SITE CLOSURE REPORT

PROPERTY NO. 4826
BROADWAY VOLKSWAGEN
2740 BROADWAY AVENUE
OAKLAND, CALIFORNIA

PREPARED FOR:
CORE RESOURCE, INC.
3800 HAMLIN ROAD, SUITE 100
AUBURN HILLS, MICHIGAN 48326

PREPARED BY:
QST ENVIRONMENTAL
1340 ARNOLD DRIVE, SUITE 126
MARTINEZ, CA 94553
(925) 313-0840
Fax: (925) 313-0844

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QST PROJECT NO. 6598059

QST Environmental
3545 Howard Way, 2nd Flr.
Costa Mesa, CA 92626

Dennis Callahan
Larry R. Froebe
Fax: 714-426-9027

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This report has been prepared by QST Environmental for the exclusive use of CORE Resource, Inc., as it pertains to the property located at 2740 Broadway Avenue in Oakland, California. Our professional services have been performed using that degree of care and skill ordinarily exercised under similar circumstances by other geologists, engineers, and environmental professionals practicing in this field. No other warranty, express or implied, is made as to the professional opinions in this report.

REPORT PREPARED BY:

Dennis Callahan — 3/1/99

Dennis Callahan
Staff Engineer
Date

UNDER THE PRIMARY REVIEW OF:

Larry R. Froebe — 3-1-99

Larry R. Froebe, Ph.D.
Manager, Risk Assessment & Toxicology
Date

UNDER THE PROFESSIONAL SUPERVISION OF:

Rose T. Scott — 3/1/99

Rose T. Scott, R.G.
Senior Project Geologist
California Registered Geologist No. 6421
Date

Abbreviations and Acronyms

ACHCSA	Alameda County Health Care Services Agency
amsl	above mean sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
Cal/EPA	California Environmental Protection Agency
COC	Chemical of Concern
CSM	Conceptual Site Model
DCA	1,2-Dichloroethane
DTSC	Cal/EPA Department of Toxic Substances Control
EPA	United States Environmental Protection Agency
ESE	Environmental Science & Engineering, Inc. (now, QST Environmental)
HVOC	Halogenated Volatile Organic Chemical
ILCR	Incremental Lifetime Cancer Risk
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/L	milligram per liter
mg/L	microgram per liter
MW	monitor well
MTBE	methyl *tertiary*-butyl ether
PCE	Perchloroethylene
ppm	parts-per-million
PRG	Preliminary Remediation Goal
QST	QST Environmental (formerly, Environmental Science & Engineering, Inc.)
RAGS	Risk Assessment Guidance for Superfund
RAP	Remedial Action Plan
RfC	Reference Concentration
RfD	Reference Dose
RWQCB	California Regional Water Quality Control Board
SB	soil boring
TCE	Trichloroethylene
TPH	Total Petroleum Hydrocarbons
TPH-g	TPH as Gasoline
VOC	Volatile Organic Chemical

1.0 INTRODUCTION

QST Environmental (QST) was retained by CORE Resource, Inc., (CORE) to prepare this Closure Report for CORE Property No. 4826 (Broadway Volkswagen) located at 2740 Broadway Avenue in Oakland, California (Figure 1). This Closure Report will be submitted to the Alameda County Health Care Services Agency (ACHCSA) and the Regional Water Quality Control Board (RWQCB), San Francisco Region for review and approval. This report describes the site conditions prior to and after implementation of remediation activities, and furthermore demonstrates the reduction of hydrocarbon concentrations in the onsite soil and groundwater to acceptable levels. Based on the reduction of hydrocarbon concentration, the asphalt/concrete surface cap which acts as a vapor migration/water infiltration barrier, and the risk assessment of the site, QST believes the site to be acceptably low environmental and human health risk and respectfully requests case closure from the ACHCSA and the RWQCB on behalf of CORE.

1.1 Site Description

The site is located on the southeast corner of the intersection of Broadway Avenue and 28th Street in Oakland, California (Figure 1) in a predominantly commercial area. The Broadway Volkswagen automobile dealership currently occupies the site and consists of a three-story steel-reinforced concrete building, multiple service bays and a showroom (Figure 2). Numerous automobile dealerships and maintenance shops are in operation in the immediate area. Numerous underground service utilities are present within the right-of-way of 28th Street immediately adjacent to the site.

1.2 Geology/Hydrogeology

The site is at an approximate elevation of 30 feet above mean sea level (amsl) in an area of moderately sloping topography. It is situated on an alluviated highland portion of Oakland and is topographically characterized by a gentle southeasterly slope toward Lake Merritt which lies approximately 2,000 feet south of the site. Soil borings drilled to depths of approximately 30 feet below ground surface (bgs) indicated that the subsurface consists of clay, silty clay, sandy clay, silt, sandy silt, and sand. A sand layer, approximately 2-feet thick, is present beneath the site at approximately 11 to 17 feet bgs and is sloping in a general northwesterly direction (ESE, 1991a).

The groundwater flow underneath the site is generally toward the west-northwest. Perched groundwater beneath the site has been observed at depths of 11 to 17 feet bgs, with observed

elevations between 16 to 23 feet amsl. Historical measurements of groundwater elevations are shown in Table 1.

1.3 Project Background

During August 1988, two underground storage tanks (USTs), consisting of one 500-gallon waste oil UST and one 3,000-gallon gasoline UST were removed from an area at the northeast side of the site along 28th Street (Figure 2). Soil samples collected during the removal of the USTs were reported to contain detectable concentrations of total petroleum hydrocarbons as gasoline (TPH-g) and benzene, toluene, ethylbenzene, and total xylenes (ESE, 1989). Soil samples collected from borings, SB-3 and SB-4, drilled subsequent to the tank removal also contained detectable concentrations of TPH-g and BTEX (ESE, 1991a).

Boring logs for five additional groundwater monitoring wells (MW-1, MW-3, MW-4, MW-5, and MW-6) installed by QST at the site indicate the presence of clay sediments with perched, moist to wet sand beds at depths ranging between 11 to 17 feet bgs (ESE, 1991a; ESE, 1991b). QST installed wells MW-1 and MW-3 to a depth of approximately 20 feet bgs and screened both over the lithological interval containing the perched sand beds and upper groundwater interval. QST identified one 2-foot thick perched sand bed in wells MW-5 and MW-6 at depths of 17 and 11 feet, respectively (ESE, 1991b). The sand bed was observed to have an apparent dip toward the west. Clay sediments above and immediately below the sand beds were observed to be dry.

Soil samples collected from the sand beds in borings MW-5 and MW-6 were noted to have a fuel odor and detectable volatile organic compound (VOC) concentrations as determined using a photo-ionization detector (PID). However, QST did not detect fuel vapors or VOCs with a PID in samples of clay collected above and below the sand bed in the borings. No detectable concentrations of halogenated VOCs (HVOCs) have been reported to occur in soil samples collected from the sand and clay sediments at the site. The analytical results of soil samples collected at this site indicate the petroleum hydrocarbon affected soil beneath the site was limited to the immediate area surrounding the former UST locations.

A sandy clay aquifer was intersected beneath the clay unit containing the perched sand beds at a depth of approximately 22 to 23 feet bgs in wells MW-4, MW-5, and MW-6. Monitoring well MW-4 was installed to a depth of 25 feet bgs and wells MW-5 and MW-6 were installed to a depth of 30 feet bgs. These three wells were screened over the interval containing the sandy clay aquifer as well as the perched sand beds.

Detectable concentrations of TPH-g, BTEX, and HVOCs including trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,2-Dichloroethane (DCA) have been reported to occur in some groundwater samples collected from various site wells since May 13, 1991 (ESE, 1991a, 1991b, 1992, 1993). Historically, the highest concentrations of TPH-g and BTEX have been reported in groundwater samples collected from well MW-3 located west and hydraulically downgradient of the former UST area. Well MW-3 is selectively screened to recharge with water from the perched sand beds. The highest concentrations of HVOCs have been reported to occur in groundwater samples collected from wells screened into the deeper aquifer (MW-4, MW-5, and MW-6). Contours of TCE concentration in groundwater indicate an offsite source of TCE located to the north of the UST area. QST concluded that groundwater containing TCE was cross-contaminating the upper perched sand beds at the site by upwardly migrating through the monitoring wells completed in both the deeper clay aquifer and the shallower sand beds (ESE, 1993).

Background research by QST (ESE, 1991a) indicates that several sites surrounding the CORE property handled petroleum hydrocarbons and solvents containing HVOCs. In addition, numerous unauthorized releases at other properties have been documented by the ACHCSA and the RWQCB (ESE, 1991a).

Wells MW-4, MW-5 and MW-6 were abandoned in March 1994. The ACHCSA recommended that one additional well be installed further west of MW-3 to define the TPH-g plume in the downgradient direction (ACHCSA, 1993). Well MW-7 was installed for this purpose (ESE, 1994).

QST performed a soil vapor extraction test in 1994 (ESE, 1995a) and aquifer testing in 1995 to determine feasibility for a remediation system. The results of these tests were reported in the Remedial Action Plan (RAP) dated August 25, 1995 (ESE, 1995b). The RAP was approved by the ACHCSA in September 1995. A dual phase extraction and treatment system was constructed in late 1995 and early 1996. The vapor phase of the system was put into operation in February 1996 and the groundwater phase was initiated in April 1996.

2.0 REMEDIATION ACTIVITIES

2.1 Groundwater Monitoring Well Sampling

Groundwater samples were obtained from the wells by lowering a new disposable bailer into each well. The groundwater was then decanted from the bailers into laboratory supplied 40-milliliter glass vials containing hydrochloric acid (a preservative). Three vials were collected for each well. The sample vials were then sealed with a Teflon®-lined cap, labeled, placed on ice in a cooler and transported under chain-of-custody to Curtis and Tompkins Laboratory in Berkeley, California. Samples were analyzed for TPH-g by EPA Method 8015M and BTEX/Methyl tert-Butyl Ether (MTBE) by EPA Method 8020. A summary of analytical results of groundwater samples is presented in Table 2.

2.2 Groundwater Extraction and Treatment

The groundwater extraction and treatment system was put into operation in April 1996, after receiving a permit to discharge from the East Bay Municipal Utility District (EBMUD). A 7½ horsepower positive displacement blower extracted vapors from wells MW-3, VW-1, VW-2 and VW-3. Groundwater was extracted by becoming entrained in the air stream flowing from the vapor extraction wells. The entrained groundwater passed through the system piping into the moisture knockout pot. The water was pumped by a transfer pump to two 200-pound carbon vessels for treatment. The treated groundwater was discharged to the sanitary sewer.

Influent, midpoint and effluent samples were collected periodically during system operation. The samples were collected from sample ports on the system in laboratory-supplied 40-milliliter glass vials containing hydrochloric acid (a preservative). Four vials were collected for each sample location. The sample vials were then sealed with a Teflon®-lined cap, labeled, placed on ice in a cooler and transported under chain-of-custody to Curtis and Tompkins Laboratory.

2.3 Vapor Extraction and Treatment

The vapor phase extraction and treatment system was put into operation in February 1996 after receiving a permit from the Bay Area Air Quality Management District (BAAQMD). The extracted vapors were routed to two 1,000-pound vapor phase carbon vessels for treatment. Influent and effluent vapor samples were collected and analyzed for TPH-g by EPA Method

8015M and BTEX by EPA Method 8020. The influent, midpoint and effluent vapor concentrations were monitored regularly using a PID. The vapor concentrations for the vapor phase treatment system are displayed in Table 3.

3.0 Treatment System Effectiveness

To date, QST has operated the groundwater extraction and treatment system at the site between the third quarter of 1996 and second quarter of 1998. During this time approximately 44,837 gallons of groundwater were extracted, treated and discharged into the sewer system (Table 4). However, groundwater influent laboratory results are available up to the third quarter of 1997. Table 5 shows the total quantity of TPH and benzene removed in grams. Figure 3 shows a graphical representation of the total quantity of TPH and benzene removed from the groundwater in grams.

Quarterly groundwater monitoring sampling data show an initial drop in hydrocarbon levels immediately after the start of the extraction and treatment system (Table 2). The overall effectiveness of the system is most noticeable from the groundwater samples collected from MW-3, which is directly east of the former underground tank area. On May 16, 1991, the maximum TPH-g concentration was 81,000 micrograms per liter (mg/L), by June 28, 1996 (two months after the initiation of the treatment system), the TPH-g concentration was reduced to 370 mg/L. TPH-g rose to 15,000 mg/L the following quarter, then declined to not-detected levels for the remainder of the sampling occurrences. More significantly, the groundwater extraction and treatment has effectively reduced the concentration of BTEX at the site from 7,800 mg/L of benzene, 12,000 mg/L of toluene, 1,200 mg/L of ethylbenzene, and 4,000 mg/L of total xylenes on May 16, 1991 to not detected levels for BTEX on October 7, 1997 (Table 2). Figure 4 shows the attenuation of the BTEX constituents in the groundwater for MW-3. Because benzene in groundwater is of greater concern than the other BTEX constituents, Figure 5 displays the reduction of benzene only. The groundwater was analyzed for methyl tertiary-butyl ether (MTBE) on October 7, 1997. MTBE concentrations were not detected at a detection limit of 2.0 mg/L .

Table 6, Summary of Analytical Results of Groundwater Treatment System, further illustrates the effectiveness of the treatment system to attenuate the levels of petroleum hydrocarbons. Samples were collected at three locations within the system (influent, midpoint, and effluent) and were analyzed for BTEX, TPH-g and MTBE. Table 6 shows that in all sampling instances, both midpoint and effluent concentrations were below the detection limit for all the constituents.

Table 3 summarizes vapor-phase total hydrocarbon concentrations measured with a photo ionization detector (PID). Influent concentrations range from 54 to 230 parts per million (ppm) in the beginning months of treatment to 12 to 14 ppm in the latter months of 1997. Figure 5 shows vapor concentrations from the vapor extraction system influent verses time. The figure further illustrates the vapor extraction system's ability to reduce the concentrations of hydrocarbons in the groundwater and soil.

Analytical results of vapor samples for both influent and effluent are reprinted in Table 7. BTEX and TPH-g were not detected in influent and effluent samples collected on July 23, 1997.

4.0 RISK ASSESSMENT SUMMARY

The removal of TPH from groundwater, as charted in Figure 3, totaled 470 grams on March 24, 1998 with the latest monthly removal of 0.4 grams per month for the period of January 14 to March 24, 1998. That is 50.08 percent of the total removed. The asymptotic trend of the removal curve in Figure 3 is at less than one percent of achieving maximum removal. A similar analysis of the data for benzene indicates the same result, a monthly incremental removal trend of less than one percent of the total benzene removed. The logical next step is to evaluate the residual chemical of concern (COC) concentrations for risk-based closure.

4.1 Chemicals of Concern

The chemicals for which the remediation program was designed and implemented are related to petroleum. With the implementation of the groundwater pump-and-treat program in 1995, the ACHCSA raised questions about chlorinated hydrocarbons in the groundwater in the region and whether they might be site-related. Both classes of chemicals are addressed herein.

4.1.1 Petroleum-Based COCs

The site-specific COCs are related to petroleum, namely TPH-g and BTEX. Historically, regulation by the RWQCB has been based on these COCs, with benzene serving as an indicator chemical for incremental lifetime cancer risk (ILCR). In this case, concentrations of the COCs are compared to risk-based regulatory concentrations as an indicator of compliance. Monitoring during the remedial action program was based on these COCs.

4.1.2 Chlorinated Hydrocarbons

Chlorinated hydrocarbons, including TCE and DCA, have been detected in some groundwater samples over the course of the site investigation and remedial action (ESE, 1991a, 1991b, 1992, 1993). The highest concentrations have been detected in samples from wells screened into the deeper sandy clay aquifer (MW-4, MW-5, and MW-6). TCE concentrations range from 2,000 mg/L in MW-6, to 500 mg/L in MW-4 to 14 mg/L in MW-3. Contours of the TCE concentrations in groundwater indicated an up-gradient, offsite source to the north of the former UST area. The conclusion was that the groundwater in the sandy clay aquifer containing TCE was cross-contaminating the upper perched sand bed at the site by upward migration through the screened monitoring well casings. This led to the proposal and approval to abandon wells MW-4, MW-5, and MW-6. ACHCSA documented the review of the proposal to close these wells in a letter from ACHCSA (James Peacock) to the owner of record at the time, Vorelco Inc. (Tom Moffatt), dated September 23, 1993. ACHCSA acknowledgment of the abandonment of the three wells was documented in a letter from ACHCSA (Eva Chu) to Vorelco Inc. (Tom Moffatt), dated May 31, 1994, describing their review of the April 1994 report of site activities. ACHCSA stated in that letter that ... "This will not require the cleanup of contamination which is from an offsite source." In a September 1994 letter from ACHCSA (Eva Chu) approving the work plan for remedial investigation of the site, monitoring for "... TPH-G, BTEX, and HVOCs ... " was specified. Approval of the RAP in a September 29, 1995 letter from ACHCSA (Eva Chu) stated "The proposal to use a soil vapor extraction and water entrainment system to remediate petroleum hydrocarbons in affected soil and groundwater beneath the site is acceptable." No mention of HVOCs was made in that letter. Further, an August 29, 1997 letter from ACHCSA (Thomas Peacock) stated "It appears that the treatment system is working very well. This site may be eligible for closure soon." Therefore, the chlorinated hydrocarbons, detected in groundwater at various times and deduced as being of offsite origin, are not carried forward in risk characterization of site-related contaminants.

4.2 Conceptual Site Model

The preparation of a risk assessment is tied to the identification of 1) COCs, 2) potential pathways in environmental media by which migration can occur, and 3) potential receptors of exposure, usually associated with a particular land use and default exposure conditions. The objectives of a conceptual site model (CSM) diagram have been realized through the identification of soil and groundwater as the environmental media for remedial action via soil vapor extraction and water entrainment. Designation of receptors of potential exposure is implied

in the site cleanup criteria designated in the remedial action plan (ESE, 1995b). Those criteria are based on residential land use and use of the groundwater, and they constitute the most restrictive exposure conditions. They are presented in detail in section 4.4 on risk characterization.

4.3 Exposure and Toxicity Assessments

Exposure assessment is conducted to identify the appropriate land use and the location of the receptors that could complete an exposure pathway. A release of the COCs from the source is evaluated for the concentration at the location of potential exposure in the designated land use. A quantification of the exposure intake of each COC is usually the product of the exposure assessment. In this case, concentrations of the COCs are compared directly to risk-based concentrations.

The land use for the Broadway Volkswagen dealership is commercial-industrial. A change in land use would require a change in zoning, an unlikely occurrence. Because the entire property is capped with asphalt and concrete, repeated exposure to soil consistent with an exposure scenario is unlikely. Therefore, the industrial soil PRG for benzene was used for risk-based evaluation. Benzene exceeded the PRG of 1.4 mg/kg in only one sample by a slight margin. This sample was collected at a depth of greater than 7½ feet bgs at the bottom of the tank excavation. Benzene was detected at a concentration of 2.2 mg/kg in this sample, the maximum concentration of benzene detected in the soil at the site prior to the operation of the vapor extraction system. Operation of the vapor extraction water entrainment system over a period of 2 years has been shown to reduce levels of TPH and correspondingly is expected to have reduced levels of benzene in soil vapor. The absence of benzene in groundwater also eliminates the possibility of vertical migration upward into soil vapor. The asphalt/concrete cap over the site and the fill over the location of the soil sample precludes exposure to possible occurrence of benzene in soil.

The protection of groundwater is based on maximum contaminant levels (MCLs), and the remedial action has been conducted for the recovery of groundwater quality beneath the property. Where an exposure assessment would normally result in the determination of an intake rate per chemical, the proper criteria for closure in this case are MCLs. The criteria for groundwater quality are the BTEX MCLs as follows:

California MCLs* for BTEX	
Chemical	Maximum Contaminant Level (MCL, mg/L)
Benzene	0.001
Ethylbenzene	0.700
Toluene	0.15
Xylenes (total)	1.750

*Cal/DHS, 1997; MCLs updated from RAP (ESE, 1995b).

Toxicity assessment includes compiling the toxicity reference values for each of the COCs. Data gaps (missing toxicity values) that leave the final risk assessment incomplete must be identified, especially for the uncertainty in the risk and hazard that are calculated in the risk characterization step. The toxicity assessment also allows the identification of special evaluations that might need to be conducted as part of risk characterization. For instance, TPH and TPH-g do not have toxicity values. For this case, the toxicity values for BTEX are, in effect, incorporated into the respective MCLs so that direct comparison of the analyte concentration in groundwater to the MCL constitutes the proper comparison for compliance. For TPH, the methodology of the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG, 1998) allows determination of risk-based criteria values for both soil and groundwater (Appendix A).

4.4 Risk Characterization

The case for closure has been evolving over the course of the remedial action based on the declining COC concentrations. Table 2 (see also Figure 2) lists the concentrations of the COCs as they have been compiled over time. The trend is clear. MW-1, MW-3, and MW-7 samples have COC analytical results below detection levels, and each detection level is less than the respective MCL, as follows.

California MCLs and Analytical Detection Limits for BTEX			Other Risk-Based Criteria	
Chemical	Maximum Contaminant Level (MCL, mg/L)	Analytical Detection Limit (mg/L)	Tap Water PRG (mg/L)	DTSC Action Level (mg/L)
Benzene	0.001	0.0005	0.00039	N/A
Ethylbenzene	0.700	0.0005	1,300	N/A
Toluene	0.15	0.0005	720	N/A
Xylenes (total)	1.750	0.0005	1,400	N/A
MTBE	N/A	0.0002	0.0020	0.0035*
TPH-g (see Appendix A)	N/A	0.0050	30.1	N/A

N/A = not available

Analyses for methyl teriary-butyl ether (MTBE) in the samples from October 7, 1997 gave results of (not detected (ND) for less than 2.0 ug/L. The duplicate analysis for the sample from MW-3 gave a result of 5.7 ug/L. Either of the results is less than the current EPA tap water PRG of 20 ug/L or the DTSC action level for MTBE in drinking water of 35 ug/L based on taste and odor criteria and not risk-based criteria. Further, both of these results are less than the more stringent standard of 14 mg/L, currently appearing in proposed legislation in the California legislature. The benzene ND result may exceed the tap water PRG due to limitation of quantification but complies with the MCL which also considers technical and economic feasibility and is the operative criterion. **The concentration criteria for BTEX and MTBE have been met for closure of the Broadway Volkswagen site.**

Table 2 also lists undetectable results for petroleum hydrocarbons as gasoline where the detection limit is 50 mg/L. In Appendix A, the risk-based concentration for gasoline petroleum hydrocarbons (C5-C8) in drinking water is 30,100 mg/L (30.1 ug/L). **The risk-based criteria for petroleum hydrocarbons as gasoline have also been met for closure of the Broadway Volkswagen site.**

5.0 CONCLUSIONS AND RECOMMENDATIONS

QST, on behalf of Core Resource, Inc., respectfully requests that the Alameda County Health Care Services grant site closure based on the following.

- Soil exposure pathways were determined to be incomplete based on the operation of the vapor extraction system, the initial concentrations of COCs, the reduction of COCs in groundwater, the depth to the occurrence of soil formerly containing COCs, the industrial use designation of the property and the asphalt/concrete surface cap which acts as a vapor migration/water infiltration barrier at the site;

- TPH-g, BTEX and MTBE concentrations in wells MW-1, MW-3, and MW-7 are below laboratory reporting limits and have steadily decreased during past quarterly monitoring events;

- Influent TPH-g concentrations in the vapor phase have been stable at minimum concentrations for 2 years, and the amounts of TPH and benzene extracted from groundwater can be graphed as asymptotically approaching a maximum;

- All the laboratory results now attained for groundwater under the site are less than closure criteria for all the COCs at their respective detection limits.

6.0 REFERENCES

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Table 1
GROUNDWATER ELEVATION DATA
CORE Resource, Inc.
2740 Broadway
Oakland, CA

Well Number	Date	Top of Well Casing Elevation (feet above MSL)	Depth to Ground Water from Top of Casing (feet)	Ground Water Elevation (feet above MSL)
MW-1	1/29/89	29.22	7.50	21.72
	2/6/89		9.00	20.22
	3/13/89		8.50	20.72
	5/13/91		12.60	16.62
	10/18/91		10.11	19.11
	10/27/92		9.63	19.59
	7/13/93		6.26	22.96
	6/27/96		6.25	22.97
	9/19/96		10.46	18.76
	12/13/96		5.85	23.37
	10/7/97		10.38	18.84
MW-3	1/29/89	30.00	11.70	18.30
	2/6/89		11.00	19.00
	3/13/89		10.70	19.30
	5/13/91		10.56	19.44
	10/18/91		10.21	19.79
	10/27/92		10.81	19.19
	7/13/93		9.64	20.36
	6/27/96		NM	NA
	9/19/96		11.22	18.78
	12/13/96		9.55	20.45
	10/7/97		11.14	18.86
MW-4 *	1/29/89	29.70	NM	NA
	2/6/89		NM	NA
	3/13/89		NM	NA
	5/13/91		11.20	18.50
	10/18/91		9.55	20.15
	10/27/92		9.21	20.49
	7/13/93		8.32	21.38

Notes:
MSL - Mean Sea Level
* - Well abandoned on 3/16/94
NM - Not Measured
NA - Not Applicable

Table 1 (continued)
GROUND WATER ELEVATION DATA
CORE Resource, Inc.
2740 Broadway
Oakland, CA

MW-5	1/29/89	30.50	NM	NA
	2/6/89		NM	NA
	3/13/89		NM	NA
	5/13/91		NM	NA
	10/18/91		11.27	19.23
	10/27/92		11.24	19.26
	7/13/93		10.21	20.29
MW-6 *	1/29/89	29.19	NM	NA
	2/6/89		NM	NA
	3/13/89		NM	NA
	5/13/91		NM	NA
	10/18/91		10.21	18.98
	10/27/92		9.78	19.41
	7/13/93		8.50	20.69
MW-7	1/29/89	Top of well casing	NM	NA
	2/6/89	not surveyed to	NM	NA
	3/13/89	date.	NM	NA
	5/13/91		NM	NA
	10/18/91		NM	NA
	10/27/92		NM	NA
	7/13/93		NM	NA
	6/27/96		9.70	--
	9/19/96		11.92	--
	12/13/96		10.13	--
	10/7/97		11.82	--

Notes:
MSL - Mean Sea Level
* - Well abandoned on 3/16/94
NM - Not Measured
NA - Not Applicable

TABLE 2
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
CORE Resource, Inc.
2740 Broadway
Oakland, CA

Well Number	Date Sampled	Benzene	Toluene	Ethylbenzene	Xylenes	TPH-G	MTBE
		Concentrations (mg/L)					
MW-1	1/21/89	53	13	1.4	8.2	ND<50	NA
	5/16/91	ND<0.5	ND<0.5	ND<0.5	1.1	130	NA
	10/18/91	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	NA
	10/27/91	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	NA
	7/13/93	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	NA
	6/27/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	NA
	9/19/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	NA
	12/13/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	NA
	10/7/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2.0
MW-3	1/21/89	9,600	8,200	1,800	6,200	32,000	NA
	5/16/91	7,800	12,000	1,200	4,000	81,000	NA
	10/18/91	9,400	8,600	750	3,300	73,000	NA
	10/27/91	7,100	4,900	970	3,500	37,000	NA
	7/13/93	8,000	6,200	8,100	4,400	41,000	NA
	6/28/96	120	75	6.2	47	370	NA
	9/25/96	6,000	2,700	450	2,180	15,000	NA
	12/13/96	30	10	2	7.4	ND<50	NA
DUP	12/13/96	21	7	1	4.9	ND<50	NA
	10/7/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2.0
DUP	10/7/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	5.7
MW-4*	1/21/89	NA	NA	NA	NA	NA	NA
	5/16/91	160	690	250	1,100	13,000	NA
	10/18/91	11.0	11.0	ND	15	ND	NA
	10/27/91	6.4	2.8	1.2	6.2	180	NA
	7/13/93	36	4.4	1.8	5.3	320	NA
MW-5*	1/21/89	NA	NA	NA	NA	NA	NA
	5/16/91	NA	NA	NA	NA	NA	NA
	10/18/91	3,500	530	670	1,100	16,000	NA
	10/27/91	ND<0.5	ND<0.5	ND<0.5	ND<0.5	87	NA
	7/13/93	ND<0.5	ND<0.5	ND<0.5	ND<0.5	90	NA

Notes:
TPH-G - Total Petroleum Hydrocarbons as gasoline
MTBE - Methyl tert-Butyl Ether
ug/L - micrograms per liter
ND - Not detected at or above detection limits
NA - Not Analyzed
DUP - duplicate sample
* - Wells abandoned on 3/16/94

TABLE 2 (continued)
Summary of Analytical Results of Ground Water Samples
CORE Resource, Inc.
2740 Broadway
Oakland, CA

Well Number	Date Sampled	Benzene	Toluene	Ethylbenzene	Xylenes	TPH-G	MTBE
		concentrations (ug/L)					
MW-6*	1/21/89	NA	NA	NA	NA	NA	NA
	5/16/91	NA	NA	NA	NA	NA	NA
	10/18/91	640	2,700	1,100	4,500	28,000	NA
	10/27/91	48	130	55	230	1,300	NA
	7/13/93	5.1	30	30	230	1,100	NA
MW-7	1/21/89	NA	NA	NA	NA	NA	NA
	5/16/91	NA	NA	NA	NA	NA	NA
	10/18/91	NA	NA	NA	NA	NA	NA
	10/27/91	NA	NA	NA	NA	NA	NA
	7/13/93	NA	NA	NA	NA	NA	NA
	6/27/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	NA
	9/19/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	67	NA
	12/13/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<0.5	NA
	10/7/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2.0

Notes:

TPH-G - Total Petroleum Hydrocarbons as gasoline

MTBE - Methyl tert-Butyl Ether

ug/L - micrograms per liter

ND - Not detected at or above detection limits

NA - Not Analyzed

DUP - duplicate sample

* - Wells abandoned on 3/16/94

TABLE 3
VAPOR CONCENTRATIONS - VAPOR PHASE TREATMENT SYSTEM
CORE Resource, Inc.
2740 Broadway
Oakland, CA

Date Sampled	Influent (ppm)	Midpoint (ppm)	Effluent (ppm)
2/29/96	54.6	ND	ND
3/22/96	23.3	ND	ND
4/19/96	126	ND	ND
4/30/96	120	ND	ND
5/3/96	55.7	ND	ND
5/21/96	120	ND	ND
5/30/96	118	ND	ND
7/22/96	230	ND	ND
8/19/96	5	ND	ND
9/4/96	120	ND	ND
9/9/96	76	ND	ND
10/8/96	35.7	1.5	ND
10/24/96	25.5	0.3	ND
11/15/96	16.5	4.5	5.6
12/12/96	15.8	3.7	2.8
1/16/97	13.5	3.6	4.2
1/24/97	15.8	3.7	2.8
1/27/97	16.5	4.5	5.6
2/4/97	14.2	4.2	3.7
2/13/97	13.8	4.2	5.0
2/20/97	14.8	5.0	4.1
3/10/97	12.6	1.8	2.0
4/22/97	13.2	4.0	5.1
6/3/97	14.2	4.1	5.0
7/10/97	12.8	3.6	4.0
7/17/97	12.6	3.2	3.0
7/23/97	12.4	2.0	2.2
7/29/97	12.2	1.8	2.0
10/8/97	14.8	0.0	0.0
10/24/97	14.2	ND	ND

Notes:
ppm - parts per million, vapor-phase total hydrocarbon concentrations measured with a photo ionization detector
ND -non detect, below detection limits

TABLE 4
Groundwater System Flow Totalizer Readings
CORE Resource, Inc.
2740 Broadway
Oakland, CA

Date	Totalizer Reading (gallons)
4/19/96	2800
4/30/96	3494
5/6/96	4080
5/21/96	4433
5/30/96	4493
7/22/96	4790
8/19/96	5780
9/9/96	8070
9/19/96	9810
10/8/96	9854
10/24/96	9894
11/15/96	11,597
12/12/96	14,217
1/16/97	14,320
1/24/97	14,860
1/27/97	15,210
2/4/97	15,460
2/13/97	15,680
2/20/97	15,790
3/10/97	15,830
4/22/97	15,960
5/13/97	15,960
5/30/97	15,960
6/3/97	15,960
7/10/97	15,960
7/17/97	15,960
7/23/97	15,960
7/29/97	15,960
10/8/97	16,234
10/24/97	16,234
1/9/98	36,470
1/14/98	38,945
1/30/98	38,945
2/6/98	38,945
2/19/98	38,945
3/17/98	39,809
3/24/98	42,681
3/31/98	44,837

TABLE 5
Quantities of TPH and Benzene Removed
CORE Resources, Inc.
2740 Broadway
Oakland, California

Date	Water Meter Reading	Gallons Pumped In Period	System Influent Conc. (mg/L)		System Effluent Conc. (mg/L)		Grams of TPH-g Removed In Period	Total Grams TPH-g Removed In Period	Grams of Benzene Removed	Total Grams Benzene Removed
			TPH-g	Benzene	TPH-g	Benzene				
5/30/96	4,493	4,493	390	ND	ND	ND	6.6323	6.6323	0.0000	0.0000
9/19/96	9,810	5,317	71	ND	ND	ND	1.4289	8.0612	0.0000	0.0000
12/13/96	14,217	4,407	81	1	ND	ND	1.3511	9.4123	0.0167	0.0167
1/15/97	14,320	103	360	6	ND	ND	0.1403	9.5527	0.0025	0.0192
7/17/97	15,960	1,640	1,300	140	ND	ND	8.0696	17.6223	0.8690	0.8882
8/19/97	16,045	85	4,300	730	ND	ND	1.3834	19.0057	0.2349	1.1231
12/2/97	not read		300	60	ND	ND	0.0000	19.0057	0.0000	1.1231
12/30/97	not read		2,400	350	ND	ND	0.0000	19.0057	0.0000	1.1231
1/14/98	38,945	22,900	5,200	1,000	ND	ND	450.7178	469.7235	86.6765	87.7996
3/24/98	42,945	4,000	53	1	ND	ND	0.8024	470.5259	0.0151	87.8147

NOTES:

TPH - total petroleum hydrocarbons

ND - non-detected above limit of detection,

Benzene, < 0.5 mg/L

TPH-G, < 50 mg/L

ppb - parts per billion

grams (TPH or benzene) = gallons pumped x 3.785 L/gal x mg/L (TPH or benzene) x 1/1000000 grams/mg

TABLE 6
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER TREATMENT SYSTEM
CORE Resource, Inc.
2740 Broadway
Oakland, CA

Sample Point	Date Sampled	Benzene	Toluene	Ethylbenzene	Xylenes	TPH-G	MTBE
		concentrations (ug/L)					
Influent	5/30/96	--	--	--	--	390	--
	6/27/96	--	--	--	--	86	--
	9/19/96	--	--	--	--	71	--
	12/13/96	1	1.2	ND<0.5	2.2	81	--
	1/15/97	6.4	26	4.2	59	360	ND
	7/17/97	140	170	22	111	1300	ND
	8/19/97	730	870	88	440	4300	<10
	12/2/97	60	44	3.6	26	300	2.7
	12/30/97	350	550	40	370	2400	<20
	1/14/98	1000	2000	130	770	5200	<20
Midpoint	5/30/96	--	--	--	--	ND<50	--
	6/27/96	--	--	--	--	ND<50	--
	9/19/96	--	--	--	--	61	--
	12/13/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	1/15/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	7/17/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	8/19/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	12/2/97	--	--	--	--	--	--
	12/30/97	--	--	--	--	--	--
	1/14/98	--	--	--	--	--	--
Effluent	5/30/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	6/27/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	9/19/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	12/13/96	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	1/15/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	7/17/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	8/19/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	12/2/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	12/30/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	1/14/98	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2

Notes:
TPH-G - Total Petroleum Hydrocarbons as gasoline
MTBE - Methyl tert-Butyl Ether
ug/L - micrograms per liter
-- - Not analyzed for this constituent
ND - Not detected at or above the laboratory reporting limit

TABLE 7
SUMMARY OF ANALYTICAL RESULTS OF VAPOR SAMPLES
CORE Resource, Inc.
2740 Broadway
Oakland, CA

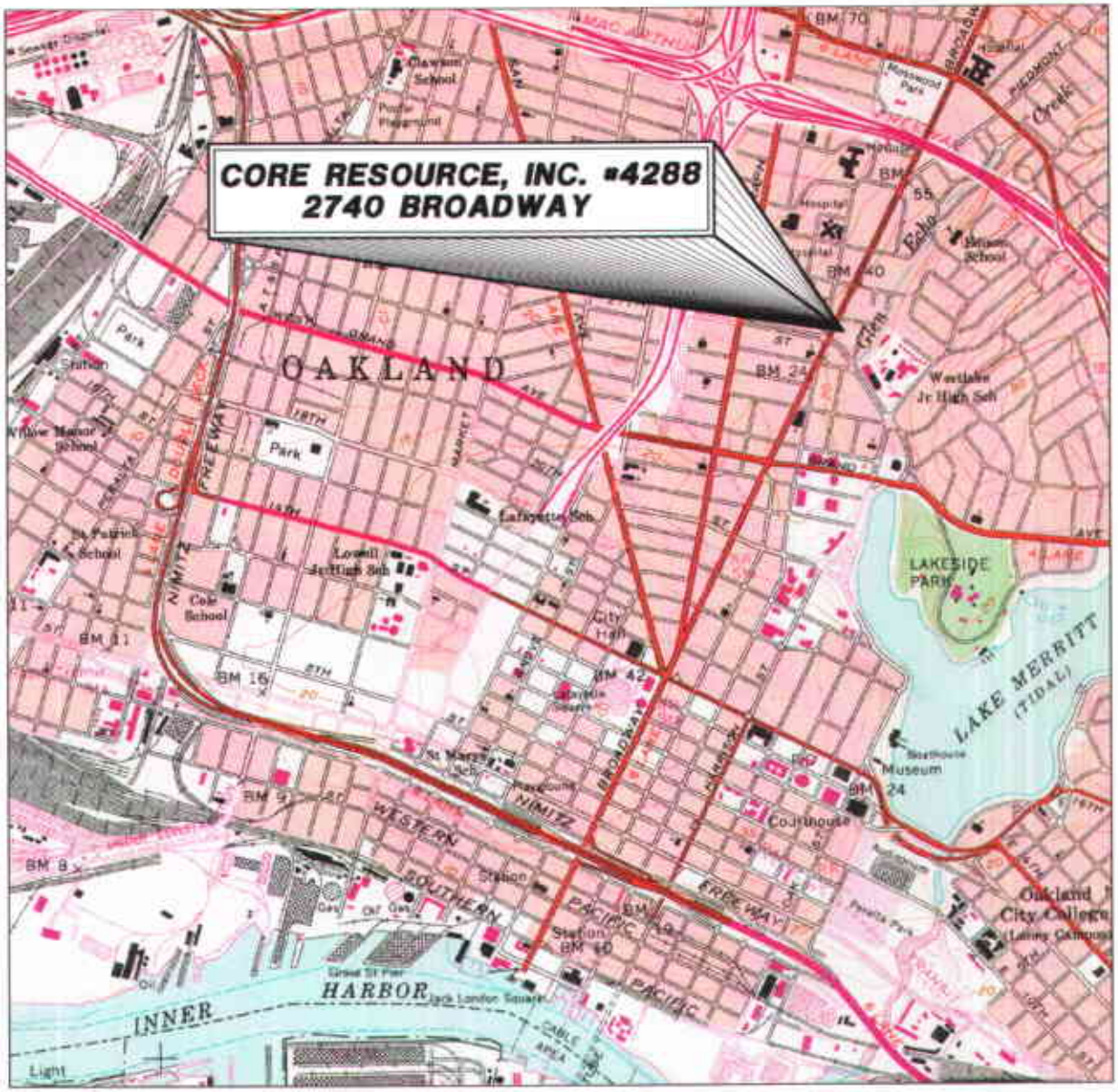
Sample Point	Date Sampled	Benzene	Toluene	Ethylbenzene	Xylenes	TPH-g	MTBE
		All results reported in milligrams per cubic meter					
Influent	5/30/96	ND	ND	ND	ND	ND	--
	9/25/96	3.6	8.5	1.6	2	78	--
	7/23/97	ND	ND	ND	ND	--	--
	12/2/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	12/30/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	1/14/98	0.96	0.8	ND<0.5	ND<0.5	ND<50	ND<2
Effluent	7/23/97	ND	ND	ND	ND	--	
	12/2/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	12/30/97	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2
	1/14/98	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<50	ND<2

Notes:

TPH-g - Total Petroleum Hydrocarbons as gasoline

ND - Not detected at or above the laboratory reporting limit

tb-a1.dwg-10/11/98



FROM: U.S. GEOLOGICAL SURVEY, 1980
QUADRANGLE: Oakland West
COUNTY: Alameda
SERIES: 7.5-minute (topographic)

0 2,000 Feet
SCALE

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QST ENVIRONMENTAL

1340 ARNOLD DRIVE, SUITE 126
MARTINEZ, CA. 94553

DWG BY	RJM
DATE	08/23/93
REV BY	BBN
REVISED	03/01/99

LOCATION MAP

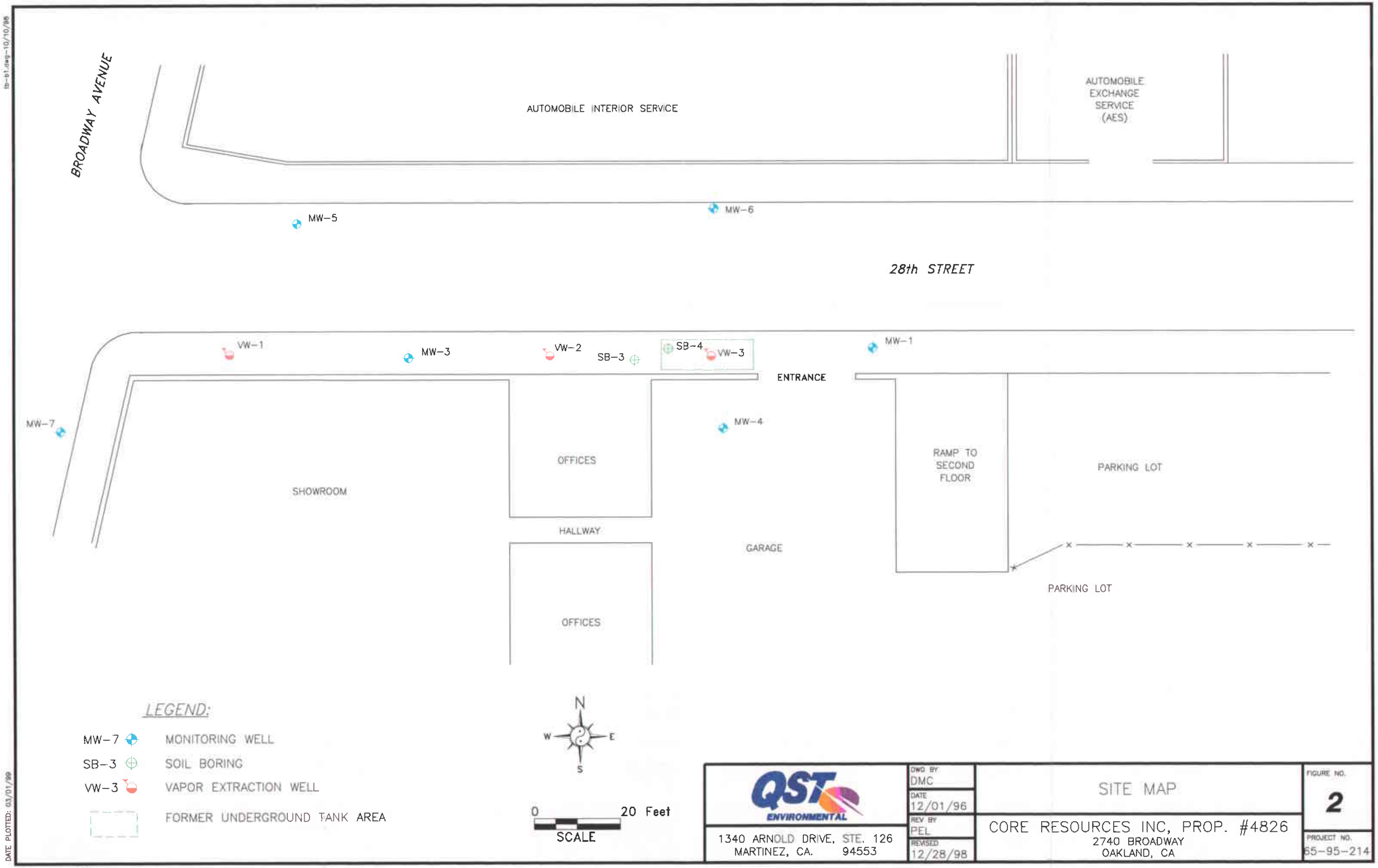
CORE RESOURCES, INC.
PROPERTY #4286
2740 BROADWAY
OAKLAND, CA.

FIGURE NO. 1

PROJECT NO. 65-95214

DATE PLOTTED: 03/01/99

FILE: K:\DWGS\MARTINEZ\CORE\Location Map



QST ENVIRONMENTAL
1340 ARNOLD DRIVE, STE. 126
MARTINEZ, CA. 94553

DWG BY	DMC
DATE	12/01/96
REV BY	PEL
REVISED	12/28/98

SITE MAP

CORE RESOURCES INC, PROP. #4826
2740 BROADWAY
OAKLAND, CA

FIGURE NO. 2

PROJECT NO. 65-95-214

DATE PLOTTED: 03/01/99

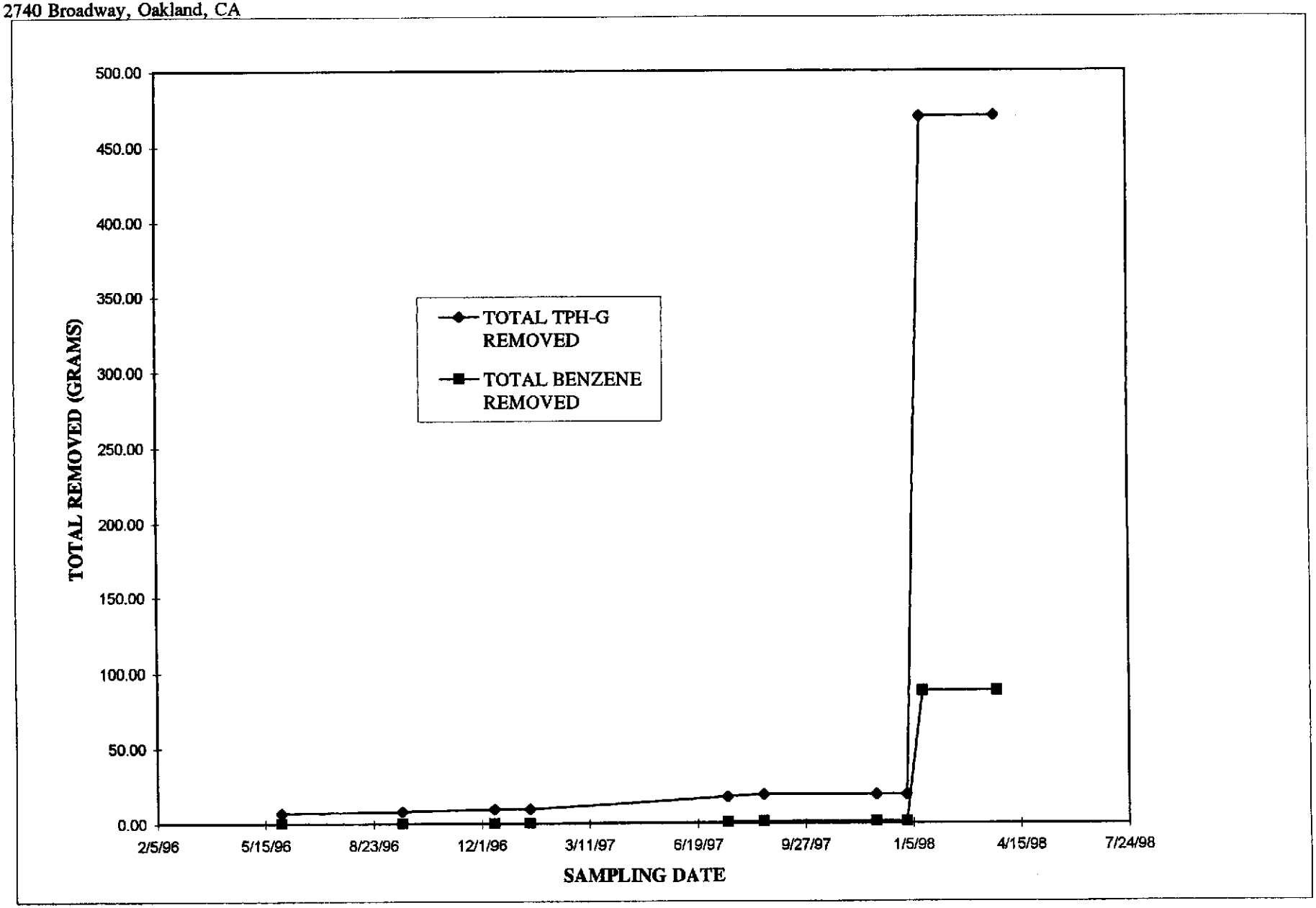
FILE: K:\DWGS\MARTINEZ\CORE\SM

ts-01.dwg-10/10/98

FIGURE 3. GROUND WATER TREATMENT - GRAMS OF TPH AND BENZENE REMOVED

Core Resources, Inc.

2740 Broadway, Oakland, CA



N:\DATA\PROJECTS\CORE\TABLE5

FIGURE 4. ATTENUATION OF BTEX IN GROUNDWATER FROM MW-3

CORE Resources, Inc.

2740 Broadway, Oakland, CA

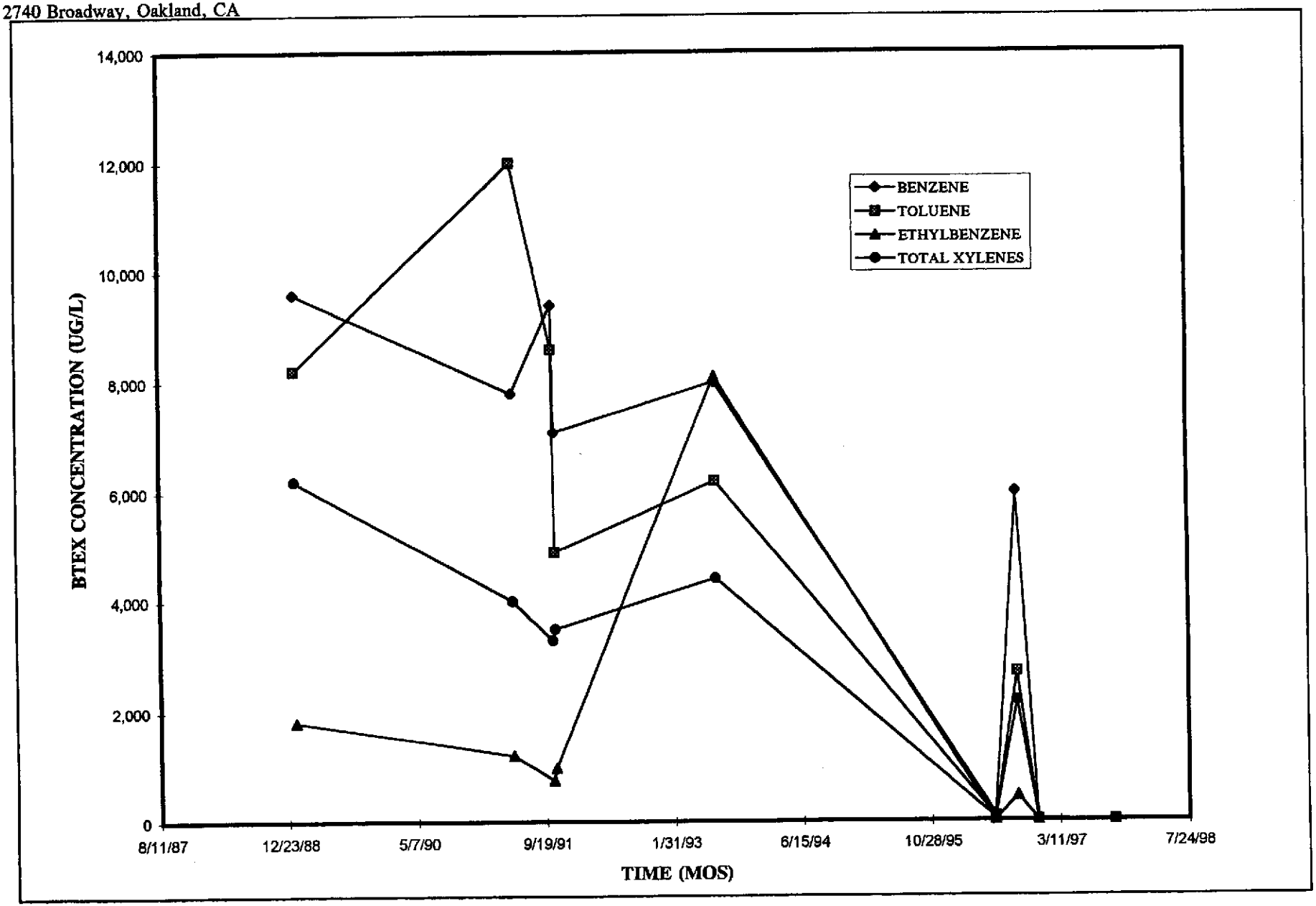


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FIGURE 5. ATTENUATION OF BENZENE IN GROUNDWATER FROM MW-3

Core Resources, Inc.

2740 Broadway, Oakland, CA

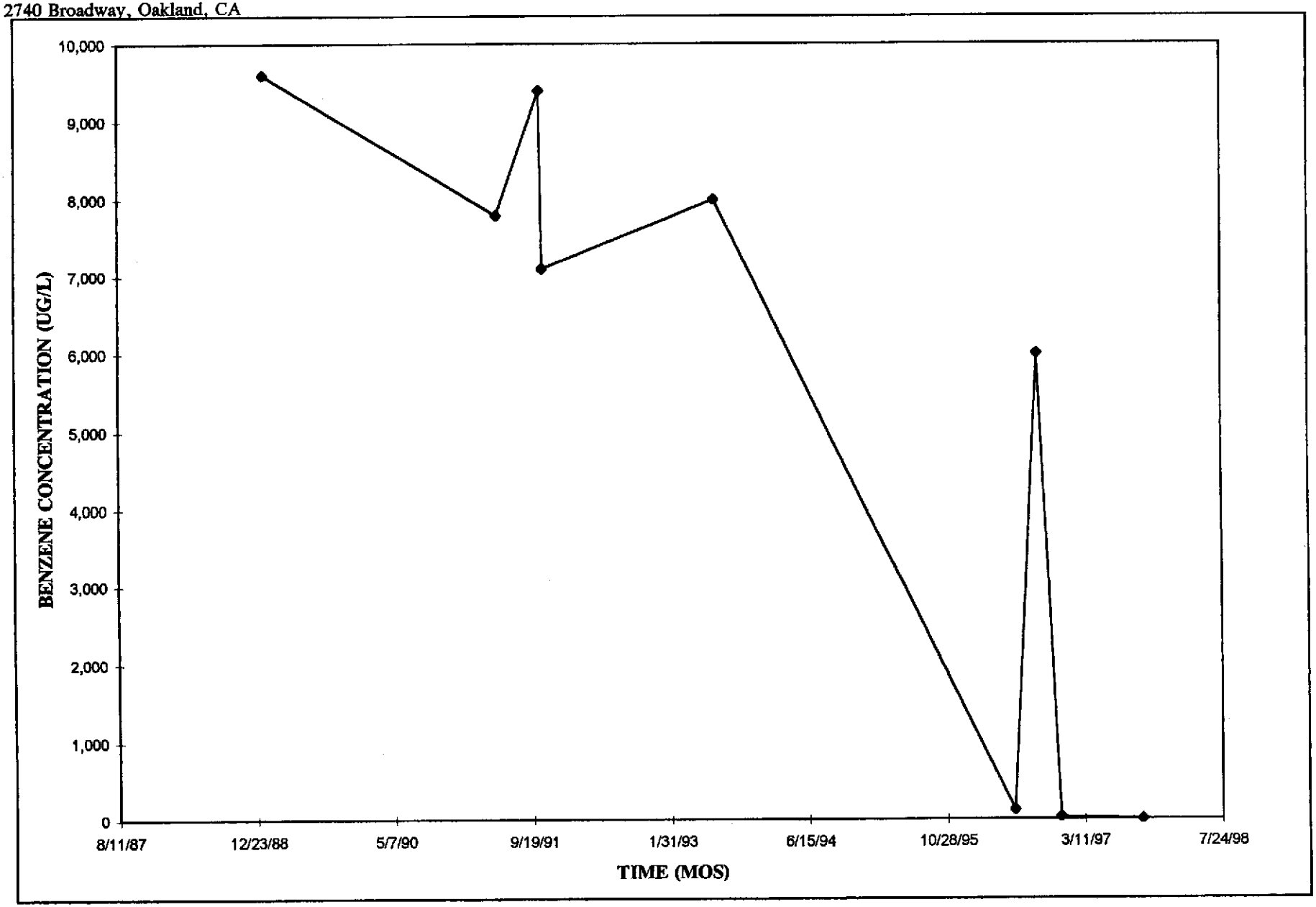

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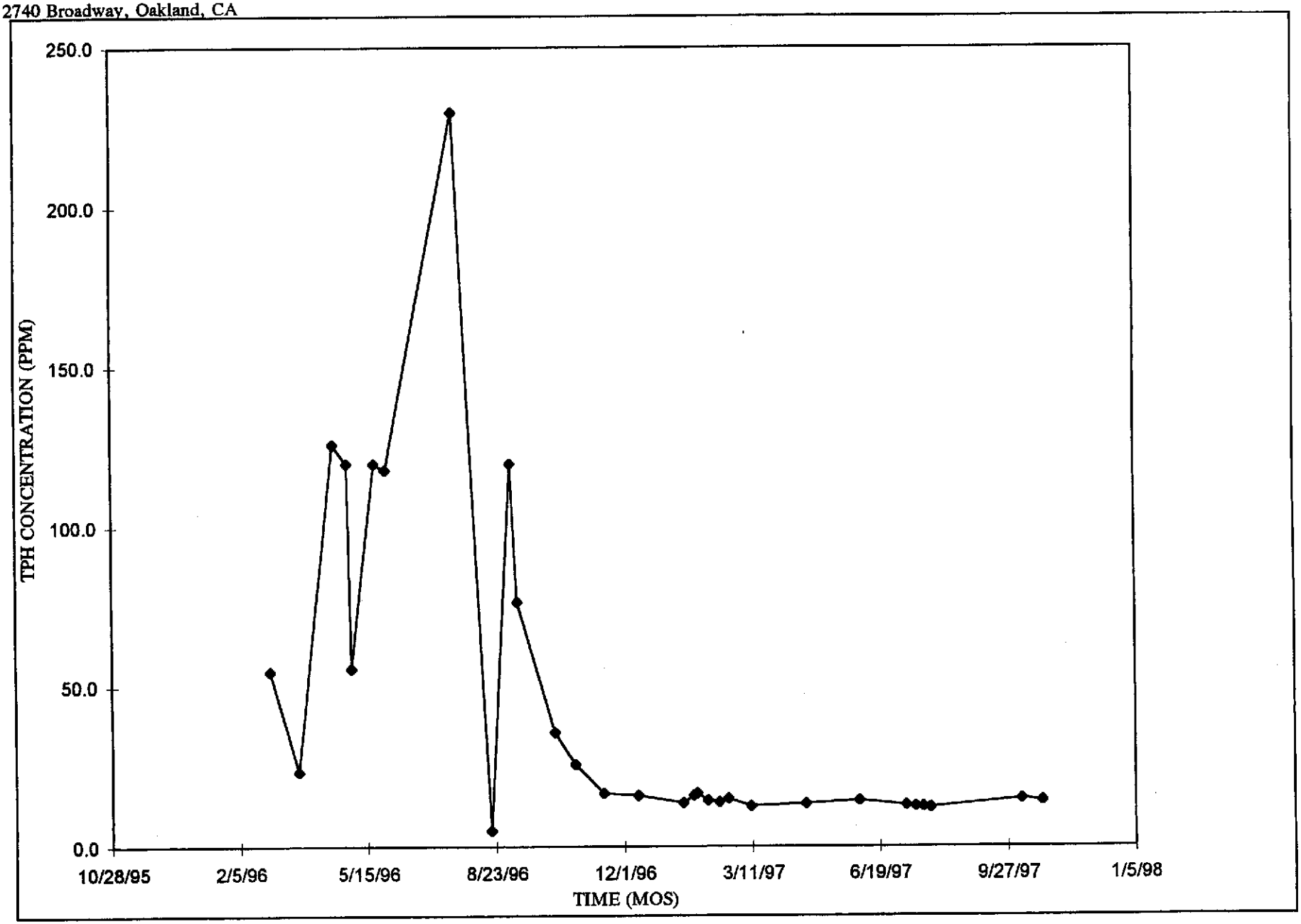
FIGURE 6. VAPOR EXTRACTION SYSTEM INFLUENT TPH OVER TIME

CORE Resources, Inc.

2740 Broadway, Oakland, CA



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APPENDIX A
PRELIMINARY CLEANUP LEVELS FOR PETROLEUM HYDROCARBONS IN SOIL AND GROUNDWATER

APPENDIX A
Preliminary Cleanup Levels for Petroleum Hydrocarbons in Soil and Groundwater

The Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) is publishing five key volumes on the Internet (http://voyager.wpafb.af.mil) about their work since 1993. That work has been directed to establishing risk-based cleanup levels for petroleum hydrocarbons. In the process, they have had to profile the complex mixture of hydrocarbons making up the various petroleum products, to develop new methodology for analyzing petroleum hydrocarbon mixtures, and to assign toxicity factors for the fractions of petroleum hydrocarbons that are analyzed. The result is that concentrations of petroleum hydrocarbon fractions can be evaluated against the toxicity standards to obtain a risk assessment. The reverse process, using target risk and health hazard standards and the new toxicity standards to solve for the allowable concentrations of petroleum hydrocarbons in environmental media, makes possible the calculation of risk-based cleanup levels for petroleum hydrocarbon fractions. Of the volumes designated by the TPHCWG and currently available, the following is the publication status of the information.

TPHCWG Documents Status (July, 1998)		
Volume	Title	Status
Technical Overview	A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, March, 1997	On-line
Draft Analysis Procedure	DRAFT: Characterization of C_6 to C_{28} Petroleum Hydrocarbons in Soil, 2/25/97	On-line
1	Petroleum Hydrocarbon Analysis of Soil and Water in the Environment	In press
2	Composition of Petroleum Mixtures	In press
3	Selection of Reprntative Total Petroleum Hydrocarbon (TPH) Fractions Based on Fate and Transport Considerations	On-line & In press
4	Development of Fraction-Specific Reference Doses (RfDs) and Reference Concentrations (RfCs) for Total Petroleum Hydrocarbons (TPH)	On-line & In press
5	Application of the TPHCWG Methodology Within the ASTM Risk Based Corrective Action Framework	In preparation
Amherst Scientific Publishers will publish volumes 1-5.		

The volume on the determination of soil cleanup levels by the TPHCWG (volume 5) is not yet available, but the methodology from the other available volumes permits a preliminary calculation of what the final cleanup level to be calculated is likely to be. A preliminary calculation is included herein.

As the basis of calculating a risk-based cleanup level for TPH, the EPA has published equations for such calculations keyed to exposure scenarios associated with particular land use (EPA, 1991a; also called RAGS, Part B). The standard land uses cited by EPA are *residential* and *commercial-industrial.* Agricultural land use is handled as a variant of commercial-industrial land use for farm workers. EPA advises against evaluating agricultural land use as a variant of residential land use unless it is known that families reside in the agricultural setting (EPA, 1991b). EPA has utilized the RAGS, Part B equations to compile a standard list of preliminary remediation goals (PRGs, EPA, 1998) for several hundred chemicals, but a similar calculation for TPH has yet to be published.

In the current case, the property is commercial-industrial land use. That has implications for what the applicable cleanup level should be. Since the EPA considers residential land use as the evergreen standard for unrestricted land use, it is likely that residential land use would be the basis for a soil cleanup value for TPH.

Cleanup levels for TPH must include consideration of both cancer-causing (carcinogenic) and non-cancer health effects. Current practice involves the assessment of carcinogenic effects via specific "indicator" chemicals, namely *benzene* and *benzo(a)pyrene*. PRGs already exist for these compounds, and analytical methods for soil measurement of the concentrations of these chemicals directly permits attaining those cleanup standards. Thanks to the work of the TPHCWG, non-cancer health effects of TPH can now be addressed by using the new toxicity reference values for specific fractions of the petroleum hydrocarbon mixture, denoted by their equivalent carbon number (ECN), to calculate risk-based cleanup concentrations. New analytical methodology to measure these TPH fractions in soil supports attaining the cleanup levels.

PRELIMINARY CALCULATION OF CLEANUP LEVEL FOR TPH FRACTIONS

The calculation of risk-based cleanup levels can be achieved using the standard equations of RAGS, Part B (EPA, 1991).

Soil

The equation for the calculation is abstracted from EPA, 1991a, page 25. The full description of the equation may be found in RAGS, Part B (EPA, 1991a), but considering consolidation of the component numerical default exposure factors in that equation, the operative equation for calculation of a PRG for residential soil, noncarcinogenic effects is as follows:

PRG (mg/kg) = 2.7×10^5 (RfD_o) [based on Target Hazard Index of 1.0]

The appropriate reference dose (oral; RfD_o) is derived from the TPHCWG work, volume 4 (see also, Weisman, 1998). Based on ECNs, there are three categories and three RfD_os. The following table lists the ECNs, RfD_os, and the calculated preliminary PRG.

Reference Doses and Preliminary PRGs for TPH Fractions in Soil		
Equivalent Carbon Number (ECN) Fraction	Reference Dose, Oral (RfD_o) (mg/kg-day)	Preliminary PRG, Residential Soil, Noncarcinogenic Effects (mg/kg)
C5 - C8	2	540,000
C8 - C16	0.1	27,000
C16 - C35	1	270,000

If only TPH analysis results are used, the final cleanup value for TPH in soil would be the most stringent of the PRGs for the ECNs as a conservative measure to represent the entire TPH mixture which contains the particular ECN fraction as a component. If cleanup were monitored for each ECN fraction, the preliminary PRGs above would be operative for cleanup, or they may be modified by further refinement of the calculation for protection of Groundwater (if appropriate) or negotiation with the administering agency.

Groundwater

The risk-based PRG for TPH fractions in Groundwater may be calculated from the reduced equation from RAGS, Part B (EPA, 1991) for a PRG for noncarcinogenic effects as follows:

$$PRG\ (mg/L) = \frac{73}{[(7.5/RfD_i) + (2/RfD_o)]}$$

The values for RfD_i and RfD_o are given in (Weisman, 1998). Incorporating these in the equation above for each of the ECN fractions yields the results in the following table.

Reference Doses and Preliminary PRGs for TPH Fractions for Groundwater			
Equivalent Carbon Number (ECN) Fraction	Reference Dose, Oral (RfD_o) mg/kg-day	Reference Dose, Inhalation (RfD_i) mg/kg-day	Preliminary PRG, Groundwater, Noncarcinogenic Effects (mg/L)
C5 - C8	2	5.26	30.1
C8 - C16	0.1	0.28	1.6
C16 - C35	1	NA	NA

NA = not available

REFERENCES

EPA, see United States Environmental Protection Agency.

United States Environmental Protection Agency, 1991a, Human Health Evaluation Manual, Part B: "Development of Risk-based Preliminary Remediation Goals," OSWER Directive 9285.7-01B, Office of Solid Waste and Emergency Response, Washington, DC 20460, December 13.

United States Environmental Protection Agency, 1991b, Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors," OSWER Directive 9285.6-03, Office of Solid Waste and Emergency Response, Washington, DC 20460, March 25.

United States Environmental Protection Agency, 1998, Region 9 Preliminary Remediation Goals (PRGs) 1998, Stanford J. Smucker, Ph.D., Regional Toxicologist, San Francisco, CA 94105-3901.

Weisman, W., 1998, Total Petroleum Hydrocarbon Criteria Working Group: A Risk-Based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Journal of Soil Contamination, Vol. 7, No. 1, pp. 1-15.