to indoor air pathway, followed by the direct contact, leaching to groundwater and volatilization to outdoor air pathways. Again, this is true for both the heating and diesel oil materials encountered at these locations.

The RBSLs varied considerably between individual samples. This variability was most pronounced for the volatilization and leaching pathways, while the direct contact RBSLs exhibited very little variability. The variability in the RBSLs for cross-media transport was primarily due to variations in the proportions of TPH accounted for by the lightest aromatic and aliphatic fractions.

The fraction of TPH responsible for the greatest portion of the risk depends on the partitioning involved in each pathway. For the direct contact pathway, no partitioning is involved, and the risk derived from a given TPH fraction is therefore a function of its relative abundance and its toxicity (RfD). For the leaching and volatilization pathways, however, solubility and volatility tend to dictate which fractions are most responsible for the associated risk. That is, the most soluble fractions account for most of the risk in the leaching pathway and the most volatile fractions account for most of the risk in the volatilization pathways.

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[6] Lowest RBSL not including that derived from sample 380SB-02-20, which was comprised largely of non-detect data, and was therefore deemed inappropriate for use in deriving a cleanup level.

6.2 Recommendations for Standard Applications

6.2.1 Comparison of Results from Conventional and Fractionation Methods

The analytical methods used to measure the fractions are critical to the Working Group protocol. This demonstration used the Direct Method developed by the Shell Development Company. The Direct Method yielded soil TPH concentrations that were on average 2 to 3 times lower than those derived from conventional TPH analyses (EPA Method 8015). Further, the results obtained for individual samples by the two methods were not closely correlated. Better correlations were achieved between results from the two methods in the Mukilteo demonstration project (RETEC, 1997). This result may reflect better laboratory quality, modifications to the 8015 method used, or the nature of the petroleum encountered at this site.

If an acceptable correlation between results from conventional and fractionation methods can be shown (as was true at Mukilteo), RBSLs based on fractionation results can be "translated" into equivalent RBSLs based on conventional methods in order to evaluate the need for remedial action at a site with historical TPH data. If this correlation cannot be shown (as is the case at MCAS El Toro), it would be difficult to use RBSLs calculated using fractionation data to compare to existing conventional TPH data. In this case, confirmational samples could be collected to demonstrate compliance with cleanup criteria. These samples could be analyzed for TPH by a modified Direct Method which would yield only a whole TPH value, rather than values for each fraction. This modification would decrease the costs associated with use of the fractionation method.

6.2.2 Importance of Values Used for Light Aromatic Fractions

One significant finding from this demonstration was that RBSL calculations can be dramatically impacted by the values used for non-detect data, particularly for the lighter compounds. In many cases, RBSLs were governed by light aromatic fractions which were not present above the detection limit. Because one-half the detection limit is generally used as the concentration in the risk calculations for non-detect data, the importance of obtaining low detection limits (or accurate concentrations for very low constituent concentrations) was demonstrated. A qualitative sensitivity analysis was performed by varying the values used for non-detect data for lighter fractions, in order to better understand how detection limits can affect RBSLs for specific pathways. It was shown that the leaching and volatilization pathways could be significantly impacted by the values used for non-detect, light, aromatic fractions.

The Direct Method also yielded values for the lightest volatile aromatic fractions (benzene and toluene) that differed from those obtained from BTEX analyses (performed by EPA Method 8020). The reason for this discrepancy are not clear, but the demonstration project does suggest that a BTEX analysis (preferably by GC/MS, EPA Method 8240 or 8260) should be included in the analytical protocol, and these values should be used for the lightest volatile aromatic fractions in order to obtain the most accurate values for these fractions. This additional analysis will increase the costs for using the Working Group protocol, but the accuracy and lower detection limits appear warranted, and should generally yield less conservative cleanup criteria.

6.2.3 Variability of RBSLs/Selection of Appropriate Cleanup Level

It is noteworthy that the average RBSLs for each pathway are similar for both Building 380A and Building 529. This similarity is to be expected due to the relatively similar nature of the materials encountered at the two locations, despite the fact that one site had both heating oil and diesel, while the other had only diesel fuel.

Although TPH fraction distributions appeared to be quite comparable for samples obtained from each site, the calculated RBSLs often varied significantly. This result demonstrates that slight variations in TPH composition can greatly affect risk calculations. The question then arises as to how to select a single, appropriate cleanup level for a site. Further, it is important to determine how many samples should be collected from a site to calculate the cleanup level.

Results of this demonstration project suggest that high concentration (total TPH) samples should be collected for use in risk calculations. This approach ensures a more representative TPH characterization and may mitigate the impacts of non-detect data, as these values would represent a lower percentage of the total TPH in a highly contaminated sample.

Further, given the range of RBSLs derived from similar samples, it seems appropriate to analyze at least three samples from each area suspected to be impacted by the same product source. Conservatively, the lowest RBSL calculated using the results from these samples may be used as the site cleanup level. Alternatively, it may be argued that the average RBSL should be used as the appropriate screening criteria. This issue will require further consideration before the Working Group protocol can be used widely.

The approach used to calculate leaching RBSLs is similar to those used to derive cleanup levels under California regulations for protection of groundwater. The average RBSL calculated for the leaching pathway was 12,000 mg/kg for Site 380A and 13,000 mg/kg for Site 529. These values are comparable to the California screening level of 10,000 mg/kg for diesel range TPH (C13–22), with a depth to groundwater greater than 150 feet. However, these values are over 100 times the California screening level of 100 mg/kg given a depth to groundwater less than 20 feet.

6.2.4 Tier 2 Calculations

This project suggested that it may be difficult to perform Tier 2 assessments using the TPH fractionation approach for cross-media pathways because of the need to consider mixture effects, which complicate the Tier 2 fate and transport modeling. The behavior of mixtures of several interacting fractions is more difficult to model than the fate of specific indicator compounds.

The Tier 2 evaluation of groundwater leaching is complicated by the interactions of TPH mixtures. Using an iterative solution to determine changes in TPH composition (due to various attenuation processes) with distance from the source area would be complicated and labor-intensive. A simplified method for developing Tier 2 SSTLs at an alternate point of compliance, assuming no biodegradation, was suggested in Section 5 of this report. Future demonstrations should consider these recommendations as well as potential methods for incorporating biodegradation into a Tier 2 assessment.

The difficulty of using models for Tier 2 assessments is particularly important when assessing vapor movement through soil. The conservatism built into the models for the indoor air vapor pathway usually produces the lowest Tier 1 RBSLs, unfortunately, it can be difficult to measure the needed site-specific parameters needed for the Tier 2 analysis. It is probably easier and more accurate to use site-specific vapor monitoring to evaluate the volatilization pathways, and derive a site-specific attenuation factor to be incorporated into a Tier 2 assessment. Future demonstrations should try to obtain sufficient site-specific data to allow a meaningful Tier 2 analysis. The indoor air pathway in particular needs greater attention, because it yielded the lowest and most conservative Tier 1 RBSL values.

6.3 Conclusions

The major strength of the Working Group's protocol is that it addresses the complex interactions of the hundreds of different hydrocarbon constituents present within TPH. Although California regulations implicitly acknowledge the different risks associated with different TPH fractions by establishing separate screening levels for three fractions, all states do not incorporate this consideration into their cleanup levels. This field demonstration project demonstrates that the Working Group protocol is a scientifically defensible approach for establishing risk-based TPH criteria which account for the complex nature of TPH.

Although implementation of the Working Group methodology will initially increase the investigation costs by requiring additional, more costly analyses, actual remediation costs may be reduced, since risk-based cleanup levels are often higher than non-risk-based cleanup levels established in many states. Further, a much better understanding of the site's potential impacts to human health and the environment can be identified through implementation of this protocol. Finally, the method for calculating Tier 1 RBSLs is easily implemented within the RBCA framework and is generally consistent with state and EPA protocols.

7 References

ASTM, 1995. *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites.* Standard No. E1739-95. American Society of Testing Materials, West Conshocken, Pennsylvania.

API, 1994. *Transport and Fate of Non-BTEX Petroleum Chemicals in Soil and Groundwater.* American Petroleum Institute Health and Environmental Sciences Department. API Publication No. 4593. September.

California EPA, 1992. *Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities.* State of California Environmental Protection Agency Department of Toxic Substances Control. July.

California EPA, 1996. *Interim Site Assessment and Cleanup Guidebook.* State of California Environmental Protection Agency Regional Water Quality Review Board, Los Angeles Region. May.

California State WRCB, 1989. *Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup and Underground Storage Tank Closure.* State of California, State Water Resource Control Board. October.

Domenico, P. A., 1987. An analytical model for multidimensional transport of decaying contaminant species. *Journal of Hydrology.* Vol. 91, No. 49–58.

Freeze, R. A. and J. A. Cherry, 1979. *Groundwater.* Prentice Hall, Englewood Cliff, New Jersey.

OHM, 1995. *Preliminary Draft Work Plan, Remediation of Various Underground Storage Tanks at the Marine Corps Air Station (MCAS).* OHM Remediation Services Corp. August.

OHM, 1996. *Information Package, MCAS El Toro.* OHM Remediation Services Corp. December 27.

OHM, 1997. *Draft Final Phase II Remedial Investigation: OU-3A Sites, MCAS El Toro.* OHM Remediation Services Corp. March.

Operational Technologies Corp., 1997. *Draft Work Plan for Total Petroleum Hydrocarbon Criteria Working Group Demonstration Program, Marine Corps Air Station, El Toro, California.* July.

RETEC, 1997. *Field Demonstration Report: Defense Fuel Supply Point, Mukilteo, Washington.* Prepared for GEO-CENTERS, Inc. and AFRL/HEST and the Total Petroleum Hydrocarbon Criteria Working Group. February 28.

TPH Criteria Working Group, 1997. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil: A Technical Overview of the TPH Criteria Working Group.* June 26.

TPH Criteria Working Group, In Press. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume I: Petroleum Hydrocarbon Analysis of Soil and Water in the Environment.*

TPH Criteria Working Group, In Press. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume II: Composition of Petroleum Mixtures.*

TPH Criteria Working Group, 1997. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume III: Selection of TPH Fractions Based on Fate and Transport Considerations.* June 26.

TPH Criteria Working Group, 1997. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume IV: Development of Fraction Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH).* June 26.

TPH Criteria Working Group, In Press. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume V: Human Health Risk-Based Evaluation of Petroleum Contaminated Sites: Implementation of the Working Group Approach.*

TPH Criteria Working Group, 1997. *A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume VI: An Analytical Method for Petroleum Fate and Transport Fractions: The Direct Method.* June 26.

Appendix B

Analytical Data

Appendix B-1

Boring Logs and Geotechnical Data

OHM REMEDIATION SERVICES CORP.

Geologic Log

BOREHOLE NUMBER: 380ASB-02B
SHEET 1 OF 3

PROJECT NO. 18292 DATE: 9.3.97
CLIENT: SWDIV
LOCATION: Bldg 380, MCAS, EL TORO
LOGGED BY: A. SIDDIQUI

DRILLNG CO.: BC²
DRILL RIG MODEL: CME 85
DRILLER: Steve
DRILLING METHOD: H.S.A HOLE DIAMETER: 8"
BORING COMPLETION DATA: Grouted with cement-Bentonite ~~Grout~~

DEPTH TO WATER:	Not Encountered				
TIME					
DATE					

TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYMBOL	GRAPHIC LOG	
										Top 5' Handaugered
	5									
1300		3.1	9	6		X		SM		Silty Sand; 75% fine to medium sand 25% non plastic fines (10YR 3/4) Dark Yellowish Brown, slightly moist
			11	6						medium dense.
			13	6						
182	92-~~380~~		601							
1305		3.0	12	6		X		SM		Silty Sand, Same as above slightly micaceous
	10		17	6						
			25	6	X					
	12'									
18	292-	60	2							
1307		3.2	11	6		X		SP		Sand, 95% fine to medium sand 5% non-plastic fine (10YR 5/4) Yellowish Brown, slightly moist
	15		12	6						medium dense, HC odor.
			16	6	X					
1310		2.0	13	6		X				
	20		16	6						

OHM REMEDIATION SERVICES CORP.

LOCATION: Bldg 380, MCAS El Toro
DATE: 9-3-97
BOREHOLE NUMBER: 380ASB-02
SHEET 2 OF 3

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
				20	6		X		SM		Silty Sand, 85% fine to medium to coarse
											sand, 15% non-plastic fines, trace
											fine subangular gravel
											(10YR5/4) yellowish Brown
											slightly moist, medium dense
											Hydrocarbon odor
2	1314		52	9	6		X		SP-SM		SAND - 90% fine sand, 10% non
		25		10	6						plastic fines, 10YR5/3 Brown
	18	292-	603	11	6	X					slightly moist, medium dense,
											micaceous, well sorted.
	1318		10.2	7	6		X		SP		SAND - 95% fine to medium sand,
		30		7	6						5% non-plastic fines, 10YR5/3
				8	6						yellowish brown, slightly moist
1	1323		13.6	7	6		X		SP		loose.
				10	6						Same as above (10YR4/4) Dark yellowish
2	18	292-	604	11	6	X					Brown, medium dense, well sorted fine grained sand
	1325		3.1	7	6		X		SP		Same as above
				8	6						
3	18	292-	605	10	6	X					
4	1329		2.1	7	6		X		SP		Same as above, very well sorted fine
				8	6						grained sand (10YR5/4) yellowish Brown
35		35		12	6						
40	1332	40	2.0	7	6		X		SP-SM		SAND - 90% fine sand, 10% non-
				8	6						plastic fines. (10YR4/4) Dark yellowish
				10	6						brown slightly moist, loose.
		43 ←									
45	1334	45	1.7	8	6		X		SP		~~85% Fine~~
				15	6						

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OHM REMEDIATION SERVICES CORP.

LOCATION: Bldg 380, MCAS El Toro
DATE: 9-3-97

BOREHOLE NUMBER: 380A SB-02
SHEET 3 OF 3

TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
			17			X		SP		85% fine to medium sand, 10% fine subangular to subrounded gravel, 5% non-plastic fines, (10YR 4/6) Dark yellowish Brown, slightly moist, medium dense.
1339	50	3.3	9 15 18			X		SP		SAND, 95% fine to medium sand, <5% non-plastic fine, trace fine subrounded gravel, (10YR 5/4) yellowish Brown, slightly moist. medium dense.
1347 1347	55 18292-606	2.0	8 14 19 17 25	0 0 14	X	X X		SM		Silty Sand. 80% fine to medium sand, 20% non plastic fine, (10YR 3/6) dark yellowish Brown, slightly moist medium dense.
										Total Depth = 56½
	0									
	5									
	0									

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Geologic Log

BOREHOLE NUMBER: 529-SB-04
SHEET 1 OF 5

PROJECT NO. 78292 DATE: 9-2-97
CLIENT: SWDIV
LOCATION: Bldg 529, MCAS, EL TORO
LOGGED BY: A. Siddiqui

DRILLNG CO.: BC2
DRILL RIG MODEL: ~~[illegible]~~ HSA, CME 85
DRILLER: Steve
DRILLING METHOD: HSA HOLE DIAMETER: 8"

BORING COMPLETION DATA: Grouted to the surface with cement-Bentonite grout on 9-2-97

DEPTH TO WATER:
TIME Not Encountered.
DATE

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYMBOL	GRAPHIC LOG	
0											Top 5' Hand Augered. No Samples collected in top ~~[illegible]~~ 15'
5											
10											
15	0854		22.9	8 10 15	6 6 6		X		~~SP~~ SM SM		~~SAND~~ Silty sand (~85%) fine to med sand ~~25~~ 15% non plastic fines, (10YR 3/3) Dark Brown, slightly moist, medium dense HC odor
20	1829 0857	2-5	29 127	5B0 7 8 11	4-584 6 6 6		X		SP-SM		SAND ~ 96% fine to medium sand, (5%) non-plastic fines (10YR 3/3) dark brown, slightly moist, medium dense.

MCAS. EL TORO

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LOCATION: Bldg 529,
DATE: 9-2-97

BOREHOLE NUMBER: 529-SB-04
SHEET 2 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
20										SP-SM	Same as above
21½											
25	0900		832	8 13 17	6 6 6		X		ML		SILT. - 85% low plastic fines, 15% fine sand. (10YR 3/2) v. dark grayish Brown. slightly moist - v. stiff
		23									
30	18292 0906	-5	295 17.9	804- 8 12 15	5 6 6 6	85	X		SM		silty sand - 75% fine to medium sand 25% non-plastic fines. (10YR 3/4) dark yell. Brown, slightly moist, medium dense.
		33									
35	0913		202	9 14 16	6 6 6		X		ML		Sandy silt - 70% non to low plastic fines, 30% fine sand, (10YR 3/3) dark Brown, slightly moist, very stiff (strong hydrocarbon odor)
40	0920		120	9 12 16	6 6 6		X		ML		Silt - 85% low plastic fines, 15% fine sand, (10YR 3/2) very dark grayish Brown, slightly moist, very stiff
		43									
45	0928		216	12 23	6 6		X		SM		

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LOCATION: MCAS, El Toro Bldg 529
BOREHOLE NUMBER: 529-SB-04
DATE: 9-2-97
SHEET 3 OF 5

	TIME	DEPTH	PID/~~FID/HNU~~ ~~OVA~~ (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
45	0928			27	6		X		SM		Silty sand. 75% fine to medium (fine dominant) sand 25% low plastic fines. (10YR 3/4) Dark yellowish brown, slightly moist, dense
50	0933		264	13 15 20	6 6 6		X		SM		Silty sand, 80% fine sand, 20% non-plastic fines. (7.5YR 4/6) strong Brown slightly moist. medium dense.
55	0942		208	18 22 27	6 6 6		X		SM		Silty sand. 80% fine to medium sand. 20% non-plastic fines, (10YR 5/6) yellowish Brown, slightly moist; dense to medium dense.
	18292-5		295	304	-	586					
60	0949		221	15 17 21	6 6 6		X		SM		Silty sand same as above medium dense
		63 ←									
65	0959		219	17 19 24	6 6 6		X		SP		Sand, 95% fine to medium sand, 5% non-plastic fines, (10YR 5/4) yellowish Brown, slightly moist. medium dense.
70	1006		136	16 20	6 6		X				

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LOCATION: Bldg 529, MCAS, EL TORO
DATE: 9-2-97

BOREHOLE NUMBER: 529-SB-04
SHEET 4 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
70				25			X		SP		Sand. 95% fine to medium sand,
											5% non-plastic fines, (10YR5/6)
											Yellowish Brown, slightly
											moist. medium dense.
		73 ←									
	1020		168	17	6		X		SM		Silty Sand, 80% fine to medium sand,
75				20	6						20% non-plastic fines, (10YR3/6) Dark
				34	6						yellowish Brown, slightly moist,
											Dense, (Hydrocarbon Odor)
	1829	2-	529	SB04	-	587					
	1026		269	12	6		X		SM		silty sand. 75% fine to medium
80				15	6						sand, 25% non-plastic fines,
				17	6						(10YR4/4) dark yellowish Brown
											slightly moist. medium dense,
											Hydrocarbon Odor.
											Becomes (SP-SM at place.)
		82 ←									
	1032		184	4	6		X		SP		SAND, 95% fine to medium grained
85				13	6						sand, 5% non-plastic fines.
				14	6						(2.5Y5/4) light olive Brown.
											slightly moist. medium dense.
											Hydrocarbon Odor.
	18292	-52	9SB	04-5		88					
	1041		130	14	6		X		SP		Same as above
90				21	6				~~[illegible]~~		~~Clay. Lean Clay~~ SILT, 100%
				30	6				ML		medium plastic clay (2.5Y 5/3)
											Light olive brown, slightly
											moist very stiff.
		92 ←									
	18292	-5	295	B04	-	589					
	1048		41	17			X		SM		
95				25							

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LOCATION: Bldg 529, MCAS, EL TORO
DATE: 9-2-97

BOREHOLE NUMBER: 529-SB-04
SHEET 5 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
95				37			☒		SM		Silty Sand, 75%. fine to medium sand 25% non-low plastic fines (10YR 5/4) yellowish Brown ~~[illegible]~~ moist, dense. ~~[illegible]~~ (pieces of Shale, siltstone @ Vaqueros fm).
		98 ←									
	18292-529SB04-590										
	1051		11.5	16	6		X		SP		SAND, 90% fine to medium sand 10% non plastic fines (10YR 5/4) yellowish Brown, very very moist. dense.
100				21	6				SM		
				22	6						
											Total depth = 100½'
5											
0											
5											
0											

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Geologic Log

BOREHOLE NUMBER: 529-SB-05
SHEET 1 OF 5

PROJECT NO. 18292
DATE: 9·2·97
CLIENT: SWDIV
LOCATION: Bldg 529 MCAS, EL TORO
LOGGED BY: A. SIDDIQUI

DRILLNG CO.: BC²
DRILL RIG MODEL: CME 85
DRILLER: Steve
DRILLING METHOD: H.S.A
HOLE DIAMETER: 8"

BORING COMPLETION DATA: ~~not encountered~~ Grouted with Cement-Bentonite grout - 9-3-97

DEPTH TO WATER: Not Encountered
TIME
DATE

TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYMBOL	GRAPHIC LOG	
	0									
										No soil samples collected till 15 feet.
	5									
	10									
~~1350~~ 1315	15	17	7 8 12	6 6 6	X			SM		silty sand - 70% fine to medium sand, 30% non-low plastic fines. (10YR 3/2) very dark grayish Brown. slightly moist - med. dense
18292-529SB05-597										
1317	20	157	6 7 7	6 6 6	X	X		SP-SM		Sand ~ 90% fine to medium (fine & dominates) sand, 10% non-plastic fines (10YR 4/4) dark yell. Brown slightly moist, loose strong HC odor

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LOCATION: Bldg 529 MCAS, EL TORO

DATE: 9-2-97

BOREHOLE NUMBER: 529-SB-05

SHEET 2 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
20									SP		
	18292-529SB05-S94 1330		175	6 7 8	6 6 6				SM		Silty sand, 60% fine sand 40% non-low plastic fine, (2.5Y3/2) very dark grayish Brown, slightly moist loose. at places becomes sandy silt.
25											
	~~18292-529SB05-~~ 1325		115	8 10 12	6 6 6				SM		Silty sand. Same as above, medium dense. strong Hydrocarbon odor. discolored & saturated at places with product.
30											
	18292-529SB05-S95 1330		68	8 13 15					SM		Silty sand, 75% fine to medium sand, 25% non-plastic fines, (10YR 3/6) Dark yell. Brown slightly moist. discolored to dark gray at places. strong odor medium ~~g~~ dense
35											
	1334		137	11 13 14	6 6 6				SM		Silty sand, 70% fine sand 30% non-plastic fines, (10YR2/4) Dark yellowish Brown, slightly moist, medium dense, odor At places sandy silt.
40											
	18292-529SB05-S96 1340		172	12 15	6 6				SM		Silty Sand
45											

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LOCATION: Bldg 529, MCAS, El Toro
DATE: 9-2-97

BOREHOLE NUMBER: 529.SB-#5
SHEET 3 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
45				18	6	X	X		SM		silty sand, 80% fine to medium sand, 20% non plastic fines, (10YR 4/6) Dark yell. Brown, slightly moist. medium dense.
50	1346		358	11 16 18	6 6 6		X		SM		Silty sand, same as above
55	1354		185	17 21 25	6 6 6		X		SM		Silty Sand, 75% fine to medium sand, 25% non-plastic fines (10YR 3/6) Dark yell. Brown, slightly moist, dense. Hydrocarbon odor.
60	1405		272	15 19 23	6 6 6		X		SM		Silty Sand: 80% fine Sand, 20% ~~Same as above~~ non-plastic fines (10YR 4/6) Dark yell. Brown. slightly moist. medium dense
65	1430		186	13 20 25	6 6 6		X		SP SM		SAND: 90% fine sand, 10% non-plastic fines (2.5Y 5/3) light Olive Brown, slightly moist, medium dense
		68?									
70	1450		62	14 18	6 6		X		SP		

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SERVICES CORP.

LOCATION: Bldg 529, MCAS, EL TORO

DATE: 9-2-97

BOREHOLE NUMBER: 529 SB-05

SHEET 4 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
70			62	22	6				SP		Sand, 95% fine to medium sand, 5% non-plastic fines (10YR5/8) yellowish Brown, slightly moist. medium dense.
		72 ←									
9-2-97 9-3-97	0740		181	16 23 26	6 6 6		☒		SM		Silty Sand, 80% fine sand 20% non plastic fines (2.5Y 5/4) light olive Brown, slightly moist, medium dense. Hydrocarbon odor
75											
	0745		145	17 19 23	6 6 6		☒		SM		Silty Sand, 85% fine to medium sand, 15% non-plastic fines, (10YR 5/4) yellowish Brown slightly moist. medium dense. Hydrocarbon odor
80											
	18292-529SB05-600 (dup)										
	18292-529SB05-597										
		83½ ←									
	0757		113	16 18 20	6 6 6		☒	Dup	SP		Sand, 95% fine to medium sand, 5% non plastic fines, (10YR 5/6) yellowish brown slightly moist, medium dense
85											
		87 ←									
	0803		196	14 18 20	6 6 6		☒		SM		Silty Sand, 75% fine to medium ~~[illegible]~~ / trace coarse sand, 25% low plastic fines (10YR 4/6) Dark yellowish Brown, slightly moist / moist ~~[illegible]~~ medium dense, Hydrocarbon odor.
90											
		93 ←									
	0810		205	14 19	6 6		☒		SP-SM		
95											

OHM REMEDIATION SERVICES CORP.

LOCATION: Bldg 529, MCAS, El Toro
DATE: 9-3-97

BOREHOLE NUMBER: 529-SB-05
SHEET 5 OF 5

	TIME	DEPTH	PID/FID HNU OVA (PPM)	BLOWS/ 6 IN PRESSURE (PSI)	RECOVERY	SAMPLE NUMBER	SAMPLE INTERVAL	WELL DETAIL	SOIL/ROCK SYSMBOL	GRAPHIC LOG	FIELD SOIL DESCRIPTION
95				24	6				SP-SM		SAND, 90% fine to medium Sand, 10% non-plastic fines, (2.5Y5/4) light olive brown, ~~moist~~ slightly moist, medium dense, strong hydrocarbon odor.
	18292-529SB05-59.8										
	0815		174	19	6		X		SP		Sand, 95% fine to medium grained, (<5%) non-plastic fines, (2.5Y5/3) light olive Brown, moist, dense Hydrocarbon odor.
100				24	6						
				29	4	X					
											TD = 100 1/2'.
5											
0											
5											
0											

Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

November 11, 1997
Project No. 201181-01

Mr. Bill Sedlak
OHM Remediation Services Corporation
2031 Main Street
Irvine, California 92614

Subject: Geotechnical Analytical Services
TPHCWG Project at UST 380 and 529
Marine Corps Air Station, El Toro, California
Contract No. N68711-93-D-1459; OHM Project No. 18292

Reference: Ninyo & Moore, 1997, Fee Proposal for Geotechnical Analytical Services, TPHCWG Project at UST 380 and 529, Marine Corps Air Station, El Toro, California, Contract No. N68711-93-D-1459; OHM Project No. 18292, dated August 25.

Dear Mr. Sedlak:

In accordance with our proposal dated August 25, 1997, we provided geotechnical laboratory testing of soil samples provided by you. Based on test data you provided, we understand the soil was contaminated with petroleum hydrocarbons, and therefore used appropriate health and safety procedures. The results of our laboratory testing are provided in Appendix A, and the Chain-of-Custody Records are provided in Appendix B.

We appreciate the opportunity to be of service on this project. If you have any questions, please contact the undersigned.

Sincerely,
NINYO & MOORE

Deron J. van Hoff, P.E.
Project Engineer

Jalal Vakili, Ph.D., P.E.
Principal Engineer

DV/CAP/JV/tw

Distribution: (2) Addressee
(1) Operational Technologies, Inc., Ms. Elaine Merrill
(1) RETEC, Ms. Jill Nordstrom

Attachments: Appendix A – Laboratory Testing
Appendix B – Chain-of-Custody Records

10225 Barnes Canyon Road • Suite A-112 • San Diego, California 92121 • Phone (619) 457-0400 • Fax (619) 558-1236
9272 Jeronimo Road • Suite 123A • Irvine, California 92618 • Phone (714) 472-5444 • Fax (714) 472-5445
700 South Flower Street • Suite 1100 • Los Angeles, California 90017 • Phone (213) 488-5111 • Fax (213) 892-2206
14175 Telephone Avenue • Suite Q • Chino, California 91710 • Phone (909) 465-5125 • Fax (909) 465-5126
B-16

APPENDIX A

LABORATORY TESTING

In-Place Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples were evaluated in general accordance with ASTM D 2937-94.

Gradation Analysis

Gradation analysis tests, including hydrometer analyses of soil passing the No. 200 sieve, were performed on soil samples in general accordance with ASTM D 422-63.

Hydraulic Conductivity Tests

Falling head hydraulic conductivity tests were performed on selected remolded soil samples in general accordance with ASTM D 5084-90. The samples were remolded to the dry density and moisture content requested by OHM Remediation Services Corporation personnel. The samples were placed in the permeameter cell and saturated. Water flow through the soil was sustained using a pneumatically induced head. The quantity of flow, the elapsed time, and the hydraulic gradient were recorded. The permeability was then calculated using Darcy's equation.

Soil pH Tests

Soil pH tests were performed on representative samples in general accordance with California Test (CT) Method 643.

Specific Gravity Tests

Specific gravity tests of selected soil samples were performed in general accordance with ASTM C 128-93.

Total Porosity

Total porosity of relatively undisturbed samples was calculated using the results of laboratory tests of in-situ moisture and density, and specific gravity.

Total Organic Carbon

Tests to evaluate the total organic carbon content in selected soil samples were performed in general accordance with Environmental Protection Agency (EPA) Method 9060.

LABORATORY TEST RESULTS

PROJECT NAME: OHM/ UST 380 & 529
PROJECT NO: 201181-01

SAMPLE	DEPTH (FT.)	POROSITY (%)
529-GT-010	39.5-40.0	38.8
529-GT-010	40.0-40.5	33.9
529-GT-010	44.5-45.0	35.8
529-GT-013	64.5-65.0	41.3
529-GT-013	65.0-65.5	36.3
529-GT-013	69.5-70.0	29.6
529-GT-013	70.0-70.5	26.9
380-GT-005	29.5-30.0	36.5
380-GT-005	30.0-30.5	44.4
380-GT-005	34.0-34.5	35.5
380-GT-005	34.5-35.0	38.5
380-GT-006	39.5-40.0	36.4
380-GT-006	40.0-40.5	37.8
380-GT-006	44.5-45.0	32.3
380-GT-006	45.0-45.5	42.6

SMITH-EMERY GEOSERVICES
A MEMBER OF THE SMITH-EMERY COMPANIES, ESTABLISHED 1904
791 EAST WASHINGTON BOULEVARD
LOS ANGELES, CALIFORNIA 90021
PHONE 213/745-5333
FAX 213/746-0744

November 4, 1997

SEG File No.: 90827
SEG Report No.: G-97-5999

Ninyo & Moore
9272 Jeronimo Road, Suite 123A
Irvine, California 92618

Attention: Messrs. Lawrence Jansen/Deron Van Hoff

RE: Laboratory Soil Testing
MCAS EL TORO/TPHCWE PROJECT
at UST 380 & 529
Project No. 201181-01

Gentlemen:

Smith Emery GeoServices has completed soil sample for laboratory testing delivered in our Los Angeles facility on October 6,1 997 with the following results.

REPORT OF TEST

1. Sample I.D. - Jar

	Depth, Feet	pH (Units)	T.O.C. mg/kg
380-GT-001	10	7.6	1600

2. Sample I.D. - Driven

	Depth, Feet	Moisture Content %	Dry Density, pcf	pH (Units)	G_s	T.O.C. mg/kg
380-GT-005	29.5 - 30.0	7.4	103	7.8	2.60	2200
380-GT-005	30.0 - 30.5	2.3	92	7.8	2.65	2600
380-GT-005	34.0 - 34.5	4.1	107	7.9	2.66	<100
380-GT-005	34.5 - 35.0	10.9	101	7.8	2.63	200

3. Sample I.D. - Driven

	Depth, Feet	Moisture Content %	Dry Density, pcf	pH (Units)	G_s	T.O.C. mg/kg
380-GT-006	39.5 - 40.0	6.0	106	8.0	2.67	1600
380-GT-006	40.0 - 40.5	6.5	104	7.9	2.68	1800
380-GT-006	44.5 - 45.0	2.8	112	7.9	2.65	860
380-GT-006	45.0 - 45.5	6.0	96	9.2	2.68	510

4. Sample I.D. - Driven

	Depth, Feet	pH (Units)	T.O.C mg/kg
529-GT-007	5 - 5.5	7.7	2400

5. Sample I.D. - Driven

	Depth, Feet	Moisture Content %	Dry Density, pcf	G_s
529-GT-010	39.5 - 40.0	24.0	100	2.62
529-GT-010	40.0 - 40.5	22.4	108	2.62
529-GT-010	44.5 - 45.0	13.8	107	2.67

6. Sample I.D. - Driven

	Depth, Feet	p^HUnits)
529-GT-012	15.0 - 15.5	7.6

7. **Sample I.D. - Driven**

	Depth, Feet	Moisture Content %	Dry Density, pcf	G_s
529-GT-013	64.5 - 65.0	24.6	97	2.65
529-GT-013	65.0 - 65.5	19.2	105	2.64
529-GT-013	69.5 - 70.0	11.3	116	2.64
529-GT-013	70.0 - 70.5	7.6	119	2.61

8. **Sample I.D. - Driven**

	Depth, Feet	Moisture Content %	Dry Density, pcf
529-GT-014	54.5 - 55.0	10.3	116
529-GT-014	55.0 - 55.5	14.9	122
529-GT-014	59.5 - 60.0	13.5	111
529-GT-014	60.0 - 60.5	13.2	118

9. **Sample I.D. - Driven**

	Depth, Feet	pH	T.O.C. mg/kg
529-GT-015	90.0 - 90.5	6.7	6600
529-GT-015	90.5 - 91.0	8.0	7400
529-GT-015	94.5 - 95.0	8.2	7000
529-GT-015	95.0 - 95.5	8.2	9900

10. Permeability Test ASTM D 5084 - Sample I.D. - Bulk

	Moisture Content, %		Dry Density		Coefficient of Permeability K20°c(Ave.) cm/sec
	Before Test	After Test	Before Test	After Test	
529-GT-SP01	20.1	21.9	105.1	106.4	7.58x10^{-8}
529-GT-SP04(gray)	12.9	14.8	117.2	120.3	9.12x10^{-6}
529-GT-SP03	20.0	21.7	105.1	104.3	2.49x10^{-8}
529-GT-SP04(brown)	15.8	18.1	109.2	109.1	8.85x10^{-6}
529-GT-SP05	19.9	20.8	105.2	104.8	1.34x10^{-7}

11. Permeability Test ASTM D 5084 - Sample I.D. - Bulk

	Moisture Content, %		Dry Density		T.O.C. mg/kg	Coefficient of Permeability K20°c(Ave.) cm/sec
	Before Test	After Test	Before Test	After Test		
380-GT-SP01	6.5	23.6	101.3	99.7	1800	5.89x10^{-6}
380-GT-SP02	5.3	21.8	105.1	105.1		9.17x10^{-4}

ATTACHMENT: 7 MECHANICAL ANALYSIS PLOTS

Should you have any questions, please call.

Respectfully submitted,

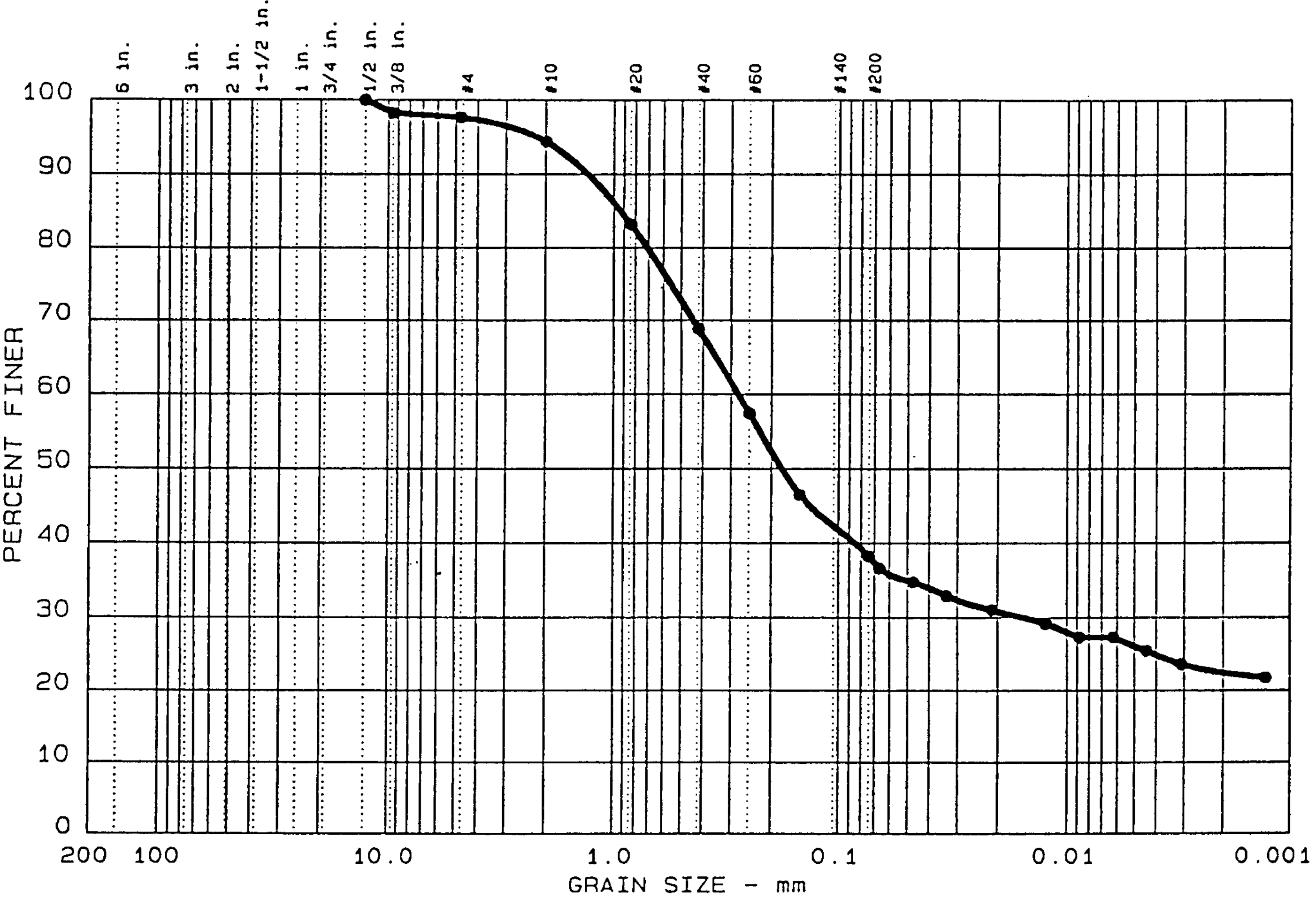
SMITH-EMERY GEOSERVICES

Raf Hutalla

RAF HUTALLA
Geotechnical Manager

RH/rc
cc: 2-Addressee

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	1	0.0	2.3	59.4	12.2	26.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.92	0.28	0.18	0.015				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown CLAYEY SAND	SC	

Job No.: 90827
Job Name: NINYO & MOORE - OHM/UST 380 & 529
● Sample Location: 380-GT-SP01

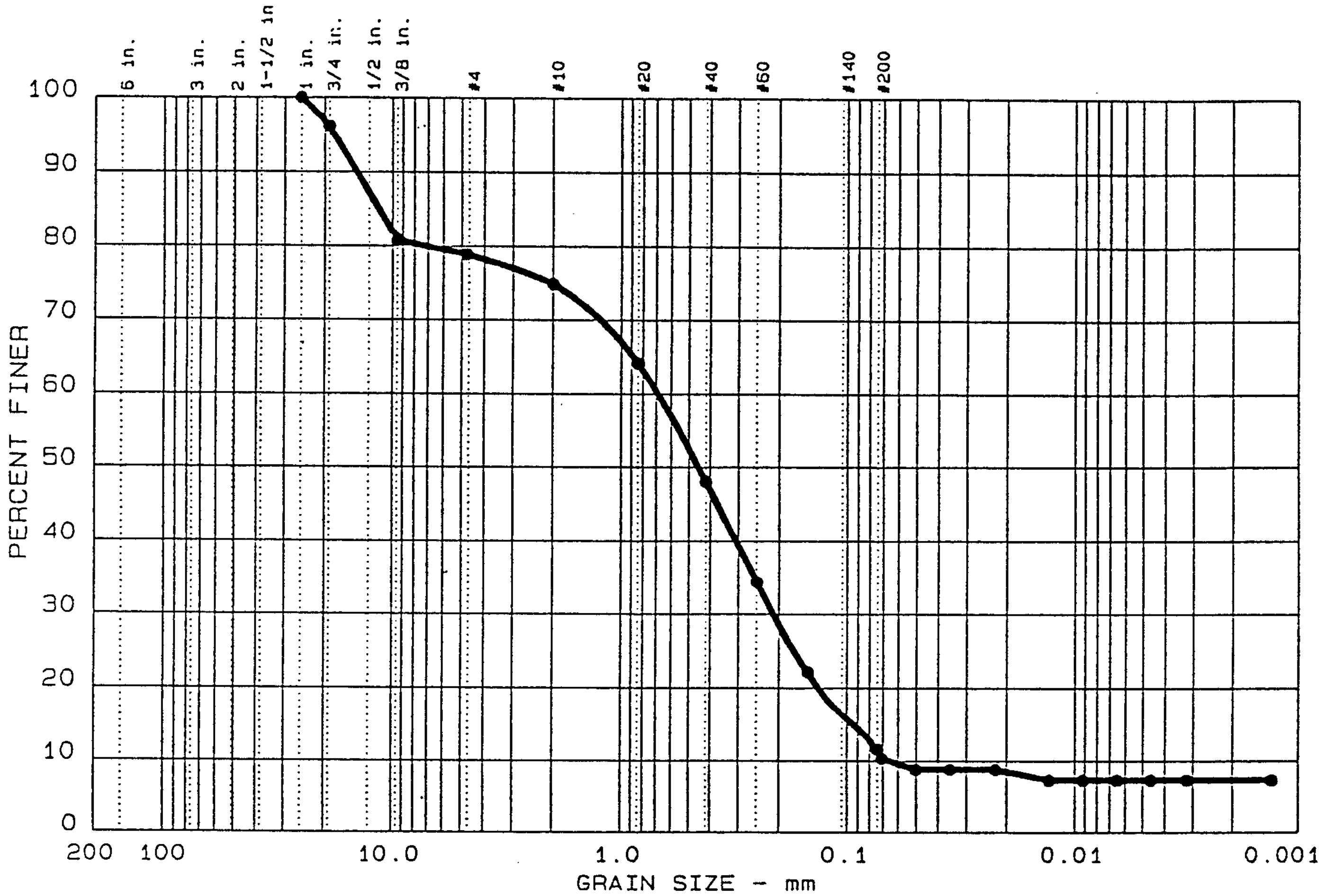
Date: 10-16-97

Tested by: ATF
Date: 10-13-97
Sampled by: CLIENT
Date:
Remarks:

Smith-Emery Company

Plate No. 1

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	21.1	67.3	4.2	7.4

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			11.48	0.68	0.45	0.211	0.0933	0.0661	0.99	10.4

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown SAND with SILTY CLAY and GRAVEL	SP-SC	

Job No.: 90827

Job Name: NINYO & MOORE -- OHM/UST 380 & 529

● Sample Location: 380-GT-SP02

Date: 10-16-97

Tested by: ATF

Date: 10-13-97

Sampled by: CLIENT

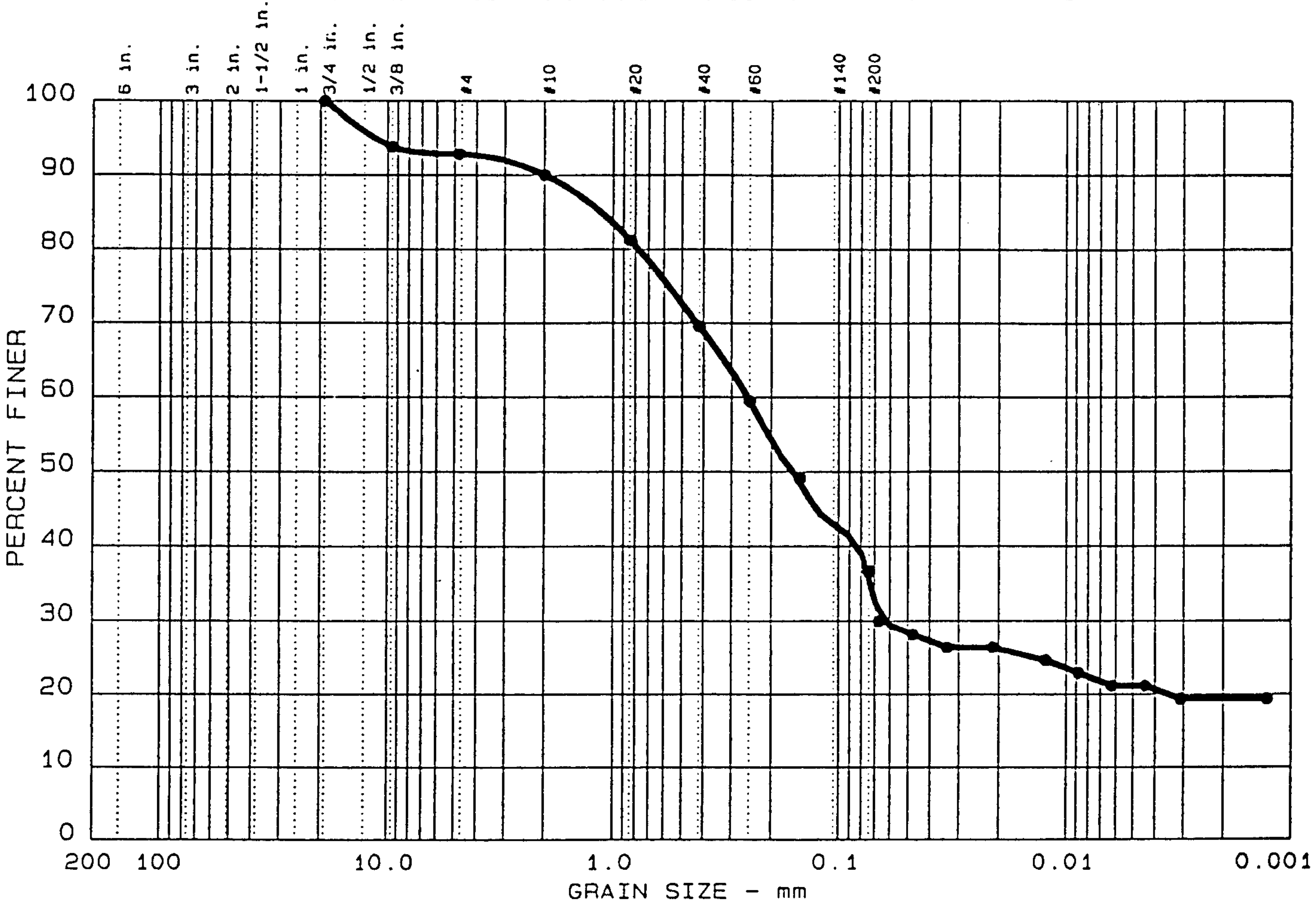
Date:

Remarks:

Smith-Emery Company

Plate No. 2

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	3	0.0	7.2	56.1	15.6	21.1

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.12	0.25	0.16	0.066				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown CLAYEY SAND	SC	

Job No.: 90827
Job Name: NINYO & MOORE - OHM/UST 380 & 529
● Sample Location: 529-GT-SP01

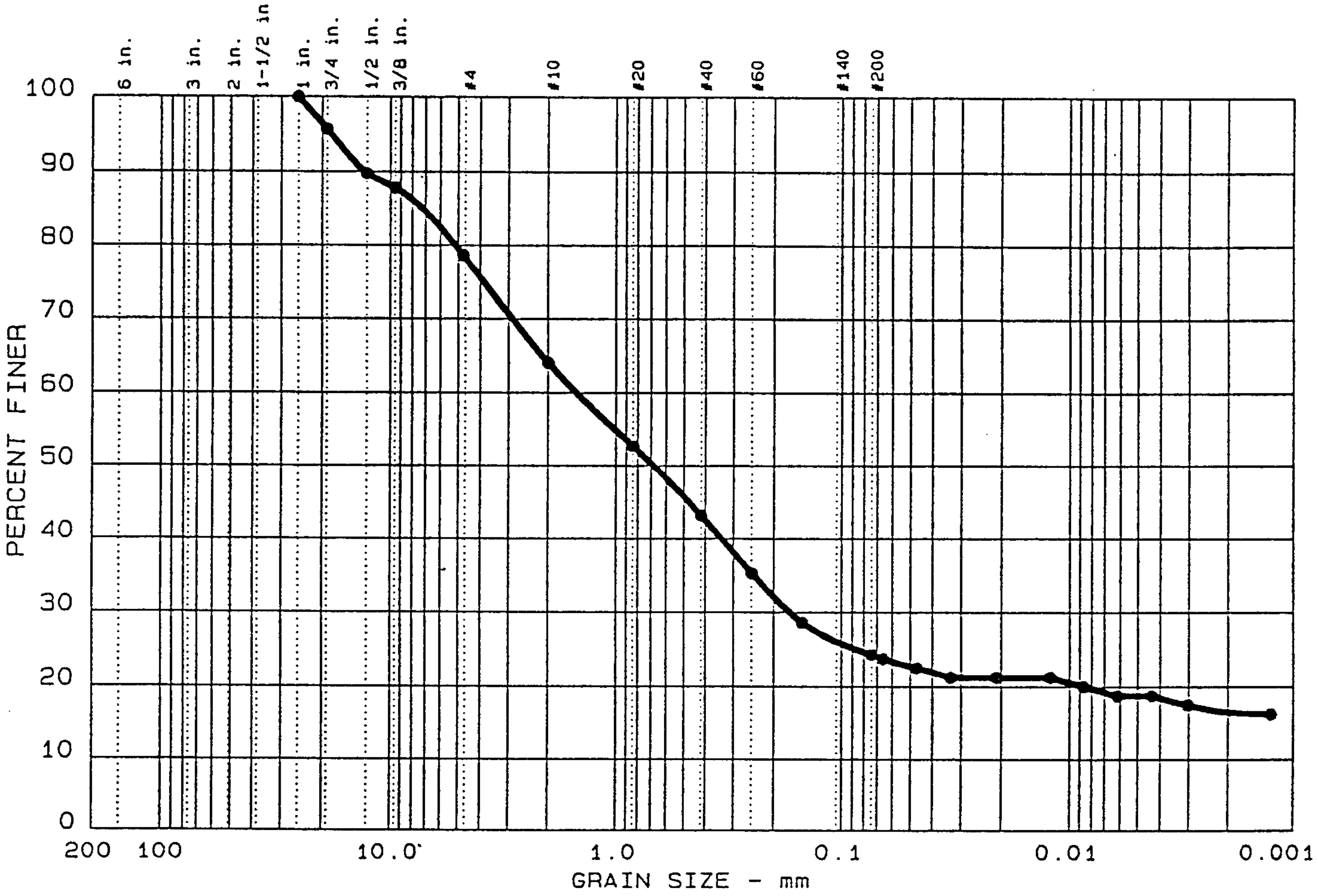
Date: 10-16-97

Tested by: ATF
Date: 10-13-97
Sampled by: CLIENT
Date:
Remarks:

Smith-Emery Company

Plate No. 3

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	5	0.0	21.4	54.3	5.6	18.7

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			7.16	1.50	0.68	0.168				

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray CLAYEY SAND with GRAVEL	SC	

Job No.: 90827
Job Name: NINYO & MOORE - OHM/UST 380 & 529
● Sample Location: 529-GT-SP04 (gray)

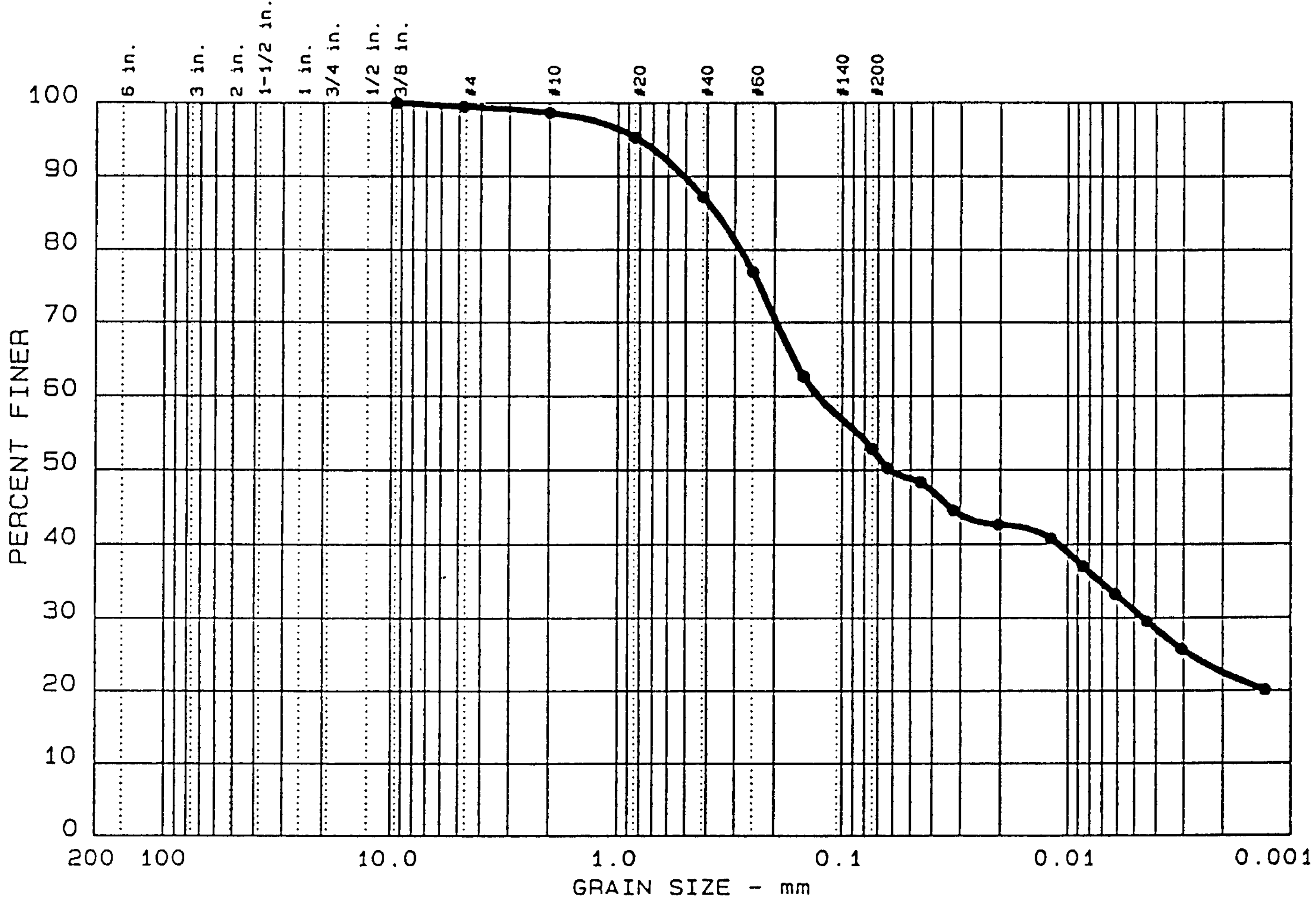
Date: 10-16-97

Smith-Emery Company

Tested by: ATF
Date: 10-15-97
Sampled by: CLIENT
Date:
Remarks:

Plate No. 4

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	4	0.0	0.5	46.7	21.8	31.0

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.37	0.13	0.06	0.005				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown SANDY SILTY CLAY	CL - ML	

Job No.: 90827

Job Name: NINYO & MOORE - OHM/UST 380 & 529

● Sample Location: 529-GT-SP03

Date: 10-16-97

Tested by: ATF

Date: 10-13-97

Sampled by: CLIENT

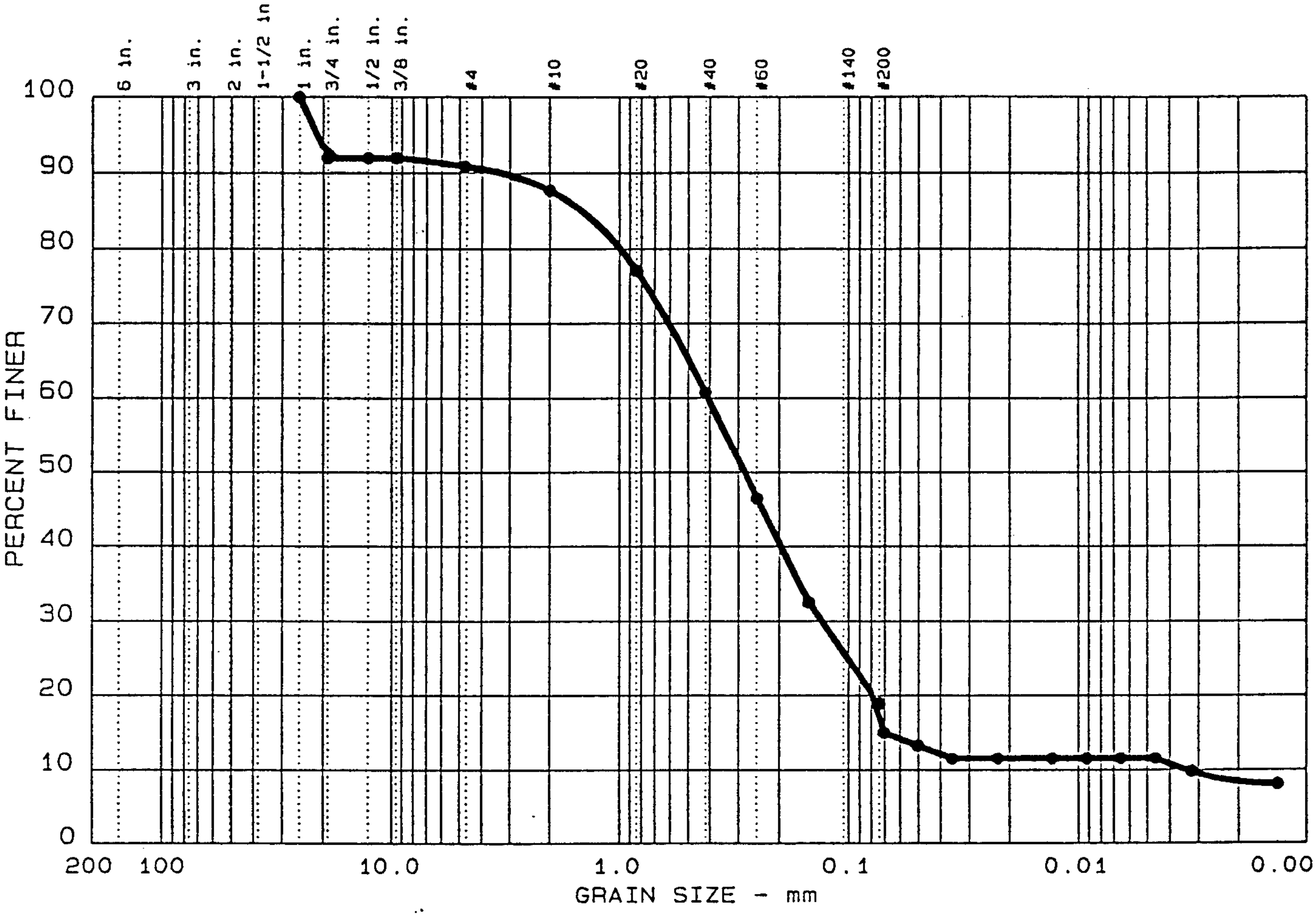
Date:

Remarks:

Smith-Emery Company

Plate No. 5

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	9.1	72.0	7.4	11.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			1.45	0.41	0.28	0.130	0.0700	0.0032	12.88	125.9

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown SILTY CLAYEY SAND	SC	

Job No.: 90827

Job Name: NINYO & MOORE - OHM/UST 380 & 529

● Sample Location: 529-GT-SP04 (brown)

Date: 10-16-97

Smith-Emery Company

Tested by: ATF

Date: 10-15-97

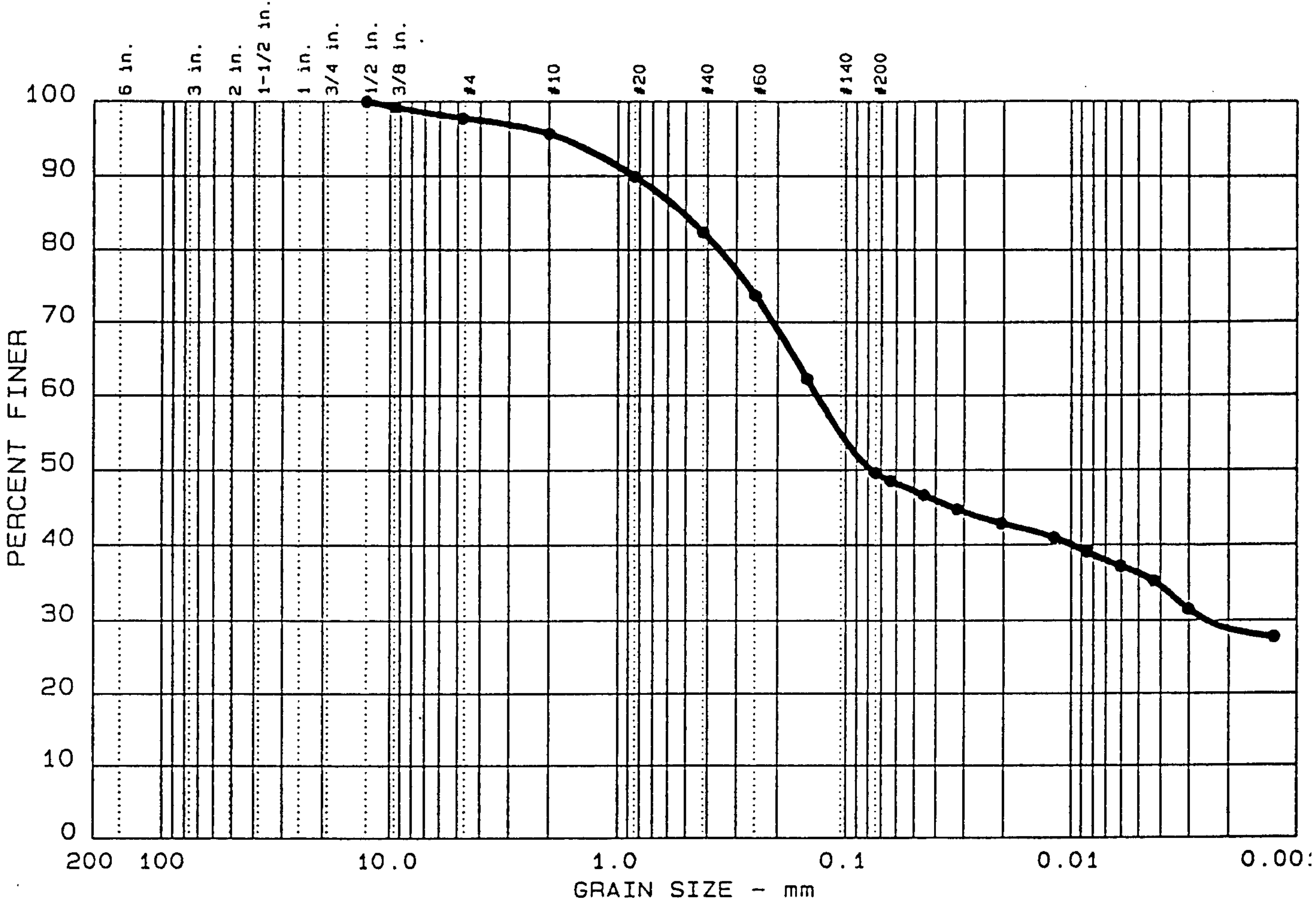
Sampled by: CLIENT

Date:

Remarks:

Plate No. 6

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	2.3	48.2	13.2	36.3

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			0.51	0.13	0.08	0.002				

MATERIAL DESCRIPTION	USCS	AASHTO
● Brown SANDY SILTY CLAY	CL - ML	

Job No.: 90827
Job Name: NINYO & MOORE - OHM/UST 380 & 529
● Sample Location: 529-GT-SP05

Date: 10-16-97

Smith-Emery Company

Tested by: ATF
Date: 10-13-97
Sampled by: CLIENT
Date:
Remarks:

Plate No. 7

APPENDIX B

CHAIN-OF-CUSTODY RECORDS

OHM Remediation Services Corp
Subsidiary of OHM Corporation
U.S. Route 224 East • Findlay, Ohio 45840 • (419) 423-3526

CHAIN-OF-CUSTODY RECORD

LABORATORY COPY
209515
FORM 0019 REV. 2-97

OHM's LAB COORDINATOR D. Uchida	LAB COORDINATOR'S PHONE 263 1146	LAB COORDINATOR'S FAX 263 1147	LABORATORY SERVICE ID	LABORATORY CONTACT D. VanHoff	MAIL REPORT (COMPANY NAME)
PROJECT NAME: MCAS El TORO	PROJECT LOCATION Building 529	PROJECT NUMBER 18292	LABORATORY PHONE	LABORATORY FAX	RECIPIENT NAME
PROJECT CONTACT J. Diebenow	PROJECT PHONE NUMBER 263 1146	PROJECT FAX 263 1147	LABORATORY ADDRESS 9272 Jeronimo		ADDRESS
PROJECT ADDRESS 2031 Main St.	CITY, STATE AND ZIPCODE Irvine, CA	CLIENT NAVY SW DIV	CITY, STATE AND ZIPCODE Irvine, CA		CITY, STATE AND ZIPCODE
PROJECT MANAGER Bill Sedlak	PROJECT MANAGER'S PHONE 263 1146	PROJECT MANAGER'S FAX 263 1147			

Ninyo and Mo

Item	Sample Identifier	Matrix	Date	Time	Preserved	# of Cont.	QC Level	T.A.T	Analyses: TOC	pH	Bulk density	grain size	permeability	porosity	~~test~~ hydraulic cond	moisture	Comments
1	18292-529-GT-SP01	soil	n/a	n/a	–	1						X	X				Bag Sample
2	18292-529-GT-SP02	soil	n/a	n/a	–	1						X	X				Bag Sample
3	18292-529-GT-SP03	soil	n/a	n/a	–	1						X	X				Bag sample
4	18292-529-GT-SP-04	soil	n/a	n/a	–	1						X	X				Bag Sample
5	18292-529-GT-010	soil	n/a	n/a	–	~~4~~ 3					X			X		X	39.5 - 45.0 - sample interval @ SB-05
6	18292-529-GT-011	soil	n/a	n/a	–	2								X			29.5 - 30.5 - sample interval @ SB-05
7	18292-529-GT-012	soil	n/a	n/a	–	2				X							14.5 - 15.5 - sample interval @ SB-05
8	18292-529-GT-013	soil	n/a	n/a	–	4					X			X		X	64.5 - 70.5 - sample interval SB-05
9	18292-529-GT-014	soil	n/a	n/a	–	4					X					X	54.5 - 60.5 - sample interval SB-05
10	18292-529-GT-~~014~~ 015	soil	n/a	n/a	–	4			X	X							90 - 95.5 - sample interval SB-05

Send grain size to select sample interval for perm.

SAMPLES COLLECTED BY:

COURIER AND AIR BILL NUMBER:

COOLER TEMPERATURE UPON RECEIPT — geotech

RELINQUISHED BY	RECEIVED BY	DATE	TIME	SAMPLE'S CONDITION UPON RECEIPT
J. Diebenow	Dave VanHoff	9-8-97	3:35	

samples relinquished to Smith-Emery on 10/2/97 DV

Distribution: White - Laboratory (To be returned with Analytical Report); Goldenrod - Project File; Yellow - Project Data Manager

OHM Remediation Services Corp
Subsidiary of OHM Corporation
U.S. Route 224 East • Findlay, Ohio 45840 • (419) 423-3526

CHAIN-OF-CUSTODY RECORD

LABORATORY COPY
209516
FORM 0019 REV. 2-97

OHM's LAB COORDINATOR D. Bhidan	LAB COORDINATOR'S PHONE 263 - 1146	LAB COORDINATOR'S FAX	LABORATORY SERVICE ID	LABORATORY CONTACT D. VanHoff	MAIL REPORT (COMPANY NAME)
PROJECT NAME: MCAS El Toro	PROJECT LOCATION Building ~~529~~ 380A	PROJECT NUMBER 18292	LABORATORY PHONE	LABORATORY FAX	RECIPIENT NAME
PROJECT CONTACT J. Dickerson	PROJECT PHONE NUMBER 263 1146	PROJECT FAX 263 1147	LABORATORY ADDRESS 9292 Jeronimo		ADDRESS
PROJECT ADDRESS 2031 Main St.	CITY, STATE AND ZIPCODE Irvine CA	CLIENT NAVY SWDIV	CITY, STATE AND ZIPCODE Irvine, CA		CITY, STATE AND ZIPCODE
PROJECT MANAGER Bill Scdlak	PROJECT MANAGER'S PHONE 263 1146	PROJECT MANAGER'S FAX 263 1147			

Ninyo and Moore

Item	Sample Identifier	Matrix	Date	Time	Preserved	# of Cont	QC Level	T.A.T	Analyses TOC	pH	Bulk density	grain size	permeability	porosity	~~Hydraulic cond.~~	moisture	Comments
1	18292-380-GT-SP01	Soil	n/a	n/a	-	1			X			X					Bag sample
2	18292-380-GT-SP02	Soil	n/a	n/a	-	1						X	X				Bag sample (32-55')
3	18292-380-GT-005	Soil	n/a	n/a	-	4			X	X	X	~~4~~	NO	1		X	29.5-35 sample interval Building 380 → use SP02
4	18292-380-GT-006	Soil	n/a	n/a	-	4			X	X	X	~~4~~	NO	1		X	39.5-45.5 sample interval Building 380 → use SP03
5																	
6	18292-529-GT-~~015~~ 016	Soil	n/a	n/a	-	4											24.5-30.5 sample interval Building 529 SB-03
7	18292-529-GT-007	Soil	8-29-97	1330	-	1			X	X							5-5.5 sample interval Building 529 SB-03
8																	
9																	
10																	

→ analyze each brass sleeve for Drydensity and Moisture content. then average for geotech. perm
1-porosity per 4 brass sleeve set

SAMPLES COLLECTED BY:

COURIER AND AIR BILL NUMBER:

COOLER TEMPERATURE UPON RECEIPT:

RELINQUISHED BY	RECEIVED BY	DATE	TIME	SAMPLE'S CONDITION UPON RECEIPT
J. Dickerson	Dom J. VanHoff	9.8.97	3:30	- Send analytical results for TPH
samples relinquished to Smith-Emery on 10/2/97 DV				

Distribution: White - Laboratory (To be returned with Analytical Report); Goldenrod - Project File; Yellow - Project Data Manager

OHM Remediation Services Corp
Subsidiary of OHM Corporation
U.S. Route 224 East • Findlay, Ohio 45840 • (419) 423-3526

CHAIN-OF-CUSTODY RECORD

LABORATORY COPY
209517
FORM 0019 REV. 2-97

OHM's LAB COORDINATOR D. Ishida	LAB COORDINATOR'S PHONE 263 1146	LAB COORDINATOR'S FAX	LABORATORY SERVICE ID	LABORATORY CONTACT D. VanHoff	MAIL REPORT (COMPANY NAME)
PROJECT NAME: MCAS El Toro	PROJECT LOCATION	PROJECT NUMBER 18292	LABORATORY PHONE	LABORATORY FAX	RECIPIENT NAME
PROJECT CONTACT J. Dickenson	PROJECT PHONE NUMBER 263 1146	PROJECT FAX 263 1147	LABORATORY ADDRESS ~~9272~~ Jeronimo		ADDRESS
PROJECT ADDRESS 2031 Main St.	CITY, STATE AND ZIPCODE Irvine CA	CLIENT NAVY SW DIV	CITY, STATE AND ZIPCODE Irvine CA		CITY, STATE AND ZIPCODE
PROJECT MANAGER Bill Sedlak	PROJECT MANAGER'S PHONE 263 1146	PROJECT MANAGER'S FAX 263 1147			

Item	Sample Identifier	Matrix	Date	Time	Preserved	# of Cont	QC Level	T.A.T	Analyses: TOC	pH	Bulk density	grain size	permeability	porosity	moisture		Ninyo and Moore Comments
1	18292-529-GT-SP05	soil	NA	NA	–	1					X	X					Bulk Bag sample
2	18292-380-GT-001	soil	8.29.97	1000	–	1			X	X							
3																	* Note for bulk density / and moisture samples
4																	noted on COC 209515 and 209516 run
5																	2 of the 4 brass sleeves. of consecutive depths.
6																	ie.
7																	18292-~~SS~~529-GT-011 39.5-45.0
8																	run ~~the~~ one sample from 39.5-40.5
9																	and one from 44-45.
10																	

SAMPLES COLLECTED BY	COURIER AND AIR BILL NUMBER			COOLER TEMPERATURE UPON RECEIPT
RELINQUISHED BY	RECEIVED BY	DATE	TIME	SAMPLE'S CONDITION UPON RECEIPT
J. Dickenson		9.9.97	8:20	

Samples relinquished to Smith-Emery on 10/2/97

Distribution: White - Laboratory (To be returned with Analytical Report); Goldenrod - Project File; Yellow - Project Data Manager

Appendix B-2

Analytical Data
Lancaster Laboratories
(Direct Method)

Lancaster Laboratories
A division of Thermo Analytical Inc.
Where quality is a science.

October 28, 1997

Ms. Elaine Merrill
Operational Technologies Corp.
1010 Woodman Drive Suite 160
Dayton, OH 45432

Dear Ms. Merrill:

Enclosed with this letter is a diskette which contains the hydrocarbon speciation data for the El Toro site. The data is presented in Excel 5.0 spreadsheets, one spreadsheet for each sample that was chosen for analysis. There are two "sheets" in each spreadsheet; one named RAWDATA that contains the raw sample data, the other named PRINT which has the data we list in the hard copy report. Each spreadsheet is identified by the Lancaster Laboratories sample number. In these spreadsheets are the identification codes that you provided.

I've also included a spreadsheet named ELTORO which cross references all the sample identification information: the OPTECH sample identification, the site number, and the date and time of collection along with the Lancaster Laboratories sample numbers.

A hard copy report of the data along with the chains of custody will be sent to Erik Vermulen through the mail. This hard copy is our official report. If you have questions about the data, give me a call at 717-656-2300, Ext. 1559. A copy of this diskette is also being sent to Jill Nordstrom of Remediation Technologies Inc. in Seattle.

Sincerely,

Richard Entz
Principal Specialist

RE/hzk
Enclosures

cc: Jill Nordstrom

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Lancaster Laboratories
A Thermo Analytical Laboratory

Operational Technologies - Account 9729
Project: El Toro

9/16/97

Samples for analysis

Sampling Information				Lancaster Laboratories	Analyses		
Sample Identification	Site #	Date Collected	Time Collected	Sample #	Moisture	Volatiles Range Hydrocarbon Speciation	Extractables Range Hydrocarbon Speciation
529SB-05-20	529	9/2/97	1317	2781270	x	x	x
529SB-05-25	529	9/2/97	1320	2781271	x	x	x
529SB-05-50	529	9/2/97	1346	2781272	x	x	x
529SB-05-75	529	9/3/97	0740	2781273	x	x	x
529SB-05-77	529	9/3/97	0743	2781274	x	x	x
529SB-05-100	529	9/3/97	0815	2781275	x	x	x
529SB-04-20	529	9/2/97	0857	2781276	x	x	x
529SB-04-60	529	9/2/97	0949	2781277	x	x	x
529SB-04-95	529	9/2/97	1048	2781278	x	x	x
529SB-04-80	529	9/2/97	1026	2781279	x	x	x
380-SB-02B-15	380A	9/3/97	1307	2781281	x	x	x
380SB-02B-20	380A	9/3/97	1310	2781282	x	x	x
380SB-02B-21	380A	9/3/97	1311	2781283	x	x	x
380SB-02B-32	380A	9/3/97	1323	2781284	x	x	x
380SB-02B-33	380A	9/3/97	1325	2781285	x	x	x

Samples <u>not</u> analyzed

529SB-05-25	529	9/2/97	1320
529SB-05-35	529	9/2/97	1330

529SB-04-30	529	9/2/97	0906
529SB-04-90	529	9/2/97	1041
529SB-04-100	529	9/2/97	1051
380SB-02B-10	380A	9/3/97	1305
380SB-02B-2S	380A	9/3/97	1314

All samples were received on 9/4/97. Information about specific samples to analyze was received on 9/16/97.

Richard Entz
Project Manager

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781281 Extractable Batch ID: 97273-0002A

Sample ID: 380SB-02B-15

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.2	ND	0.2	ND	NA
VRH 2 **	NA	NA	ND	0.2	ND	0.2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	ND	8	ND	8	ND	8	ND	NA
>C12 - <=C16	75	20	57	20	ND	20	59	79%
>C16 - <=C21	310	20	151	20	101	20	252	81%
>C21 - <=C35	121	50	ND	50	58	50	105	87%
Total >C8 - <=C35	508	100	258	100	162	100	420	83%
Total >C5 - <=C35	NA	NA	258	100	162	100	420	NA

Laboratory ID: 2781281 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 4.4

Sample ID: 380SB-02B-15

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.2	ND	0.2	ND	NA
VRH 2 **	NA	NA	ND	0.2	ND	0.2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	ND	8	ND	8	ND	8	ND	NA
>C12 - <=C16	78	21	60	21	ND	21	62	79%
>C16 - <=C21	324	21	157	21	106	21	263	81%
>C21 - <=C35	126	52	ND	52	61	52	110	87%
Total >C8 - <=C35	532	105	270	105	169	105	439	83%
Total >C5 - <=C35	NA	NA	270	105	169	105	439	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781282
Sample ID: 380SB-02B-20

Extractable Batch ID: 97260-0014A

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.2	ND	0.2	ND	NA
VRH 2 **	NA	NA	ND	0.2	ND	0.2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	ND	8	ND	8	ND	8	ND	NA
>C12 - <=C16	26	20	ND	20	ND	20	21	82%
>C16 - <=C21	93	20	54	20	ND	20	73	79%
>C21 - <=C35	52	50	ND	50	ND	50	ND	NA
Total >C8 - <=C35	173	100	ND	100	ND	100	118	69%
Total >C5 - <=C35	NA	NA	ND	100	ND	100	118	NA

Laboratory ID: 2781282
Sample ID: 380SB-02B-20

C5 to C35 Hydrocarbons "Dry Weight Data"

% moisture = 5.6

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.2	ND	0.2	ND	NA
VRH 2 **	NA	NA	ND	0.2	ND	0.2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	ND	8	ND	8	ND	8	ND	NA
>C12 - <=C16	27	21	ND	21	ND	21	22	82%
>C16 - <=C21	99	21	57	21	ND	21	77	79%
>C21 - <=C35	55	53	ND	53	ND	53	ND	NA
Total >C8 - <=C35	183	106	ND	106	ND	106	125	69%
Total >C5 - <=C35	NA	NA	ND	106	ND	106	125	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781283 Extractable Batch ID: 97260-0014A
Sample ID: 380SB-02B-21

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.2	ND	0.2	ND	NA
VRH 2 **	NA	NA	ND	0.2	ND	0.2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	ND	8	ND	8	ND	8	ND	NA
>C12 - <=C16	81	20	67	20	ND	20	74	92%
>C16 - <=C21	295	20	162	20	80	20	242	82%
>C21 - <=C35	111	50	ND	50	ND	50	77	70%
Total >C8 - <=C35	489	100	266	100	130	100	396	81%
Total >C5 - <=C35	NA	NA	266	100	130	100	396	NA

Laboratory ID: 2781283 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 4.3
Sample ID: 380SB-02B-21

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.2	ND	0.2	ND	NA
VRH 2 **	NA	NA	ND	0.2	ND	0.2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	ND	8	ND	8	ND	8	ND	NA
>C12 - <=C16	85	21	70	21	ND	21	77	92%
>C16 - <=C21	308	21	169	21	84	21	253	82%
>C21 - <=C35	116	52	ND	52	ND	52	81	70%
Total >C8 - <=C35	511	104	278	104	135	104	413	81%
Total >C5 - <=C35	NA	NA	278	104	135	104	413	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781284
Sample ID: 380SB-02B-32

Extractable Batch ID: 97260-0014A

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	2	ND	2	ND	NA
VRH 2 **	NA	NA	ND	2	ND	2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	31	8	35	8	ND	8	35	115%
>C12 - <=C16	535	20	427	20	30	20	457	86%
>C16 - <=C21	724	20	467	20	70	20	537	74%
>C21 - <=C35	166	50	77	50	ND	50	88	53%
Total >C8 - <=C35	1456	100	1009	100	112	100	1121	77%
Total >C5 - <=C35	NA	NA	1009	100	112	100	1121	NA

Laboratory ID: 2781284
Sample ID: 380SB-02B-32

C5 to C35 Hydrocarbons "Dry Weight Data"

% moisture = 4.6

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	2	ND	2	ND	NA
VRH 2 **	NA	NA	ND	2	ND	2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	32	8	36	8	ND	8	37	115%
>C12 - <=C16	560	21	448	21	32	21	479	86%
>C16 - <=C21	758	21	490	21	73	21	562	74%
>C21 - <=C35	173	52	80	52	ND	52	92	53%
Total >C8 - <=C35	1526	105	1058	105	117	105	1175	77%
Total >C5 - <=C35	NA	NA	1058	105	117	105	1175	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781285 Extractable Batch ID: 97260-0014A
Sample ID: 380SB-02B-33

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	2	2	2	2	NA
VRH 2 **	NA	NA	ND	2	ND	2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	13	8	15	8	ND	8	15	121%
>C12 - <=C16	575	20	464	20	29	20	492	86%
>C16 - <=C21	858	20	568	20	77	20	645	75%
>C21 - <=C35	192	50	82	50	ND	50	101	52%
Total >C8 - <=C35	1638	100	1129	100	125	100	1254	77%
Total >C5 - <=C35	NA	NA	1129	100	127	100	1256	NA

Laboratory ID: 2781285 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 5.3
Sample ID: 380SB-02B-33

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	2	2.111	2	2	NA
VRH 2 **	NA	NA	ND	2	ND	2	ND	NA
>C8 - <=C10	ND	8	ND	8	ND	8	ND	NA
>C10 - <=C12	13	8	16	8	ND	8	16	121%
>C12 - <=C16	607	21	489	21	30	21	520	86%
>C16 - <=C21	906	21	599	21	81	21	681	75%
>C21 - <=C35	203	53	87	53	ND	53	106	52%
Total >C8 - <=C35	1729	106	1192	106	132	106	1324	77%
Total >C5 - <=C35	NA	NA	1192	106	134	106	1326	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781276 Extractable Batch ID: 97260-0014A
Sample ID: 529SB-04-20

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.8	ND	0.8	ND	NA
VRH 2 **	NA	NA	1	0.8	ND	0.8	1	NA
>C8 - <=C10	54	8	52	8	ND	8	59	109%
>C10 - <=C12	341	8	265	8	51	8	316	93%
>C12 - <=C16	1644	20	1013	20	381	20	1394	85%
>C16 - <=C21	1759	20	894	20	505	20	1399	80%
>C21 - <=C35	334	50	158	50	117	50	275	82%
Total >C8 - <=C35	4131	100	2382	100	1060	100	3442	83%
Total >C5 - <=C35	NA	NA	2383	100	1060	100	3443	NA

Laboratory ID: 2781276 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 11.3
Sample ID: 529SB-04-20

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	0.9	ND	0.9	ND	NA
VRH 2 **	NA	NA	1	0.9	ND	0.9	1	NA
>C8 - <=C10	61	9	58	9	ND	9	66	109%
>C10 - <=C12	384	9	299	9	57	9	356	93%
>C12 - <=C16	1853	23	1142	23	429	23	1571	85%
>C16 - <=C21	1983	23	1008	23	569	23	1578	80%
>C21 - <=C35	376	56	178	56	132	56	310	82%
Total >C8 - <=C35	4657	113	2686	113	1195	113	3881	83%
Total >C5 - <=C35	NA	NA	2687	113	1195	113	3882	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781277 Extractable Batch ID: 97260-0014A
Sample ID: 529SB-04-60

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8.00	ND	NA
VRH 2 **	NA	NA	23	8	ND	8.00	23	NA
>C8 - <=C10	142	8	114	8	22	8	136	95%
>C10 - <=C12	579	8	399	8	95	8	493	85%
>C12 - <=C16	3323	20	1842	20	754	20	2596	78%
>C16 - <=C21	3892	20	1813	20	1042	20	2855	73%
>C21 - <=C35	469	50	189	50	252	50	441	94%
Total >C8 - <=C35	8406	100	4356	100	2165	100	6521	78%
Total >C5 - <=C35	NA	NA	4379	100	2166	100	6545	NA

Laboratory ID: 2781277 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 10.0
Sample ID: 529SB-04-60

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	9	ND	9	ND	NA
VRH 2 **	NA	NA	25	9	ND	9	26	NA
>C8 - <=C10	158	9	126	9	25	9	151	95%
>C10 - <=C12	644	9	443	9	105	9	548	85%
>C12 - <=C16	3692	22	2047	22	838	22	2885	78%
>C16 - <=C21	4324	22	2014	22	1158	22	3172	73%
>C21 - <=C35	521	56	210	56	280	56	490	94%
Total >C8 - <=C35	9339	111	4840	111	2406	111	7246	78%
Total >C5 - <=C35	NA	NA	4865	111	2407	111	7272	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781279 Extractable Batch ID: 97260-0014A
Sample ID: 529SB-04-80

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	ND	8	ND	8	ND	NA
>C8 - <=C10	89	8	76	8	15	8	91	102%
>C10 - <=C12	343	8	247	8	65	8	312	91%
>C12 - <=C16	2343	20	1406	20	540	20	1946	83%
>C16 - <=C21	2681	20	1444	20	600	20	2044	76%
>C21 - <=C35	295	50	119	50	61	50	180	61%
Total >C8 - <=C35	5751	100	3293	100	1281	100	4574	80%
Total >C5 - <=C35	NA	NA	3293	100	1281	100	4574	NA

Laboratory ID: 2781279 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 11.3
Sample ID: 529SB-04-80

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	9	ND	9	ND	NA
VRH 2 **	NA	NA	ND	9	ND	9	ND	NA
>C8 - <=C10	100	9	86	9	17	9	103	102%
>C10 - <=C12	387	9	279	9	73	9	352	91%
>C12 - <=C16	2641	23	1585	23	609	23	2194	83%
>C16 - <=C21	3023	23	1628	23	677	23	2305	76%
>C21 - <=C35	332	56	134	56	69	56	203	61%
Total >C8 - <=C35	6484	113	3712	113	1444	113	5157	80%
Total >C5 - <=C35	NA	NA	3713	113	1445	113	5157	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781278 Extractable Batch ID: 97260-0014A

Sample ID: 529SB-04-95

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	2	ND	2	ND	NA
VRH 2 **	NA	NA	ND	2	ND	2	ND	NA
>C8 - <=C10	48	8	47	8	ND	8	54	113%
>C10 - <=C12	380	8	264	8	66	8	331	87%
>C12 - <=C16	3290	20	1885	20	690	20	2575	78%
>C16 - <=C21	3826	20	1968	20	791	20	2759	72%
>C21 - <=C35	391	50	154	50	87	50	241	62%
Total >C8 - <=C35	7935	100	4318	100	1641	100	5960	75%
Total >C5 - <=C35	NA	NA	4319	100	1641	100	5960	NA

Laboratory ID: 2781278 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 9.9

Sample ID: 529SB-04-95

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	2	ND	2	ND	NA
VRH 2 **	NA	NA	ND	2	ND	2	ND	NA
>C8 - <=C10	53	9	52	9	ND	9	60	113%
>C10 - <=C12	422	9	293	9	74	9	367	87%
>C12 - <=C16	3653	22	2093	22	766	22	2859	78%
>C16 - <=C21	4248	22	2185	22	878	22	3064	72%
>C21 - <=C35	434	56	171	56	97	56	267	62%
Total >C8 - <=C35	8810	111	4795	111	1823	111	6618	75%
Total >C5 - <=C35	NA	NA	4796	111	1823	111	6618	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781270
Sample ID: 529SB-05-20

Extractable Batch ID: 97260-0014A

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	8	8	ND	8	8	NA
>C8 - <=C10	114	8	99	16	ND	16	115	101%
>C10 - <=C12	668	8	449	16	119	16	568	85%
>C12 - <=C16	3593	20	1962	40	859	40	2821	79%
>C16 - <=C21	3446	20	1696	40	930	40	2626	76%
>C21 - <=C35	1870	50	659	100	688	100	1347	72%
Total >C8 - <=C35	9690	100	4864	200	2613	200	7477	77%
Total >C5 - <=C35	NA	NA	4873	200	2613	200	7485	NA

Laboratory ID: 2781270 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 10.3
Sample ID: 529SB-05-20

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	9	ND	9	ND	NA
VRH 2 **	NA	NA	9	9	ND	9	9	NA
>C8 - <=C10	127	9	111	18	ND	18	128	101%
>C10 - <=C12	744	9	501	18	133	18	633	85%
>C12 - <=C16	4006	22	2187	45	958	45	3145	79%
>C16 - <=C21	3842	22	1890	45	1037	45	2927	76%
>C21 - <=C35	2085	56	734	111	767	111	1502	72%
Total >C8 - <=C35	10803	111	5423	223	2913	223	8335	77%
Total >C5 - <=C35	NA	NA	5432	223	2913	223	8345	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781271 Extractable Batch ID: 97260-0014A

Sample ID: 529SB-05-25

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	10	8	ND	8	10	NA
>C8 - <=C10	120	8	98	16	ND	16	112	93%
>C10 - <=C12	723	8	471	16	105	16	576	80%
>C12 - <=C16	3519	20	1801	40	701	40	2502	71%
>C16 - <=C21	3227	20	1429	40	736	40	2164	67%
>C21 - <=C35	1631	50	498	100	450	100	947	58%
Total >C8 - <=C35	9220	100	4296	200	2005	200	6301	68%
Total >C5 - <=C35	NA	NA	4306	200	2005	200	6311	NA

Laboratory ID: 2781271 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 15.4

Sample ID: 529SB-05-25

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	9	ND	9	ND	NA
VRH 2 **	NA	NA	11	9	ND	9	11	NA
>C8 - <=C10	142	9	115	19	ND	19	132	93%
>C10 - <=C12	854	9	557	19	124	19	681	80%
>C12 - <=C16	4160	24	2129	47	828	47	2957	71%
>C16 - <=C21	3814	24	1689	47	869	47	2558	67%
>C21 - <=C35	1928	59	588	118	531	118	1119	58%
Total >C8 - <=C35	10899	118	5078	236	2370	236	7448	68%
Total >C5 - <=C35	NA	NA	5090	236	2370	236	7460	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781272 Extractable Batch ID: 97260-0014A
Sample ID: 529SB-05-50

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	19	8	ND	8	20	NA
>C8 - <=C10	171	8	145	8	23	8	168	98%
>C10 - <=C12	821	8	592	8	117	8	709	86%
>C12 - <=C16	3644	20	2133	20	765	20	2899	80%
>C16 - <=C21	3373	20	1647	20	850	20	2497	74%
>C21 - <=C35	1152	50	412	50	341	50	754	65%
Total >C8 - <=C35	9160	100	4930	100	2097	100	7027	77%
Total >C5 - <=C35	NA	NA	4949	100	2098	100	7047	NA

Laboratory ID: 2781272 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 15.3
Sample ID: 529SB-05-50

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	9	ND	9	ND	NA
VRH 2 **	NA	NA	22	9	ND	9	23	NA
>C8 - <=C10	202	9	171	9	27	9	198	98%
>C10 - <=C12	969	9	699	9	138	9	837	86%
>C12 - <=C16	4302	24	2519	24	904	24	3422	80%
>C16 - <=C21	3982	24	1945	24	1004	24	2949	74%
>C21 - <=C35	1360	59	487	59	403	59	890	65%
Total >C8 - <=C35	10815	118	5820	118	2476	118	8296	77%
Total >C5 - <=C35	NA	NA	5843	118	2477	118	8319	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781273 Extractable Batch ID: 97260-0014A

Sample ID: 529SB-05-75

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	4	ND	4	ND	NA
VRH 2 **	NA	NA	5	4	ND	4	5	NA
>C8 - <=C10	14	8	16	8	ND	8	19	137%
>C10 - <=C12	71	8	56	8	17	8	73	102%
>C12 - <=C16	579	20	366	20	141	20	506	87%
>C16 - <=C21	638	20	367	20	154	20	521	82%
>C21 - <=C35	94	50	ND	50	ND	50	65	69%
Total >C8 - <=C35	1397	100	842	100	343	100	1185	85%
Total >C5 - <=C35	NA	NA	847	100	343	100	1190	NA

Laboratory ID: 2781273 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 14.3

Sample ID: 529SB-05-75

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	5	ND	5	ND	NA
VRH 2 **	NA	NA	6	5	ND	5	6	NA
>C8 - <=C10	16	9	18	9	ND	9	23	137%
>C10 - <=C12	83	9	65	9	19	9	85	102%
>C12 - <=C16	676	23	427	23	164	23	591	87%
>C16 - <=C21	744	23	428	23	180	23	608	82%
>C21 - <=C35	110	58	ND	58	ND	58	76	69%
Total >C8 - <=C35	1630	117	983	117	400	117	1383	85%
Total >C5 - <=C35	NA	NA	988	117	400	117	1388	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781274
Sample ID: 529SB-05-77

Extractable Batch ID: 97260-0014A

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	20	8	ND	8	21	NA
>C8 - <=C10	23	8	22	8	ND	8	28	119%
>C10 - <=C12	107	8	81	8	27	8	108	100%
>C12 - <=C16	837	20	517	20	215	20	732	87%
>C16 - <=C21	921	20	517	20	233	20	750	81%
>C21 - <=C35	110	50	ND	50	ND	50	65	59%
Total >C8 - <=C35	1999	100	1173	100	509	100	1682	84%
Total >C5 - <=C35	NA	NA	1194	100	509	100	1703	NA

Laboratory ID: 2781274
Sample ID: 529SB-05-77

C5 to C35 Hydrocarbons "Dry Weight Data"

% moisture = 12.6

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	9	ND	9	ND	NA
VRH 2 **	NA	NA	23	9	ND	9	24	NA
>C8 - <=C10	27	9	26	9	ND	9	32	119%
>C10 - <=C12	123	9	93	9	31	9	123	100%
>C12 - <=C16	958	23	591	23	246	23	837	87%
>C16 - <=C21	1054	23	592	23	266	23	858	81%
>C21 - <=C35	126	57	ND	57	ND	57	74	59%
Total >C8 - <=C35	2287	114	1343	114	582	114	1925	84%
Total >C5 - <=C35	NA	NA	1366	114	583	114	1948	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

HYDROCARBON SPECIATION PROJECT

C5 to C8 Hydrocarbons by Purge & Trap GC PID/FID
C8 to C35 Hydrocarbons by Pentane Extraction w/ Aliphatic/Aromatic Separation Performed on Silica Gel Column
"As Received (Wet Weight) Data"

Laboratory ID: 2781275 Extractable Batch ID: 97260-0014A
Sample ID: 529SB-05-100

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	21	8	ND	8	22	NA
>C8 - <=C10	83	8	73	16	ND	16	88	106%
>C10 - <=C12	440	8	312	16	78	16	390	89%
>C12 - <=C16	4367	20	2602	40	911	40	3513	80%
>C16 - <=C21	5173	20	2742	40	1118	40	3860	75%
>C21 - <=C35	491	50	203	100	103	100	306	62%
Total >C8 - <=C35	10554	100	5932	200	2225	200	8157	77%
Total >C5 - <=C35	NA	NA	5953	200	2226	200	8179	NA

Laboratory ID: 2781275 **C5 to C35 Hydrocarbons "Dry Weight Data"** % moisture = 3.8
Sample ID: 529SB-05-100

Approximate Carbon Number Range	TPH Pentane Extract (mg/kg)	LOQ	Aliphatic (mg/kg)	LOQ	Aromatic Hydrocarbons (mg/kg)	LOQ	Aliphatics + Aromatics (mg/kg)	Aliph + Arom Total (%)
VRH 1 *	NA	NA	ND	8	ND	8	ND	NA
VRH 2 **	NA	NA	22	8	ND	8	23	NA
>C8 - <=C10	86	8	76	17	ND	17	91	106%
>C10 - <=C12	457	8	324	17	81	17	405	89%
>C12 - <=C16	4538	21	2704	42	947	42	3650	80%
>C16 - <=C21	5376	21	2850	42	1162	42	4011	75%
>C21 - <=C35	511	52	211	104	107	104	318	62%
Total >C8 - <=C35	10968	104	6164	208	2312	208	8476	77%
Total >C5 - <=C35	NA	NA	6186	208	2313	208	8499	NA

* Volatile Range Hydrocarbons (Range 1 Aliphatics = C5 to C6 aliphatic (total)hydrocarbons
Aromatics = C6 to C7 aromatic hydrocarbons (benzene only)

** Volatile Range Hydrocarbons (Range 2 Aliphatics = >C6 to C7 aliphatic hydrocarbons (total minus benzene and toluene)
Aromatics = >C7 to C8 aromatics (toluene only)

Prepared by Delwyn K Schumacher 10/30/97

Appendix B-3

Analytical Data
EMAX Laboratories
(Conventional Method)

EMAX
LABORATORIES, INC.
630 Maple Ave.
Torrance, CA 90503
Telephone: (310) 618-8889
Fax: (310) 618-0818

RECEIVED
23 1997

COPY

Date: 09-22-1997
EMAX Batch No.: 97I010

Attn: Ms. Mary Schneider

OHM Remediation Services
2031 Main Street
Irvine CA 92614-6509

Subject: Laboratory Report
Project: 18292/El Toro/D.O. 50

Enclosed is the Laboratory report for samples received on 09/04/97. The data reported include :

Sample ID	Control #	Col Date	Matrix	Analysis
18292-601	I010-01	09/03/97	Soil	EPA 5030/M8015 EPA 8020 M8015 (Fingerprint)
18292-602	I010-02	09/03/97	Soil	EPA 5030/M8015 EPA 8020 M8015 (Fingerprint)
18292-603	I010-03	09/03/97	Soil	EPA 5030/M8015 EPA 8020 M8015 (Fingerprint)
18292-604	I010-04	09/03/97	Soil	EPA 5030/M8015 EPA 8020 M8015 (Fingerprint) SPLP 8015
18292-605	I010-05	09/03/97	Soil	EPA 5030/M8015 EPA 8020 M8015 (Fingerprint) SPLP 8015
18292-606	I010-06	09/03/97	Soil	EPA 5030/M8015 EPA 8020

Sample ID	Control #	Col Date	Matrix	Analysis
				M8015 (Fingerprint)
18292-607	I010-07	09/03/97	Water	EPA 5030/M8015
				M8015 (Fingerprint)
				EPA 8020
18292-614	I010-08	09/03/97	Soil	EPA 5030/M8015
				EPA 8020
				M8015 (Fingerprint)
				SPLP 8015

The results are summarized on the following pages.

Please feel free to call if you have any questions concerning these results.

Sincerely yours,

Kam Pang

Kam Y. Pang, Ph.D.
Laboratory Director

OHM Remediation Services Corp.

CHAIN-OF-CUSTODY RECORD

TRANSFER 3
Form 0019
Field Technical Services
Rev. 08/89

180395

97I010 B3/WB6

O.H. MATERIALS CORP. • P.O. BOX 551 • FINDLAY, OH 45839-0551 • 419-423-3526

PROJECT NAME: UST 380 ~~SITE~~ DRILLING VERIFICATION	PROJECT LOCATION: MCAS EL TORO
PROJ. NO.: 18292	PROJECT CONTACT: DWAYNE ISHIDA
PROJECT TELEPHONE NO.: (714) 263-1146	
CLIENT'S REPRESENTATIVE: LYNN HORNECKER	PROJECT MANAGER/SUPERVISOR: BILL SEDLAK

ANALYSIS DESIRED (INDICATE SEPARATE CONTAINERS)

T=2°C

ITEM NO.	SAMPLE NUMBER	DATE	TIME	COMP	GRAB	SAMPLE DESCRIPTION (INCLUDE MATRIX AND POINT OF SAMPLE)	NUMBER OF CONTAINERS	8015 gas / 8020	8015 TPH full range	SPLP: 1312 / diesel	REMARKS
1	18292-601	9/3/97	1305			UST 380, SB02B, SOIL 9.5-10'	1	X	X		
2	18292-602	9/3/97	1307			UST 380, SB02B, SOIL 14.5-15'	1	X	X		
3	18292-603	9/3/97	1314			UST 380, SB02B, SOIL 24.5-25'	1	X	X		
4	18292-604	9/3/97	1323			UST 380, SB02B, SOIL 31-31.5'	1	X	X	X	
5	18292-605	9/3/97	1325			UST 380, SB02B, SOIL 32.5-33'	1	X	X		
6	18292-606	9/3/97	1347			UST 380, SB02B, SOIL 56-56.5'	1	X	X		
7	18292-607	9/3/97	1405			Rinsate for UST 380 SB02B	3	X	X		
8	18292-614	9/3/97	0740			UST 529, SB05, SOIL 75-75.5'	1	X	X		
9											
10						9/3/97					

TRANSFER NUMBER	ITEM NUMBER	TRANSFERS RELINQUISHED BY	TRANSFERS ACCEPTED BY	DATE	TIME
1	1-8			9/3/97	1520
2	1-8			9/3/97	1645
3					
4					

REMARKS: 7B - per 18292-599, COC 180394
5 day TAT

SAMPLER'S SIGNATURE: , D. Ishida

SAMPLE RESULTS

EPA 5030/M8015
TOTAL PETROLEUM HYDROCARBONS BY PURGE & TRAP

LIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
ROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
ATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
ATRIX:	SOIL	DATE ANALYZED:	09/05/97

AMPLE ID	CONTROL NO	RESULT (mg/kg)	% RECOVERY SURR	DL FACTOR	MOIST (%)	PRL (mg/kg)
8292-601	I010-01	ND	86	1	7.7	10.83
8292-602	I010-02	ND	82	1	4.3	10.45
8292-603	I010-03	ND	75	1	3.7	10.38
8292-604	I010-04	ND	86	1	9.3	11.03
8292-605	I010-05	ND	72	1	3.1	10.32
8292-606	I010-06	ND	94	1	6.4	10.68
8292-614	I010-08	620+	257*	1	12.0	11.36
BLK1S	VAI0435B	ND	85	1	NA	10

C LIMIT: 60-140

URR : Bromofluorobenzene

RL : Project Reporting Limit

: Not gasoline pattern, chromatogram indicated heavy hydrocarbon.

: Out of QC limit due to matrix interferences.

EPA 5030/M8015
TOTAL PETROLEUM HYDROCARBONS BY PURGE & TRAP

LIENT: OHM Remediation Services
ROJECT: 18292/El Toro/D.O. 50
ATCH NO.: 97I010
ATRIX: WATER

DATE COLLECTED: 09/03/97
DATE RECEIVED: 09/04/97
DATE EXTRACTED: 09/05/97
DATE ANALYZED: 09/05/97

AMPLE ID	CONTROL NO	RESULT (mg/L)	% RECOVERY SURR	DILUTION FACTOR	PRL (mg/L)
8292-607	I010-07	ND	85	1	.1
BLK1W	VAI0435B	ND	85	1	.1

C LIMIT: 65-135
URR : Bromofluorobenzene
RL : Project Reporting Limit

4006

EPA METHOD 8020
BTEX

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
BATCH NO.: 97I010
SAMPLE ID: 18292-601
CONTROL NO.: I010-01
% MOISTURE: 7.7

DATE COLLECTED: 09/03/97
DATE RECEIVED: 09/04/97
DATE EXTRACTED: 09/05/97
DATE ANALYZED: 09/05/97
MATRIX: SOIL
DILUTION FACTOR: 1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5.42
Toluene	ND	5.42
Ethylbenzene	ND	5.42
Total Xylenes	ND	16.3

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	113	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	18292-602	DATE ANALYZED:	09/05/97
CONTROL NO.:	I010-02	MATRIX:	SOIL
% MOISTURE:	4.3	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5.22
Toluene	ND	5.22
Ethylbenzene	ND	5.22
Total Xylenes	ND	15.7

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	104	50-150

PRL: Project Reporting Limit

4043

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	18292-604	DATE ANALYZED:	09/05/97
CONTROL NO.:	I010-04	MATRIX:	SOIL
% MOISTURE:	9.3	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5.51
Toluene	ND	5.51
Ethylbenzene	ND	5.51
Total Xylenes	ND	16.5

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	107	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	18292-603	DATE ANALYZED:	09/05/97
CONTROL NO.:	I010-03	MATRIX:	SOIL
% MOISTURE:	3.7	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5.19
Toluene	ND	5.19
Ethylbenzene	ND	5.19
Total Xylenes	ND	15.6

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	94	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	18292-614	DATE ANALYZED:	09/05/97
CONTROL NO.:	I010-08	MATRIX:	SOIL
% MOISTURE:	12.0	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	300	114
Toluene	1600	114
Ethylbenzene	4900	114
Total Xylenes	11700	340

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	159*	50-150

PRL: Project Reporting Limit
* : Out of QC limit due to matrix interferences.
Positive results were confirmed by a secondary GC column.

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	NA
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	NA
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	MBLK1S	DATE ANALYZED:	09/05/97
CONTROL NO.:	VAI0435B	MATRIX:	SOIL
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5
Toluene	ND	5
Ethylbenzene	ND	5
Total Xylenes	ND	15

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	112	50-150

PRL: Project Reporting Limit

4049

EPA METHOD 8020
BTEX

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
BATCH NO.: 97I010
SAMPLE ID: 18292-607
CONTROL NO.: I010-07
% MOISTURE: NA

DATE COLLECTED: 09/03/97
DATE RECEIVED: 09/04/97
DATE EXTRACTED: 09/05/97
DATE ANALYZED: 09/05/97
MATRIX: WATER
DILUTION FACTOR: 1

PARAMETERS	RESULTS (ug/L)	PRL (ug/L)
Benzene	ND	.3
Toluene	ND	.3
Ethylbenzene	ND	.3
Total Xylenes	ND	1

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	111	60-140

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	NA
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	NA
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	MBLK1W	DATE ANALYZED:	09/05/97
CONTROL NO.:	VAI0435B	MATRIX:	WATER
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/L)	PRL (ug/L)
Benzene	ND	.3
Toluene	ND	.3
Ethylbenzene	ND	.3
Total Xylenes	ND	1

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	112	60-140

PRL: Project Reporting Limit

EPA METHOD SPLP/M8015
TOTAL PETROLEUM HYDROCARBONS BY EXTRACTION

LIENT: OHM Remediation Services
ROJECT: 18292/El Toro/D.O. 50
ATCH NO.: 97I010
ATRIX: WATER

DATE COLLECTED: 09/03/97
DATE RECEIVED: 09/04/97
DATE EXTRACTED: 09/08/97
DATE ANALYZED: 09/08/97

AMPLE ID	CONTROL NO	RESULT (mg/L)	H-C RANGE	% RECOVERY SURR1	% RECOVERY SURR2	DL FACTOR	PRL (mg/L)
8292-604	I010-04	19	C12-C30	DO	DO	5	.5
BLK1W	DSI008WB	ND	N.A.	93	86	1	.1
BLK1S	TXI006SB	ND	N.A.	93	84	1	.1

C LIMIT: 65-135 60-140
URR1 : Bromobenzene
URR2 : Hexacosane
RL : Project Reporting Limit

ote : SPLP blank TXI006SB was extracted on 09/05/97
O : Diluted out
PLP EXTRACTION DATE : 09/05/97

EMAX QUALITY CONTROL DATA
MS/MSD ANALYSIS

CLIENT:	OHM Remediation Services
PROJECT:	18292/El Toro/D.O. 50
METHOD:	EPA M8015G
MATRIX:	SOIL
% MOISTURE:	4.3

BATCH NO.:	971010	DATE RECEIVED:	09/04/97
SAMPLE ID:	18292-602	DATE EXTRACTED:	09/05/97
CONTROL NO.:	I010-02	DATE ANALYZED:	09/05/97

ACCESSION:

PARAMETER	SMPL RSLT (mg/kg)	SPIKE AMT (mg/kg)	MS RSLT (mg/kg)	MS % REC	SPIKE AMT (mg/kg)	MSD RSLT (mg/kg)	MSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Gasoline	ND	5.75	5.21	91	5.75	5.24	91	0	60-140	40

SURROGATE PARAMETER	SPIKE AMT (mg/kg)	MS RSLT (mg/kg)	MS % REC	SPIKE AMT (mg/kg)	MSD RSLT (mg/kg)	MSD % REC	QC LIMIT %
Bromofluorobenzene	.261	.209	80	.261	.24	92	60-140

4008

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

LIENT: OHM Remediation Services
ROJECT: 18292/El Toro/D.O. 50
ETHOD: EPA SPLP/M8015
ATRIX: WATER
MOISTURE: NA

ATCH NO.: 971010
AMPLE ID: LCS1W/LCD1W
ONTROL NO.: DSI008WL/C

DATE RECEIVED: NA
DATE EXTRACTED: 09/08/97
DATE ANALYZED: 09/08/97

CCESSION:

ARAMETER	BLNK RSLT (mg/L)	SPIKE AMT (mg/L)	BS RSLT (mg/L)	BS % REC	SPIKE AMT (mg/L)	BSD RSLT (mg/L)	BSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
iesel	ND	1.00	1.03	103	1.00	.90	90	13	65-135	30

URROGATE PARAMETER	SPIKE AMT (mg/L)	BS RSLT (mg/L)	BS % REC	SPIKE AMT (mg/L)	BSD RSLT (mg/L)	BSD % REC	QC LIMIT %
romobenzene	1.00	.99	99	1.00	1.34	134	65-135
exacosane	1.00	.91	91	1.00	.91	91	60-140

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	18292-605	DATE ANALYZED:	09/05/97
CONTROL NO.:	I010-05	MATRIX:	SOIL
% MOISTURE:	3.1	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5.16
Toluene	ND	5.16
Ethylbenzene	ND	5.16
Total Xylenes	ND	15.5

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	92	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/03/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/04/97
BATCH NO.:	97I010	DATE EXTRACTED:	09/05/97
SAMPLE ID:	18292-606	DATE ANALYZED:	09/05/97
CONTROL NO.:	I010-06	MATRIX:	SOIL
% MOISTURE:	6.4	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5.34
Toluene	ND	5.34
Ethylbenzene	ND	5.34
Total Xylenes	ND	16

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	115	50-150

PRL: Project Reporting Limit

EPA METHOD SPLP/M8015
TOTAL PETROLEUM HYDROCARBONS BY EXTRACTION

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
BATCH NO.: 97I010
MATRIX: SOIL

DATE COLLECTED: 09/03/97
DATE RECEIVED: 09/04/97
DATE EXTRACTED: 09/16/97
DATE ANALYZED: 09/17/97

SAMPLE ID	CONTROL NO	RESULT (mg/L)	H-C RANGE	% RECOVERY SURR1	% RECOVERY SURR2	DL FACTOR	RL (mg/L)
18292-605	I010-05	3.8	C13-C30	78	84	1	.1
18292-614	I010-08	5.8	C7-C30	85	85	1	.1
MBLK1W	DSI021WB	ND	N.A.	97	80	1	.1
MBLK1X	TXI008SB	ND	N.A.	91	79	1	.1
QC LIMIT:				65-135	60-140		

SURR1 : Bromobenzene
SURR2 : Hexacosane
PRL : Project Reporting Limit
SPLP Extraction Date : 09/13/97

EMAX
LABORATORIES, INC.
630 Maple Ave.
Torrance, CA 90503
Telephone: (310) 618-8889
Fax: (310) 618-0818

RECEIVED
23 1997
COPY

Date: 09-19-1997
EMAX Batch No.: 97I005

Attn: Ms. Mary Schneider

OHM Remediation Services
2031 Main Street
Irvine CA 92614-6509

Subject: Laboratory Report
Project: 18292/El Toro/D.O. 50

Enclosed is the Laboratory report for samples received on 09/02/97. The data reported include :

Sample ID	Control #	Col Date	Matrix	Analysis
529SB04-584	I005-01	09/02/97	Soil	EPA 5030/M8015 EPA M8015 EPA 8020
529SB04-585	I005-02	09/02/97	Soil	EPA 5030/M8015 EPA M8015 EPA 8020
529SB04-586	I005-03	09/02/97	Soil	EPA 5030/M8015 EPA M8015 EPA 8020 SPLP 8015
529SB04-587	I005-04	09/02/97	Soil	EPA 5030/M8015 EPA M8015 EPA 8020
529SB04-588	I005-05	09/02/97	Soil	EPA 5030/M8015 EPA M8015 EPA 8020
529SB04-589	I005-06	09/02/97	Soil	EPA 5030/M8015 EPA M8015 EPA 8020

Sample ID	Control #	Col Date	Matrix	Analysis
529SB04-590	I005-07	09/02/97	Soil	SPLP 8015 EPA 5030/M8015 EPA M8015 EPA 8020
529SB04-591	I005-08	09/02/97	Water	EPA 5030/M8015 EPA M8015 EPA 8020
529SB04-592	I005-09	09/02/97	Water	EPA 5030/M8015 EPA 8020

The results are summarized on the following pages.

Please feel free to call if you have any questions concerning these results.

Sincerely yours,

Kam Pang

Kam Y. Pang, Ph.D.
Laboratory Director

OHM Remediation Services Corp
Subsidiary of OHM Corporation
U.S. Route 224 East • Findlay, Ohio 45840 • (419) 423-3526

97I005 F4/RGC4A

CHAIN-OF-CUSTODY RECORD

PROJECT FILE CARD
209502
FORM 0019 REV 2-97

OHM'S LAB COORDINATOR DWAYNE IsHiDA	LAB COORDINATOR'S PHONE (714) 263-1146 X525	LAB COORDINATOR'S FAX (714) 263-1147	LABORATORY SERVICE ID	LABORATORY CONTACT	MAIL REPORT (COMPANY NAME)
PROJECT NAME EL TORO	PROJECT LOCATION MCAS EL TORO	PROJECT NUMBER 18292	LABORATORY PHONE	LABORATORY FAX	RECIPIENT NAME
PROJECT CONTACT DWAYNE IsHiDA	PROJECT PHONE NUMBER (714) 263-1146	PROJECT FAX 263-1147	LABORATORY ADDRESS		ADDRESS
PROJECT ADDRESS 230 MAIN ST	CITY, STATE AND ZIPCODE IRVINE, CA 92709	CLIENT SWDIV	CITY, STATE AND ZIPCODE TORRANCE, CA		CITY, STATE AND ZIPCODE
PROJECT MANAGER Bill SEDLAK	PROJECT MANAGER'S PHONE 263-1146	PROJECT MANAGER'S FAX 263-1147			

Item	Sample Identifier	Matrix	Date	Time	Preserved	# of Cont	QC Level	T.A.T.	Analyses TPH-PURGEABLE	TPH-EXTRACTABLE	1312-SPLP	8020-BTEX					Comments
1	18292-S295B04-S84	S	9/2/97	0857	—	1	—	5DAY	X	X		X					EMAX
2	18292-S295B04-S85	S		0900	—	1	—	5DAY	X	X		X					
3	18292-S295B04-S86	S		0949	—	1	—	5DAY	X	X		X					
4	18292-S295B04-S87	S		1026	—	1	—	5DAY	X	X		X					
5	18292-S295B04-S88	S		1041	—	1	—	5DAY	X	X		X					
6	18292-S295B04-S89	S		1048	—	1	—	5DAY	X	X		X					
7	18292-S295B04-S90	S		1051	—	1	—	5DAY	X	X		X					
8	18292-S295B04-S91	W		1200	HCL	3	—	5DAY	X	X		X					
9	18292-S295B04-S92	W	9/2/97	0800	HCL	1	—	5DAY	X			X					KMB 9/2/97
10																	

SAMPLES COLLECTED BY KMB
COURIER AND AIR BILL NUMBER
COOLER TEMPERATURE UPON RECEIPT

RELINQUISHED BY	RECEIVED BY	DATE	TIME	SAMPLE'S CONDITION UPON RECEIPT
		9/2/97	1445	
		9/2/97	1600	

Distribution: White - Laboratory (To be returned with Analytical Report), Goldenrod - Project File, Yellow - Project Data Manager

EPA 5030/M8015
TOTAL PETROLEUM HYDROCARBONS BY PURGE & TRAP

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
MATRIX:	WATER	DATE ANALYZED:	09/03/97

SAMPLE ID	CONTROL NO	RESULT (mg/L)	% RECOVERY SURR	DILUTION FACTOR	PRL (mg/L)
529SB04-591	I005-08	ND	85	1	.1
529SB04-592	I005-09	ND	86	1	.1
MBLK1W	VAI0235B	ND	86	1	.1
QC LIMIT:			65-135		

SURR : Bromofluorobenzene
PRL : Project Reporting Limit

4005

EPA 5030/M8015
TOTAL PETROLEUM HYDROCARBONS BY PURGE & TRAP

LIENT: OHM Remediation Services
ROJECT: 18292/El Toro/D.O. 50
ATCH NO.: 97I005
ATRIX: SOIL

DATE COLLECTED: 09/02/97
DATE RECEIVED: 09/02/97
DATE EXTRACTED: 09/03/97
DATE ANALYZED: 09/03/97

AMPLE ID	CONTROL NO	RESULT (mg/kg)	% RECOVERY SURR	DL FACTOR	MOIST (%)	PRL (mg/kg)
29SB04-584	I005-01	460+	185*	1	12.2	11.39
29SB04-585	I005-02	200+	138	1	9.3	11.03
29SB04-586	I005-03	650+	245*	1	12.0	11.36
29SB04-587	I005-04	700+	296*	1	9.5	11.05
29SB04-588	I005-05	710+	252*	1	11.7	11.33
29SB04-589	I005-06	340+	131	1	5.0	10.53
29SB04-590	I005-07	ND	82	1	16.7	12
BLK1S	VAI0235B	ND	86	1	NA	10
BLK2S	97I01SB	ND	85	1	NA	10

C LIMIT: 60-140
URR : Bromofluorobenzene
RL : Project Reporting Limit

: Out of QC limit due to matrix interferences.
: Not gasoline pattern, the chromatogram indicates heavy hydrocarbon.

4006

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
METHOD: EPA M8015G
MATRIX: SOIL
% MOISTURE: NA

BATCH NO.: 97I005
SAMPLE ID: LCS1S/LCD1S
CONTROL NO.: VAI0235L/C

DATE RECEIVED: NA
DATE EXTRACTED: 09/03/97
DATE ANALYZED: 09/03/97

ACCESSION:

PARAMETER	BLNK RSLT (mg/kg)	SPIKE AMT (mg/kg)	BS RSLT (mg/kg)	BS % REC	SPIKE AMT (mg/kg)	BSD RSLT (mg/kg)	BSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Gasoline	ND	5.50	4.60	84	5.50	4.85	88	5	70-125	40

SURROGATE PARAMETER	SPIKE AMT (mg/kg)	BS RSLT (mg/kg)	BS % REC	SPIKE AMT (mg/kg)	BSD RSLT (mg/kg)	BSD % REC	QC LIMIT %
Bromofluorobenzene	.25	.23	92	.25	.23	92	60-140

4007

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

CLIENT:	OHM Remediation Services
PROJECT:	18292/El Toro/D.O. 50
METHOD:	EPA M8015G
MATRIX:	WATER
% MOISTURE:	NA

BATCH NO.:	971005	**DATE RECEIVED:**	NA
SAMPLE ID:	LCS1W/LCD1W	**DATE EXTRACTED:**	09/03/97
CONTROL NO.:	VAI0235L/C	**DATE ANALYZED:**	09/03/97

ACCESSION:

PARAMETER	BLNK RSLT (mg/L)	SPIKE AMT (mg/L)	BS RSLT (mg/L)	BS % REC	SPIKE AMT (mg/L)	BSD RSLT (mg/L)	BSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Gasoline	ND	1.10	.92	84	1.10	.97	88	5	70-125	30

SURROGATE PARAMETER	SPIKE AMT (mg/L)	BS RSLT (mg/L)	BS % REC	SPIKE AMT (mg/L)	BSD RSLT (mg/L)	BSD % REC	QC LIMIT %
Bromofluorobenzene	.05	.046	92	.05	.046	92	65-135

4008

EMAX QUALITY CONTROL DATA
MS/MSD ANALYSIS

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
METHOD: EPA M8015G
MATRIX: WATER
% MOISTURE: NA

BATCH NO.: 97I005
SAMPLE ID: 529SB04-591
CONTROL NO.: I005-08

DATE RECEIVED: 09/02/97
DATE EXTRACTED: 09/03/97
DATE ANALYZED: 09/03/97

ACCESSION:

PARAMETER	SMPL RSLT (mg/L)	SPIKE AMT (mg/L)	MS RSLT (mg/L)	MS % REC	SPIKE AMT (mg/L)	MSD RSLT (mg/L)	MSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Gasoline	ND	1.10	1.02	93	1.10	.97	88	5	65-135	30

SURROGATE PARAMETER	SPIKE AMT (mg/L)	MS RSLT (mg/L)	MS % REC	SPIKE AMT (mg/L)	MSD RSLT (mg/L)	MSD % REC	QC LIMIT %
Bromofluorobenzene	.05	.047	94	.05	.047	94	65-135

4009

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-585	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-02	MATRIX:	SOIL
% MOISTURE:	9.3	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	110
Toluene	ND	110
Ethylbenzene	970	110
Total Xylenes	850	331

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	125	50-150

PRL: Project Reporting Limit

Results were confirmed by a secondary GC column.

4044

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-586	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-03	MATRIX:	SOIL
% MOISTURE:	12.0	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	114
Toluene	1500	114
Ethylbenzene	3600	114
Total Xylenes	12500	341

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	145	50-150

PRL: Project Reporting Limit

Results were confirmed by a secondary GC column.

4045

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-587	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-04	MATRIX:	SOIL
% MOISTURE:	9.5	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	110
Toluene	1700	110
Ethylbenzene	3800	110
Total Xylenes	12000	331

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	166*	50-150

PRL: Project Reporting Limit

Results were confirmed by a secondary GC column.
* : Out of QC limit due to matrix interferences.

4046

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-588	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-05	MATRIX:	SOIL
% MOISTURE:	11.7	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	113
Toluene	620	113
Ethylbenzene	2400	113
Total Xylenes	7000	340

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	158*	50-150

PRL: Project Reporting Limit

Results were confirmed by a secondary GC column.
* : Out of QC limit due to matrix interferences.

4047

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-589	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-06	MATRIX:	SOIL
% MOISTURE:	5.0	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	105
Toluene	ND	105
Ethylbenzene	440	105
Total Xylenes	1200	316

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	119	50-150

PRL: Project Reporting Limit

Results were confirmed by a secondary GC column.

4048

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-584	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-01	MATRIX:	SOIL
% MOISTURE:	12.2	DILUTION FACTOR:	20

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	114
Toluene	ND	114
Ethylbenzene	1400	114
Total Xylenes	1500	342

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	126	50-150

PRL: Project Reporting Limit

Results were confirmed by a secondary GC column.

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-590	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-07	MATRIX:	SOIL
% MOISTURE:	16.7	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	6
Toluene	ND	6
Ethylbenzene	ND	6
Total Xylenes	.ND	18

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	106	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	NA
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	NA
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	MBLK1S	DATE ANALYZED:	09/03/97
CONTROL NO.:	VAI0235B	MATRIX:	SOIL
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5
Toluene	ND	5
Ethylbenzene	ND	5
Total Xylenes	ND	15

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	108	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	NA
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	NA
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	MBLK2S	DATE ANALYZED:	09/03/97
CONTROL NO.:	97I01SB	MATRIX:	SOIL
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/kg)	PRL (ug/kg)
Benzene	ND	5
Toluene	ND	5
Ethylbenzene	ND	5
Total Xylenes	ND	15

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	110	50-150

PRL: Project Reporting Limit

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-591	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-08	MATRIX:	WATER
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/L)	PRL (ug/L)
Benzene	ND	.3
Toluene	ND	.3
Ethylbenzene	ND	.3
Total Xylenes	ND	1

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	105	60-140

PRL: Project Reporting Limit

4052

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	09/02/97
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	09/02/97
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	529SB04-592	DATE ANALYZED:	09/03/97
CONTROL NO.:	I005-09	MATRIX:	WATER
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/L)	PRL (ug/L)
Benzene	ND	.3
Toluene	ND	.3
Ethylbenzene	ND	.3
Total Xylenes	ND	1

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	113	60-140

PRL: Project Reporting Limit

4053

EPA METHOD 8020
BTEX

CLIENT:	OHM Remediation Services	DATE COLLECTED:	NA
PROJECT:	18292/El Toro/D.O. 50	DATE RECEIVED:	NA
BATCH NO.:	97I005	DATE EXTRACTED:	09/03/97
SAMPLE ID:	MBLK1W	DATE ANALYZED:	09/03/97
CONTROL NO.:	VAI0235B	MATRIX:	WATER
% MOISTURE:	NA	DILUTION FACTOR:	1

PARAMETERS	RESULTS (ug/L)	PRL (ug/L)
Benzene	ND	.3
Toluene	ND	.3
Ethylbenzene	ND	.3
Total Xylenes	ND	1

SURROGATE PARAMETER	% RECOVERY	QC LIMIT
1-Bromo-4-fluorobenzene	108	60-140

PRL: Project Reporting Limit

EMAX QUALITY CONTROL DATA
MS/MSD ANALYSIS

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
METHOD: EPA 8020
MATRIX: WATER
% MOISTURE: NA

BATCH NO.: 97I005
SAMPLE ID: 529SB04-591
CONTROL NO.: I005-08

DATE RECEIVED: 09/02/97
DATE EXTRACTED: 09/03/97
DATE ANALYZED: 09/03/97

ACCESSION:

PARAMETER	SMPL RSLT (ug/L)	SPIKE AMT (ug/L)	MS RSLT (ug/L)	MS % REC	SPIKE AMT (ug/L)	MSD RSLT (ug/L)	MSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Benzene	ND	13.00	14.80	114	13.00	14.20	109	4	39-150	30
Toluene	ND	79.60	90.90	114	79.60	86.90	109	5	46-148	30
Ethylbenzene	ND	17.80	20.20	114	17.80	19.40	109	4	32-160	30
Total Xylenes	ND	93.40	103.00	110	93.40	98.60	106	4	61-129	30

SURROGATE PARAMETER	SPIKE AMT (ug/L)	MS RSLT (ug/L)	MS % REC	SPIKE AMT (ug/L)	MSD RSLT (ug/L)	MSD % REC	QC LIMIT %
1-Bromo-4-fluorobenzene	50.00	55.90	112	50.00	56.40	113	60-140

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
METHOD: EPA 8020
MATRIX: SOIL
% MOISTURE: NA

BATCH NO.: 97I005
SAMPLE ID: LCS1S/LCD1S
CONTROL NO.: VAI0235L/C

DATE RECEIVED: NA
DATE EXTRACTED: 09/03/97
DATE ANALYZED: 09/03/97

ACCESSION:

PARAMETER	BLNK RSLT (ug/kg)	SPIKE AMT (ug/kg)	BS RSLT (ug/kg)	BS % REC	SPIKE AMT (ug/kg)	BSD RSLT (ug/kg)	BSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Benzene	ND	65.00	66.40	102	65.00	71.20	110	7	39-150	50
Toluene	ND	398.00	404.00	102	398.00	433.00	109	7	46-148	50
Ethylbenzene	ND	89.00	88.60	100	89.00	100.00	113	12	32-160	50
Total Xylenes	ND	467.00	457.00	98	467.00	488.00	105	7	61-129	50

SURROGATE PARAMETER	SPIKE AMT (ug/kg)	BS RSLT (ug/kg)	BS % REC	SPIKE AMT (ug/kg)	BSD RSLT (ug/kg)	BSD % REC	QC LIMIT %
1-Bromo-4-fluorobenzene	250.00	274.00	110	250.00	278.00	111	50-150

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

CLIENT:	OHM Remediation Services
PROJECT:	18292/El Toro/D.O. 50
METHOD:	EPA 8020
MATRIX:	WATER
% MOISTURE:	NA

BATCH NO.:	971005	**DATE RECEIVED:**	NA
SAMPLE ID:	LCS1W/LCD1W	**DATE EXTRACTED:**	09/03/97
CONTROL NO.:	VAI0235L/C	**DATE ANALYZED:**	09/03/97

ACCESSION:

PARAMETER	BLNK RSLT (ug/L)	SPIKE AMT (ug/L)	BS RSLT (ug/L)	BS % REC	SPIKE AMT (ug/L)	BSD RSLT (ug/L)	BSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Benzene	ND	13.00	13.30	102	13.00	14.20	110	7	39-150	30
Toluene	ND	79.60	80.90	102	79.60	86.50	109	7	46-148	30
Ethylbenzene	ND	17.80	17.70	100	17.80	20.00	113	12	32-160	30
Total Xylenes	ND	93.40	91.40	98	93.40	97.60	105	7	61-129	30

SURROGATE PARAMETER	SPIKE AMT (ug/L)	BS RSLT (ug/L)	BS % REC	SPIKE AMT (ug/L)	BSD RSLT (ug/L)	BSD % REC	QC LIMIT %
1-Bromo-4-fluorobenzene	50.00	54.90	110	50.00	55.50	111	60-140

4057

EPA METHOD SPLP/M8015
TOTAL PETROLEUM HYDROCARBONS BY EXTRACTION

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
BATCH NO.: 97I005
MATRIX: WATER

DATE COLLECTED: 09/02/97
DATE RECEIVED: 09/02/97
DATE EXTRACTED: 09/16/97
DATE ANALYZED: 09/17/97

SAMPLE ID	CONTROL NO	RESULT (mg/L)	H-C RANGE	% RECOVERY		DL FACTOR	PRL (mg/L)
				SURR1	SURR2		
529SB04-586	I005-03	4.0	C9-C31	76	80	1	.1
529SB04-589	I005-06	2.2	C10-C25	81	79	1	.1
MBLK1W	DSI021WB	ND	N.A.	97	80	1	.1
MBLK1S	TXI008SB	ND	N.A.	91	79	1	.1
QC LIMIT:				65-135	60-140		

SURR1 : Bromobenzene
SURR2 : Hexacosane
PRL : Project Reporting Limit
SPLP EXTRACTION DATE : 09/13/97

EMAX QUALITY CONTROL DATA
LCS/LCD ANALYSIS

CLIENT: OHM Remediation Services
PROJECT: 18292/El Toro/D.O. 50
METHOD: EPA SPLP/M8015
MATRIX: WATER
% MOISTURE: NA

BATCH NO.: 97I005
SAMPLE ID: LCS1W/LCD1W
CONTROL NO.: DSI021WL/C

DATE RECEIVED: NA
DATE EXTRACTED: 09/16/97
DATE ANALYZED: 09/17/97

ACCESSION:

PARAMETER	BLNK RSLT (mg/L)	SPIKE AMT. (mg/L)	BS RSLT (mg/L)	BS % REC	SPIKE AMT (mg/L)	BSD RSLT (mg/L)	BSD % REC	RPD %	QC LIMIT %	RPD LIMIT %
Diesel	ND	1.00	.93	93	1.00	.78	78	18	65-135	30

SURROGATE PARAMETER	SPIKE AMT (mg/L)	BS RSLT (mg/L)	BS % REC	SPIKE AMT (mg/L)	BSD RSLT (mg/L)	BSD % REC	QC LIMIT %
Bromobenzene	1.00	1.13	113	1.00	1.01	101	65-135
Hexacosane	1.00	.91	91	1.00	.84	84	60-140

Appendix C

RBCA Equations and Assumptions

B Risk-Based Screening Level Calculation Procedures

This appendix provides the risk equations and mathematical models used to estimate the risk posed to residential and commercial receptors through contact with TPH-impacted soils using the TPH Criteria Working Group (Working Group) protocol. The RBCA framework was selected for evaluation of the Working Group protocol at this site since it is widely distributed, well understood, based on straight-forward numerical models, and is becoming increasingly accepted throughout the country. Example models presented in the RBCA guidance document were used to calculate risk-based screening levels (RBSLs) for applicable pathways.

A discussion of risk equations used to estimate exposure to contaminated groundwater and soils are provided in the following section. This discussion is followed by a presentation of mathematical models used to determine chemical exposure for direct and cross-media transport pathways. Note that these equations are used to find RBSLs for different exposure pathways for single compounds, or, in this case, single TPH fractions. The fraction RBSLs are then used to calculate "whole TPH" RBSLs as described in Section 4 of this report.

B.1 Exposure Calculations

This section provides a general discussion of the assumptions used to calculate intakes resulting from various exposure pathways. Exposure pathways are defined as a direct contact route between a receptor and an impacted medium. Exposure pathways are determined for receptors based on the receptors' expected activities at the Site.

B.1.1 Intake Assumptions

In order to translate exposures to potentially impacted media into intakes or doses, intake assumptions must be specified. These intake assumptions consider the number of times a receptor is expected to contact a particular medium, the duration of the contact, and the mechanisms that enable chemicals in impacted media to be potentially assimilated by the receptor.

Generally, the intake or dose of a particular chemical by a receptor is calculated with Equation 1:

(1) Chemical Intake $$I = \frac{C \cdot CR}{BW} \cdot \frac{EF \cdot ED}{AT}$$

where:

I = Chemical intake [mg/kg BW-day]
C = Chemical concentration [e.g., mg/kg-soil or mg/L-water]
CR = Contact rate or the amount of impacted medium contacted per event [e.g., liters/day, mg/day]
EF = Exposure frequency [days/year]
ED = Exposure duration [years]
BW = Body weight of the receptor [kg]
AT = Averaging time of the exposure [days]

This equation calculates an intake that is normalized over the body weight of the individual and the time of the exposure.

Since the intake or dose is combined with quantitative indices of toxicity (chemical-specific dose-response information such as reference doses or cancer slope factors) to give a measure of potential health effects, the intake or dose must be calculated in a manner that is compatible with the quantitative dose-response information for the constituents of interest used in the analysis.

In an analysis of the potential risk associated with exposure to TPH-impacted media, both carcinogenic and non-carcinogenic risk is calculated. The Working Group approach was developed to assess non-carcinogenic risk; the appendix describes that procedure. Risk associated with individual carcinogenic components of TPH (e.g., benzene) should be evaluated prior to an evaluation of non-carcinogenic risk since the presence of these compounds will often drive cleanup.

Non-carcinogenic effects are evaluated for potential chronic exposures. The relevant intake or dose is based on the daily intake averaged over the exposure period. The quantitative dose-response function for non-carcinogenic effects is based on the assumption that effects occur once a threshold dose resulting from exposure is attained. For non-carcinogenic effects, the averaging time (AT_n) is equal to the period of exposure for the receptor.

B.1.2 Receptor-Specific Exposure Assumptions

Site receptors include both residential and commercial/industrial workers at the site. Table B-1 provides a list of receptor-specific exposure parameters which were used to calculate fraction-specific and "whole TPH" RBSLs.

Table B-1 Receptor-Specific Exposure Assumptions

Parameter	Units	Resident	Commercial/ Industrial Worker
Exposure Duration (ED)	*yr*	30	25
Exposure Frequency (EF)	*d/yr*	350	250
Averaging Time (AT_n) for Non-Carcinogens	*yr*	30	25
Body Weight (BW)	*kg*	70	70
Ingestion Rate - Soil (IR_{soil})	*mg/d*	100	50
Inhalation Rate - Indoor Air ($Ir_{air\text{-}in}$)	m^3/d	15	20
Inhalation Rate - Outdoor Air ($IR_{air\text{-}out}$)	m^3/d	20	20
Ingestion Rate - Water (IR_w)	*L/d*	2	1
Oral Relative Absorption Factor (RAF_d)	—	1	1
Skin Surface Area (SA)	cm^2	3,160	3,160
Soil to Skin Adherance Factor (M)	mg/cm^2	0.5	0.5

NOTE:

All values are default values specified in RBCA (ASTM E1739-95).

B.2 Risk Equations

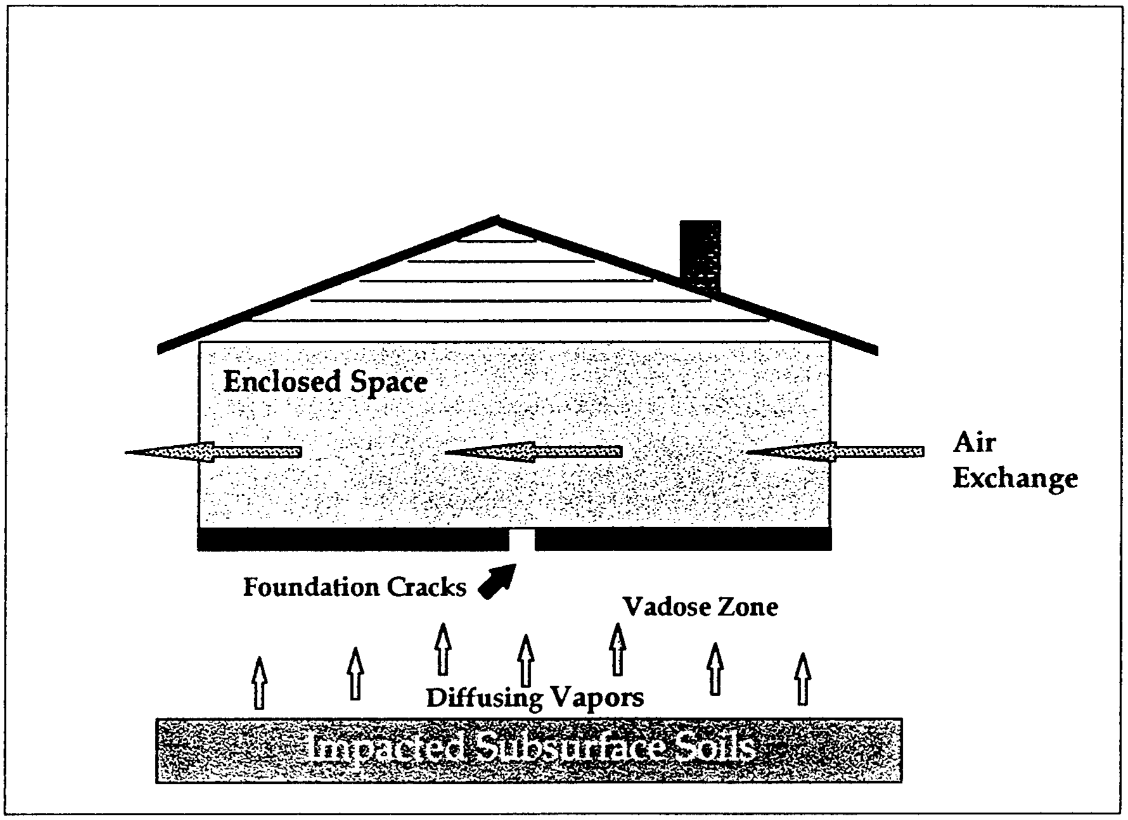
This section describes the risk equations used to develop Tier 1 risk-based screening levels (RBSLs) for different pathways and receptors at the site. RBSLs for exposure to contaminated water, soil, and air are developed. For this site, the potential pathways include: 1) inhalation via volatilization from soils, which includes enclosed-space accumulation, 2) inhalation via volatilization from soils to outdoor air, 3) ingestion of groundwater via leaching from soil to groundwater, and 4) ingestion, inhalation and/or dermal absorption via direct contact with soils. Soil RBSLs for individual TPH fractions are calculated for each pathway and receptor. These RBSLs are then used to calculate "whole TPH" RBSLs, as described in Section 4 of this report, using the Working Group methodology.

B.2.1 Volatilization to Indoor Air Pathway

The analytical model used to estimate volatilization from soil to indoor air is based upon the partitioning of a constituent into water, vapor, and sorbed phases as determined by the physical and chemical properties of the constituent. A schematic of this model is provided in Figure B-1. In this model, contaminants partition into soil pore gas which migrates through the vadose zone to the base of a building foundation. At this point, the contaminant vapors diffuse through cracks present in the building foundation and into the building air space where they may accumulate. Exposure occurs through inhalation of these vapors.

Calculation of a soil RBSL for the indoor air pathway first requires calculation of an indoor air RBSL. This corresponds with an "acceptable" indoor air concentration for the receptors evaluated in this report. Using the indoor air RBSL, and taking into account enclosed space accumulation, transport from vadose zone soils and chemical partitioning, soil RBSLs can be calculated which are protective of indoor air quality for each of the potential receptors. RBSLs are calculated for each TPH fraction individually. A "whole TPH" RBSL is then calculated as described in Section 4 of this report.

Figure B-1 Volatilization to Indoor Air Model



This model is based on several conservative assumptions, including: 1) a constant chemical concentration in subsurface soils; 2) linear, equilibrium partitioning in the soil between sorbed, dissolved, and vapor phases; and 3) steady-state vapor- and liquid-phase diffusion through the vadose zone and foundation cracks. As presented in the example calculation of RBSLs in the ASTM RBCA standard, the Johnson and Ettinger model neglects the potential for convected transport of vapor into a building. However, the full model does consider this. While this assumption is generally conservative, it may not be for some situations in which convection dominates.

The model additionally assumes that vapors migrate completely and instantaneously into the building, i.e., no attenuation occurs between impacted subsurface soils and the structure foundation. It is important to stress that this is a very conservative assumption since considerable attenuation including biodegradation and sorption onto clean soil particles could occur as the vapor migrates through the vadose zone.

Indoor Air RBSL Calculation

The indoor air RBSL is equal to the concentration of a chemical (or TPH fraction) in indoor air which yields a hazard index of 1. It incorporates exposure parameters, which differ for different receptors (see Table B-1), and the reference dose (RfD) for each TPH fraction (see Table 3-3). For the EC8-EC10 fractions, where two RfD values are given, the most conservative values (i.e., for the EC9-EC10 fraction) are used to evaluate risk.

(2) Air RBSL

$$RBSL_{air}\ [\tfrac{\mu g}{m^3\text{-}air}] = \frac{THQ \times RfD_i \times BW \times AT_n \times 365\ \frac{days}{year} \times 10^3\ \frac{\mu g}{mg}}{IR_{air-in} \times EF \times ED}$$

where:

THQ = Target hazard quotient for individual constituents [unitless]
RfD_i = Inhalation chronic reference dose [mg/kg-day]
BW = Body weight [kg]
AT_n = Averaging time for non-carcinogens [years]
IR_{air-in} = Daily air inhalation rate [m^3/day]
EF = Exposure frequency [days/year]
ED = Exposure duration [years]

The target hazard quotient (THQ) for calculation of non-carcinogenic effects is 1. The inhalation rate (IR_{air-in}) is the amount of air inhaled per day, which varies based on the receptor. The exposure frequency (EF), exposure duration (ED) and body weight (BW) are described in the intake assumptions for specific receptors (Table B-1). For non-carcinogenic effects, the averaging time (AT) is equal to the period of exposure for the receptor. These values are included in Table B-1. The RfD values for individual fractions are included in Table 3-3 in this report. For the EC8-EC10 fractions, where two RfD values are given, the most conservative values (i.e., for the EC9-EC10 fraction) are used to evaluate risk.

Transport of Vapors from Vadose Soils to Building

The next step in calculation of a soil concentration ($RBSL_{svin}$) which will yield an acceptable indoor air concentration ($RBSL_{air}$) is to evaluate transport of compounds from vadose soil into indoor air.

Because some dilution of the vapor is expected to occur between the source and the building foundation, a diffusion factor is used. Equation 3 defines this factor:

(3) Effective Diffusion Coefficient in Soil

$$D_s^{eff}\ [\frac{cm^2}{s}] = D^{air}\ \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat}\ \frac{1}{H_c}\ \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

where:

D^{air} = Diffusion coefficient in air [cm^2/sec]
D^{wat} = Diffusion coefficient in water [cm^2/sec]
θ_T = Total soil porosity [cm^3/cm^3]
H_c = Henry's Constant [cm^3-H_2O/cm^3-air]
θ_{as} = Soil volumetric air content [cm^3-air/cm^3-soil]
θ_{ws} = Soil volumetric water content [cm^3-H_2O/cm^3-soil]

In addition, the diffusion of the pore gas through cracks present in the building foundation is governed by the following equation:

(4) Effective Diffusion Coefficient Foundation Cracks

$$D_{crack}^{eff}\ [\frac{cm^2}{s}] = D^{air}\ \frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^{wat}\ \frac{1}{H_c}\ \frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$$

where:

θ_{acrack} = Volumetric air content in foundations [cm^3-air/cm^3]
θ_{wcrack} = Volumetric water content in foundations [cm^3-H_2O/cm^3]
D^{air} = Diffusion coefficient in air [cm^2/sec]
D^{wat} = Diffusion coefficient in water [cm^2/sec]
θ_T = Total soil porosity [cm^3/cm^3]
H_c = Henry's Constant [cm^3-H_2O/cm^3-air]

Default values for these parameters are given in Table B-2 at the end of this section. Henry's Constants for each TPH fraction are provided in Table 1-2 in the main text of this report.

Chemical Partitioning

The chemical properties of a compound determine how it will partition between soil, water and air. The partitioning equation which accounts for the movement of chemicals from the soil into the vapor phase in the soil pore spaces is defined as follows:

(5) Partitioning Factor
Soil/Vapor Phase

$$PF_{S-V} = \frac{H_c \, \rho_s}{\theta_{ws} + k_s \, \rho_s + H_c \, \theta_{as}}$$

where:

H_c = Henry's Constant [cm^3-H_2O/cm^3-air]
ρ_s = Soil bulk density [g/cm^3]
k_s = Soil sorption coefficient (k_{oc}*f_{oc}) [cm^3-H_2O/g-soil]
θ_{ws} = Volumetric water content of soil [cm^3-H_2O/cm^3-soil]
θ_{as} = Volumetric air content of soil [cm^3-air/cm^3-soil]

Fraction-specific values for Henry's Constant and the partitioning coefficient, k_{oc} are given in Tables 1-2 and 1-3 in the main text of this report. Other non-fraction-specific values are given in Table B-2 at the end of this section.

Soil RBSL - Volatilization to Indoor Air Pathway

Equations 3, 4 and 5 are then combined to yield the overall subsurface soil to enclosed space volatilization factor (VF_{sesp}), which takes into account partitioning, diffusion in the vadose zone, and effective diffusion into an enclosed space, and adds terms for accumulation of vapors in the enclosed space. This factor is defined as follows:

(6) Volatilization Factor
(Indoor Air)

$$VF_{sesp} = \frac{\dfrac{(PF_{S-V}) \, D_s^{eff}}{L_S \, (ER) \, L_B}}{1 + \dfrac{D_s^{eff}}{ER \, L_s} + \dfrac{D_s^{eff} * L_{crack}}{(L_s \, D_{crack}^{eff}) * \eta}} \times 10^3 \; [\frac{cm^3\text{-}kg}{m^3\text{-}g}$$

where:

PF_{S-V} = Partitioning Factor (see Equation 5 above)
D_s^{eff} = Effective diffusion coefficient in soil [cm^2/s] (see Equation 3 above)
D_{crack}^{eff} = Effective diffusion coefficient through foundation cracks [cm^2/s] (see Equation 4 above)
L_S = Depth to subsurface soil sources [cm]
ER = Enclosed-space air exchange rate [s^{-1}]
L_B = Enclosed-space volume/infiltration area ratio [cm]
L_{crack} = Enclosed-space foundation or wall thickness [cm]
η = Areal fraction of cracks in foundation/walls [cm^2/cm^2]

Values used in this calculation are given in Table B-2 at the end of this section.

This term, VF_{sesp}, when combined with the allowable concentration of contaminant in the air space ($RBSL_{air}$), determines the maximum allowable concentration of the contaminant in the subsurface soil source area as shown in Equation 7.

(7) Soil RBSL - Indoor Air Pathway

$$RBSL_{svin}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{RBSL_{air}\left[\frac{mg}{m^3\text{-}air}\right]}{VF_{sesp}}$$

Fraction-specific RBSLs are then used to calculate "whole TPH" RBSLs as described in Section 4 of this report.

Input Parameters

Fraction-specific parameters are given in Tables 1-2 and 1-3 of this report. Other parameters used in calculation of the soil RBSL for the indoor air pathway are as follows:

Table B-2 Input Parameters for Indoor Air RBSL Calculations

Parameter	Units	Default Value
θ_T	cm^3/cm^3	0.38
θ_{as}	cm^3-air/cm^3-soil	0.26
θ_{ws}	cm^3-H_2O/cm^3-soil	0.12
θ_{acrack}	cm^3-air/cm^3	0.26
θ_{wcrack}	cm^3-H_2O/cm^3	0.12
D^{air}	cm^2/sec	0.1*
D^{wat}	cm^2/sec	1×10^{-5}*
f_{oc}	g/g	0.01
ρ_s	g/cm^3	1.7
L_s	cm	100
L_B	cm	200 *(residential)* 300 *(commercial)*
ER	s^{-1}	0.00014 *(residential)* 0.00023 *(commercial)*
L_{crack}	cm	15
η	cm^2/cm^2	0.01

NOTES:

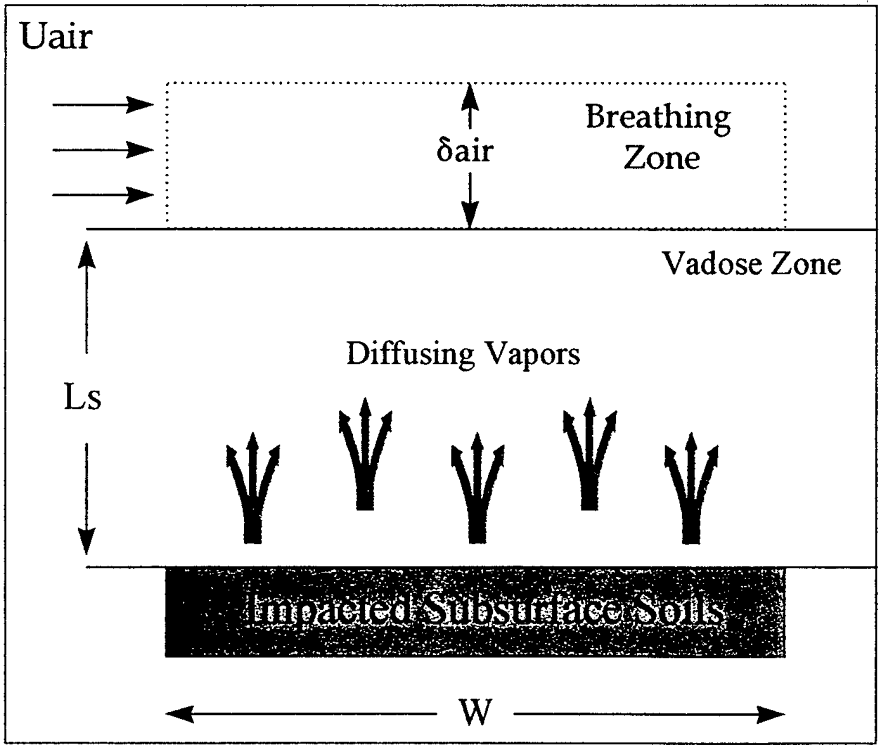
All values are default values specified in RBCA (ASTM E1739-95), unless otherwise specified.

* indicates chemical-specific value

B.2.2 Volatilization to Outdoor Air Pathway

The volatilization to outdoor air model is very similar to the indoor air model. In this model, contaminants partition into soil pore gas which migrates through the vadose zone to the ground surface (Figure B-2). Upon exiting the ground surface, the contaminant vapors mix with the ambient air. Dispersion into ambient air is modeled using a "box model" which is typically valid for source widths of less than 100 feet parallel to wind direction. Steady-state well-mixed atmospheric dispersion of the vapors within the breathing zone is assumed. Other assumptions listed for the indoor air model concerning linear equilibrium partitioning, steady-state vapor diffusion through the vadose zone, and no attenuation of the chemical as it migrates through the vadose zone, are also assumed for this model.

Figure B-2 Schematic of Soil Volatilizing to Outdoor Air Model



Soil RBSL - Volatilization to Indoor Air Pathway

Calculation of the RBSL for subsurface soil for protection of outdoor air quality is performed in a manner similar to that described for the indoor air pathway. A volatilization factor for ambient air (VF_{samb}) is derived, using the effective diffusion coefficient in vadose soils and the partitioning factor defined in Equations 3 and 5, and incorporating terms for diffusion into ambient air. This volatilization factor is defined as follows:

(8) Volatilization Factor (Outdoor Air)

$$VF_{samb}\left[\frac{mg/m^3\text{-}air}{mg/kg\text{-}soil}\right] = \frac{PF_{S-V}}{\left(1 + \dfrac{U_{air}\,\delta_{air}\,L_S}{D_S^{eff}\,W}\right)} \times 10^3 \left[\frac{cm^3\text{-}kg}{m^3\text{-}g}\right]$$

where:

$PF_{S\text{-}V}$ = Partitioning factor (see Equation 5 above)

D_s^{eff} = Effective diffusion coefficient in soil [cm^2/s] (see Equation 3 above)

L_S = Depth to subsurface soil sources [cm]

U_{air} = Wind speed above ground surface in ambient mixing zone [cm/sec]

δ_{air} = Ambient air mixing zone height [cm]

W = Width of source area parallel to wind direction [cm]

Default values for parameters used in this calculation are given in Table B-3 at the end of this section.

This term, VF_{samb}, when combined with the allowable concentration of contaminant in the air space ($RBSL_{air}$ - see Equation 2), determines the maximum allowable concentration of the contaminant in the subsurface soil source area ($RBSL_{svout}$) as shown in Equation 9.

(9) Soil RBSL - Outdoor Air Pathway

$$RBSL_{svout}\left[\frac{mg}{kg\text{-}soil}\right] = \frac{RBSL_{air}\left[\dfrac{mg}{m^3\text{-}air}\right]}{VF_{samb}}$$

Fraction-specific RBSLs are then used to calculate "whole TPH" RBSLs as described in Section 4 of this report.

Input Parameters

Fraction-specific parameters are given in Tables 1-2 and 1-3 of this report. Parameters used for calculation of the partitioning factor ($PF_{S\text{-}V}$) and diffusion coefficient (D^s_{eff}) are included in Table B-2 above. Other parameters used in calculation of the soil RBSL for protection of outdoor air are as follows:

Table B-3 Input Parameters for Outdoor Air RBSL Calculations

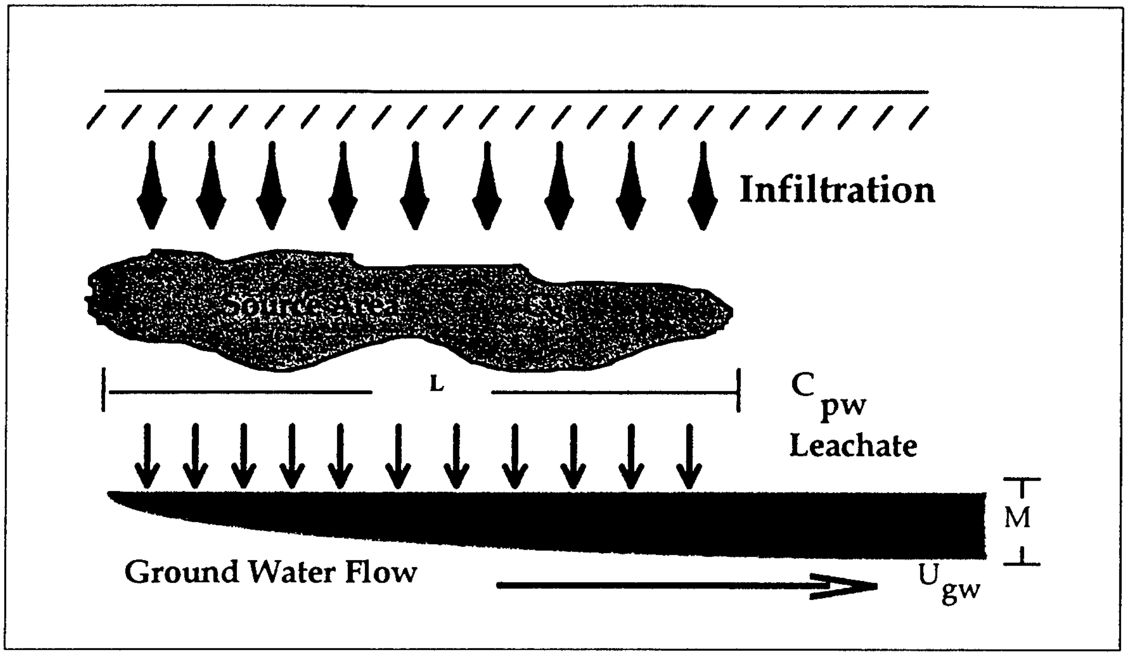
Parameter	Units	Default Value
L_s	*cm*	100
U_{air}	*cm/s*	225
δ_{air}	*cm*	200
W	*cm*	1,500

B.2.3 Leaching to Groundwater Pathway

Leaching of constituents from impacted soils into infiltrating water may result in contamination of underlying groundwater. Subsequent ingestion of this groundwater is one of the exposure pathways evaluated in this analysis. Therefore, for the RBCA analysis of TPH exposure to soils presented in this report, calculation of risk for the soil leaching to groundwater pathway was based on protection of groundwater to the groundwater ingestion RBSL ($RBSL_{gw}$). Figure B-3 illustrates this pathway.

The analytical model used to estimate soil leaching to groundwater determines the partitioning of a constituent (or TPH fraction) into water, vapor, and sorbed phases based on the physical and chemical properties of the constituent (or TPH fraction). In this model, infiltrating water migrates through contaminated soils in the vadose zone. At this point, some of the contaminant partitions from the soil or vapor phase into the water phase. This leachate is then assumed to migrate completely and instantaneously into groundwater.

Figure B-3 Schematic of Soil Leaching to Groundwater Model



Based on this model, the soil RBSL for the leaching to groundwater pathway involves 3 steps:

1. Calculation of a groundwater RBSL ($RBSL_{gw}$) to determine an acceptable groundwater concentration for the given exposure scenarios;
2. Calculation of a leachate concentration (C_{pw}) which would be protective of groundwater to this groundwater RBSL; and
3. Calculation of a soil concentration (C_s) which would result in this leachate concentration. This soil concentration is the soil RBSL for the leaching to groundwater pathway.

Ingestion of Groundwater

Calculation of the RBSL for the ingestion of groundwater is based on Equation 10:

(10) Groundwater RBSL

$$RBSL_{gw}\left[\frac{mg}{L\text{-}H_2O}\right] = \frac{THQ \times RfD_o \times BW \times AT_n \times 365\ \frac{days}{year}}{IR_w \times EF \times ED}$$

where:

THQ = Target hazard quotient for individual constituents (unitless);
RfD_o = Oral chronic reference dose (mg/kg-day);
BW = Body weight (kg);
AT_n = Averaging time for non-carcinogens (years);
IR_w = Daily water ingestion rate (L/day);
EF = Exposure frequency (days/year); and
ED = Exposure duration (years).

The target hazard quotient (THQ) for calculation of non-carcinogenic effects is 1. Reference doses are fraction-specific; a list of RfDs for each fraction is presented in Table 3-3. For the EC8-EC10 fractions, where two RfD values are given, the most conservative values (i.e., for the EC9-EC10 fraction) are used to evaluate risk. The ingestion rate (IR_w) is the amount of water incidentally ingested per day; this value varies based on the receptor. The exposure frequency (EF), exposure duration (ED) and body weight (BW) are described in the intake assumptions for specific receptors. For non-carcinogenic effects, the averaging time (AT_n) is equal to the period of exposure for the receptor. Receptor-specific values used for these exposure parameters are included in Table B-1.

Leachate Concentration

Once a groundwater RBSL has been calculated, an acceptable leachate concentration must be derived. Because some dilution of the leachate is expected as it combines with the bulk groundwater underlying the vadose zone, an attenuation factor based on infiltration rate (I), groundwater velocity (U_{gw}), source width (L), and height of the mixing zone in the water column (M or δ_{GW}) is used. The equation describing this attenuation factor is as follows:

(11) Attenuation Factor

$$AF = [1 + \frac{U_{GW}\,\delta_{GW}}{I\,W}]$$

where:

U_{gw} = Groundwater Darcy velocity [cm/yr]
δ_{gw} = Height of groundwater mixing zone [cm]
I = Precipitation infiltration rate [cm/yr]
W = Width of the source area parallel to the mixing zone [cm]

Default values for these parameters are included in Table B-4 at the end of this section.

Chemical Partitioning

In order to determine a soil concentration which will result in an acceptable leachate concentration for protection of groundwater, contaminant partitioning into the three phases, soil, water, and air, must be evaluated. This partitioning is governed by the partitioning factor ($PF_{S\text{-}W}$) shown below:

(12) Partitioning Factor Soil/Water

$$PF_{S\text{-}W} = \frac{[\theta_{ws} + k_s\,\rho_s + H_c\,\theta_{as}]}{\rho_s}$$

where:

H_c = Henry's Constant [cm^3-H_2O/cm^3-air]

θ_{as} = Soil volumetric air content [cm^3-air/cm^3-soil]

θ_{ws} = Soil volumetric water content [cm^3-H_2O/cm^3-soil]

k_s = Soil sorption coefficient (k_{oc}*f_{oc}) [cm^3/g]

ρ_s = Soil density [g/cm^3]

Henry's Constant (H_c) and the soil partitioning coefficient (k_{oc}) are chemical-specific parameters. Values used for each TPH fraction are included in Table 1-2. Values used for the other parameters are included in Table B-4 at the end of this section.

Soil RBSL - Leaching to Groundwater Pathway

The partitioning factor ($PF_{S\text{-}W}$), multiplied by the attenuation factor (AF) which accounts for dilution of leached water into underlying groundwater, derives the inverse of the leaching factor ($1/LF_{sw}$). Note that the leaching model is very conservative since it assumes that no attenuation of the leachate occurs from the vadose zone to saturated zone. In fact, biological degradation of the constituent or repartitioning onto soil or into the vapor phase are all likely to occur as the leachate migrates to groundwater. Other assumptions of the model include: 1) a constant chemical concentration in the subsurface soils, 2) linear equilibrium partitioning within the soil matrix between sorbed, dissolved, and vapor phases, 3) steady-state leaching from the vadose zone to groundwater, and 4) steady state, well-mixed dispersion of the leachate within the groundwater mixing zone.

Thus, the leaching factor (LF_{sw}) which governs transport of contaminants from soil to infiltrating water incorporates both the $PF_{S\text{-}W}$ (Equation 12) and the AF (Equation 11) which yields the following equation:

(13) Leaching Factor

$$LF_{sw} = \frac{1}{[\ PF_{S\text{-}W} \times AF\ ]}$$

or

$$LF_{sw} = \frac{\rho_s}{[\theta_{ws} + k_s\,\rho_s + H_c\,\theta_{as}][1 + \frac{U_{GW}\,\delta_{GW}}{I\,W}]} \times 10^0\ \frac{cm^3\text{-}kg}{L\text{-}g}$$

where:

U_{gw} = Groundwater Darcy velocity [cm/yr]
δ_{gw} = Height of groundwater mixing zone [cm]
I = Precipitation infiltration rate [cm/yr]
W = Width of the source area parallel to the mixing zone [cm]
H_c = Henry's Constant [cm^3-H_2O/cm^3-air]
θ_{as} = Soil volumetric air content [cm^3-air/cm^3-soil]
θ_{ws} = Soil volumetric water content [cm^3-H_2O/cm^3-soil]
k_s = Soil sorption coefficient (k_{oc}*f_{oc}) [cm^3/g]
ρ_s = Soil density [g/cm^3]

Using this leaching factor, a soil RBSL ($RBSL_s$) which is protective of groundwater to the appropriate groundwater RBSL ($RBSL_{gw}$) for each fraction can be calculated using the following equation:

(14) Soil RBSL

$$RBSL_s\ [mg/kg\text{-}soil] = \frac{RBSL_w\ [mg/L\text{-}H_2O]}{LF_{sw}}$$

Fraction-specific RBSLs are then used to calculate "whole TPH" RBSLs as described in Section 4 of this report.

Input Parameters

Fraction-specific parameters are given in Tables 1-2 and 1-3 of this report. Other parameters used in calculation of the soil RBSL for protection of groundwater are as follows:

Table B-4 Input Parameters for Leaching to Groundwater RBSL Calculations

Parameter	Units	Default Value
U_{gw}	*cm/yr*	2,500
δ_{gw}	*cm*	200
I	*cm/yr*	30
W	*cm*	1,500
θ_{as}	$cm^3\text{-}air/cm^3\text{-}soil$	0.26
θ_{ws}	$cm^3\text{-}H_2O/cm^3\text{-}soil$	0.12
f_{oc}	*g/g*	0.01
ρ_s	g/cm^3	1.7

B.2.4 Direct Contact With Soils Pathway

The direct soils contact pathway assumes that chemical intake results from a combination of ingestion, dermal absorption, particulate inhalation, and vapor inhalation exposure routes. Generally, this pathway governs exposure due to contact with surface soils, though it may also be applied to contact with subsurface soils resulting from excavation, utilities installation, or other work performed in the subsurface. For subsurface applications, exposure durations are modified to reflect the actual duration of the work.

For the calculation of a "whole TPH" RBSL for the direct contact pathway, it is important to note that C_{sat} will not limit exposure, as is discussed in Section 4.2, since the exposure which occurs is to the original contaminated media, not a media to which the contamination was transferred (e.g., water or air).

Volatilization Factors

Soil RBSLs for the direct contact pathway incorporate terms for inhalation of both particulates and vapors as well as ingestion and dermal absorption of soils.

The surface soil "volatilization factor" for particulates is defined as follows:

(15) Volatilization Factor
Surface Soil to Particulates

$$VF_p \left[\frac{(mg/m^3\text{-}air)}{(mg/kg\text{-}soil)}\right] = \frac{P_e\, W}{U_{air}\, \delta_{air}} \times 10^3 \left[\frac{cm^3\text{-}kg}{m^3\text{-}g}\right]$$

where:

P_e = Particulate emission rate [g/cm^2-sec]
W = Width or source area parallel to wind direction [cm]
U_{air} = Wind speed above ground surface in ambient mixing zone [cm/s]
δ_{air} = Ambient air mixing zone height [cm]

The volatilization factor for surficial soil to ambient vapors is defined as the lesser of the following two values:

(16) Volatilization Factor -
Surface Soil to Vapors

$$VF_{ss}\left[\frac{(mg/m^3\text{-}air)}{(mg/L\text{-}H_2O)}\right] = \frac{2\ W\ \rho_s}{U_{air}\ \delta_{air}}\sqrt{\frac{D_s^{eff}\ H_c}{\pi\ [\theta_{ws} + k_s\rho_s + H_c\ \theta_{as}]\ \tau}} \times 10^3\ \left[\frac{cm^3\text{-}kg}{m^3\text{-}g}\right]$$

or

$$VF_{ss}\left[\frac{(mg/m^3\text{-}air)}{(mg/L\text{-}H_2O)}\right] = \frac{W\ \rho_s\ d}{U_{air}\ \delta_{air}\ \tau} \times 10^3\ \left[\frac{cm^3\text{-}kg}{m^3\text{-}g}\right]\ ;\ \textit{whichever is less}$$

where:

P_e = Particulate emission rate [g/cm^2-sec]
W = Width or source area parallel to wind direction [cm]
U_{air} = Wind speed above ground surface in ambient mixing zone [cm/s]
δ_{air} = Ambient air mixing zone height [cm]
H_c = Henry's law constant [cm^3-H$_2$O/cm^3-air]
θ_{ws} = Volumetric water content in vadose zone soils [cm^3-H$_2$O/cm^3-soil]
θ_{as} = Volumetric air content in vadose zone soils [cm^3-air/cm^3-soil]
k_s = Soil sorption coefficient (k_{oc}*f_{oc}) [cm^3/g]
ρ_s = Soil bulk density [g-soil/cm^3-soil]
τ = Averaging time for vapor flux [sec]
D_s^{eff} = Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/sec] (See Equation 3)

Soil RBSL - Direct Contact Pathway

These factors are then incorporated into an intake equation (similar to Equation 1) which is modified to include inhalation as well as ingestion and dermal absorption to yield a surface soil RBSL which accounts for all direct contact pathways. Thus, the RBSL for direct contact with soil ($RBSL_{ss}$) is calculated using the following equation:

(17) Soil RBSL for Direct Contact Pathway

$$RBSL_{ss}\ [\frac{\mu g}{kg\text{-}soil}] = \frac{THQ \times BW \times AT_n \times 365\ \frac{days}{year}}{EF \times ED\ [\frac{10^{-6}\ \frac{kg}{mg} \times (IR_{soil} \times RAF_o + SA \times M \times RAF_d)}{RfD_o}] + \frac{(IR_{air} \times (VF_{ss} + VF_p))}{RfD_i}}$$

where:

THQ = Target hazard quotient for individual constituents [unitless]
BW = Body weight [kg]
AT_n = Averaging time for non-carcinogens [years]
EF = Exposure frequency [days/year]
ED = Exposure duration [years]
IR_{soil} = Soil ingestion rate [mg/day]
IR_{air} = Air inhalation rate [m^3/day]
RfD_o = Oral chronic reference dose [mg/kg-day]
RfD_i = Inhalation chronic reference dose [mg/kg-day]
RAF_d = Dermal relative absorption factor [unitless]
RAF_o = Oral relative absorption factor [unitless]
VF_p = Surficial soils to ambient air partition factor [particulates] (see Equation 15 above)
VF_{ss} = Surficial soils to ambient air partition factor [vapors] (see Equation 16 above)
SA = Skin surface area [cm^2/day]
M = Soil to skin adherence factor [mg/cm^2]

The target hazard quotient (THQ) for calculation of non-carcinogenic effects is 1. Reference doses are fraction-specific; a list of RfDs for each fraction is presented in Table 3-3. For the EC8-EC10 fractions, where two RfD values are given, the most conservative values (i.e., for the EC9-EC10 fraction) are used to evaluate risk. The relative dermal absorption factor (RAF_d) is assumed to be 0.5, indicating that half of the material contacted is absorbed dermally; the relative oral absorption factor (RAF_o) is assumed to be 1, indicating that all of the material ingested is available for absorption in the body. The skin surface area (SA) exposed to soil is the product of the total body surface area and the fraction of body exposed. The fraction of body exposed is dependent on the nature of the activity being conducted and the age and type of the individuals involved. Exposures via dermal contact are generally limited to certain parts of the body (i.e., hands, forearms, head, neck, etc.). The soil adherence factor (M) is the density of soil adhering to the exposed fraction of the body.

Receptor-specific exposure parameters are included in Table B-1 above. Fraction-specific parameters are defined in Tables 1-2 and 1-3 in the main text of this report. Other values used in this calculation are listed below in Table B-5.

Note that this RBSL calculation applies to an individual compound only. Thus, a separate RBSL is calculated for each TPH fraction. The "whole TPH" RBSL is then calculated as described in Section 4 of this report.

Input Parameters

Fraction-specific parameters are given in Tables 1-2 and 1-3 of this report. Other parameters used in calculation of the soil RBSL for protection of groundwater are as follows:

Table B-5 Input Parameters for Direct Contact RBSL Calculations

Parameter	Units	Default Value
P_e	*g/cm²-sec*	2.2×10^{-10}
W	*cm*	1,500
U_{air}	*cm/sec*	225
δ_{air}	*cm*	200
θ_{ws}	*cm³-H₂O/cm³-soil*	0.12
θ_{as}	*cm³-air/cm³-soil*	0.26
f_{oc}	*g/g*	0.01
ρ_s	*g-soil/cm³-soil*	1.7
τ	*sec*	7.88×10^{8}
RAF_d	—	0.5
RAF_o	—	1.0

Appendix D

Model Runs

Appendix D-1

Model Runs

Sample No. 380SB-02B-15

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	2.29E-04	0.01%	5.30E-02	3.31E-06		5-6 Aliphatics	2.29E-04	1.19E-04	7.66E-02	3.34E-06
5-7 Aromatics	2.29E-04	3.21%	2.22E-01	9.44E-05		5-7 Aromatics	2.29E-04	4.30E-02	3.21E-01	9.56E-05
>6-8 Aliphatics	2.29E-04	0.00%	2.20E-02	3.31E-06		>6-8 Aliphatics	2.29E-04	3.31E-05	2.80E-02	3.34E-06
>7-8 Aromatics	2.29E-04	1.20%	9.87E-02	9.44E-05		>7-8 Aromatics	2.29E-04	1.61E-02	1.43E-01	9.56E-05
>8-10 Aliphatics	9.16E-03	0.72%	8.38E-02	6.01E-03		>8-10 Aliphatics	9.16E-03	3.47E-03	5.98E-02	6.02E-03
>8-10 Aromatics	9.16E-03	36.79%	4.54E-01	1.61E-02		>8-10 Aromatics	9.16E-03	4.93E-01	3.24E-01	1.62E-02
>10-12 Aliphatics	9.16E-03	0.08%	1.05E-02	6.01E-03		>10-12 Aliphatics	9.16E-03	2.75E-04	7.50E-03	6.02E-03
>10-12 Aromatics	9.16E-03	23.34%	4.99E-02	1.61E-02		>10-12 Aromatics	9.16E-03	3.13E-01	3.56E-02	1.62E-02
>12-16 Aliphatics	1.37E-01	0.00%	9.75E-04	9.02E-02		>12-16 Aliphatics	1.37E-01	6.14E-06	6.96E-04	9.03E-02
>12-16 Aromatics	2.40E-02	30.77%	4.46E-03	4.09E-02		>12-16 Aromatics	2.40E-02	1.17E-01	3.19E-03	4.10E-02
>16-21 Aliphatics	4.19E-01	0.00%	2.96E-06	1.42E-02		>16-21 Aliphatics	4.19E-01	5.25E-10	2.12E-06	1.42E-02
>16-21 Aromatics	2.43E-01	3.85%	1.45E-04	5.19E-01		>16-21 Aromatics	2.43E-01	1.37E-02	1.04E-04	5.19E-01
>21-35 Aromatics	1.40E-01	0.05%	1.08E-07	2.91E-01		>21-35 Aromatics	1.40E-01	1.78E-04	7.70E-08	2.90E-01
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		11,363	631,700	5,113		RBSL(HI=1) mg/kg		42,651	1,277,808	7,571

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	6.33E-04	0.01%	5.30E-02	1.16E-05		5-6 Aliphatics	6.33E-04	1.19E-04	7.66E-02	1.17E-05
5-7 Aromatics	6.33E-04	3.21%	2.22E-01	3.31E-04		5-7 Aromatics	6.33E-04	4.30E-02	3.21E-01	3.35E-04
>6-8 Aliphatics	6.33E-04	0.00%	2.20E-02	1.16E-05		>6-8 Aliphatics	6.33E-04	3.31E-05	2.80E-02	1.17E-05
>7-8 Aromatics	6.33E-04	1.20%	9.87E-02	3.31E-04		>7-8 Aromatics	6.33E-04	1.61E-02	1.43E-01	3.35E-04
>8-10 Aliphatics	2.53E-02	0.72%	8.38E-02	2.11E-02		>8-10 Aliphatics	2.53E-02	3.47E-03	5.98E-02	2.11E-02
>8-10 Aromatics	2.53E-02	36.79%	4.54E-01	5.65E-02		>8-10 Aromatics	2.53E-02	4.93E-01	3.24E-01	5.67E-02
>10-12 Aliphatics	2.53E-02	0.08%	1.05E-02	2.11E-02		>10-12 Aliphatics	2.53E-02	2.75E-04	7.50E-03	2.11E-02
>10-12 Aromatics	2.53E-02	23.34%	4.99E-02	5.65E-02		>10-12 Aromatics	2.53E-02	3.13E-01	3.56E-02	5.67E-02
>12-16 Aliphatics	6.65E-02	0.00%	9.75E-04	5.53E-02		>12-16 Aliphatics	6.65E-02	6.14E-06	6.96E-04	5.54E-02
>12-16 Aromatics	6.65E-02	30.77%	4.46E-03	1.43E-01		>12-16 Aromatics	6.65E-02	1.17E-01	3.19E-03	1.44E-01
>16-21 Aliphatics	5.29E-01	0.00%	2.96E-06	2.27E-02		>16-21 Aliphatics	5.29E-01	5.25E-10	2.12E-06	2.28E-02
>16-21 Aromatics	6.65E-02	3.85%	1.45E-04	1.80E-01		>16-21 Aromatics	6.65E-02	1.37E-02	1.04E-04	1.80E-01
>21-35 Aromatics	1.68E-01	0.05%	1.08E-07	4.43E-01		>21-35 Aromatics	1.68E-01	1.78E-04	7.70E-08	4.42E-01
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		4,107	228,302	6,475		RBSL(HI=1) mg/kg		15,414	461,812	9,583

Sample No. 380SB-02B-21

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	2.49E-04	0.01%	5.30E-02	4.47E-06		5-6 Aliphatics	2.49E-04	1.19E-04	7.66E-02	4.50E-06
5-7 Aromatics	2.49E-04	3.21%	2.22E-01	1.27E-04		5-7 Aromatics	2.49E-04	4.30E-02	3.21E-01	1.29E-04
>6-8 Aliphatics	2.49E-04	0.00%	2.20E-02	4.47E-06		>6-8 Aliphatics	2.49E-04	3.31E-05	2.80E-02	4.50E-06
>7-8 Aromatics	2.49E-04	1.20%	9.87E-02	1.27E-04		>7-8 Aromatics	2.49E-04	1.61E-02	1.43E-01	1.29E-04
>8-10 Aliphatics	9.95E-03	0.72%	8.38E-02	8.11E-03		>8-10 Aliphatics	9.95E-03	3.47E-03	5.98E-02	8.12E-03
>8-10 Aromatics	9.95E-03	36.79%	4.54E-01	2.17E-02		>8-10 Aromatics	9.95E-03	4.93E-01	3.24E-01	2.18E-02
>10-12 Aliphatics	9.95E-03	0.08%	1.05E-02	8.11E-03		>10-12 Aliphatics	9.95E-03	2.75E-04	7.50E-03	8.12E-03
>10-12 Aromatics	9.95E-03	23.34%	4.99E-02	2.17E-02		>10-12 Aromatics	9.95E-03	3.13E-01	3.56E-02	2.18E-02
>12-16 Aliphatics	1.74E-01	0.00%	9.75E-04	1.42E-01		>12-16 Aliphatics	1.74E-01	6.14E-06	6.96E-04	1.42E-01
>12-16 Aromatics	2.61E-02	30.77%	4.46E-03	5.51E-02		>12-16 Aromatics	2.61E-02	1.17E-01	3.19E-03	5.53E-02
>16-21 Aliphatics	4.85E-01	0.00%	2.96E-06	2.04E-02		>16-21 Aliphatics	4.85E-01	5.25E-10	2.12E-06	2.05E-02
>16-21 Aromatics	2.09E-01	3.85%	1.45E-04	5.55E-01		>16-21 Aromatics	2.09E-01	1.37E-02	1.04E-04	5.55E-01
>21-35 Aromatics	6.47E-02	0.05%	1.08E-07	1.67E-01		>21-35 Aromatics	6.47E-02	1.78E-04	7.70E-08	1.67E-01
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		10,453	581,095	6,345		RBSL(HI=1) mg/kg		39,234	1,175,443	9,392

Sample No. 380SB-02B-32

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	8.33E-04	0.05%	6.95E-02	2.34E-05		5-6 Aliphatics	8.33E-04	7.39E-04	7.66E-02	2.35E-05
5-7 Aromatics	8.33E-04	19.31%	2.92E-01	6.66E-04		5-7 Aromatics	8.33E-04	2.66E-01	3.21E-01	6.73E-04
>6-8 Aliphatics	8.33E-04	0.01%	2.89E-02	2.34E-05		>6-8 Aliphatics	8.33E-04	2.05E-04	2.80E-02	2.35E-05
>7-8 Aromatics	8.33E-04	7.22%	1.29E-01	6.66E-04		>7-8 Aromatics	8.33E-04	9.95E-02	1.43E-01	6.73E-04
>8-10 Aliphatics	3.33E-03	0.43%	8.38E-02	4.24E-03		>8-10 Aliphatics	3.33E-03	3.47E-03	5.98E-02	4.24E-03
>8-10 Aromatics	3.33E-03	22.14%	3.31E-01	1.14E-02		>8-10 Aromatics	3.33E-03	3.05E-01	3.24E-01	1.14E-02
>10-12 Aliphatics	3.00E-02	0.08%	1.05E-02	3.82E-02		>10-12 Aliphatics	3.00E-02	2.75E-04	7.50E-03	3.82E-02
>10-12 Aromatics	3.33E-03	14.05%	4.99E-02	1.14E-02		>10-12 Aromatics	3.33E-03	1.94E-01	3.56E-02	1.14E-02
>12-16 Aliphatics	3.73E-01	0.00%	9.75E-04	4.75E-01		>12-16 Aliphatics	3.73E-01	6.14E-06	6.96E-04	4.75E-01
>12-16 Aromatics	2.66E-02	32.80%	4.46E-03	8.78E-02		>12-16 Aromatics	2.66E-02	1.17E-01	3.19E-03	8.80E-02
>16-21 Aliphatics	4.75E-01	0.00%	2.96E-06	3.12E-02		>16-21 Aliphatics	4.75E-01	5.25E-10	2.12E-06	3.12E-02
>16-21 Aromatics	6.08E-02	3.85%	1.45E-04	2.52E-01		>16-21 Aromatics	6.08E-02	1.37E-02	1.04E-04	2.52E-01
>21-35 Aromatics	2.16E-02	0.05%	1.08E-07	8.74E-02		>21-35 Aromatics	2.16E-02	1.78E-04	7.70E-08	8.72E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		18,803	227,556	9,909		RBSL(HI=1) mg/kg		72,541	351,259	14,658

Sample No. 380SB-02B-33

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	7.43E-04	0.04%	5.07E-02	2.22E-05		5-6 Aliphatics	7.43E-04	5.51E-04	5.29E-02	2.23E-05
5-7 Aromatics	1.57E-03	30.44%	4.49E-01	1.33E-03		5-7 Aromatics	1.57E-03	4.19E-01	4.68E-01	1.35E-03
>6-8 Aliphatics	7.43E-04	0.01%	2.11E-02	2.22E-05		>6-8 Aliphatics	7.43E-04	1.53E-04	2.20E-02	2.23E-05
>7-8 Aromatics	7.43E-04	5.39%	9.44E-02	6.32E-04		>7-8 Aromatics	7.43E-04	7.42E-02	9.84E-02	6.39E-04
>8-10 Aliphatics	2.97E-03	0.32%	8.38E-02	4.03E-03		>8-10 Aliphatics	2.97E-03	3.47E-03	5.98E-02	4.03E-03
>8-10 Aromatics	2.97E-03	16.53%	2.41E-01	1.08E-02		>8-10 Aromatics	2.97E-03	2.27E-01	2.52E-01	1.08E-02
>10-12 Aliphatics	1.19E-02	0.08%	1.05E-02	1.61E-02		>10-12 Aliphatics	1.19E-02	2.75E-04	7.50E-03	1.61E-02
>10-12 Aromatics	2.97E-03	10.49%	4.38E-02	1.08E-02		>10-12 Aromatics	2.97E-03	1.44E-01	3.56E-02	1.08E-02
>12-16 Aliphatics	3.63E-01	0.00%	9.75E-04	4.92E-01		>12-16 Aliphatics	3.63E-01	6.14E-06	6.96E-04	4.92E-01
>12-16 Aromatics	2.23E-02	32.80%	4.46E-03	7.82E-02		>12-16 Aromatics	2.23E-02	1.17E-01	3.19E-03	7.83E-02
>16-21 Aliphatics	5.10E-01	0.00%	2.96E-06	3.56E-02		>16-21 Aliphatics	5.10E-01	5.25E-10	2.12E-06	3.57E-02
>16-21 Aromatics	6.02E-02	3.85%	1.45E-04	2.66E-01		>16-21 Aromatics	6.02E-02	1.37E-02	1.04E-04	2.65E-01
>21-35 Aromatics	1.97E-02	0.05%	1.08E-07	8.46E-02		>21-35 Aromatics	1.97E-02	1.78E-04	7.70E-08	8.44E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		15,730	185,952	10,542		RBSL(HI=1) mg/kg		60,578	271,474	15,594

	RESIDENTIAL SCENARIO			
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18
		s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	1.16E-04	0.01%	5.06E-02	1.94E-06
5-7 Aromatics	1.16E-04	2.28%	2.12E-01	5.53E-05
>6-8 Aliphatics	2.58E-04	0.00%	3.93E-02	4.32E-06
>7-8 Aromatics	1.16E-04	0.85%	9.42E-02	5.53E-05
>8-10 Aliphatics	1.50E-02	0.97%	8.38E-02	1.14E-02
>8-10 Aromatics	1.16E-03	6.54%	4.54E-01	2.36E-03
>10-12 Aliphatics	7.71E-02	0.08%	1.05E-02	5.85E-02
>10-12 Aromatics	1.47E-02	52.57%	4.99E-02	2.99E-02
>12-16 Aliphatics	2.94E-01	0.00%	9.75E-04	2.24E-01
>12-16 Aromatics	1.11E-01	32.80%	4.46E-03	2.17E-01
>16-21 Aliphatics	3.06E-01	0.00%	2.96E-06	1.20E-02
>16-21 Aromatics	1.47E-01	3.85%	1.45E-04	3.63E-01
>21-35 Aromatics	3.40E-02	0.05%	1.08E-07	8.19E-02
Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18
		s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		15,946	1,188,979	5,910

		COMMERCIAL SCENARIO		
	Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	1.16E-04	2.36E-04	7.66E-02	1.95E-06
5-7 Aromatics	1.16E-04	8.49E-02	3.21E-01	5.59E-05
>6-8 Aliphatics	2.58E-04	1.45E-04	2.80E-02	4.34E-06
>7-8 Aromatics	1.16E-04	3.17E-02	1.43E-01	5.59E-05
>8-10 Aliphatics	1.50E-02	3.47E-03	5.98E-02	1.14E-02
>8-10 Aromatics	1.16E-03	2.43E-01	3.24E-01	2.37E-03
>10-12 Aliphatics	7.71E-02	2.75E-04	7.50E-03	5.85E-02
>10-12 Aromatics	1.47E-02	5.05E-01	3.56E-02	3.00E-02
>12-16 Aliphatics	2.94E-01	6.14E-06	6.96E-04	2.24E-01
>12-16 Aromatics	1.11E-01	1.17E-01	3.19E-03	2.18E-01
>16-21 Aliphatics	3.06E-01	5.25E-10	2.12E-06	1.20E-02
>16-21 Aromatics	1.47E-01	1.37E-02	1.04E-04	3.63E-01
>21-35 Aromatics	3.40E-02	1.78E-04	7.70E-08	8.17E-02
Total	1.00E+00			
		RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		166,046	2,521,008	8,741

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	6.18E-04	0.02%	5.93E-02	1.00E-05		5-6 Aliphatics	6.18E-04	3.36E-04	7.66E-02	1.01E-05
5-7 Aromatics	6.18E-04	8.63%	2.49E-01	2.85E-04		5-7 Aromatics	6.18E-04	1.21E-01	3.21E-01	2.88E-04
>6-8 Aliphatics	3.43E-03	0.04%	3.93E-02	5.56E-05		>6-8 Aliphatics	3.43E-03	5.18E-04	2.80E-02	5.59E-05
>7-8 Aromatics	6.18E-04	3.23%	1.10E-01	2.85E-04		>7-8 Aromatics	6.18E-04	4.53E-02	1.43E-01	2.88E-04
>8-10 Aliphatics	1.73E-02	0.97%	8.38E-02	1.27E-02		>8-10 Aliphatics	1.73E-02	3.47E-03	5.98E-02	1.27E-02
>8-10 Aromatics	3.43E-03	13.74%	3.92E-01	6.75E-03		>8-10 Aromatics	3.43E-03	1.93E-01	3.24E-01	6.78E-03
>10-12 Aliphatics	6.08E-02	0.08%	1.05E-02	4.47E-02		>10-12 Aliphatics	6.08E-02	2.75E-04	7.50E-03	4.47E-02
>10-12 Aromatics	1.44E-02	36.60%	4.99E-02	2.84E-02		>10-12 Aromatics	1.44E-02	5.05E-01	3.56E-02	2.85E-02
>12-16 Aliphatics	2.81E-01	0.00%	9.75E-04	2.06E-01		>12-16 Aliphatics	2.81E-01	6.14E-06	6.96E-04	2.06E-01
>12-16 Aromatics	1.15E-01	32.80%	4.46E-03	2.19E-01		>12-16 Aromatics	1.15E-01	1.17E-01	3.19E-03	2.19E-01
>16-21 Aliphatics	3.05E-01	0.00%	2.96E-06	1.16E-02		>16-21 Aliphatics	3.05E-01	5.25E-10	2.12E-06	1.16E-02
>16-21 Aromatics	1.59E-01	3.85%	1.45E-04	3.81E-01		>16-21 Aromatics	1.59E-01	1.37E-02	1.04E-04	3.80E-01
>21-35 Aromatics	3.84E-02	0.05%	1.08E-07	8.95E-02		>21-35 Aromatics	3.84E-02	1.78E-04	7.70E-08	8.93E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		11,320	261,819	5,718		RBSL(HI=1) mg/kg		44,517	473,444	8,457

Sample No. 529SB-04-80

	RESIDENTIAL SCENARIO			
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18
		s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	8.70E-04	0.03%	7.10E-02	1.58E-05
5-7 Aromatics	8.70E-04	11.51%	2.98E-01	4.49E-04
>6-8 Aliphatics	8.70E-04	0.01%	2.95E-02	1.58E-05
>7-8 Aromatics	8.70E-04	4.30%	1.32E-01	4.49E-04
>8-10 Aliphatics	1.66E-02	0.97%	8.38E-02	1.37E-02
>8-10 Aromatics	3.29E-03	12.46%	3.19E-01	7.24E-03
>10-12 Aliphatics	5.39E-02	0.08%	1.05E-02	4.44E-02
>10-12 Aromatics	1.41E-02	33.94%	4.99E-02	3.11E-02
>12-16 Aliphatics	3.06E-01	0.00%	9.75E-04	2.52E-01
>12-16 Aromatics	1.18E-01	32.80%	4.46E-03	2.51E-01
>16-21 Aliphatics	3.40E-01	0.00%	2.96E-06	1.45E-02
>16-21 Aromatics	1.31E-01	3.85%	1.45E-04	3.51E-01
>21-35 Aromatics	1.33E-02	0.05%	1.08E-07	3.48E-02
Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18
		s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		10,727	222,709	6,405

		COMMERCIAL SCENARIO		
	Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	8.70E-04	4.44E-04	7.66E-02	1.59E-05
5-7 Aromatics	8.70E-04	1.60E-01	3.21E-01	4.54E-04
>6-8 Aliphatics	8.70E-04	1.23E-04	2.80E-02	1.59E-05
>7-8 Aromatics	8.70E-04	5.98E-02	1.43E-01	4.54E-04
>8-10 Aliphatics	1.66E-02	3.47E-03	5.98E-02	1.37E-02
>8-10 Aromatics	3.29E-03	1.73E-01	3.24E-01	7.27E-03
>10-12 Aliphatics	5.39E-02	2.75E-04	7.50E-03	4.44E-02
>10-12 Aromatics	1.41E-02	4.72E-01	3.56E-02	3.12E-02
>12-16 Aliphatics	3.06E-01	6.14E-06	6.96E-04	2.52E-01
>12-16 Aromatics	1.18E-01	1.17E-01	3.19E-03	2.51E-01
>16-21 Aliphatics	3.40E-01	5.25E-10	2.12E-06	1.45E-02
>16-21 Aromatics	1.31E-01	1.37E-02	1.04E-04	3.50E-01
>21-35 Aromatics	1.33E-02	1.78E-04	7.70E-08	3.47E-02
Total	1.00E+00			
		RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		41,743	336,343	9,470

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	1.51E-04	0.01%	6.63E-02	2.78E-06		5-6 Aliphatics	1.51E-04	3.75E-04	7.66E-02	2.80E-06
5-7 Aromatics	1.51E-04	3.86%	2.78E-01	7.92E-05		5-7 Aromatics	1.51E-04	1.35E-01	3.21E-01	8.02E-05
>6-8 Aliphatics	1.51E-04	0.00%	2.75E-02	2.78E-06		>6-8 Aliphatics	1.51E-04	1.04E-04	2.80E-02	2.80E-06
>7-8 Aromatics	1.51E-04	1.44%	1.23E-01	7.92E-05		>7-8 Aromatics	1.51E-04	5.05E-02	1.43E-01	8.02E-05
>8-10 Aliphatics	7.86E-03	0.97%	8.38E-02	6.56E-03		>8-10 Aliphatics	7.86E-03	3.47E-03	5.98E-02	6.56E-03
>8-10 Aromatics	6.80E-04	4.98%	3.55E-01	1.52E-03		>8-10 Aromatics	6.80E-04	1.74E-01	3.24E-01	1.53E-03
>10-12 Aliphatics	4.43E-02	0.08%	1.05E-02	3.70E-02		>10-12 Aliphatics	4.43E-02	2.75E-04	7.50E-03	3.70E-02
>10-12 Aromatics	1.12E-02	51.95%	4.99E-02	2.50E-02		>10-12 Aromatics	1.12E-02	5.05E-01	3.56E-02	2.51E-02
>12-16 Aliphatics	3.16E-01	0.00%	9.75E-04	2.64E-01		>12-16 Aliphatics	3.16E-01	6.14E-06	6.96E-04	2.64E-01
>12-16 Aromatics	1.16E-01	32.80%	4.46E-03	2.50E-01		>12-16 Aromatics	1.16E-01	1.17E-01	3.19E-03	2.51E-01
>16-21 Aliphatics	3.56E-01	0.00%	2.96E-06	1.53E-02		>16-21 Aliphatics	3.56E-01	5.25E-10	2.12E-06	1.54E-02
>16-21 Aromatics	1.33E-01	3.85%	1.45E-04	3.61E-01		>16-21 Aromatics	1.33E-01	1.37E-02	1.04E-04	3.61E-01
>21-35 Aromatics	1.47E-02	0.05%	1.08E-07	3.88E-02		>21-35 Aromatics	1.47E-02	1.78E-04	7.70E-08	3.87E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		20,711	1,195,664	6,501		RBSL(HI=1) mg/kg		202,867	1,935,430	9,614

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	5.39E-04	0.02%	8.59E-02	8.54E-06		5-6 Aliphatics	5.39E-04	5.13E-04	9.17E-02	8.59E-06
5-7 Aromatics	5.39E-04	8.50%	3.61E-01	2.43E-04		5-7 Aromatics	5.39E-04	1.85E-01	3.85E-01	2.46E-04
>6-8 Aliphatics	1.08E-03	0.01%	3.93E-02	1.71E-05		>6-8 Aliphatics	1.08E-03	2.84E-04	2.80E-02	1.72E-05
>7-8 Aromatics	5.39E-04	3.18%	1.60E-01	2.43E-04		>7-8 Aromatics	5.39E-04	6.90E-02	1.71E-01	2.46E-04
>8-10 Aliphatics	1.33E-02	0.97%	8.38E-02	9.56E-03		>8-10 Aliphatics	1.33E-02	3.47E-03	5.98E-02	9.56E-03
>8-10 Aromatics	1.08E-03	4.87%	2.05E-01	2.08E-03		>8-10 Aromatics	1.08E-03	1.06E-01	2.18E-01	2.09E-03
>10-12 Aliphatics	6.00E-02	0.08%	1.05E-02	4.31E-02		>10-12 Aliphatics	6.00E-02	2.75E-04	7.50E-03	4.32E-02
>10-12 Aromatics	1.59E-02	45.67%	4.99E-02	3.07E-02		>10-12 Aromatics	1.59E-02	5.05E-01	3.56E-02	3.08E-02
>12-16 Aliphatics	2.62E-01	0.00%	9.75E-04	1.88E-01		>12-16 Aliphatics	2.62E-01	6.14E-06	6.96E-04	1.88E-01
>12-16 Aromatics	1.15E-01	32.80%	4.46E-03	2.14E-01		>12-16 Aromatics	1.15E-01	1.17E-01	3.19E-03	2.14E-01
>16-21 Aliphatics	3.14E-01	0.00%	2.96E-06	1.17E-02		>16-21 Aliphatics	3.14E-01	5.25E-10	2.12E-06	1.17E-02
>16-21 Aromatics	1.24E-01	3.85%	1.45E-04	2.91E-01		>16-21 Aromatics	1.24E-01	1.37E-02	1.04E-04	2.91E-01
>21-35 Aromatics	9.19E-02	0.05%	1.08E-07	2.09E-01		>21-35 Aromatics	9.19E-02	1.78E-04	7.70E-08	2.09E-01
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		12,781	434,688	5,597		RBSL(HI=1) mg/kg		77,745	649,084	8,280

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	6.03E-04	0.02%	8.48E-02	9.98E-06		5-6 Aliphatics	6.03E-04	5.04E-04	9.04E-02	1.00E-05
5-7 Aromatics	6.03E-04	8.90%	3.56E-01	2.84E-04		5-7 Aromatics	6.03E-04	1.82E-01	3.79E-01	2.88E-04
>6-8 Aliphatics	1.47E-03	0.02%	3.93E-02	2.44E-05		>6-8 Aliphatics	1.47E-03	3.41E-04	2.80E-02	2.45E-05
>7-8 Aromatics	6.03E-04	3.33%	1.58E-01	2.84E-04		>7-8 Aromatics	6.03E-04	6.79E-02	1.68E-01	2.88E-04
>8-10 Aliphatics	1.54E-02	0.97%	8.38E-02	1.16E-02		>8-10 Aliphatics	1.54E-02	3.47E-03	5.98E-02	1.16E-02
>8-10 Aromatics	1.27E-03	5.39%	2.13E-01	2.56E-03		>8-10 Aromatics	1.27E-03	1.10E-01	2.27E-01	2.57E-03
>10-12 Aliphatics	7.46E-02	0.08%	1.05E-02	5.60E-02		>10-12 Aliphatics	7.46E-02	2.75E-04	7.50E-03	5.60E-02
>10-12 Aromatics	1.66E-02	44.60%	4.99E-02	3.34E-02		>10-12 Aromatics	1.66E-02	5.05E-01	3.56E-02	3.36E-02
>12-16 Aliphatics	2.85E-01	0.00%	9.75E-04	2.14E-01		>12-16 Aliphatics	2.85E-01	6.14E-06	6.96E-04	2.14E-01
>12-16 Aromatics	1.11E-01	32.80%	4.46E-03	2.16E-01		>12-16 Aromatics	1.11E-01	1.17E-01	3.19E-03	2.16E-01
>16-21 Aliphatics	3.05E-01	0.00%	2.96E-06	1.18E-02		>16-21 Aliphatics	3.05E-01	5.25E-10	2.12E-06	1.18E-02
>16-21 Aromatics	1.16E-01	3.85%	1.45E-04	2.85E-01		>16-21 Aromatics	1.16E-01	1.37E-02	1.04E-04	2.85E-01
>21-35 Aromatics	7.11E-02	0.05%	1.08E-07	1.69E-01		>21-35 Aromatics	7.11E-02	1.78E-04	7.70E-08	1.69E-01
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		11,967	383,217	5,844		RBSL(HI=1) mg/kg		68,372	572,225	8,645

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	5.40E-04	0.02%	5.71E-02	9.14E-06		5-6 Aliphatics	5.40E-04	3.23E-04	7.66E-02	9.19E-06
5-7 Aromatics	5.40E-04	7.17%	2.40E-01	2.60E-04		5-7 Aromatics	5.40E-04	1.16E-01	3.21E-01	2.63E-04
>6-8 Aliphatics	2.64E-03	0.03%	3.93E-02	4.47E-05		>6-8 Aliphatics	2.64E-03	4.37E-04	2.80E-02	4.49E-05
>7-8 Aromatics	5.40E-04	2.68%	1.06E-01	2.60E-04		>7-8 Aromatics	5.40E-04	4.35E-02	1.43E-01	2.63E-04
>8-10 Aliphatics	2.05E-02	0.97%	8.38E-02	1.58E-02		>8-10 Aliphatics	2.05E-02	3.47E-03	5.98E-02	1.58E-02
>8-10 Aromatics	3.24E-03	12.34%	4.08E-01	6.67E-03		>8-10 Aromatics	3.24E-03	2.00E-01	3.24E-01	6.69E-03
>10-12 Aliphatics	8.39E-02	0.08%	1.05E-02	6.44E-02		>10-12 Aliphatics	8.39E-02	2.75E-04	7.50E-03	6.44E-02
>10-12 Aromatics	1.66E-02	40.01%	4.99E-02	3.41E-02		>10-12 Aromatics	1.66E-02	5.05E-01	3.56E-02	3.42E-02
>12-16 Aliphatics	3.02E-01	0.00%	9.75E-04	2.32E-01		>12-16 Aliphatics	3.02E-01	6.14E-06	6.96E-04	2.32E-01
>12-16 Aromatics	1.08E-01	32.80%	4.46E-03	2.16E-01		>12-16 Aromatics	1.08E-01	1.17E-01	3.19E-03	2.16E-01
>16-21 Aliphatics	2.92E-01	0.00%	2.96E-06	1.16E-02		>16-21 Aliphatics	2.92E-01	5.25E-10	2.12E-06	1.16E-02
>16-21 Aromatics	1.20E-01	3.85%	1.45E-04	3.01E-01		>16-21 Aromatics	1.20E-01	1.37E-02	1.04E-04	3.01E-01
>21-35 Aromatics	4.84E-02	0.05%	1.08E-07	1.18E-01		>21-35 Aromatics	4.84E-02	1.78E-04	7.70E-08	1.17E-01
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		10,769	288,328	5,976		RBSL(HI=1) mg/kg		48,838	541,560	8,839

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	1.82E-03	0.05%	8.82E-02	3.24E-05		5-6 Aliphatics	1.82E-03	7.33E-04	9.40E-02	3.25E-05
5-7 Aromatics	1.82E-03	19.06%	3.70E-01	9.22E-04		5-7 Aromatics	1.82E-03	2.64E-01	3.94E-01	9.32E-04
>6-8 Aliphatics	4.36E-03	0.04%	3.93E-02	7.77E-05		>6-8 Aliphatics	4.36E-03	4.87E-04	2.80E-02	7.81E-05
>7-8 Aromatics	1.82E-03	7.13%	1.64E-01	9.22E-04		>7-8 Aromatics	1.82E-03	9.87E-02	1.75E-01	9.32E-04
>8-10 Aliphatics	1.31E-02	0.77%	8.38E-02	1.06E-02		>8-10 Aliphatics	1.31E-02	3.47E-03	5.98E-02	1.06E-02
>8-10 Aromatics	3.27E-03	9.84%	1.89E-01	7.08E-03		>8-10 Aromatics	3.27E-03	1.36E-01	2.01E-01	7.11E-03
>10-12 Aliphatics	4.72E-02	0.08%	1.05E-02	3.82E-02		>10-12 Aliphatics	4.72E-02	2.75E-04	7.50E-03	3.82E-02
>10-12 Aromatics	1.38E-02	26.35%	4.99E-02	2.99E-02		>10-12 Aromatics	1.38E-02	3.65E-01	3.56E-02	3.00E-02
>12-16 Aliphatics	3.10E-01	0.00%	9.75E-04	2.51E-01		>12-16 Aliphatics	3.10E-01	6.14E-06	6.96E-04	2.51E-01
>12-16 Aromatics	1.19E-01	32.80%	4.46E-03	2.49E-01		>12-16 Aromatics	1.19E-01	1.17E-01	3.19E-03	2.50E-01
>16-21 Aliphatics	3.32E-01	0.00%	2.96E-06	1.39E-02		>16-21 Aliphatics	3.32E-01	5.25E-10	2.12E-06	1.39E-02
>16-21 Aromatics	1.31E-01	3.85%	1.45E-04	3.44E-01		>16-21 Aromatics	1.31E-01	1.37E-02	1.04E-04	3.44E-01
>21-35 Aromatics	2.11E-02	0.05%	1.08E-07	5.40E-02		>21-35 Aromatics	2.11E-02	1.78E-04	7.70E-08	5.38E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		8,512	132,380	6,294		RBSL(HI=1) mg/kg		33,013	197,671	9,307

		RESIDENTIAL SCENARIO						COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	2.32E-03	0.06%	9.83E-02	4.07E-05		5-6 Aliphatics	2.32E-03	8.23E-04	1.05E-01	4.09E-05
5-7 Aromatics	2.32E-03	21.41%	4.13E-01	1.16E-03		5-7 Aromatics	2.32E-03	2.96E-01	4.40E-01	1.17E-03
>6-8 Aliphatics	1.18E-02	0.08%	3.93E-02	2.08E-04		>6-8 Aliphatics	1.18E-02	8.73E-04	2.80E-02	2.09E-04
>7-8 Aromatics	2.32E-03	8.01%	1.83E-01	1.16E-03		>7-8 Aromatics	2.32E-03	1.11E-01	1.95E-01	1.17E-03
>8-10 Aliphatics	1.34E-02	0.69%	8.38E-02	1.07E-02		>8-10 Aliphatics	1.34E-02	3.47E-03	5.98E-02	1.07E-02
>8-10 Aromatics	2.32E-03	6.14%	1.17E-01	4.95E-03		>8-10 Aromatics	2.32E-03	8.50E-02	1.25E-01	4.96E-03
>10-12 Aliphatics	4.79E-02	0.08%	1.05E-02	3.82E-02		>10-12 Aliphatics	4.79E-02	2.75E-04	7.50E-03	3.82E-02
>10-12 Aromatics	1.60E-02	26.83%	4.99E-02	3.41E-02		>10-12 Aromatics	1.60E-02	3.71E-01	3.56E-02	3.42E-02
>12-16 Aliphatics	3.04E-01	0.00%	9.75E-04	2.42E-01		>12-16 Aliphatics	3.04E-01	6.14E-06	6.96E-04	2.42E-01
>12-16 Aromatics	1.27E-01	32.80%	4.46E-03	2.61E-01		>12-16 Aromatics	1.27E-01	1.17E-01	3.19E-03	2.62E-01
>16-21 Aliphatics	3.19E-01	0.00%	2.96E-06	1.31E-02		>16-21 Aliphatics	3.19E-01	5.25E-10	2.12E-06	1.32E-02
>16-21 Aromatics	1.37E-01	3.85%	1.45E-04	3.56E-01		>16-21 Aromatics	1.37E-01	1.37E-02	1.04E-04	3.55E-01
>21-35 Aromatics	1.47E-02	0.05%	1.08E-07	3.71E-02		>21-35 Aromatics	1.47E-02	1.78E-04	7.70E-08	3.70E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		7,496	115,757	6,205		RBSL(HI=1) mg/kg		29,049	172,850	9,175

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	2.73E+03	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	3.82E+03	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	6.50E+02	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	9.10E+02	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	6.56E+03	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	9.18E+03	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	1.46E+03	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	2.05E+03	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	1.69E+03	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	2.36E+03	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	2.29E+03	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	3.21E+03	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	8.20E+03	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	1.15E+04	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	1.26E+04	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	1.77E+04	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	3.91E+04	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	5.48E+04	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	6.52E+04	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	9.13E+04	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	4.39E+06	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	6.14E+06	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	5.56E+05	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	7.78E+05	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	7.71E+07	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	1.08E+08	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	4.70E-04	0.03%	8.46E-02	8.74E-06		5-6 Aliphatics	4.70E-04	5.03E-04	9.02E-02	8.79E-06
5-7 Aromatics	4.70E-04	10.97%	3.55E-01	2.49E-04		5-7 Aromatics	4.70E-04	1.81E-01	3.79E-01	2.52E-04
>6-8 Aliphatics	2.59E-03	0.05%	3.93E-02	4.81E-05		>6-8 Aliphatics	2.59E-03	7.66E-04	2.80E-02	4.83E-05
>7-8 Aromatics	4.70E-04	4.10%	1.57E-01	2.49E-04		>7-8 Aromatics	4.70E-04	6.77E-02	1.68E-01	2.52E-04
>8-10 Aliphatics	8.94E-03	0.97%	8.38E-02	7.54E-03		>8-10 Aliphatics	8.94E-03	3.47E-03	5.98E-02	7.54E-03
>8-10 Aromatics	9.99E-04	6.68%	2.14E-01	2.26E-03		>8-10 Aromatics	9.99E-04	1.10E-01	2.28E-01	2.27E-03
>10-12 Aliphatics	3.81E-02	0.08%	1.05E-02	3.21E-02		>10-12 Aliphatics	3.81E-02	2.75E-04	7.50E-03	3.21E-02
>10-12 Aromatics	9.52E-03	40.41%	4.99E-02	2.15E-02		>10-12 Aromatics	9.52E-03	5.05E-01	3.56E-02	2.16E-02
>12-16 Aliphatics	3.18E-01	0.00%	9.75E-04	2.68E-01		>12-16 Aliphatics	3.18E-01	6.14E-06	6.96E-04	2.68E-01
>12-16 Aromatics	1.11E-01	32.80%	4.46E-03	2.43E-01		>12-16 Aromatics	1.11E-01	1.17E-01	3.19E-03	2.44E-01
>16-21 Aliphatics	3.60E-01	0.00%	2.96E-06	1.57E-02		>16-21 Aliphatics	3.60E-01	5.25E-10	2.12E-06	1.57E-02
>16-21 Aromatics	1.37E-01	3.85%	1.45E-04	3.75E-01		>16-21 Aromatics	1.37E-01	1.37E-02	1.04E-04	3.75E-01
>21-35 Aromatics	1.26E-02	0.05%	1.08E-07	3.36E-02		>21-35 Aromatics	1.26E-02	1.78E-04	7.70E-08	3.36E-02
Total	1.00E+00					Total	1.00E+00			
		RBSL.R.11	RBSL.R.16	RBSL.R.18				RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v out	ss				s lch	s v out	ss
		(mg/kg)	(mg/kg)	(mg/kg)				(mg/kg)	(mg/kg)	(mg/kg)
HI		1.00E+00	1.00E+00	1.00E+00		HI		1.00E+00	1.00E+00	1.00E+00
RBSL(HI=1) mg/kg		18,915	490,372	6,564		RBSL(HI=1) mg/kg		87,363	732,229	9,707

Appendix D-2

Model Runs Modified to Include Indoor Air Pathway

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	2.29E-04	8.91E-05	6.46E-03	3.31E-06		5-6 Aliphatics	2.29E-04	1.19E-04	6.70E-03	3.34E-06
5-7 Aromatics	2.29E-04	3.21E-02	2.71E-02	9.44E-05		5-7 Aromatics	2.29E-04	4.30E-02	2.81E-02	9.56E-05
>6-8 Aliphatics	2.29E-04	2.47E-05	2.69E-03	3.31E-06		>6-8 Aliphatics	2.29E-04	3.31E-05	2.78E-03	3.34E-06
>7-8 Aromatics	2.29E-04	1.20E-02	1.20E-02	9.44E-05		>7-8 Aromatics	2.29E-04	1.61E-02	1.25E-02	9.56E-05
>8-10 Aliphatics	9.16E-03	7.16E-03	4.17E-01	6.01E-03		>8-10 Aliphatics	9.16E-03	3.47E-03	4.33E-01	6.02E-03
>8-10 Aromatics	9.16E-03	3.68E-01	3.08E-01	1.61E-02		>8-10 Aromatics	9.16E-03	4.93E-01	3.19E-01	1.62E-02
>10-12 Aliphatics	9.16E-03	7.69E-04	8.60E-02	6.01E-03		>10-12 Aliphatics	9.16E-03	2.75E-04	8.91E-02	6.02E-03
>10-12 Aromatics	9.16E-03	2.33E-01	5.58E-02	1.61E-02		>10-12 Aromatics	9.16E-03	3.13E-01	5.78E-02	1.62E-02
>12-16 Aliphatics	1.37E-01	1.72E-05	4.90E-02	9.02E-02		>12-16 Aliphatics	1.37E-01	6.14E-06	1.89E-02	9.03E-02
>12-16 Aromatics	2.40E-02	3.08E-01	2.84E-02	4.09E-02		>12-16 Aromatics	2.40E-02	1.17E-01	2.94E-02	4.10E-02
>16-21 Aliphatics	4.19E-01	1.47E-09	1.49E-04	1.42E-02		>16-21 Aliphatics	4.19E-01	5.25E-10	5.75E-05	1.42E-02
>16-21 Aromatics	2.43E-01	3.85E-02	7.30E-03	5.19E-01		>16-21 Aromatics	2.43E-01	1.37E-02	2.82E-03	5.19E-01
>21-35 Aromatics	1.40E-01	4.98E-04	5.41E-06	2.91E-01		>21-35 Aromatics	1.40E-01	1.78E-04	2.09E-06	2.90E-01
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		11,363	**1,533**	5,113		RBSL(HI=1) mg/kg		42,651	**4,111**	7,571

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	6.33E-04	8.91E-05	6.50E-03	1.16E-05		5-6 Aliphatics	6.33E-04	1.19E-04	6.70E-03	1.17E-05
5-7 Aromatics	6.33E-04	3.21E-02	2.73E-02	3.31E-04		5-7 Aromatics	6.33E-04	4.30E-02	2.81E-02	3.35E-04
>6-8 Aliphatics	6.33E-04	2.47E-05	2.70E-03	1.16E-05		>6-8 Aliphatics	6.33E-04	3.31E-05	2.78E-03	1.17E-05
>7-8 Aromatics	6.33E-04	1.20E-02	1.21E-02	3.31E-04		>7-8 Aromatics	6.33E-04	1.61E-02	1.25E-02	3.35E-04
>8-10 Aliphatics	2.53E-02	7.16E-03	4.20E-01	2.11E-02		>8-10 Aliphatics	2.53E-02	3.47E-03	4.33E-01	2.11E-02
>8-10 Aromatics	2.53E-02	3.68E-01	3.09E-01	5.65E-02		>8-10 Aromatics	2.53E-02	4.93E-01	3.19E-01	5.67E-02
>10-12 Aliphatics	2.53E-02	7.69E-04	8.64E-02	2.11E-02		>10-12 Aliphatics	2.53E-02	2.75E-04	8.91E-02	2.11E-02
>10-12 Aromatics	2.53E-02	2.33E-01	5.61E-02	5.65E-02		>10-12 Aromatics	2.53E-02	3.13E-01	5.78E-02	5.67E-02
>12-16 Aliphatics	6.65E-02	1.72E-05	4.75E-02	5.53E-02		>12-16 Aliphatics	6.65E-02	6.14E-06	1.89E-02	5.54E-02
>12-16 Aromatics	6.65E-02	3.08E-01	2.85E-02	1.43E-01		>12-16 Aromatics	6.65E-02	1.17E-01	2.94E-02	1.44E-01
>16-21 Aliphatics	5.29E-01	1.47E-09	1.49E-04	2.27E-02		>16-21 Aliphatics	5.29E-01	5.25E-10	5.75E-05	2.28E-02
>16-21 Aromatics	6.65E-02	3.85E-02	3.35E-03	1.80E-01		>16-21 Aromatics	6.65E-02	1.37E-02	2.82E-03	1.80E-01
>21-35 Aromatics	1.68E-01	4.98E-04	5.41E-06	4.43E-01		>21-35 Aromatics	1.68E-01	1.78E-04	2.09E-06	4.42E-01
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		4,107	**557**	6,475		RBSL(HI=1) mg/kg		15,414	**1,486**	9,583

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	2.49E-04	8.91E-05	6.46E-03	4.47E-06		5-6 Aliphatics	2.49E-04	1.19E-04	6.70E-03	4.50E-06
5-7 Aromatics	2.49E-04	3.21E-02	2.71E-02	1.27E-04		5-7 Aromatics	2.49E-04	4.30E-02	2.81E-02	1.29E-04
>6-8 Aliphatics	2.49E-04	2.47E-05	2.69E-03	4.47E-06		>6-8 Aliphatics	2.49E-04	3.31E-05	2.78E-03	4.50E-06
>7-8 Aromatics	2.49E-04	1.20E-02	1.20E-02	1.27E-04		>7-8 Aromatics	2.49E-04	1.61E-02	1.25E-02	1.29E-04
>8-10 Aliphatics	9.95E-03	7.16E-03	4.17E-01	8.11E-03		>8-10 Aliphatics	9.95E-03	3.47E-03	4.33E-01	8.12E-03
>8-10 Aromatics	9.95E-03	3.68E-01	3.08E-01	2.17E-02		>8-10 Aromatics	9.95E-03	4.93E-01	3.19E-01	2.18E-02
>10-12 Aliphatics	9.95E-03	7.69E-04	8.60E-02	8.11E-03		>10-12 Aliphatics	9.95E-03	2.75E-04	8.91E-02	8.12E-03
>10-12 Aromatics	9.95E-03	2.33E-01	5.58E-02	2.17E-02		>10-12 Aromatics	9.95E-03	3.13E-01	5.78E-02	2.18E-02
>12-16 Aliphatics	1.74E-01	1.72E-05	4.90E-02	1.42E-01		>12-16 Aliphatics	1.74E-01	6.14E-06	1.89E-02	1.42E-01
>12-16 Aromatics	2.61E-02	3.08E-01	2.84E-02	5.51E-02		>12-16 Aromatics	2.61E-02	1.17E-01	2.94E-02	5.53E-02
>16-21 Aliphatics	4.85E-01	1.47E-09	1.49E-04	2.04E-02		>16-21 Aliphatics	4.85E-01	5.25E-10	5.75E-05	2.05E-02
>16-21 Aromatics	2.09E-01	3.85E-02	7.30E-03	5.55E-01		>16-21 Aromatics	2.09E-01	1.37E-02	2.82E-03	5.55E-01
>21-35 Aromatics	6.47E-02	4.98E-04	5.41E-06	1.67E-01		>21-35 Aromatics	6.47E-02	1.78E-04	2.09E-06	1.67E-01
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		10,453	**1,410**	6,345		RBSL(HI=1) mg/kg		39,234	**3,782**	9,392

Sample No. 380SB-02B-32

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	8.33E-04	5.36E-04	2.87E-02	2.34E-05		5-6 Aliphatics	8.33E-04	7.39E-04	3.71E-02	2.35E-05
5-7 Aromatics	8.33E-04	1.93E-01	1.20E-01	6.66E-04		5-7 Aromatics	8.33E-04	2.66E-01	1.55E-01	6.73E-04
>6-8 Aliphatics	8.33E-04	1.49E-04	1.19E-02	2.34E-05		>6-8 Aliphatics	8.33E-04	2.05E-04	1.54E-02	2.35E-05
>7-8 Aromatics	8.33E-04	7.22E-02	5.34E-02	6.66E-04		>7-8 Aromatics	8.33E-04	9.95E-02	6.90E-02	6.73E-04
>8-10 Aliphatics	3.33E-03	4.31E-03	1.85E-01	4.24E-03		>8-10 Aliphatics	3.33E-03	3.47E-03	2.39E-01	4.24E-03
>8-10 Aromatics	3.33E-03	2.21E-01	1.37E-01	1.14E-02		>8-10 Aromatics	3.33E-03	3.05E-01	1.76E-01	1.14E-02
>10-12 Aliphatics	3.00E-02	7.69E-04	3.44E-01	3.82E-02		>10-12 Aliphatics	3.00E-02	2.75E-04	2.04E-01	3.82E-02
>10-12 Aromatics	3.33E-03	1.40E-01	2.48E-02	1.14E-02		>10-12 Aromatics	3.33E-03	1.94E-01	3.20E-02	1.14E-02
>12-16 Aliphatics	3.73E-01	1.72E-05	4.90E-02	4.75E-01		>12-16 Aliphatics	3.73E-01	6.14E-06	1.89E-02	4.75E-01
>12-16 Aromatics	2.66E-02	3.28E-01	3.84E-02	8.78E-02		>12-16 Aromatics	2.66E-02	1.17E-01	4.96E-02	8.80E-02
>16-21 Aliphatics	4.75E-01	1.47E-09	1.49E-04	3.12E-02		>16-21 Aliphatics	4.75E-01	5.25E-10	5.75E-05	3.12E-02
>16-21 Aromatics	6.08E-02	3.85E-02	7.30E-03	2.52E-01		>16-21 Aromatics	6.08E-02	1.37E-02	2.82E-03	2.52E-01
>21-35 Aromatics	2.16E-02	4.98E-04	5.41E-06	8.74E-02		>21-35 Aromatics	2.16E-02	1.78E-04	2.09E-06	8.72E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		18,803	**1,872**	9,909		RBSL(HI=1) mg/kg		72,541	**6,252**	14,658

Sample No. 380SB-02B-33

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	7.43E-04	4.00E-04	3.06E-02	2.22E-05		5-6 Aliphatics	7.43E-04	5.51E-04	3.18E-02	2.23E-05
5-7 Aromatics	1.57E-03	3.04E-01	2.71E-01	1.33E-03		5-7 Aromatics	1.57E-03	4.19E-01	2.81E-01	1.35E-03
>6-8 Aliphatics	7.43E-04	1.11E-04	1.27E-02	2.22E-05		>6-8 Aliphatics	7.43E-04	1.53E-04	1.32E-02	2.23E-05
>7-8 Aromatics	7.43E-04	5.39E-02	5.70E-02	6.32E-04		>7-8 Aromatics	7.43E-04	7.42E-02	5.91E-02	6.39E-04
>8-10 Aliphatics	2.97E-03	3.22E-03	1.98E-01	4.03E-03		>8-10 Aliphatics	2.97E-03	3.47E-03	2.05E-01	4.03E-03
>8-10 Aromatics	2.97E-03	1.65E-01	1.46E-01	1.08E-02		>8-10 Aromatics	2.97E-03	2.27E-01	1.51E-01	1.08E-02
>10-12 Aliphatics	1.19E-02	7.69E-04	1.63E-01	1.61E-02		>10-12 Aliphatics	1.19E-02	2.75E-04	1.69E-01	1.61E-02
>10-12 Aromatics	2.97E-03	1.05E-01	2.65E-02	1.08E-02		>10-12 Aromatics	2.97E-03	1.44E-01	2.74E-02	1.08E-02
>12-16 Aliphatics	3.63E-01	1.72E-05	4.90E-02	4.92E-01		>12-16 Aliphatics	3.63E-01	6.14E-06	1.89E-02	4.92E-01
>12-16 Aromatics	2.23E-02	3.28E-01	3.84E-02	7.82E-02		>12-16 Aromatics	2.23E-02	1.17E-01	3.98E-02	7.83E-02
>16-21 Aliphatics	5.10E-01	1.47E-09	1.49E-04	3.56E-02		>16-21 Aliphatics	5.10E-01	5.25E-10	5.75E-05	3.57E-02
>16-21 Aromatics	6.02E-02	3.85E-02	7.30E-03	2.66E-01		>16-21 Aromatics	6.02E-02	1.37E-02	2.82E-03	2.65E-01
>21-35 Aromatics	1.97E-02	4.98E-04	5.41E-06	8.46E-02		>21-35 Aromatics	1.97E-02	1.78E-04	2.09E-06	8.44E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		15,730	**2,239**	10,542		RBSL(HI=1) mg/kg		60,578	**6,004**	15,594

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	1.16E-04	6.34E-05	1.83E-03	1.94E-06		5-6 Aliphatics	1.16E-04	2.36E-04	2.69E-03	1.95E-06
5-7 Aromatics	1.16E-04	2.28E-02	7.67E-03	5.53E-05		5-7 Aromatics	1.16E-04	8.49E-02	1.13E-02	5.59E-05
>6-8 Aliphatics	2.58E-04	3.90E-05	1.69E-03	4.32E-06		>6-8 Aliphatics	2.58E-04	1.45E-04	2.49E-03	4.34E-06
>7-8 Aromatics	1.16E-04	8.53E-03	3.40E-03	5.53E-05		>7-8 Aromatics	1.16E-04	3.17E-02	5.01E-03	5.59E-05
>8-10 Aliphatics	1.50E-02	9.73E-03	3.81E-01	1.14E-02		>8-10 Aliphatics	1.50E-02	3.47E-03	5.61E-01	1.14E-02
>8-10 Aromatics	1.16E-03	6.54E-02	2.18E-02	2.36E-03		>8-10 Aromatics	1.16E-03	2.43E-01	3.21E-02	2.37E-03
>10-12 Aliphatics	7.71E-02	7.69E-04	4.04E-01	5.85E-02		>10-12 Aliphatics	7.71E-02	2.75E-04	2.04E-01	5.85E-02
>10-12 Aromatics	1.47E-02	5.26E-01	5.00E-02	2.99E-02		>10-12 Aromatics	1.47E-02	5.05E-01	7.36E-02	3.00E-02
>12-16 Aliphatics	2.94E-01	1.72E-05	4.90E-02	2.24E-01		>12-16 Aliphatics	2.94E-01	6.14E-06	1.89E-02	2.24E-01
>12-16 Aromatics	1.11E-01	3.28E-01	7.29E-02	2.17E-01		>12-16 Aromatics	1.11E-01	1.17E-01	8.67E-02	2.18E-01
>16-21 Aliphatics	3.06E-01	1.47E-09	1.49E-04	1.20E-02		>16-21 Aliphatics	3.06E-01	5.25E-10	5.75E-05	1.20E-02
>16-21 Aromatics	1.47E-01	3.85E-02	7.30E-03	3.63E-01		>16-21 Aromatics	1.47E-01	1.37E-02	2.82E-03	3.63E-01
>21-35 Aromatics	3.40E-02	4.98E-04	5.41E-06	8.19E-02		>21-35 Aromatics	3.40E-02	1.78E-04	2.09E-06	8.17E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		15,946	**855**	5,910		RBSL(HI=1) mg/kg		166,046	**3,261**	8,741

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	6.18E-04	2.39E-04	8.84E-03	1.00E-05		5-6 Aliphatics	6.18E-04	3.36E-04	1.05E-02	1.01E-05
5-7 Aromatics	6.18E-04	8.63E-02	3.71E-02	2.85E-04		5-7 Aromatics	6.18E-04	1.21E-01	4.39E-02	2.88E-04
>6-8 Aliphatics	3.43E-03	3.69E-04	2.04E-02	5.56E-05		>6-8 Aliphatics	3.43E-03	5.18E-04	2.42E-02	5.59E-05
>7-8 Aromatics	6.18E-04	3.23E-02	1.65E-02	2.85E-04		>7-8 Aromatics	6.18E-04	4.53E-02	1.95E-02	2.88E-04
>8-10 Aliphatics	1.73E-02	9.73E-03	4.00E-01	1.27E-02		>8-10 Aliphatics	1.73E-02	3.47E-03	4.73E-01	1.27E-02
>8-10 Aromatics	3.43E-03	1.37E-01	5.85E-02	6.75E-03		>8-10 Aromatics	3.43E-03	1.93E-01	6.92E-02	6.78E-03
>10-12 Aliphatics	6.08E-02	7.69E-04	2.89E-01	4.47E-02		>10-12 Aliphatics	6.08E-02	2.75E-04	2.04E-01	4.47E-02
>10-12 Aromatics	1.44E-02	3.66E-01	4.45E-02	2.84E-02		>10-12 Aromatics	1.44E-02	5.05E-01	5.27E-02	2.85E-02
>12-16 Aliphatics	2.81E-01	1.72E-05	4.90E-02	2.06E-01		>12-16 Aliphatics	2.81E-01	6.14E-06	1.89E-02	2.06E-01
>12-16 Aromatics	1.15E-01	3.28E-01	6.88E-02	2.19E-01		>12-16 Aromatics	1.15E-01	1.17E-01	8.15E-02	2.19E-01
>16-21 Aliphatics	3.05E-01	1.47E-09	1.49E-04	1.16E-02		>16-21 Aliphatics	3.05E-01	5.25E-10	5.75E-05	1.16E-02
>16-21 Aromatics	1.59E-01	3.85E-02	7.30E-03	3.81E-01		>16-21 Aromatics	1.59E-01	1.37E-02	2.82E-03	3.80E-01
>21-35 Aromatics	3.84E-02	4.98E-04	5.41E-06	8.95E-02		>21-35 Aromatics	3.84E-02	1.78E-04	2.09E-06	8.93E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		11,320	**777**	5,718		RBSL(HI=1) mg/kg		44,517	**2,379**	8,457

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	8.70E-04	3.19E-04	1.30E-02	1.58E-05		5-6 Aliphatics	8.70E-04	4.44E-04	1.49E-02	1.59E-05
5-7 Aromatics	8.70E-04	1.15E-01	5.45E-02	4.49E-04		5-7 Aromatics	8.70E-04	1.60E-01	6.25E-02	4.54E-04
>6-8 Aliphatics	8.70E-04	8.85E-05	5.40E-03	1.58E-05		>6-8 Aliphatics	8.70E-04	1.23E-04	6.19E-03	1.59E-05
>7-8 Aromatics	8.70E-04	4.30E-02	2.42E-02	4.49E-04		>7-8 Aromatics	8.70E-04	5.98E-02	2.77E-02	4.54E-04
>8-10 Aliphatics	1.66E-02	9.73E-03	4.01E-01	1.37E-02		>8-10 Aliphatics	1.66E-02	3.47E-03	4.60E-01	1.37E-02
>8-10 Aromatics	3.29E-03	1.25E-01	5.84E-02	7.24E-03		>8-10 Aromatics	3.29E-03	1.73E-01	6.70E-02	7.27E-03
>10-12 Aliphatics	5.39E-02	7.69E-04	2.68E-01	4.44E-02		>10-12 Aliphatics	5.39E-02	2.75E-04	2.04E-01	4.44E-02
>10-12 Aromatics	1.41E-02	3.39E-01	4.55E-02	3.11E-02		>10-12 Aromatics	1.41E-02	4.72E-01	5.21E-02	3.12E-02
>12-16 Aliphatics	3.06E-01	1.72E-05	4.90E-02	2.52E-01		>12-16 Aliphatics	3.06E-01	6.14E-06	1.89E-02	2.52E-01
>12-16 Aromatics	1.18E-01	3.28E-01	7.35E-02	2.51E-01		>12-16 Aromatics	1.18E-01	1.17E-01	8.43E-02	2.51E-01
>16-21 Aliphatics	3.40E-01	1.47E-09	1.49E-04	1.45E-02		>16-21 Aliphatics	3.40E-01	5.25E-10	5.75E-05	1.45E-02
>16-21 Aromatics	1.31E-01	3.85E-02	7.30E-03	3.51E-01		>16-21 Aromatics	1.31E-01	1.37E-02	2.82E-03	3.50E-01
>21-35 Aromatics	1.33E-02	4.98E-04	5.41E-06	3.48E-02		>21-35 Aromatics	1.33E-02	1.78E-04	2.09E-06	3.47E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		10,727	**811**	6,405		RBSL(HI=1) mg/kg		41,743	**2,406**	9,470

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	1.51E-04	1.07E-04	3.90E-03	2.78E-06		5-6 Aliphatics	1.51E-04	3.75E-04	6.10E-03	2.80E-06
5-7 Aromatics	1.51E-04	3.86E-02	1.63E-02	7.92E-05		5-7 Aromatics	1.51E-04	1.35E-01	2.56E-02	8.02E-05
>6-8 Aliphatics	1.51E-04	2.97E-05	1.62E-03	2.78E-06		>6-8 Aliphatics	1.51E-04	1.04E-04	2.53E-03	2.80E-06
>7-8 Aromatics	1.51E-04	1.44E-02	7.25E-03	7.92E-05		>7-8 Aromatics	1.51E-04	5.05E-02	1.14E-02	8.02E-05
>8-10 Aliphatics	7.86E-03	9.73E-03	3.27E-01	6.56E-03		>8-10 Aliphatics	7.86E-03	3.47E-03	5.12E-01	6.56E-03
>8-10 Aromatics	6.80E-04	4.98E-02	2.09E-02	1.52E-03		>8-10 Aromatics	6.80E-04	1.74E-01	3.27E-02	1.53E-03
>10-12 Aliphatics	4.43E-02	7.69E-04	3.80E-01	3.70E-02		>10-12 Aliphatics	4.43E-02	2.75E-04	2.04E-01	3.70E-02
>10-12 Aromatics	1.12E-02	5.20E-01	6.22E-02	2.50E-02		>10-12 Aromatics	1.12E-02	5.05E-01	9.74E-02	2.51E-02
>12-16 Aliphatics	3.16E-01	1.72E-05	4.90E-02	2.64E-01		>12-16 Aliphatics	3.16E-01	6.14E-06	1.89E-02	2.64E-01
>12-16 Aromatics	1.16E-01	3.28E-01	1.25E-01	2.50E-01		>12-16 Aromatics	1.16E-01	1.17E-01	8.67E-02	2.51E-01
>16-21 Aliphatics	3.56E-01	1.47E-09	1.49E-04	1.53E-02		>16-21 Aliphatics	3.56E-01	5.25E-10	5.75E-05	1.54E-02
>16-21 Aromatics	1.33E-01	3.85E-02	7.30E-03	3.61E-01		>16-21 Aromatics	1.33E-01	1.37E-02	2.82E-03	3.61E-01
>21-35 Aromatics	1.47E-02	4.98E-04	5.41E-06	3.88E-02		>21-35 Aromatics	1.47E-02	1.78E-04	2.09E-06	3.87E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		20,711	**1,400**	6,501		RBSL(HI=1) mg/kg		202,867	**5,669**	9,614

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	5.39E-04	2.36E-04	9.22E-03	8.54E-06		5-6 Aliphatics	5.39E-04	5.13E-04	1.22E-02	8.59E-06
5-7 Aromatics	5.39E-04	8.50E-02	3.87E-02	2.43E-04		5-7 Aromatics	5.39E-04	1.85E-01	5.11E-02	2.46E-04
>6-8 Aliphatics	1.08E-03	1.31E-04	7.66E-03	1.71E-05		>6-8 Aliphatics	1.08E-03	2.84E-04	1.01E-02	1.72E-05
>7-8 Aromatics	5.39E-04	3.18E-02	1.72E-02	2.43E-04		>7-8 Aromatics	5.39E-04	6.90E-02	2.27E-02	2.46E-04
>8-10 Aliphatics	1.33E-02	9.73E-03	3.67E-01	9.56E-03		>8-10 Aliphatics	1.33E-02	3.47E-03	4.85E-01	9.56E-03
>8-10 Aromatics	1.08E-03	4.87E-02	2.19E-02	2.08E-03		>8-10 Aromatics	1.08E-03	1.06E-01	2.90E-02	2.09E-03
>10-12 Aliphatics	6.00E-02	7.69E-04	3.41E-01	4.31E-02		>10-12 Aliphatics	6.00E-02	2.75E-04	2.04E-01	4.32E-02
>10-12 Aromatics	1.59E-02	4.57E-01	5.88E-02	3.07E-02		>10-12 Aromatics	1.59E-02	5.05E-01	7.77E-02	3.08E-02
>12-16 Aliphatics	2.62E-01	1.72E-05	4.90E-02	1.88E-01		>12-16 Aliphatics	2.62E-01	6.14E-06	1.89E-02	1.88E-01
>12-16 Aromatics	1.15E-01	3.28E-01	8.20E-02	2.14E-01		>12-16 Aromatics	1.15E-01	1.17E-01	8.67E-02	2.14E-01
>16-21 Aliphatics	3.14E-01	1.47E-09	1.49E-04	1.17E-02		>16-21 Aliphatics	3.14E-01	5.25E-10	5.75E-05	1.17E-02
>16-21 Aromatics	1.24E-01	3.85E-02	7.30E-03	2.91E-01		>16-21 Aromatics	1.24E-01	1.37E-02	2.82E-03	2.91E-01
>21-35 Aromatics	9.19E-02	4.98E-04	5.41E-06	2.09E-01		>21-35 Aromatics	9.19E-02	1.78E-04	2.09E-06	2.09E-01
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		12,781	**928**	5,597		RBSL(HI=1) mg/kg		77,745	**3,174**	8,280

	RESIDENTIAL SCENARIO			
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18
		s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	6.03E-04	2.47E-04	8.85E-03	9.98E-06
5-7 Aromatics	6.03E-04	8.90E-02	3.71E-02	2.84E-04
>6-8 Aliphatics	1.47E-03	1.67E-04	8.99E-03	2.44E-05
>7-8 Aromatics	6.03E-04	3.33E-02	1.65E-02	2.84E-04
>8-10 Aliphatics	1.54E-02	9.73E-03	3.65E-01	1.16E-02
>8-10 Aromatics	1.27E-03	5.39E-02	2.22E-02	2.56E-03
>10-12 Aliphatics	7.46E-02	7.69E-04	3.64E-01	5.60E-02
>10-12 Aromatics	1.66E-02	4.46E-01	5.26E-02	3.34E-02
>12-16 Aliphatics	2.85E-01	1.72E-05	4.90E-02	2.14E-01
>12-16 Aromatics	1.11E-01	3.28E-01	6.81E-02	2.16E-01
>16-21 Aliphatics	3.05E-01	1.47E-09	1.49E-04	1.18E-02
>16-21 Aromatics	1.16E-01	3.85E-02	7.30E-03	2.85E-01
>21-35 Aromatics	7.11E-02	4.98E-04	5.41E-06	1.69E-01
Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18
		s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		11,967	**797**	5,844

		COMMERCIAL SCENARIO		
	Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	6.03E-04	5.04E-04	1.19E-02	1.00E-05
5-7 Aromatics	6.03E-04	1.82E-01	4.99E-02	2.88E-04
>6-8 Aliphatics	1.47E-03	3.41E-04	1.21E-02	2.45E-05
>7-8 Aromatics	6.03E-04	6.79E-02	2.21E-02	2.88E-04
>8-10 Aliphatics	1.54E-02	3.47E-03	4.91E-01	1.16E-02
>8-10 Aromatics	1.27E-03	1.10E-01	2.99E-02	2.57E-03
>10-12 Aliphatics	7.46E-02	2.75E-04	2.04E-01	5.60E-02
>10-12 Aromatics	1.66E-02	5.05E-01	7.08E-02	3.36E-02
>12-16 Aliphatics	2.85E-01	6.14E-06	1.89E-02	2.14E-01
>12-16 Aromatics	1.11E-01	1.17E-01	8.67E-02	2.16E-01
>16-21 Aliphatics	3.05E-01	5.25E-10	5.75E-05	1.18E-02
>16-21 Aromatics	1.16E-01	1.37E-02	2.82E-03	2.85E-01
>21-35 Aromatics	7.11E-02	1.78E-04	2.09E-06	1.69E-01
Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks			
		RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		68,372	**2,772**	8,645

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	5.40E-04	1.99E-04	6.54E-03	9.14E-06		5-6 Aliphatics	5.40E-04	3.23E-04	8.36E-03	9.19E-06
5-7 Aromatics	5.40E-04	7.17E-02	2.74E-02	2.60E-04		5-7 Aromatics	5.40E-04	1.16E-01	3.51E-02	2.63E-04
>6-8 Aliphatics	2.64E-03	2.70E-04	1.33E-02	4.47E-05		>6-8 Aliphatics	2.64E-03	4.37E-04	1.70E-02	4.49E-05
>7-8 Aromatics	5.40E-04	2.68E-02	1.22E-02	2.60E-04		>7-8 Aromatics	5.40E-04	4.35E-02	1.56E-02	2.63E-04
>8-10 Aliphatics	2.05E-02	9.73E-03	4.01E-01	1.58E-02		>8-10 Aliphatics	2.05E-02	3.47E-03	5.13E-01	1.58E-02
>8-10 Aromatics	3.24E-03	1.23E-01	4.67E-02	6.67E-03		>8-10 Aromatics	3.24E-03	2.00E-01	5.97E-02	6.69E-03
>10-12 Aliphatics	8.39E-02	7.69E-04	3.38E-01	6.44E-02		>10-12 Aliphatics	8.39E-02	2.75E-04	2.04E-01	6.44E-02
>10-12 Aromatics	1.66E-02	4.00E-01	4.33E-02	3.41E-02		>10-12 Aromatics	1.66E-02	5.05E-01	5.53E-02	3.42E-02
>12-16 Aliphatics	3.02E-01	1.72E-05	4.90E-02	2.32E-01		>12-16 Aliphatics	3.02E-01	6.14E-06	1.89E-02	2.32E-01
>12-16 Aromatics	1.08E-01	3.28E-01	5.49E-02	2.16E-01		>12-16 Aromatics	1.08E-01	1.17E-01	7.02E-02	2.16E-01
>16-21 Aliphatics	2.92E-01	1.47E-09	1.49E-04	1.16E-02		>16-21 Aliphatics	2.92E-01	5.25E-10	5.75E-05	1.16E-02
>16-21 Aromatics	1.20E-01	3.85E-02	7.16E-03	3.01E-01		>16-21 Aromatics	1.20E-01	1.37E-02	2.82E-03	3.01E-01
>21-35 Aromatics	4.84E-02	4.98E-04	5.41E-06	1.18E-01		>21-35 Aromatics	4.84E-02	1.78E-04	2.09E-06	1.17E-01
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		10,769	**658**	5,976		RBSL(HI=1) mg/kg		48,838	**2,175**	8,839

Sample No. 529SB-05-75

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	1.82E-03	5.29E-04	2.71E-02	3.24E-05		5-6 Aliphatics	1.82E-03	7.33E-04	2.96E-02	3.25E-05
5-7 Aromatics	1.82E-03	1.91E-01	1.14E-01	9.22E-04		5-7 Aromatics	1.82E-03	2.64E-01	1.24E-01	9.32E-04
>6-8 Aliphatics	4.36E-03	3.52E-04	2.70E-02	7.77E-05		>6-8 Aliphatics	4.36E-03	4.87E-04	2.95E-02	7.81E-05
>7-8 Aromatics	1.82E-03	7.13E-02	5.04E-02	9.22E-04		>7-8 Aromatics	1.82E-03	9.87E-02	5.50E-02	9.32E-04
>8-10 Aliphatics	1.31E-02	7.65E-03	3.15E-01	1.06E-02		>8-10 Aliphatics	1.31E-02	3.47E-03	3.44E-01	1.06E-02
>8-10 Aromatics	3.27E-03	9.84E-02	5.80E-02	7.08E-03		>8-10 Aromatics	3.27E-03	1.36E-01	6.33E-02	7.11E-03
>10-12 Aliphatics	4.72E-02	7.69E-04	2.34E-01	3.82E-02		>10-12 Aliphatics	4.72E-02	2.75E-04	2.04E-01	3.82E-02
>10-12 Aromatics	1.38E-02	2.63E-01	4.44E-02	2.99E-02		>10-12 Aromatics	1.38E-02	3.65E-01	4.85E-02	3.00E-02
>12-16 Aliphatics	3.10E-01	1.72E-05	4.90E-02	2.51E-01		>12-16 Aliphatics	3.10E-01	6.14E-06	1.89E-02	2.51E-01
>12-16 Aromatics	1.19E-01	3.28E-01	7.42E-02	2.49E-01		>12-16 Aromatics	1.19E-01	1.17E-01	8.10E-02	2.50E-01
>16-21 Aliphatics	3.32E-01	1.47E-09	1.49E-04	1.39E-02		>16-21 Aliphatics	3.32E-01	5.25E-10	5.75E-05	1.39E-02
>16-21 Aromatics	1.31E-01	3.85E-02	7.30E-03	3.44E-01		>16-21 Aromatics	1.31E-01	1.37E-02	2.82E-03	3.44E-01
>21-35 Aromatics	2.11E-02	4.98E-04	5.41E-06	5.40E-02		>21-35 Aromatics	2.11E-02	1.78E-04	2.09E-06	5.38E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		8,512	**810**	6,294		RBSL(HI=1) mg/kg		33,013	**2,286**	9,307

	RESIDENTIAL SCENARIO			
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18
		s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	2.32E-03	5.95E-04	3.11E-02	4.07E-05
5-7 Aromatics	2.32E-03	2.14E-01	1.30E-01	1.16E-03
>6-8 Aliphatics	1.18E-02	8.42E-04	6.61E-02	2.08E-04
>7-8 Aromatics	2.32E-03	8.01E-02	5.79E-02	1.16E-03
>8-10 Aliphatics	1.34E-02	6.90E-03	2.90E-01	1.07E-02
>8-10 Aromatics	2.32E-03	6.14E-02	3.70E-02	4.95E-03
>10-12 Aliphatics	4.79E-02	7.69E-04	2.14E-01	3.82E-02
>10-12 Aromatics	1.60E-02	2.68E-01	4.62E-02	3.41E-02
>12-16 Aliphatics	3.04E-01	1.72E-05	4.90E-02	2.42E-01
>12-16 Aromatics	1.27E-01	3.28E-01	7.11E-02	2.61E-01
>16-21 Aliphatics	3.19E-01	1.47E-09	1.49E-04	1.31E-02
>16-21 Aromatics	1.37E-01	3.85E-02	7.30E-03	3.56E-01
>21-35 Aromatics	1.47E-02	4.98E-04	5.41E-06	3.71E-02
Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18
		s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		7,496	**729**	6,205

		COMMERCIAL SCENARIO		
	Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)			
5-6 Aliphatics	2.32E-03	8.23E-04	3.30E-02	4.09E-05
5-7 Aromatics	2.32E-03	2.96E-01	1.38E-01	1.17E-03
>6-8 Aliphatics	1.18E-02	8.73E-04	7.01E-02	2.09E-04
>7-8 Aromatics	2.32E-03	1.11E-01	6.14E-02	1.17E-03
>8-10 Aliphatics	1.34E-02	3.47E-03	3.08E-01	1.07E-02
>8-10 Aromatics	2.32E-03	8.50E-02	3.93E-02	4.96E-03
>10-12 Aliphatics	4.79E-02	2.75E-04	2.04E-01	3.82E-02
>10-12 Aromatics	1.60E-02	3.71E-01	4.90E-02	3.42E-02
>12-16 Aliphatics	3.04E-01	6.14E-06	1.89E-02	2.42E-01
>12-16 Aromatics	1.27E-01	1.17E-01	7.54E-02	2.62E-01
>16-21 Aliphatics	3.19E-01	5.25E-10	5.75E-05	1.32E-02
>16-21 Aromatics	1.37E-01	1.37E-02	2.82E-03	3.55E-01
>21-35 Aromatics	1.47E-02	1.78E-04	2.09E-06	3.70E-02
Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks			
		RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		29,049	**2,001**	9,175

	RESIDENTIAL SCENARIO							COMMERCIAL SCENARIO		
	Csat	RBSL.R.11	RBSL.R.16	RBSL.R.18			Csat	RBSL.C.11	RBSL.C.16	RBSL.C.18
		s lch	s v in	ss				s lch	s v in	ss
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
		HQ=1	HQ=1	HQ=1				Non-Carc	Non-Carc	Non-Carc
5-6 Aliphatics	4.76E+02	2.92E+04	5.43E+01	3.53E+05		5-6 Aliphatics	4.76E+02	8.18E+04	1.40E+02	5.19E+05
5-7 Aromatics	1.63E+03	8.11E+01	1.29E+01	1.24E+04		5-7 Aromatics	1.63E+03	2.27E+02	3.35E+01	1.81E+04
>6-8 Aliphatics	2.57E+02	1.05E+05	1.31E+02	3.53E+05		>6-8 Aliphatics	2.57E+02	2.95E+05	3.38E+02	5.19E+05
>7-8 Aromatics	1.26E+03	2.17E+02	2.92E+01	1.24E+04		>7-8 Aromatics	1.26E+03	6.07E+02	7.55E+01	1.81E+04
>8-10 Aliphatics	1.41E+02	1.45E+04	3.36E+01	7.78E+03		>8-10 Aliphatics	1.41E+02	4.07E+04	8.70E+01	1.15E+04
>8-10 Aromatics	1.04E+03	2.83E+02	4.56E+01	2.91E+03		>8-10 Aromatics	1.04E+03	7.92E+02	1.18E+02	4.28E+03
>10-12 Aliphatics	8.61E+01	1.12E+05	1.63E+02	7.78E+03		>10-12 Aliphatics	8.61E+01	3.13E+05	4.22E+02	1.15E+04
>10-12 Aromatics	6.30E+02	4.46E+02	2.52E+02	2.91E+03		>10-12 Aromatics	6.30E+02	1.25E+03	6.51E+02	4.28E+03
>12-16 Aliphatics	3.82E+01	2.22E+06	7.79E+02	7.78E+03		>12-16 Aliphatics	3.82E+01	6.21E+06	2.02E+03	1.15E+04
>12-16 Aromatics	2.91E+02	8.88E+02	1.30E+03	3.01E+03		>12-16 Aromatics	2.91E+02	2.49E+03	3.36E+03	4.44E+03
>16-21 Aliphatics	1.30E+01	8.84E+09	8.73E+04	1.51E+05		>16-21 Aliphatics	1.30E+01	2.48E+10	2.26E+05	2.23E+05
>16-21 Aromatics	8.09E+01	2.10E+03	1.11E+04	2.39E+03		>16-21 Aromatics	8.09E+01	5.89E+03	2.86E+04	3.54E+03
>21-35 Aromatics	8.31E+00	1.67E+04	1.53E+06	2.45E+03		>21-35 Aromatics	8.31E+00	4.67E+04	3.97E+06	3.64E+03
	Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)			Fraction	HQ(Ci)	HQ(Ci)	HQ(Ci)
	(mg/kg/mg/kg)						(mg/kg/mg/kg)			
5-6 Aliphatics	4.70E-04	3.05E-04	1.13E-02	8.74E-06		5-6 Aliphatics	4.70E-04	5.03E-04	1.47E-02	8.79E-06
5-7 Aromatics	4.70E-04	1.10E-01	4.73E-02	2.49E-04		5-7 Aromatics	4.70E-04	1.81E-01	6.15E-02	2.52E-04
>6-8 Aliphatics	2.59E-03	4.64E-04	2.58E-02	4.81E-05		>6-8 Aliphatics	2.59E-03	7.66E-04	3.35E-02	4.83E-05
>7-8 Aromatics	4.70E-04	4.10E-02	2.10E-02	2.49E-04		>7-8 Aromatics	4.70E-04	6.77E-02	2.73E-02	2.52E-04
>8-10 Aliphatics	8.94E-03	9.73E-03	3.46E-01	7.54E-03		>8-10 Aliphatics	8.94E-03	3.47E-03	4.50E-01	7.54E-03
>8-10 Aromatics	9.99E-04	6.68E-02	2.85E-02	2.26E-03		>8-10 Aromatics	9.99E-04	1.10E-01	3.71E-02	2.27E-03
>10-12 Aliphatics	3.81E-02	7.69E-04	3.03E-01	3.21E-02		>10-12 Aliphatics	3.81E-02	2.75E-04	2.04E-01	3.21E-02
>10-12 Aromatics	9.52E-03	4.04E-01	4.92E-02	2.15E-02		>10-12 Aromatics	9.52E-03	5.05E-01	6.40E-02	2.16E-02
>12-16 Aliphatics	3.18E-01	1.72E-05	4.90E-02	2.68E-01		>12-16 Aliphatics	3.18E-01	6.14E-06	1.89E-02	2.68E-01
>12-16 Aromatics	1.11E-01	3.28E-01	1.12E-01	2.43E-01		>12-16 Aromatics	1.11E-01	1.17E-01	8.67E-02	2.44E-01
>16-21 Aliphatics	3.60E-01	1.47E-09	1.49E-04	1.57E-02		>16-21 Aliphatics	3.60E-01	5.25E-10	5.75E-05	1.57E-02
>16-21 Aromatics	1.37E-01	3.85E-02	7.30E-03	3.75E-01		>16-21 Aromatics	1.37E-01	1.37E-02	2.82E-03	3.75E-01
>21-35 Aromatics	1.26E-02	4.98E-04	5.41E-06	3.36E-02		>21-35 Aromatics	1.26E-02	1.78E-04	2.09E-06	3.36E-02
Total	1.00E+00					Total	1.00E+00			
	SV in Calculation based on 1.0 percent foundation cracks						**SV in Calculation based on 1.0 percent foundation cracks**			
		RBSL.R.11	**RBSL.R.16**	RBSL.R.18				RBSL.C.11	**RBSL.C.16**	RBSL.C.18
		s lch	**s v in**	ss				s lch	**s v in**	ss
		(mg/kg)	**(mg/kg)**	(mg/kg)				(mg/kg)	**(mg/kg)**	(mg/kg)
HI		1.00E+00	**1.00E+00**	1.00E+00		HI		1.00E+00	**1.00E+00**	1.00E+00
RBSL(HI=1) mg/kg		18,915	**1,300**	6,564		RBSL(HI=1) mg/kg		87,363	**4,377**	9,707

Appendix E

Commercial RBSLs

Table D-1 Commercial Exposure via the Soil Leaching to Groundwater Pathway

Sample ID	Total TPH* (mg/kg)	RBSL (mg/kg)	Hazard Index
Site 380A:			
380SB-02B-15	437	42,651	0.01
380SB-02B-20	158	15,414	0.01
380SB-02B-21	402	39,234	0.01
380SB-02B-32	1,201	72,541	0.02
380SB-02B-33	1,346	60,578	0.02
Site 529:			
529SB-04-20	3,879	166,046	0.02
529SB-04-60	7,284	44,517	0.16
529SB-04-80	5,175	41,743	0.12
529SB-04-95	6,618	202,867	0.03
529SB-05-20	8,350	77,745	0.11
529SB-05-25	7,464	68,372	0.11
529SB-05-50	8,332	48,838	0.17
529SB-05-75	1,377	33,013	0.04
529SB-05-77	1,943	29,049	0.07
529SB-05-100	8,504	87,363	0.10

NOTE:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

Table D-2 Commercial Exposure via the Direct Contact Pathway

Sample ID	Total TPH* (mg/kg)	RBSL (mg/kg)	Hazard Index
Site 380A:			
380SB-02B-15	437	7,571	0.06
380SB-02B-20	158	9,583	0.02
380SB-02B-21	402	3,392	0.12
380SB-02B-32	1,201	14,658	0.08
380SB-02B-33	1,346	15,594	0.09
Site 529:			
529SB-04-20	3,879	8,741	0.44
529SB-04-60	7,284	8,457	0.86
529SB-04-80	5,175	9,470	0.55
529SB-04-95	6,618	9,614	0.69
529SB-05-20	8,350	8,280	***1.01***
529SB-05-25	7,464	8,645	0.86
529SB-05-50	8,332	8,839	0.94
529SB-05-75	1,377	9,307	0.15
529SB-05-77	1,943	9,175	0.21
529SB-05-100	8,504	9,707	0.88

NOTE:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.

Table D-3 Commercial Exposure via Volatilization to Indoor and Outdoor Air

Sample ID	Total TPH* (mg/kg)	RBSL *Indoor* (mg/kg)	Hazard Index *Indoor*	RBSL *Outdoor* (mg/kg)	Hazard Index *Outdoor*
Site 380A:					
380SB-02B-15	437	4,111	0.11	>100%	NA
380SB-02B-20	158	1,486	0.11	461,812	0.0003
380SB-02B-21	402	3,782	0.11	>100%	NA
380SB-02B-32	1,201	6,252	0.19	351,259	0.003
380SB-02B-33	1,346	6,004	0.22	271,474	0.005
Site 529:					
529SB-04-20	3,879	3,261	***1.19***	>100%	NA
529SB-04-60	7,284	2,379	***3.06***	473,444	0.015
529SB-04-80	5,175	2,406	***2.15***	336,343	0.015
529SB-04-95	6,618	5,669	***1.17***	>100%	NA
529SB-05-20	8,350	3,174	***2.63***	649,084	0.013
529SB-05-25	7,464	2,772	***2.69***	572,225	0.013
529SB-05-50	8,332	2,175	***3.83***	541,560	0.015
529SB-05-75	1,377	2,286	0.60	197,671	0.007
529SB-05-77	1,943	2,001	0.97	172,850	0.011
529SB-05-100	8,504	4,377	***1.94***	732,229	0.012

NOTE:

* Total TPH = Sum of all fractions reported in Direct Method analysis, using ½ detection limit for non-detect results.