CAMBRIA
Environmental Technology, Inc.

January 30, 1996

Jennifer Eberle
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway, 2nd Floor
Alameda, CA 94502-6577

Re: **Investigation Workplan**
Former Shell Service Station
1230 14th Street
Oakland, California
WIC # 204-4878-1300

Dear Ms. Eberle:

As required by Alameda County Department of Environmental Health (ACDEH), Cambria Environmental Technology (Cambria) is submitting this workplan to complete a subsurface investigation at the site referenced above on behalf of Shell Oil Company (Shell). Based on analytic results collected by Cambria during a November 27, 1995 piping trench and tankpit soil sampling event, hydrocarbons are in soil beneath the site. The objective of the proposed investigation workplan are to: 1) Define the horizontal and vertical extent of hydrocarbons in soil and ground water in the vicinity of the former tankpit and pump islands; and 2) Install wells for future monitoring and remediation. To achieve these objectives Cambria recommends drilling soil borings adjacent to and downgradient of potential hydrocarbon source areas and installing ground water monitoring and remediation wells in selected borings. All work will be conducted in accordance with the Tri-Regional Guidelines and pertinent state regulations including Title 23, Subchapter 16, Article 7 UST Closure Requirements. The site background and our proposed scope of work are presented below.

SITE BACKGROUND

Site Status: The site is currently occupied by a non-operating service station.

1991 Soil Borings: In February 1991, Tank Protect Engineering (TPE) drilled soil borings SB-1, SB-2, and SB-3 adjacent to the existing gasoline USTs. Maximum concentrations of 1,600 ppm total petroleum hydrocarbons as gasoline (TPHg) and 18 ppm benzene were detected in the soil sample collected at 10.5 ft depth in boring SB-3 located immediately downgradient of the gasoline UST tankpit. A figure presenting boring locations, boring logs, and analytic results are included as Attachment A.

1144 Sixty-Fifth Street Suite C Oakland, CA 94608 Fax (510) 420-9170 Phone (510) 420-0700

1993 Tank Removal: [redacted]. They also collected confirmation soil samples from beneath each tank end and from beneath each dispenser. Maximum concentrations of 18,000 ppm TPHg and 11 ppm benzene were detected in the soil samples collected from the gasoline tankpit. The soil sample collected from the waste oil tankpit at about 8 ft depth contained 1,200 ppm TPH as diesel (TPHd) and 7,700 ppm oil and grease. Maximum concentrations of 13 ppm TPHg and 0.007 ppm benzene were detected in the soil samples collected beneath the product dispensers. A figure and analytic results are included as Attachment B.

1995 Piping Trench and Tankpit Excavation Sampling: On November 27, 1995, Cambria collected 8 soil samples from 15.0 ft depth beneath the ends of the former gasoline tanks using a remote controlled backhoe. Cambria also collected six soil samples beneath product piping removed by K.E. Curtis Construction Inc., of Castro Valley, California, the general contractor. Hydrocarbons were detected in all eight tank excavation samples, at up to 5,600 ppm TPHg and 72 ppm benzene. No TPHg were detected in four of the six product piping soil samples collected. However, 3,100 ppm TPHg and 30 ppm benzene were detected beneath the southern pump island in sample TS6-3.0 (Figure 1 and Table 1). Since only 46 ppm TPHg and no benzene were detected in adjacent sample TS5-2.5, the horizontal extent of hydrocarbons originating from the southern pump island appears limited. No additional waste oil tankpit samples were collected because the remote backhoe could not reach as deep as the original soil sample collected by TPE. Sample locations are shown on Figure 1 and analytic results for soil are summarized on Table 1.

Ground Water: During the tankpit sampling completed on November 27, 1995 by Cambria, sediments were moist to wet at about 15 ft depth. Therefore, ground water is probably about 15 ft deep beneath the site.

Soil Lithology: The site is underlain by silty sand and sandy silt of moderate estimated permeability to the total depth explored during recent and historical investigations of about 20 ft.

PROPOSED INVESTIGATION SCOPE OF WORK

Soil Borings: To define the horizontal and vertical extent of hydrocarbons in soil and ground water adjacent to the former underground storage tanks and to assess whether the former pumps are a potential hydrocarbon source, we propose drilling 6-8 soil borings near the former tanks and 2 borings near the pump islands. Proposed boring locations are shown on Figure 1.

As described in the Standard Field Procedures in Attachment A, we will use a photoionization detector (PID) and field observations to screen soil samples for the presence of hydrocarbons. We will continue drilling until no PID or field hydrocarbon indications are detected. We may need to alter this sampling plan based on field observations if it will provide better horizontal and vertical hydrocarbon definition. For example, if hydrocarbons are detected in an initial boring, an additional boring may be drilled further from the hydrocarbon source to define the horizontal extent of hydrocarbons.

Selected soil samples will be analyzed for TPHg and benzene, toluene, ethylbenzene and xylenes (BTEX) using EPA Methods 8015M/8020. Soil samples collected near the former waste oil tank will be analyzed for petroleum oil and grease (POG) by EPA method 5520 B/F. Cambria will attempt to collect grab ground water samples from borings that will not be converted into ground water monitoring wells. The ground water samples will also be analyzed for TPHg/BETX.

Well Installation: Cambria will install ground water monitoring wells and/or soil vapor extraction (SVE) wells and air-sparging (AS) wells in the soil borings depending on the boring location and the hydrocarbon concentrations detected. AS wells may also be used for future ground water sampling. Possible well locations are presented on Figure 2.

Summary: The specific tasks for this investigation will include:

1. Preparing a site safety plan and coordinating field activities;

2. Obtaining boring permits and notifying Underground Service Alert of our drilling activities to locate underground utilities at the site boundaries prior to drilling;

3. Drilling about eight soil borings to define the horizontal and vertical extent of hydrocarbons near the former tanks and existing pump islands;

4. Collecting soil samples at five ft intervals, at lithologic changes and immediately above the water table and analyzing selected samples for TPHg/BETX and/or POG;

5. Collecting grab ground water samples from borings when possible and analyzing the samples for TPHg/BETX and/or POG. No grab ground water samples will be collected from borings that will be converted into ground water monitoring wells;

6. Installing ground water monitoring wells, SVE wells, and AS wells as appropriate;

7. Developing and sampling newly installed ground water monitoring wells, analyzing ground water samples for TPHg/BETX and/or POG;

8. Grouting the borings; and

9. After the analytic results are received, preparing a subsurface investigation report that, at a minimum, will contain:

   - A summary of the site background and history;
   - Descriptions of the drilling and soil sampling methods;
   - Boring logs;
   - Tabulated soil and ground water analytic results;
   - Analytic reports and chain-of-custody forms; and
   - A discussion of the hydrocarbon distribution.

CLOSING

We appreciate this opportunity to provide environmental consulting services to Shell Oil Company. Please call if you have any questions or comments.

Sincerely,
Cambria Environmental Technology, Inc.

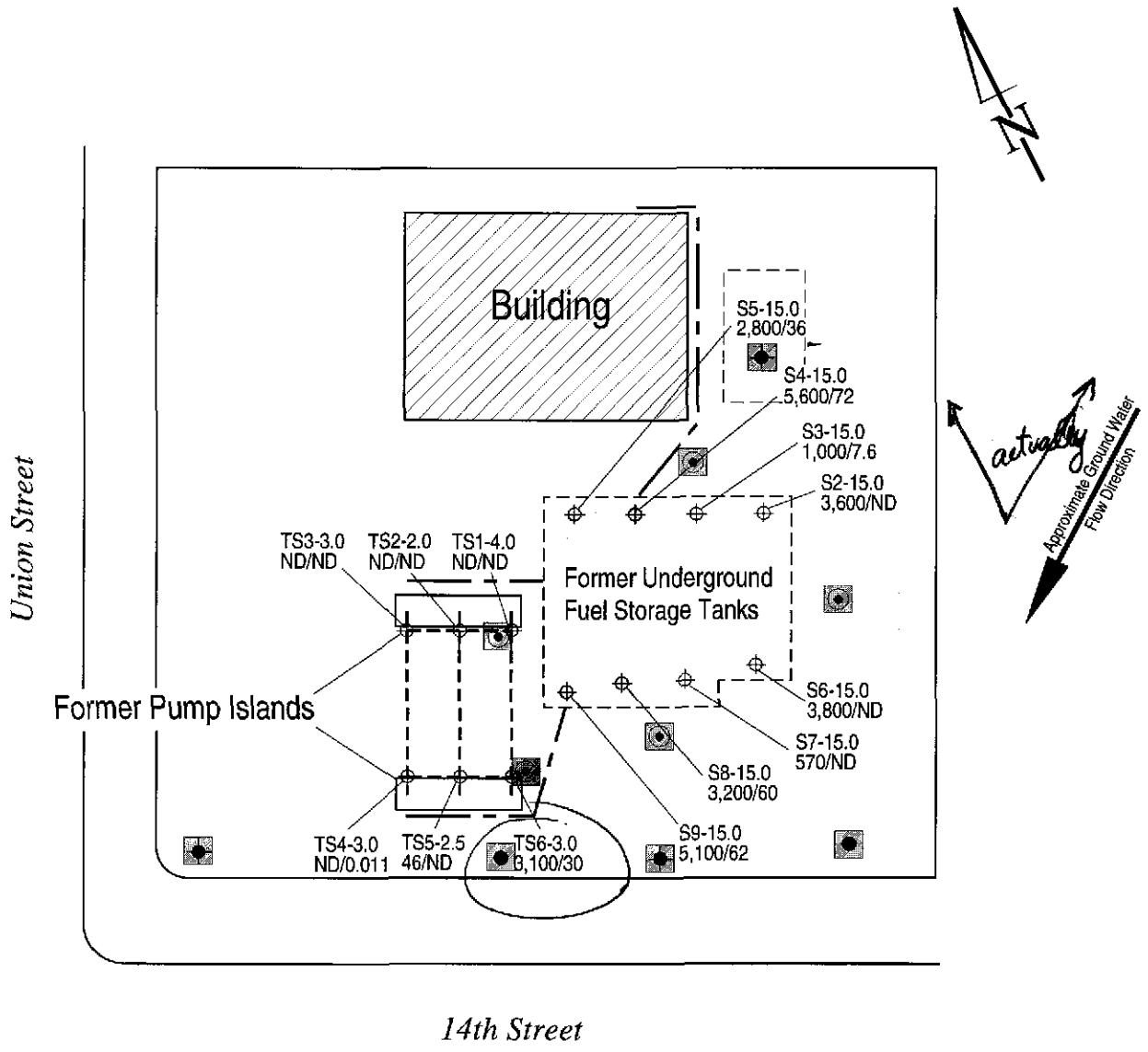
David C. Elias
Project Geologist

N. Scott MacLeod, R.G.
Principal Geologist

cc: Jeff Granberry, Shell Oil Company

D:\PROJECT\SHELL\OAKLAND\WORKPLAN.WPD

Attachments: A - TPE Soil Borings
B - TPE UST Removal
C - Standard Operating Procedures



LEGEND

- Sample ID-Depth (ft)
  TPHg/Benzene Concentration in ppm
- Former Vent Piping
- Former Product Piping
- ND = Not Detected
- Proposed Ground Water Monitoring Well
- Proposed Combination Air Sparge/Soil Vapor Extraction Wells
- Proposed Soil Boring

0 20
Scale (ft)

Base Map by Tank Protect Engineering

CAMBRIA
Environmental Technology, Inc.

Former Shell Service Station
WIC # 204-4878-1300
1230 14th Street
Oakland, California

D:/PROJECT/SHELL/OAKLAND/SITE.DWG

Proposed Soil
Boring and Well Locations

FIGURE
1

Table 1. Soil Analytic Data - Former Shell Service Station - 1230 14th Street, Oakland, California

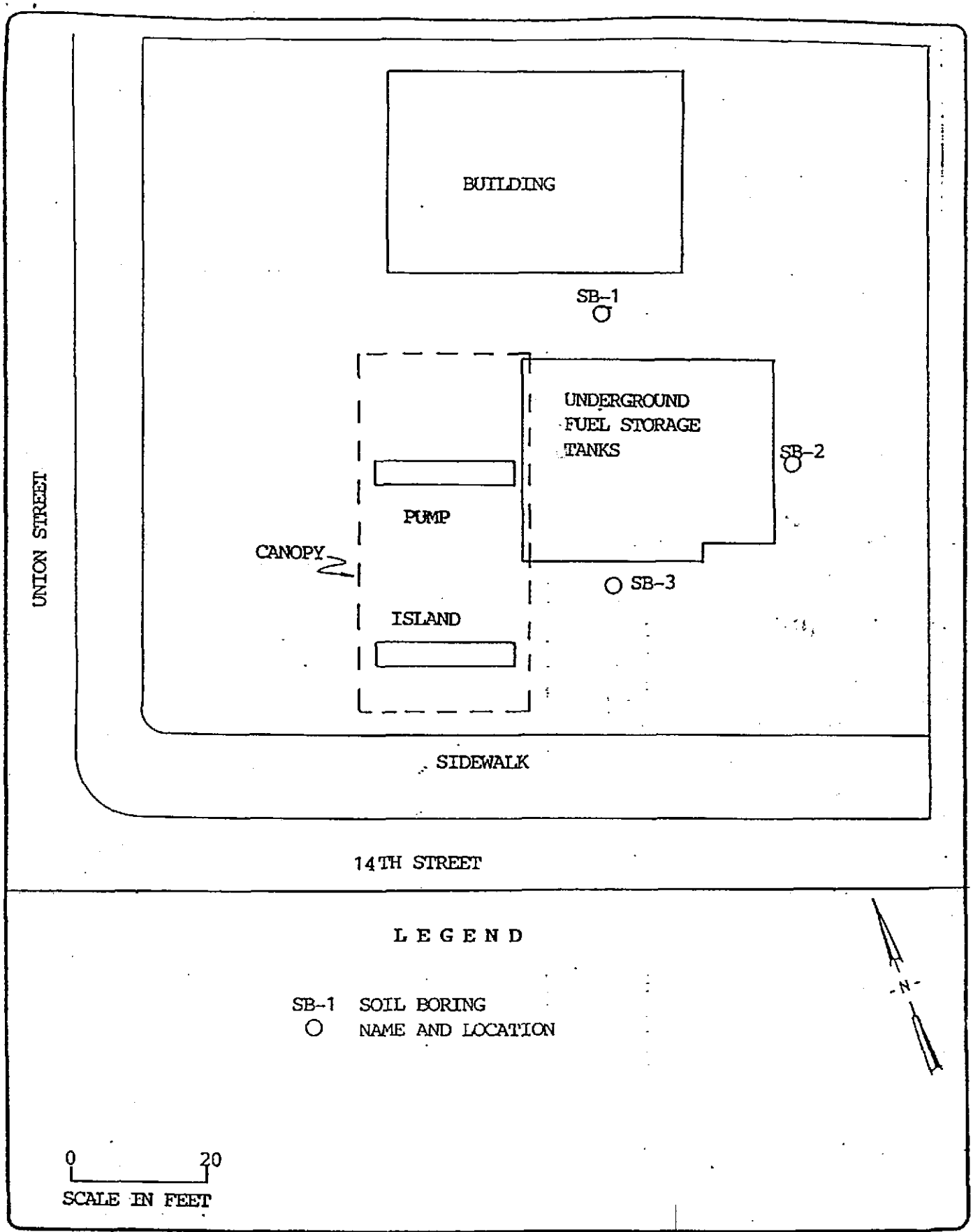
Boring/ well ID	Date Sampled	Sample Depth (ft)	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes
			All concentrations in parts per million (mg/kg)				
Product Piping Samples							
TS-1-4.0	11/27/95	4.0	<1.0	<0.0050	0.0050	<0.0050	<0.0050
TS-2-2.0	11/27/95	2.0	<1.0	<0.0050	0.0057	<0.0050	0.0075
TS-3-3.0	11/27/95	3.0	<1.0	<0.0050	<0.0050	<0.0050	0.0069
TS-4-3.0	11/27/95	3.0	<0.0	0.011	0.038	0.0073	0.043
TS-5-2.5	11/27/95	2.5	46	<0.10	<0.10	<0.10	2.0
TS-6-3.0	11/27/95	3.0	3,100	30	<6.0	33	230
Tankpit Excavation Samples							
S2-15.0	11/27/95	15.0	3,600	<6.0	140	78	430
S3-15.0	11/27/95	15.0	1,000	7.6	33	19	100
S4-15.0	11/27/95	15.0	5,600	72	280	110	580
S5-15.0	11/27/95	15.0	2,800	36	160	64	350
S6-15.0	11/27/95	15.0	3,800	<6.0	<6.0	76	350
S7-15.0	11/27/95	15.0	570	<0.50	<0.50	4.9	13
S8-15.0	11/27/95	15.0	3,200	60	200	69	350
S9-15.0	11/27/95	15.0	5,100	62	260	110	570

Abbreviations
TPHg = Total petroleum hydrocarbons as gasoline
<x.xx = not detected above x.xx ppm detection limit

Notes
TPHg analyzed by modified EPA Method 8015
Benzene, ethylbenzene, toluene and xylenes analyzed by EPA Method 8020

ATTACHMENT A

TPE Soil Borings



LEGEND

SB-1 SOIL BORING
○ NAME AND LOCATION

N

0 20
SCALE IN FEET

TANK PROTECT ENGINEERING
Of Northern California

SITE PLAN
1230 14TH STREET
OAKLAND, CALIFORNIA

FIGURE

LOG OF EXPLORATORY BORING

PROJECT NUMBER 150 BORING NO. SB-1

PROJECT NAME 1230 14th Street, Oakland, CA PAGE

BY J. V. Mrakovich DATE 2/21/91 SURFACE ELEV. 17 FT

RECOVERY (FT/FT)	OVA (PPM)	PENETRATION (BLOWS/FT)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION
				1			ASPHALT
				2			AGGREGATE BASE: SANDY GRAVEL (GW), yellow-brown, medium to coarse, damp, no odor.
				3			FILL: SILTY SAND (SP), grey to black, fine to medium-grained, medium-dense, damp, gasoline odor.
				4			
1.5/1.5	-	27		5			
				6			Fill: As Above, mottled brown and blue-green, gasoline odor.
				7			
				8			
				9			
1.25/1.5	-	67		10			FILL: As Above, olive-green, very dense at 10 feet, medium dense at 15 feet, gasoline odor.
				11			
				12			
				13			
				14			
1.5/1.5	-	14		15			
				16			SILTY SAND (SP), olive-green, fine to medium grained, medium dense, saturated, stiff seam at 17.5 feet, gasoline odor.
			▽	17			Boring terminated at 20'.
				18			
				19			
				20			

REMARKS: Boring drilled with continuous-flight, 8-inch O. D., hollow-stem augers. Samples collected in a 2.5-inch O. D. California Sampler.

LOG OF EXPLORATORY BORING

PROJECT NUMBER 150 — BORING NO. SB-3

PROJECT NAME 1230 14th Street, Oakland, CA — PAGE

BY J. V. Mrakovich — DATE 2/21/91 — SURFACE ELEV. 17 FT

RECOVERY (FT/FT)	OVA (PPM)	PENETRATION (BLOWS/FT)	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOGRAPHIC COLUMN	DESCRIPTION
				1			ASPHALT
				2			AGGREGRATE BASE AND FILL: GRAVELLY SAND (SP), yellow-brown first 3-inches, then grey, fine to coarse-grained, red brick fragments, damp, strong gasoline odor.
				3			
				4			
1.5/1.5	-	34		5			SILTY SAND (SP), olive-green, fine to medium-grained, dense, damp, strong gasoline odor.
				6			FILL: As Above, mottled red-brown and grey, gasoline odor.
				7			
				8			FILL: As Above, brown, minor clay, very dense at 10 feet, dense and saturated at 15 feet, gasoline odor.
				9			
1.5/1.5	-	65		10			
				11			
				12			
				13			
				14			Boring terminated at 15'; sampled to 16.5'.
1.5/1.5	-	32		15			
				16			

REMARKS: Boring drilled with continuous-flight, 8-inch O. D., hollow-stem augers. Samples collected in a 2.5-inch O. D. California Sampler.

SEQUOIA ANALYTICAL

1900 Bates Avenue • Suite LM • Concord, California 94520
(415) 686-9600 • FAX (415) 686-9689

Tank Protect Engineering of N. Calif	Client Project ID:	#150B-022191	Sampled: Feb 21, 1991
2821 Whipple Road	Matrix Descript:	Soil	Received: Feb 22, 1991
Union City, CA 94587	Analysis Method:	EPA 5030/8015/8020	Analyzed: Feb 28, 1991
Attention: John Mrakovich	First Sample #:	102-0534	Reported: Mar 1, 1991

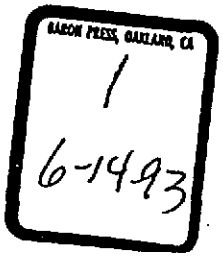
TOTAL PETROLEUM FUEL HYDROCARBONS with BTEX DISTINCTION (EPA 8015/8020)

Sample Number	Sample Description	Low/Medium B.P. Hydrocarbons mg/kg (ppm)	Benzene mg/kg (ppm)	Toluene mg/kg (ppm)	Ethyl Benzene mg/kg (ppm)	Xylenes mg/kg (ppm)
102-0534	SB1-6-6.5	11	0.014	0.37	0.22	1.2
102-0535	SB1-10.5-11	4.6	0.15	0.50	0.13	0.68
102-0536	SB1-15.5-16	7.5	2.1	1.8	0.18	1.1
102-0537	SB2-6-6.5	N.D.	N.D.	N.D.	N.D.	0.034
102-0538	SB2-10.5-11	1.8	0.062	0.038	0.035	0.082
102-0539	SB2-15.5-16	6.1	1.2	1.4	0.15	0.80
102-0540	SB3-6-6.5	N.D.	0.038	0.0054	0.015	0.034
102-0541	SB3-10.5-11	1,600	18	98	35	190
102-0542	SB3-15.5-16	2.4	0.31	0.21	0.064	0.35
Detection Limits:		1.0	0.0050	0.0050	0.0050	0.0050

Low to Medium Boiling Point Hydrocarbons are quantitated against a gasoline standard.
Analytes reported as N.D. were not present above the stated limit of detection.

EQUOIA ANALYTICAL

Julia R. Malerstein
Project Manager



SEQUOIA ANALYTICAL

1900 Bates Avenue • Suite LM • Concord, California 94520
(415) 686-9600 • FAX (415) 686-9689

ank Protect Engineering of N. Calif	Client Project ID:	#1508-022191	Sampled:	Feb 21, 1991
2821 Whipple Road	Sample Descript:	Soil	Received:	Feb 22, 1991
Union City, CA 94587	Analysis Method:	California LUFT Manual, 12/87	Extracted:	Feb 26, 1991
Attention: John Mrakovich	First Sample #:	102-0534	Analyzed:	Feb 26, 1991
			Reported:	Mar 1, 1991

ORGANIC LEAD

Sample Number	Sample Description	Sample Results mg/kg (ppm)
102-0534	SB1-6-6.5	N.D.
102-0535	SB1-10.5-11	N.D.
102-0536	SB1-15.5-16	N.D.
102-0537	SB2-6-6.5	N.D.
102-0538	SB2-10.5-11	N.D.
102-0539	SB2-15.5-16	N.D.
102-0540	SB3-6-6.5	N.D.
102-0541	SB3-10.5-11	N.D.
102-0542	SB3-15.5-16	N.D.

Detection Limits:	0.005

Analytes reported as N.D. were not present above the stated limit of detection.

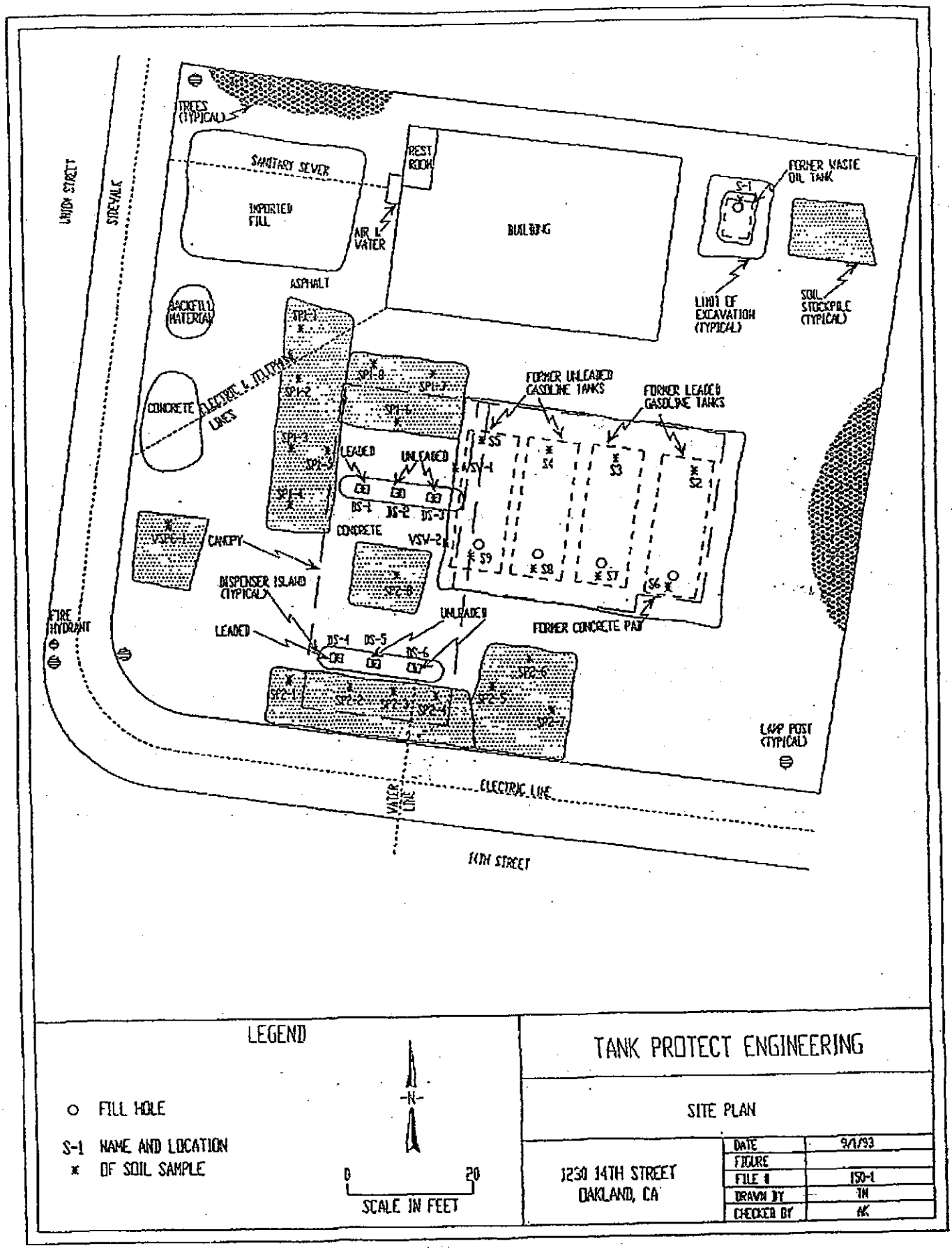
EQUOIA ANALYTICAL

Julia R. Malerstein
Project Manager

CAMBRIA

ATTACHMENT B

TPE UST Removal



LEGEND

- ○ FILL HOLE
- S-1 NAME AND LOCATION
- ✱ OF SOIL SAMPLE

-N-

0 20

SCALE IN FEET

TANK PROTECT ENGINEERING

SITE PLAN

1230 14TH STREET
OAKLAND, CA

DATE	9/1/93
FIGURE	
FILE #	150-1
DRAWN BY	TN
CHECKED BY	AK

PRIORITY ENVIRONMENTAL LABS

Precision Environmental Analytical Laboratory

August 31, 1993 PEL # 9308104

TANK PROTECT ENGINEERING, INC. Attn: Jeff
Re: Twenty two soil samples for Gasoline/BTEX, Diesel, and Oil & Grease analyses.

Project name: Sabek, Inc. Project location: 1230 14th St.
Project number: 150A082693

Date sampled: Aug 25-26, 1993 Date submitted: Aug 27, 1993
Date extracted: Aug 27-30, 1993 Date analyzed: Aug 27-30,1993

RESULTS:

SAMPLE I.D.	Gasoline (mg/Kg)	Diesel (mg/Kg)	Benzene (ug/Kg)	Toluene (ug/Kg)	Ethyl Benzene (ug/Kg)	Total Xylenes (ug/Kg)	Oil & Grease (mg/Kg)
DS-1	13	---	7.0	17	21	72	---
DS-2	2.0	---	5.3	8.9	12	31	---
DS-3	1.3	---	N.D.	5.9	6.1	18	---
DS-4	2.7	---	5.5	9.4	16	47	---
DS-5	3.4	---	5.9	11	18	61	---
DS-6	11	---	6.8	15	18	64	---
S-1 waste oil UST	67	1200	38	89	110	380	7700
S-2	2200	---	1400	3200	3500	13000	---
S-3	530	---	400	760	830	3100	---
S-4	40	---	31	59	66	290	---
S-5	1.4	---	N.D.	6.3	8.1	25	---
S-6	1600	---	970	2300	2700	10000	---
S-7	11000	---	6700	16000	18000	69000	---
S-8	18000	---	11000	26000	30000	110000	---
S-9	6200	---	3700	8700	10000	37000	---
SP1-1,2,3,4*	960	---	580	1400	1600	5900	---
SP1-5,6,7,8*	950	---	560	1400	1500	5700	---
SP2-1,2,3,4*	3500	---	2200	5100	5900	22000	---
SP2-5,6,7,8*	4800	---	2800	7100	8200	31000	---
VSPC-1	1.7	---	N.D.	6.6	9.6	28	---
VSW-1	4800	---	2900	7000	8000	30000	---
VSW-2	21	---	150	290	330	1300	---
Blank	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Spiked Recovery	82.3%	94.1%	84.0%	85.2%	83.1%	92.2%	---
Duplicate Spiked Recovery	92.0%	93.6%	89.5%	90.6%	88.4%	98.7%	---
Detection limit	1.0	1.0	5.0	5.0	5.0	5.0	10
Method of Analysis	5030/ 8015	3550/ 8015	8020	8020	8020	8020	5520 D & F

*Composited soil samples.

David Duong
Laboratory Director

1764 Houret Court Milpitas, CA. 95035 Tel: 408-946-9636 Fax: 408-946-9663

PRIORITY ENVIRONMENTAL LABS
Precision Environmental Analytical Laboratory

September 02, 1993

PEL # 9308104

TANK PROTECT ENGINEERING, INC.

Attn: Jeff

Re: Five soil samples for Cadmium, Chromium, Lead, Nickel, and Zinc analyses.

Project name: Sabek, Inc.
Project location: 1230 14th St.
Project number: 150A082693

Date sampled: Aug 25-26,1993
Date extracted: Aug 31,1993

Date submitted: Aug 27, 1993
Date analyzed: Aug 31, 1993

RESULTS:

SAMPLE I.D.	Cadmium (mg/Kg)	Chromium (mg/Kg)	Lead (mg/Kg)	Nickel (mg/Kg)	Zinc (mg/Kg)
S-1	N.D.	43	47	36	35
S-2	---	---	N.D.	---	---
S-6	---	---	N.D.	---	---
DS-1	---	---	33	---	---
DS-4	---	---	11	---	---
STLC	1.0	5.0	5.0	20	250
Blank	N.D.	N.D.	N.D.	N.D.	N.D.
Detection limit	0.5	1.0	1.0	1.0	1.0
Method of Analysis	7130	7190	7420	7520	7950

David Duong
Laboratory Director

1764 Houret Court Milpitas, CA. 95035 Tel: 408-946-9636 Fax: 408-946-9663

PRIORITY ENVIRONMENTAL LABS

Precision Environmental Analytical Laboratory

PEL #: 9308104

August 31, 1993

TANK PROTECT ENGINEERING, INC.

Attn: Jeff

Project name : Sabek, Inc.
Project location: 1230 14th St.
Sample I.D.: S-1 waste oil pit

Project number: 150A082693

Date Sampled: Aug 25, 1993
Date Analyzed: Aug 30, 1993

Date Submitted: Aug 27, 1993

Method of Analysis: EPA 8010

Detection limit: 5.0 ug/Kg

COMPOUND NAME	CONCENTRATION (ug/Kg)	SPIKE RECOVERY (%)
Chloromethane	N.D.	-----
Vinyl Chloride	N.D.	91.6
Bromomethane	N.D.	-----
Chloroethane	N.D.	-----
Trichlorofluoromethane	N.D.	-----
1,1-Dichloroethene	N.D.	87.8
Methylene Chloride	N D.	-----
1,2-Dichloroethene (TOTAL)	N.D.	-----
1,1-Dichloroethane	N.D.	83.5
Chloroform	N.D.	-----
1,1,1-Trichloroethane	N.D.	89.2
Carbon Tetrachloride	N.D.	-----
1,2-Dichloroethane	N.D.	-----
Trichloroethene	N.D.	101.6
1,2-Dichloropropane	N.D.	-----
Bromodichloromethane	N.D.	-----
2-Chloroethylvinylether	N.D.	-----
Trans-1,3-Dichloropropene	N.D.	-----
Cis-1,3-Dichloropropene	N.D.	-----
1,1,2-Trichloroethane	N.D.	-----
Tetrachloroethene	N.D.	103.8
Dibromochloromethane	N.D.	-----
Chlorobenzene	N.D.	-----
Bromoform	N.D.	-----
1,1,2,2-Tetrachloroethane	N.D.	-----
1,3-Dichlorobenzene	N.D.	-----
1,4-Dichlorobenzene	N.D.	-----
1,2-Dichlorobenzene	N.D.	-----

David Duong
Laboratory Director

1764 Houret Court Milpitas, CA. 95035 Tel: 408-946-9636 Fax: 408-946-9663

CAMBRIA

ATTACHMENT C

Standard Operating Procedures

STANDARD FIELD PROCEDURE FOR MONITORING WELLS

This document presents standard field methods for drilling and sampling soil borings and installing, developing and sampling ground water monitoring wells. These procedures are designed to comply with Federal, State and local regulatory guidelines. Specific field procedures are summarized below.

SOIL BORING AND SAMPLING

Objectives

Soil samples are collected to characterize subsurface lithology, assess whether the soils exhibit obvious hydrocarbon or other compound vapor or staining, and to collect samples for analysis at a State-certified laboratory. All borings are logged using the Unified Soil Classification System by a trained geologist working under the supervision of a California Registered Geologist (RG) or a Certified Engineering Geologist (CEG).

Soil Boring and Sampling

Soil borings are typically drilled using hollow-stem augers or push technologies such as the Geoprobe. Soil samples are collected at least every five ft to characterize the subsurface sediments and for possible chemical analysis. Additional soil samples are collected near the water table and at lithologic changes. Samples are collected using lined split-barrel or equivalent samplers driven into undisturbed sediments at the bottom of the borehole.

Drilling and sampling equipment is steam-cleaned prior to drilling and between borings to prevent cross-contamination. Sampling equipment is washed between samples with trisodium phosphate or an equivalent EPA-approved detergent.

Sample Analysis

Sampling tubes chosen for analysis are trimmed of excess soil and capped with Teflon tape and plastic end caps. Soil samples are labeled and stored at or below 4°C on either crushed or dry ice, depending upon local regulations. Samples are transported under chain-of-custody to a State-certified analytic laboratory.

Field Screening

One of the remaining tubes is partially emptied leaving about one-third of the soil in the tube. The tube is capped with plastic end caps and set aside to allow hydrocarbons to volatilize from the soil. After ten to fifteen minutes, a portable photoionization detector (PID) measures volatile hydrocarbon vapor concentrations in the tube headspace, extracting the vapor through a slit in the cap. PID measurements are used along with the field observations, odors, stratigraphy and ground water depth to select soil samples for analysis.

Water Sampling

Water samples, if they are collected from the boring, are either collected using a driven Hydropunch type sampler or are collected from the open borehole using bailers. The ground water samples are decanted into the appropriate containers supplied by the analytic laboratory. Samples are labeled, placed in protective foam sleeves, stored on crushed ice at or below 4°C, and transported under chain-of-custody to the laboratory. Laboratory-supplied trip blanks accompany the samples and are analyzed to check for cross-contamination. An equipment blank may be analyzed if non-dedicated sampling equipment is used.

Grouting

If the borings are not completed as wells, the borings are filled to the ground surface with cement grout poured or pumped through a tremie pipe.

MONITORING WELL INSTALLATION, DEVELOPMENT AND SAMPLING

Well Construction and Surveying

Ground water monitoring wells are installed to monitor ground water quality and determine the ground water elevation, flow direction and gradient. Well depths and screen lengths are based on ground water depth, occurrence of hydrocarbons or other compounds in the borehole, stratigraphy and State and local regulatory guidelines. Well screens typically extend 10 to 15 ft below and 5 ft above the static water level at the time of drilling. However, the well screen will generally not extend into or through a clay layer that is at least three ft thick.

Well casing and screen are flush-threaded, Schedule 40 PVC. Screen slot size varies according to the sediments screened, but slots are generally 0.010 or 0.020 inches wide. A rinsed and graded sand occupies the annular space between the boring and the well screen to about one to two ft above the well screen. A two ft thick hydrated bentonite seal separates the sand from the overlying sanitary surface seal composed of Portland type I,II cement.

Well-heads are secured by locking well-caps inside traffic-rated vaults finished flush with the ground surface. A stovepipe may be installed between the well-head and the vault cap for additional security.

The well top-of-casing elevation is surveyed with respect to mean sea level and the well is surveyed for horizontal location with respect to an onsite or nearby offsite landmark.

Well Development

Wells are generally developed using a combination of ground water surging and extraction. Surging agitates the ground water and dislodges fine sediments from the sand pack. After about ten minutes of surging, ground water is extracted from the well using bailing, pumping and/or reverse air-lifting through an eductor pipe to remove the sediments from the well. Surging and extraction continue until at least ten

well-casing volumes of ground water are extracted and the sediment volume in the ground water is negligible. This process usually occurs prior to installing the sanitary surface seal to ensure sand pack stabilization. If development occurs after surface seal installation, then development occurs 24 to 72 hours after seal installation to ensure that the Portland cement has set up correctly.

All equipment is steam-cleaned prior to use and air used for air-lifting is filtered to prevent oil entrained in the compressed air from entering the well. Wells that are developed using air-lift evacuation are not sampled until at least 24 hours after they are developed.

Ground Water Sampling

Depending on local regulatory guidelines, three to four well-casing volumes of ground water are purged prior to sampling. Purging continues until ground water pH, conductivity, and temperature have stabilized. Ground water samples are collected using bailers or pumps and are decanted into the appropriate containers supplied by the analytic laboratory. Samples are labeled, placed in protective foam sleeves, stored on crushed ice at or below 4°C, and transported under chain-of-custody to the laboratory. Laboratory-supplied trip blanks accompany the samples and are analyzed to check for cross-contamination. An equipment blank may be analyzed if non-dedicated sampling equipment is used.