EA Project CHV 82X

SOIL VAPOR CONTAMINANT ASSESSMENT
REPORT OF INVESTIGATION
FORMER CHEVRON SS 9-0020
17TH AND HARRISON
OAKLAND, CALIFORNIA

1-27-88

Prepared for

Chevron U.S.A. Inc.
San Ramon, California

Prepared by

EA Engineering, Science, and Technology, Inc.
Lafayette, California

Anita Yan — 27 Jan 88
Anita Yan — Date

Douglas A. Selby, Ph.D., P.E. — 27 Jan 88
Civil Engineer — Date

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS A. SELBY
No. C039906
CIVIL
STATE OF CALIFORNIA

January 1988

June 24, 1988

9/2/88
LM - Do you want this to be assigned to anyone?
LZ

RWQCB
Bay Area Region
1111 Jackson St., Rm. 6040
Oakland, CA 94607

Re: Former Chevron SS #90020 - 17th & Harrison, Oakland, CA

Gentlemen:

Enclosed is the soil vapor survey conducted at the above site. As indicated minor amounts of hydrocarbon vapors were observed over the entire site. These vapors have tentatively been identified as methanol. Only one sample point yielded any BTX isomers.

To further investigate the site, Chevron plans to install (3) soil borings that will be converted to monitor wells if groundwater is encountered.

If you have any questions, please contract Gordon Davitt at (415) 838-5225, or Steve Camello at (415) 838-5219.

Sincerely,

D. MOLLER

By_____
S.G. Camello, Engineer

GJD/jas:MW1-39
Enclosure

cc: Alameda County
Dept. of Environmental
47 - 27th St., Rm. 322
Oakland, CA 94612

7/8/88
Returned to Storm until monies received - Then will log in.
LB Needs letter to accom w/ Request for $ for reviewing & Statement that it would be reviewed w/o $.

1. INTRODUCTION

1.1 SCOPE

At the request of Chevron U.S.A. Inc., EA Engineering, Science, and Technology, Inc. (EA) conducted a Soil Vapor Contaminant Assessment (SVCA) at the site of former Chevron Service Station (SS) 9-0020 in Oakland, California. This report describes the SVCA technique, the site investigation, and its results.

1.2 SITE SETTING

Chevron SS 9-0020 is located in Oakland, California (Figure 1), on the southwest corner of the intersection of 17th and Harrison streets (Figure 2). At present the site is a parking lot. Land use nearby is mainly commercial and residential. A dry cleaning facility is located on 17th Street, one building to the west of the site.

The site is located on the edge of Oakland City Center. Broadway Street, where major department stores and large office buildings are located, lies within one-quarter mile to the west of the site. A residential area, consisting mostly of large apartment buildings, is located to the northeast of the site, near Lake Merritt.

1.3 HYDROGEOLOGY

The downtown portion of the City of Oakland lies over Quaternary marine and non-marine alluvial deposits consisting of layers of sand and gravel interspersed with thick sections of sandy clay and clay. The uppermost of these strata is the Merritt Sand, which underlies the site (Helley et al. 1972). These deposits are unconsolidated, and the aquifers in the area tend to be unconfined.

Figure 1. Location of Chevron Service Station 9-0020, Oakland California.

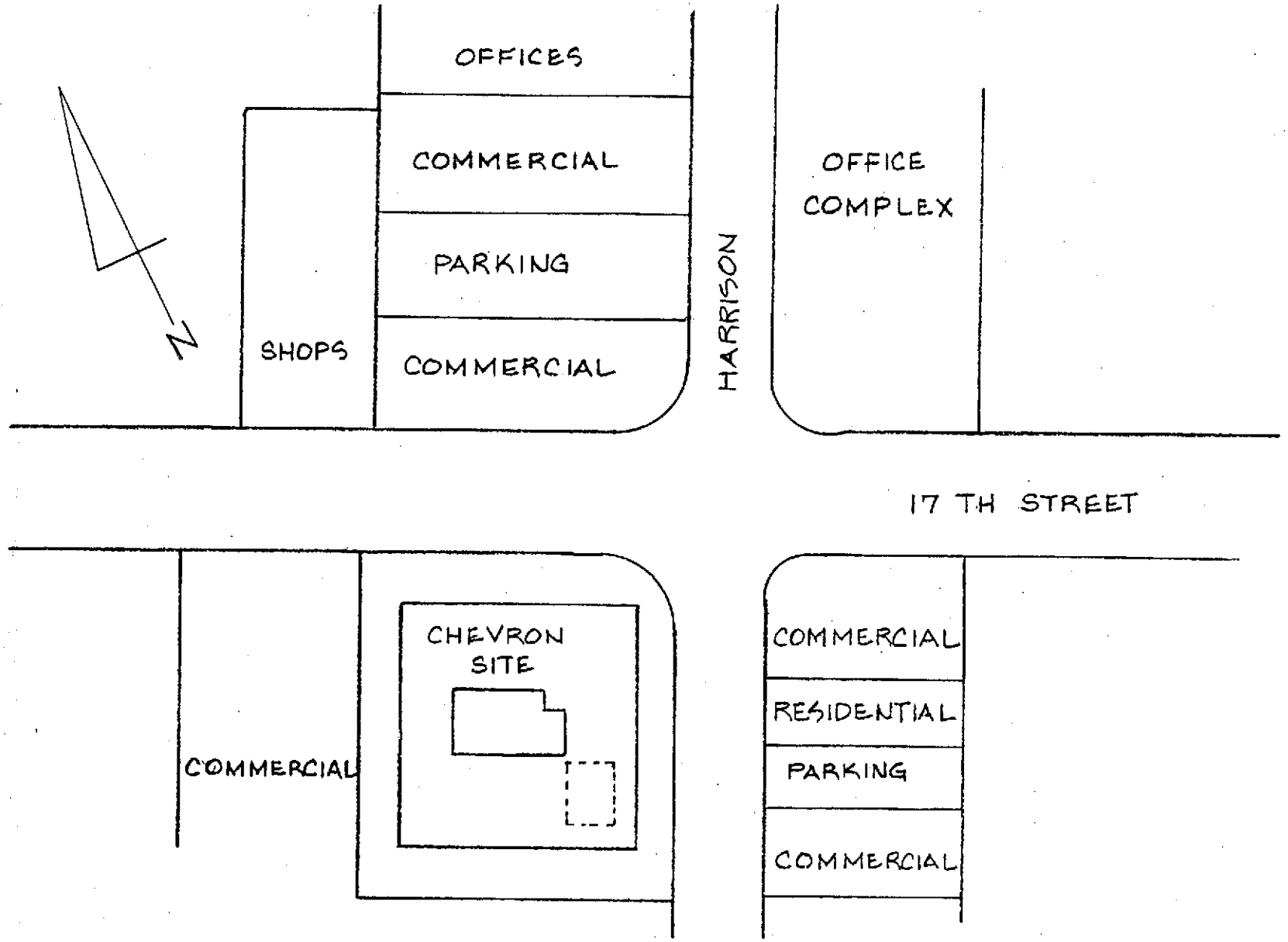

Figure 2. Land use in the vicinity of Chevron Service Station 9-0020, Oakland, California.

No soil borings are available for the site, so the site-specific subsurface geology and water table depth are unknown. There are a number of wells within several blocks, and a cathodic protection well in the area indicates a ground water depth of 20 feet (Alameda County Flood Control and Water Conservation District 1987). The site is at an elevation of approximately 35 feet, about 30 feet above the surface of Lake Merritt, located about 2,000 feet to the east (see Figure 1). The immediate topographical gradient is approximately 65 feet per mile, a little over one percent, sloping down to the east, toward Lake Merritt. The ground-water gradient is presumed to follow topography, i.e., about a one percent slope down to the east.

2. SOIL VAPOR CONTAMINANT ASSESSMENT

Following a subsurface gasoline release, as free product migrates downward towards the ground water some of the gasoline will be adsorbed to the soils and some will vaporize. In the case of a spill of sufficient volume to exceed the soil binding capacity, free liquid will reach ground water, at which point it will float and may begin to vaporize and solubilize.

On the basis of these and other physicochemical properties and behaviors of hydrocarbon mixtures, described in Appendix A, it can be seen that associated with any ground-water, soil, or free-product contamination there is vapor phase contamination. The SVCA technique takes advantage of this, and through the collection and analysis of soil vapor permits rapid delineation of the extent of contamination.

2.1 FIELD INVESTIGATION

EA conducted an SVCA at the site of former Chevron SS 9-0020 on 17 December 1987. Soil vapor samples were taken from 11 locations at depths between 3 and 13 feet (Figure 3). Vertical profiles were completed at sample points V1 (3, 5.5, 8, 10.5, and 13 feet), V2 and V9 (3, 8 feet), V3 (3, 5.5, 8, and 10.5 feet), and V6 (3, 8, and 13 feet).

2.2.1 Sample Collection Methods

Before each sample was collected, a vacuum pump was used to purge previously collected vapor from the probe to ensure that the sample was not contaminated. The vacuum pressure reading on the purging apparatus was recorded. This vacuum pressure is related to the soil's gas permeability: a high reading suggests that there is a resistance to soil gas movement and a vacuum is being created between the tip of the probe and the pump. If this vacuum is maintained through the pumping period, a representative

sample of the soil gas may not be obtained, and anomalously low hydrocarbon readings may result. In most situations, initial vacuums are released and the vacuum pressure readings drop. A low reading indicates that there is a free flow of soil gas from the vadose zone through the probe, and after purging the sample is assumed to be representative.

The samples were collected through a septum with a microsyringe and injected into an HNu 421 chromatograph for analysis. The HNu 421 is a laboratory-size, temperature-programmable gas chromatograph equipped with a flame ionization detector (FID). The hydrogen-air flame ionizes compounds, generating an energy increase in the detector, which appears as an electrical signal. Vapor samples are injected into the gas chromatograph, separated on an analytical column, sensed by the detector, integrated, and reported as individual compounds on chromatograms. The instrument is operated isothermally at 60^{o}C and the capillary column flow rate is 10 ml/min. These conditions ensure peak retention time stability and prevent contaminant build-up within the column. Blanks are run to verify that the system is free of contamination; as necessary, the instrument is re-calibrated by injecting standards and by running ambient air blanks. These data, along with multiple standard runs, ensure system reproducibility.

The chromatograph yields a response in the form of an electrical signal, measured in volts; this is recorded and integrated across time by a Shimadzu C-R3A integrator. The peak area is expressed as volt-seconds (V-sec). The instrument is calibrated with a multicomponent standard consisting of known concentrations of benzene, toluene, xylene, and ethylbenzene. The integrator calculates and stores the response ratio, V-sec:ppm. The ratio for each component of the standard is used to quantify the concentrations of identifiable vapors in field samples according to their V-sec values.

The concentrations of unidentified compounds are calculated in a similar manner. Although petroleum hydrocarbons produce variable instrumental responses, the assumption may be made that all of the hydrocarbon constituents have response-to-concentration ratios approximately equivalent to that of benzene and that all quantifications may be based on the ratio for benzene. In the table describing the results of the assessment, the column entitled "Peaks Prior to Benzene" represents the sum of the responses in V-sec for all peaks eluting prior to benzene, proportioned to the calibrated V-sec response for benzene. Similarly, the column entitled "Total Detected Petroleum Hydrocarbons" or "Total Volatile Hydrocarbons" represents the sum of all V-sec responses, proportioned to that for benzene.

2.1.2 Results of SVCA

Table 1 presents the results of the SVCA. No discernible pattern of soil vapor hydrocarbon concentrations was found. Although TDH was at significant levels throughout the site, benzene was below detection everywhere, and toluene was below detection at all points except V1.

The SVCA results can be used with Henry's Law to estimate a ground-water concentration. A Henry's Law constant (H) is the ratio of a chemical's concentration in air to its concentration in water at equilibrium. It can be estimated by:

$$H = C_{SV}/C_W$$

where

H = Henry's Law constant, atm-L/mole
C_{SV} = vapor concentration, atm
C_W = water concentration, mole/L.

For estimating ground-water concentrations, the equation can be rearranged as:

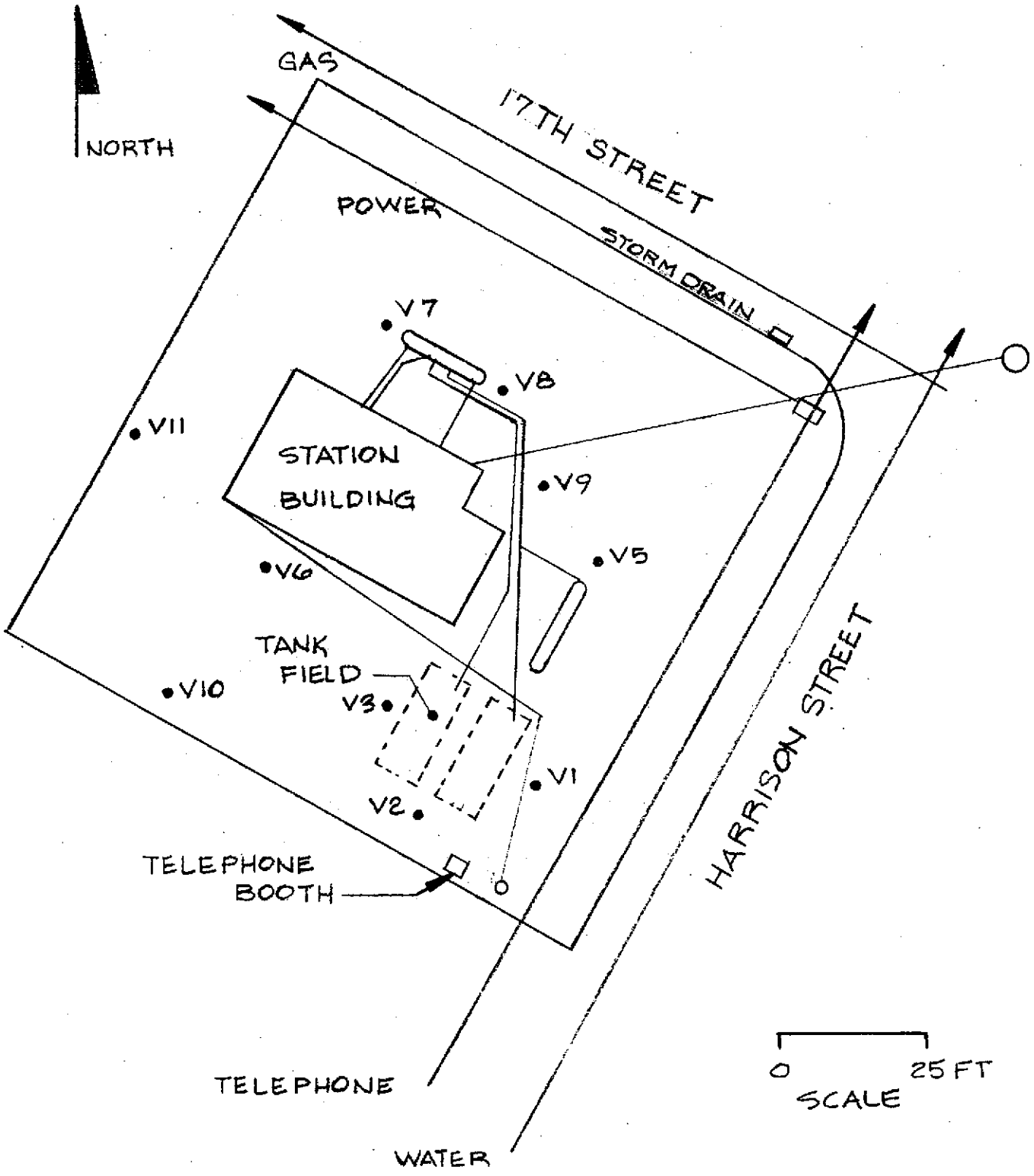

Figure 3. Locations of station facilities, and SVCA sample points at Chevron Service Station 9-0020, Oakland California.

TABLE 1 CONCENTRATIONS OF HYDROCARBON CONSTITUENTS IN SOIL VAPOR AT CHEVRON SS 9-0020, 17TH AND HARRISON, OAKLAND, CALIFORNIA, 17 DECEMBER 1987

Sample Location	Depth (ft)	Peaks Prior to Benzene[a] (ppm)[b]	Benzene (ppm)	Toluene (ppm)	o-Xylene (ppm)	m,p-Xylene (ppm)	Ethyl-benzene (ppm)	Peaks Not Otherwise Identified (ppm)[b]	Total Volatile Hydro-carbons (ppm)[b]
V1/A	3.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V1/B	5.5	5	<1	<1	<1	<1	<1	<1	5
V1/C	8.0	5	<1	1-5	<1	1-5	<1	1-5	10
V1/D	10.5	1-5	<1	<1	<1	<1	<1	<1	1-5
V1/E	13.0	5	<1	<1	<1	<1	<1	<1	5
V2/A	3.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V2/B	8.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V3/A	3.0	10	<1	<1	<1	<1	<1	<1	10
V3/B	5.5	10	<1	<1	<1	<1	<1	<1	10
V3/C	8.0	5	<1	<1	<1	<1	<1	<1	5
V3/D	10.5	1-5	<1	<1	<1	<1	<1	<1	1-5
V4	3.0	15	<1	<1	<1	<1	<1	<1	15
V5	3.0	10	<1	<1	<1	<1	<1	<1	10
V6/A	3.0	20	<1	<1	<1	<1	<1	<1	20
V6/B	8.0	140	<1	<1	<1	<1	<1	<1	140
V6/C	13.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V7	3.0	1-5	<1	<1	<1	<1	<1	1	5
V8	3.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V9/A	3.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V9/B	8.0	1-5	<1	<1	<1	<1	<1	1	5
V10	8.0	1-5	<1	<1	<1	<1	<1	<1	1-5
V11	8.0	5	<1	<1	<1	<1	<1	<1	5

a. Early peaks from blank data subtracted from total peaks prior to benzene.
b. Quantified on the basis of the V-sec:ppm response ratio for benzene (see text).

CHV21:82X

TABLE 1 (continued)

BLANK DATA

Test Time	Peaks Prior to Benzene[a] (ppm)[b]	Benzene (ppm)	Toluene (ppm)	o-Xylene (ppm)	m,p-Xylene (ppm)	Ethyl-benzene (ppm)	Peaks Not Otherwise Identified (ppm)[b]	Total Volatile Hydro-carbons (ppm)[b]
1000	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1
1349	1.0	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	1.0

PERCENTAGE OF STANDARD RECOVERED

Test Time	Benzene (ppm)	Toluene (ppm)	o-Xylene (ppm)	m,p-Xylene (ppm)	Ethyl-benzene (ppm)
1035	100	100	100	100	100
1339	97	99	105	104	102

GASOLINE STANDARD

Sample	Peaks Prior to Benzene[a] (ppm)[b]	Benzene (ppm)	Toluene (ppm)	o-Xylene (ppm)	m,p-Xylene (ppm)	Ethyl-benzene (ppm)	Peaks Not Otherwise Identified (ppm)[b]	Total Volatile Hydro-carbons (ppm)[b]
Chevron Super Unleaded	12,000	25,000	77,000	44,000	76,000	24,000	180,000	540,000

$$C_w = C_{sv}/H.$$

To make the units compatible, the following conversions are used:

1 ppm soil vapor = 1×10^{-6} atmosphere
1 mole = mole weight expressed in milligrams.

The molecular weights of benzene and toluene are 78,000 mg/mole and 92,000 mg/mole, respectively (EPA 1986b); their Henry's Law constants are 5.6 atm-L/mole and 6.4 atm-L/mole (EPA 1986b). Using these data, the expected ground-water concentration of benzene can be estimated as:

$$C_{w\text{-benzene}} = 0.014\ C_{sv\text{-benzene}}.$$

For toluene, the ground-water concentration can be estimated as

$$C_{w\text{-toluene}} = 0.014\ C_{sv\text{-toluene}}.$$

Throughout the site, the detected concentration of benzene was below detection: less than 1 ppm. This theoretically corresponds to a ground-water benzene concentration less than 0.014 mg/L. The highest detected concentration of toluene, in the vicinity of the waste oil tank, was 5 ppm, theoretically corresponding to a ground-water toluene concentration of 0.07 mg/L. The San Francisco Bay Regional Water Quality Control Board (1985) found that gasoline-saturated water at equilibrium will contain as high as 40 mg/L of benzene and from 9 to 76 mg/L of toluene. Thus, the order-of-magnitude estimates of ground-water hydrocarbon constituents at the Oakland site suggest that ground-water contact with free product has not occurred.

TDH levels were higher than would be expected from the toluene and benzene levels if the source was a petroleum product: the concentrations of total detected hydrocarbons at the respective locations are shown in Figure 4. The chromatograms showed that

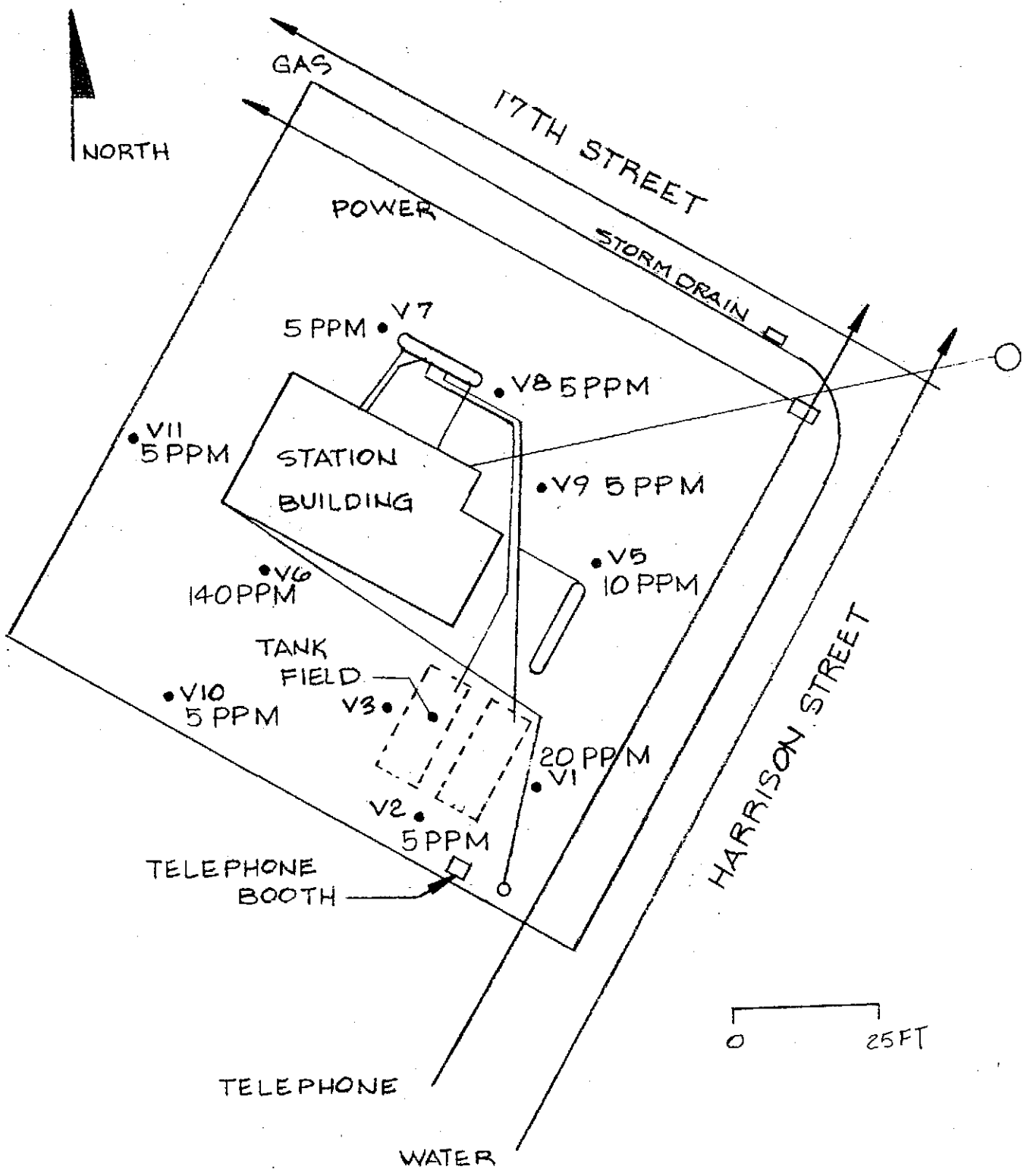

Figure 4. Concentrations of total detected hydrocarbons at each sample point at Chevron Service Station 9-0020, Oakland, California.

peaks prior to benzene, corresponding to low-boiling-point constituents, contributed almost all of the hydrocarbon concentrations found. Some of the detected early-eluting peaks are asymmetrical. An asymmetric peak indicates that the compound is polar (one in which there is a partial charge in the molecule).

2.2 DISCUSSION

Because of the anomalous presence a chromatographic peak that appears to represent a single low-boiling polar compound in no predictable UST-related pattern, a set of standards made up of low-boiling constituents was used to calibrate the gas chromatograph, and the resulting chromatograms used to examine the unidentified constituents (Appendix C). The highest detected concentration of this compound was located in the vicinity of the waste oil tank. It is suspected that this compound may be methanol or another small alcohol. Methanol is the metabolic end product of bacteria of the genus Pseudomonas. Pseudomonas spp., bacteria commonly found in soil and water, aerobically metabolizes methane (Bailey 1986). Methane may be produced by methanogenic microorganisms that exist naturally in soil. This consumption of hydrocarbons by Pseudomonas and similar microorganisms is a possible source of the small alcohol detected in the soil vapor.

In summary, there appears to be a natural biodegradation product but no significant petroleum-based hydrocarbon concentration in soil gas at the site.

3. CONCLUSIONS

Very minor amounts (averaging 1-5 ppm) of hydrocarbon vapor were observed in soil gas over the entire site of Chevron SS 9-0020, in Oakland. These vapors are low-boiling compounds (peaks eluting prior to benzene) which appear to be composed predominantly of a single polar compound: this may be methanol, whose presence is believed to be the product of bacterial metabolism. The highest concentration of this low-boiling compound was found near the waste oil tank.

Except at one point (V1, near the tank field), none of the usual aromatics (BTXE) associated with gasoline was detected. At V1, the concentration of toluene reached 1-5 ppm at a depth of 8 feet. On this basis, it is concluded that no significant fuel contamination of soil is present at this site.

4. REFERENCES

Alameda County FC&WCD (Flood Control and Water Conservation District. 1987. Bay Plain Well Base Map, Oakland West Street.

API (American Petroleum Institute). 1985a. Laboratory Study on Solubilities of Petroleum Hydrocarbons in Ground Water. Publ. 4395. API, Washington D.C.

API (American Petroleum Institute). 1985b. Literature Survey: Unassisted Natural Mechanism to Reduce Concentrations of Soluble Gasoline Components. Publ. 4415. API, Washington, D.C.

Bailey, J.E. 1986. Biochemical Engineering Fundamentals. McGraw-Hill, New York.

Bruell, G.J. and G.E. Hoag. 1986. The diffusion of gasoline range hydrocarbon vapors in porous media--experimental methodologies, in Proceedings of the Joint NWWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water, Houston, Texas.

Heeley, E.J., K.R. Lajoie and D.B. Burke. 1972. Geologic map of late Cenozoic deposits, Alameda County, California. San Francisco Bay Region Environment and Resources Study. Basic Data Contribution 48. U.S. Dept. Interior and U.S. Dept. of Housing and Urban Devel.

Hinchee, R.E. and H.J. Reisinger. 1987. A Practical Application of Multiphase Transport Theory to Ground-water Contamination Problems. Ground Water Monitoring Rev. [Winter 1987]:84-92.

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods--Environmental Behavior of Organic Compounds. McGraw-Hill Book Co., New York, New York.

Odum, E.P. 1971. Fundamentals of Ecology (3rd ed.). Saunders, Philadelphia.

APPENDIX A

Principles of Soil Vapor Contaminant Assessment

APPENDIX A: PRINCIPLES AND APPLICATION OF SOIL VAPOR CONTAMINANT ASSESSMENT

The soil vapor survey, or SVCA, technique takes advantage of the behavior of hydrocarbon mixtures and the physicochemical properties of the individual components in the subsurface. Following a subsurface gasoline release, free product will migrate downwards towards the ground water, some of the gasoline will volatilize, and some will adsorb to the soils. In the case of a spill of sufficient volume to exceed the soil binding capacity, free liquid will reach ground water, at which point it will float and may begin to vaporize and solubilize.

Like most hydrocarbon liquids, gasoline is a complex mixture of many compounds, each with its own physicochemical properties. The contaminants found in ground water located beneath a layer of floating hydrocarbon are generally less hydrophobic and are generally found in concentrations proportional to the hydrocarbon/water partition coefficient (i.e., the relative solubility of a given compound in the bulk hydrocarbon to its solubility in water) and to their percent composition in the gasoline. It may be noted that concentration of total benzene, toluene, and xylenes in product-saturated water may exceed 10-20 mg/L (API 1985a).

Hydrocarbons will also volatilize into the air- or gas-filled soil interstices. Volatilization is largely a function of vapor pressure. The natures of the contaminant mixtures, in terms of specific component mixtures, in either the aqueous or vapor phase, are distinctly different from each other and from the gasoline. That is, the more hydrophilic hydrocarbons will be more likely to move into ground water, while the more volatile compounds are more likely to move into the vapor phase, and the compounds that are both less volatile and more hydrophobic are more likely to remain in the free product or be adsorbed to soils (Hinchee and Reisinger 1987).

Hydrocarbons not remaining in the free product will partition into either ground water or soil vapor and migrate as the result of a variety of interacting forces. In ground water, contaminants will migrate with the ground-water flow, interacting with the rock or soil geological medium. As the contaminants pass through a medium, organic constituents in the medium interact with the contaminants, and some are adsorbed or bound to particle surfaces (Bruell and Hoag 1986). The result is a net retardation in the velocity of movement of those compounds relative to that of the ground water in which they are dissolved. The process is analogous to laboratory chromatography. The compound with the least affinity for the porous medium is least retarded and therefore moves most rapidly. This compound, then, is present at the leading edge of a contaminant plume.

The affinity of a compound for the soil porous medium is partly a function of the compound's hydrophobicity--that is, the more hydrophobic a compound the more likely it is to adsorb to the solid medium. Aqueous solubility is a good indicator of hydrophobicity: the more soluble a compound is, the less hydrophobic and more hydrophilic it is, and vice versa. Vapor pressure is a good indicator of volatility; compounds with higher vapor pressures are more volatile.

In determining the environmental fate of various hydrocarbon compounds in a hydrocarbon mixture such as gasoline, those which have a high vapor pressure are more likely to move into the vapor phase, or evaporate. Compounds with high solubility are more likely to move into ground water from the free product and, once in ground water, tend to move more rapidly. Compounds of low vapor pressure and low solubility tend to remain in the free product or be adsorbed to the solid matrix and remain relatively immobile.

Dissolved compounds will tend to volatilize from the aqueous phase. The Henry's Law constant is the equilibrium ratio of a

compound's concentration in the vapor phase to its concentration in the aqueous phase. The higher a compound's Henry's Law constant, the greater its tendency to volatilize from water into air.

Figure A-1 graphically illustrates the vapor pressure, aqueous solubility, and Henry's Law constants, and their relationships, for selected hydrocarbons typically found in gasoline. The Henry's Law constant is approximated here as the ratio of vapor pressure to solubility.

The Henry's Law constant is directly related to the tendency of compounds to volatilize, as opposed to solubilizing. Compounds with Henry's Law constants greater than 0.001 (atm· m^3/mole) volatilize from water into air very rapidly (Lyman et al. 1982); those with Henry's Law constants greater than 0.01 (atm· m^3/mole) are generally volatilized so rapidly that they are seldom found in gasoline-contaminated ground water. It may be observed (Figure A-1) that tetraethyl lead (TEL) has an extremely low solubility and a relatively low vapor pressure. As a result, this constituent would not be expected to solubilize and migrate in ground water, and although its low vapor pressure would indicate slow volatilization, its Henry's Law constant indicates that it may be more rapidly volatilized than solubilized. The fate of TEL would be expected to be long-term binding to the soil.

On the basis of these properties it can be seen that associated with any ground water, soil, or free-product contamination is vapor phase contamination. The SVCA technique takes advantage of this, and through the collection and analysis of soil vapor permits a rapid, cost-effective delineation of the extent of contamination.

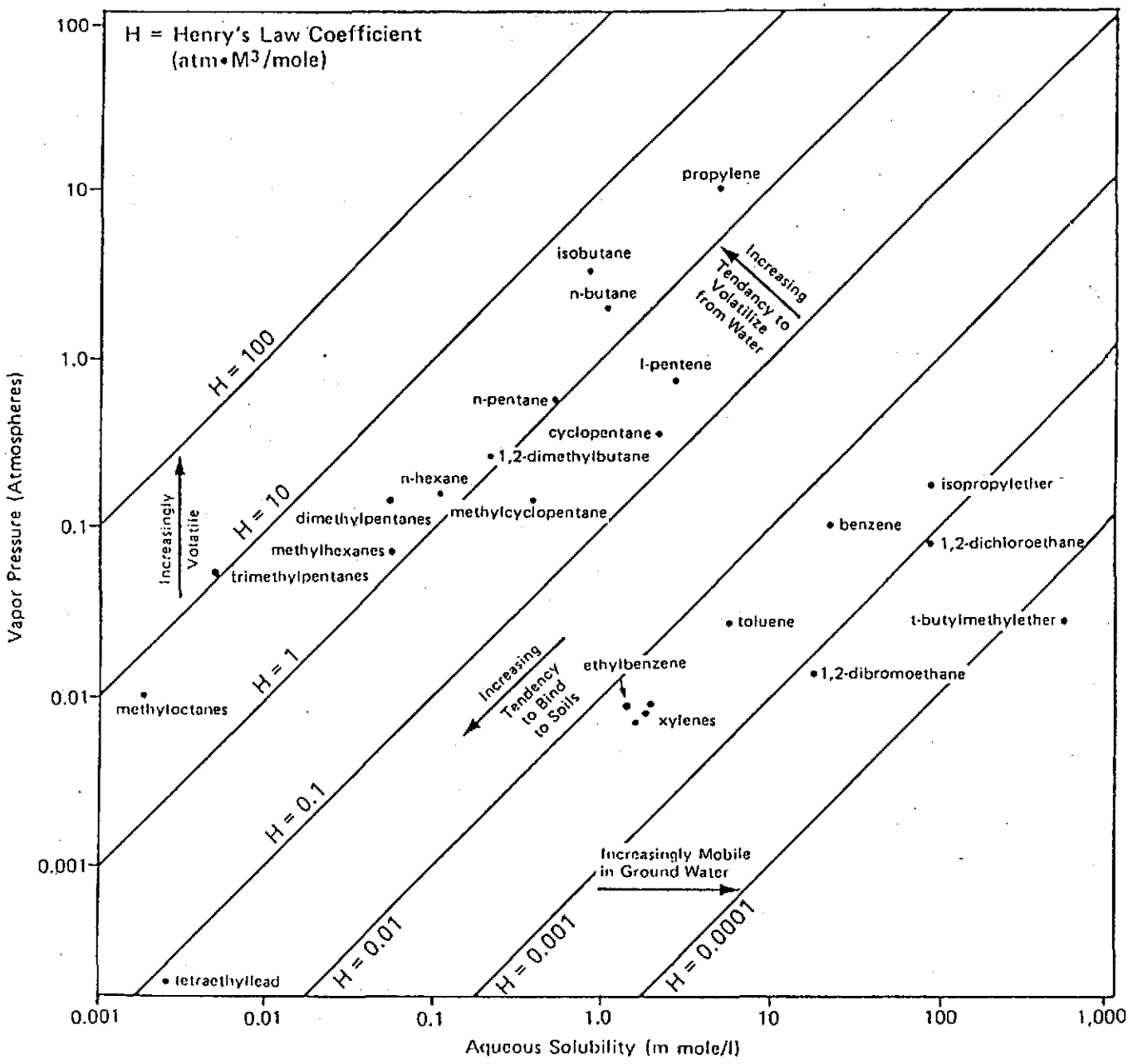

Figure A-1. Vapor pressures, solubilities, and corresponding Henry's Law constants for major constituents of gasoline.

SS9-0020-004/F/23/12/97

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

SVCA DATA SHEET

Project Number: CHV 82X
Project Manager:
Site Location: 17th & Harrison, Oakland, CA

Date: 17 Dec 1997
Analysts: AMJ ME MG
Pump Number: 9-0020

	Grid Location	Time	Depth (ft)	OVA (ppm)	Purge Time	Vacuum Reading	Soil Type	Comments
1	~~BLANK~~ ~~STD~~	9:33	—	—	—	—	—	RESET INTEGRATOR
2	STANDARD	00:00	—	—	—	—	—	DID NOT CALIBRATE
3	BLANK	10:00	—	—	—	—	—	
4	V1/A	10:25	3		10	22		TANK FIELD
5	STANDARD	10:35	—	—	—	—	—	CALIBRATED HERE
6	V3/A	10:49	3		10	4		
7	V1/B	1100	5.5		10	27		
8	V1/C	11:11	8		10	28		
9	V3/B	1121	5.5		10	20		HIT TOP OF TANKS at ~ 4.5 ft. MOVED 3ft away from tanks.
10	V1/D	1135	10.5		10	26	*	TOOK 1-2 min for vacuum to subside
11	V3/C	1146	8		10	26		
12	V1/E	1156	~~15~~ 13		10	26		
13	V3/D	1207	10.5		10	20		
14	V4~~A~~	1217	3		10	2		Hit concrete / hard layer at 4'.
15	V5	1228	3		10	20		
16	V2/A	1258	3		10	13		

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

SVCA DATA SHEET

Project Number: CHV82X
Project Manager: RH
Site Location: 17th and Harrison, Oak, CA

Date: 12/17/87
Analysts: MAE/AAY/MS
Pump Number: SS 9-0020

Grid Location	Time	Depth (ft)	OVA (ppm)	Purge Time	Vacuum Reading	Soil Type	Comments
V6/A	1307	3		10'	0.5		No flow.
V2/B	1319	8		10	25		
V6/B	1327	8		10	24		
STD	1339	—		—	—		100µL
BLANK	1349	—		—	—		
V6/C	1359	13		10	25		
V7	1409	3		10	13		
V8	1422	3		10	27		
V10	1446	8		10	25		
V9/A	1520	3		10	21		
V11	1533	8		10	27		
V9/B	1559	8		10	15		found mud sucked into probes after pulling out.
CHV Super Unleaded	~~1557~~ 1618	—		—	—		~~1 mL~~ 1 µL headspace

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V1/A

Analysts: MAE/DP/AAY

Vol. Inj: 100µl

Std. Vol. Inj: 50ul

Comments:

221-25412

057

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A.SA
START
12/17/87              10:25:24
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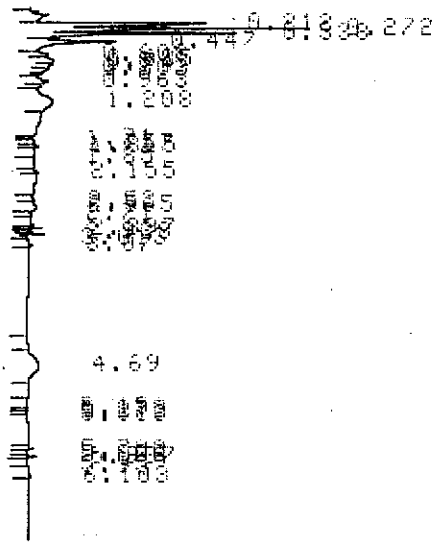


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CHROMATOGRAM   1  MEMORIZED

CHROMATOPAC    C-R3A                  FILE          0
SAMPLE NO      0                      METHOD          84
REPORT NO      1767                   SAMPLE WT     100

PKNO       TIME       AREA   MK   IDNO      CONC        NAME

RUN
VOLUME INJECTED (UL)
?  100
DILUTION
?  1
PHB                   BEN                    TOL                    O-XYL
M,P-XYL               ET BEN                 PNOI                   TVH
 1.91768               0                      0                      0
 0.188993              0                      0.372212               2.47889
*ERROR* 16:UNDEF'D STATEMENT IN    410
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EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V1/B

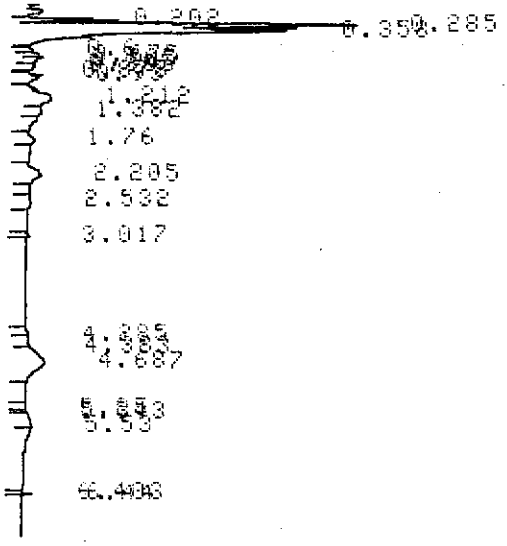
Analysts: MAE/DP/AAY

Vol. Inj: 100µl

Std. Vol. Inj: 50µl

Comments: _____

START
12/17/87 11:00:44



CHROMATOGRAM 4 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1772
FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.202	8540				
2	0.285	58692	V			
3	0.358	81554	V			

? 100
DILUTION
? 1

PAB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.46666	0	0.178388	0.0324013
0.310402	0	0.442099	4.43095

ERROR 16:UNDEF'D STATEMENT IN 410

Kimadex 221-254

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V1/C

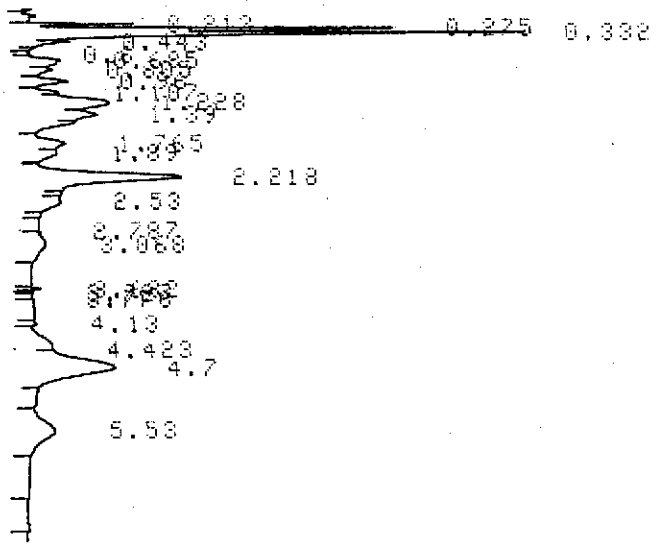
Analysts: MAE/DP/AAY

Vol. Inj: 100µl

Std. Vol. Inj: 50µl

Comments: _____

START
12/17/87 11:11



CHROMATOGRAM 5 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1773
FILE 0
METHOD 24
SAMPLE WT 100

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

*BB	BEM	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.96744	0.0873108	1.62061	0.591614
1.32259	0.0660792	1.90314	9.55879

ERROR 16:UNDEF'D STATEMENT IN 410

062

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Sample: V1/D

Vol. Inj: 100µl

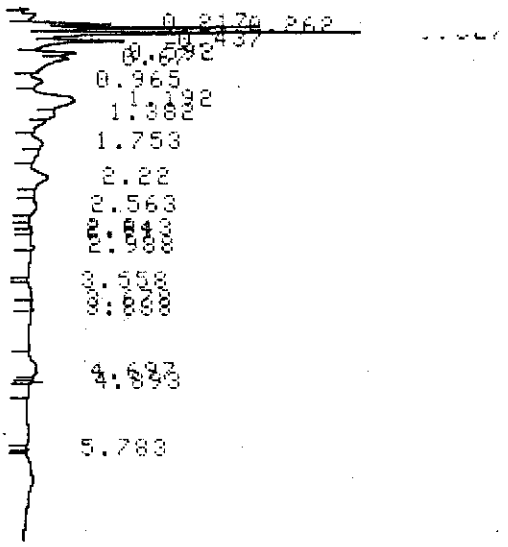
Comments: ____

Date: 12/17/87

Analysts: MAE/DP/AAY

Std. Vol. Inj: 50µl

```
START
12/17/87          11:35:
```




```
CHROMATOGRAM   7  MEMORIZED

CHROMATOPAC   C-R3A                    FILE          0
SAMPLE NO     0                        METHOD          24
REPORT NO     1775                     SAMPLE WT     100
```

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.217	9611				
2	0.262	20123	V			
3	0.327	39167	V			
4	0.437	17959	V			
5	0.592	10497	V			
6	0.67	16051	V			

```
RUN
VOLUME INJECTED (UL)
?  100
DILUTION
?  1
PXB                    BEN                    TOL                    O-XYL
M,P-XYL                ET BEN                 PNDI                   TVH
 2.25866                0                      0.201989               0
 0.103159               0                      0.756889               3.32069
*ERROR* 16:UNDEF'D STATEMENT IN   410
```

Shimadzu

221-35

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V1/E

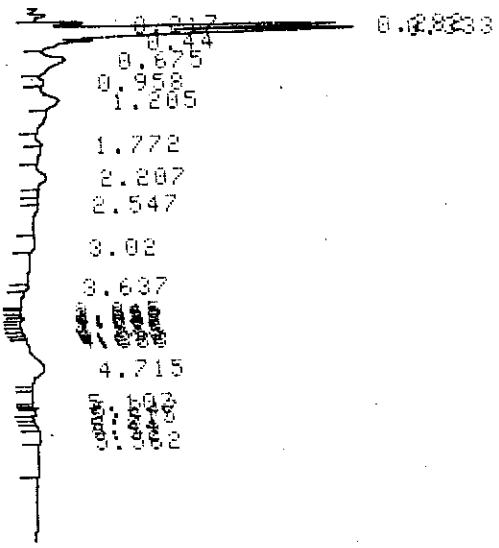
Analysts: MAE/DP/AAY

Vol. Inj: 100µL

Std. Vol. Inj: 50µL

Comments:

12/17/87 11:56:32



CHROMATOGRAM 9 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1777

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.217	7277				
2	0.282	57106	V			
3	0.333	73055	V			

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.76824	0	0.139885	0
0.342699	0	0.376586	4.62741

ERROR 16:UNDEF'D STATEMENT IN 410

⊕ Shinadu 221-25412 01

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V2/A

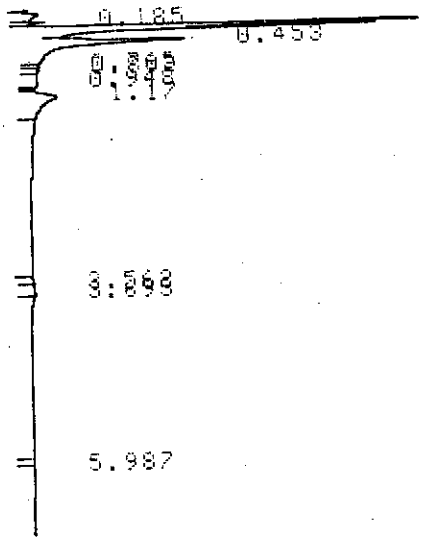
Analysts: MAE/DP/AAV

Vol. Inj: 100µl

Std. Vol. Inj: 50ul

Comments:

START
12/17/87 12:58:56



CHROMATOGRAM 13 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1781

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.185	1168				
2	0.27	109882				
3	0.453	56505	SV			
4	1.17	10986				
	TOTAL	178541			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	.BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.71369	0	0	0
0	0	0.3124	4.02619

ERROR 16:UNDEF'D STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V2/B

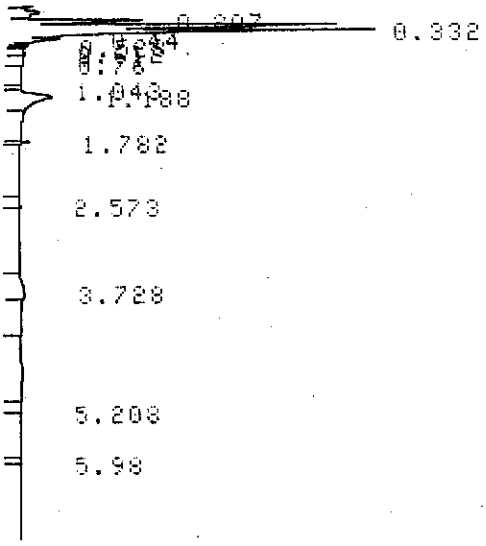
Analysts: MMAE/DP/AAV

Vol. Inj: 100µL

Std. Vol. Inj: 50µL

Comments: _____

START
12/17/87 13:19:03



CHROMATOGRAM 15 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1783

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.207	65569				
2	0.332	58954	SV			
3	0.44	1292	T			
4	1.188	12201				
5	3.728	2971				
	TOTAL	140987			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
2.52637	0	0	0
0	0	0.431564	2.95793

⊕ Shimadzu 221.25412

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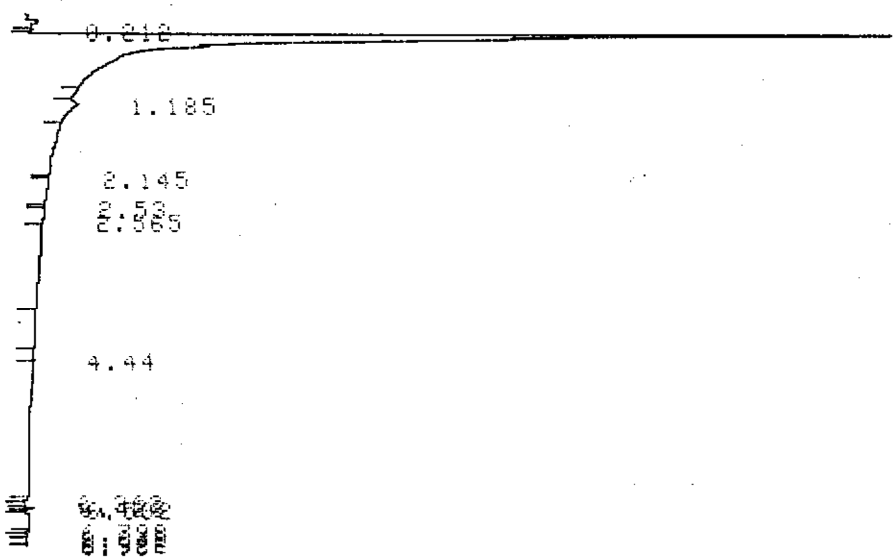
EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number:	CHV82X	**Date:**	12/17/87
Sample:	V3/A	**Analysts:**	MAE/DP/AAY
Vol. Inj:	100 μL	**Std. Vol. Inj:**	50 ul
Comments:			

START
12/17/87 10:49:05



CHROMATOGRAM 3 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1771
FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.293	362529				
2	1.185	3696				
	TOTAL	366224			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
9.25977	0	0	0
0	0	0.10512	9.36489

⊕ Shimadzu 221-25412

060

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V3/B

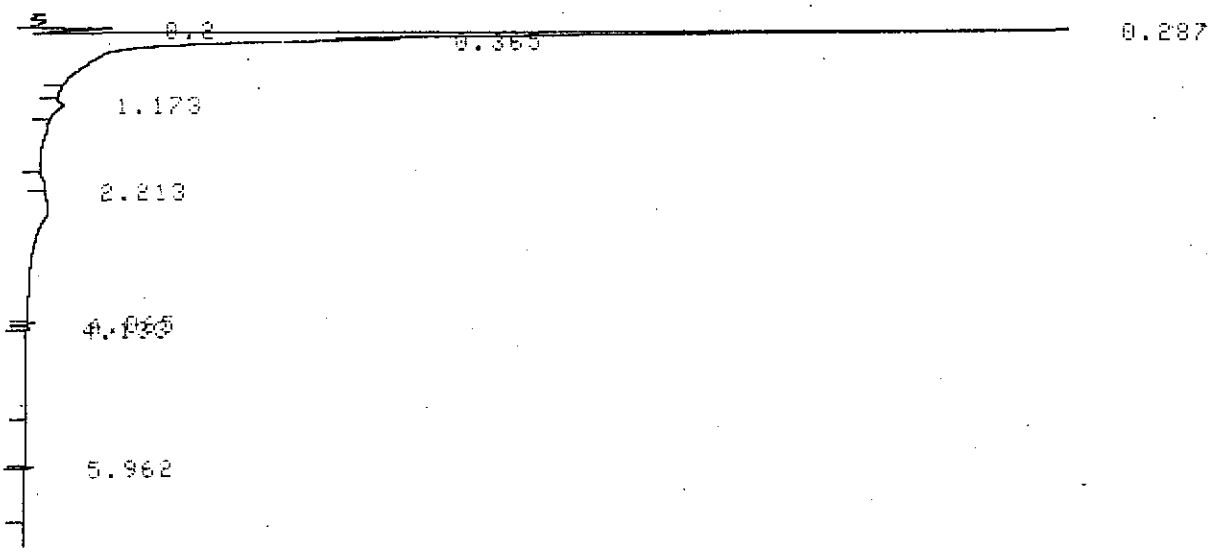
Analysts: MAE/DP/AAY

Vol. Inj: 100µl

Std. Vol. Inj: 50µl

Comments:

START
12/17/87 11:21:30.



CHROMATOGRAM 6 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1774

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.2	10568				
2	0.287	210467	V			
3	0.365	153555	V			
4	1.173	3887				
	TOTAL	378478			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
9.60287	0	0	0
0	0	0.110577	9.71345

ERROR 16:UNDEF'D STATEMENT IN 410

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221-25412

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

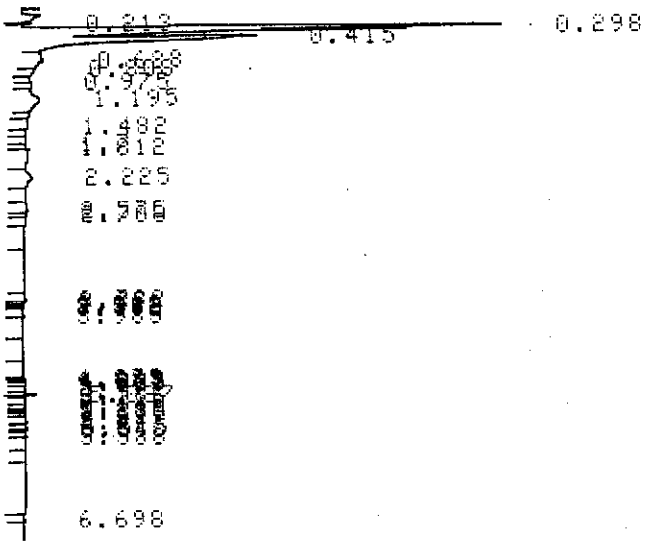
Project Number: CHV82X **Date:** 12/17/87

Sample: V3/C **Analysts:** MAE/DP/AAV

Vol. Inj: 100 µl **Std. Vol. Inj:** 50µl

Comments:

START
12/17/87 11:46:



CHROMATOGRAM 8 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1776

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.298	121653	V			
2	0.415	67687	V			
3	0.688	10135	V			
4	1.195	5070				
5	2.225	2321		2	0.1185	TOL
	TOTAL	206865			0.1185	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PRB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
4.62167	0	0.059246	0
0	0	0.150968	4.83188

PROGRAM 'C' UNRECOGNIZED STATEMENT IN 410

064

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V3/D

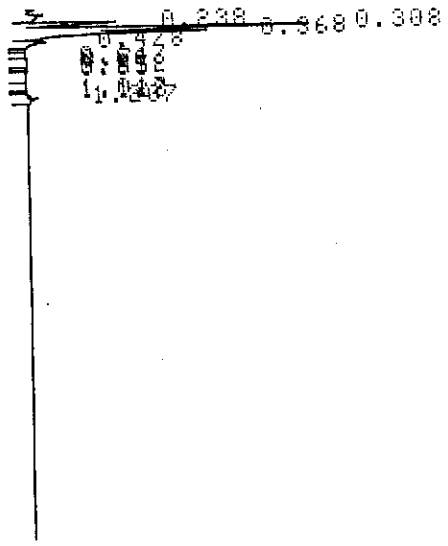
Analysts: MAE/DP/AAY

Vol. Inj: 100µL

Std. Vol. Inj: 50µL

Comments: _____

START
WARNING LEVEL OUT 0
12/17/87 12:07:18



CHROMATOGRAM 10 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1778

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.238	10440				

SUM
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PRB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
1.14958	0	0	0
0	0	0.0474395	1.19702

ERROR 16:UNDEF'D STATEMENT IN 410
START

Shimadzu 221 25412

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

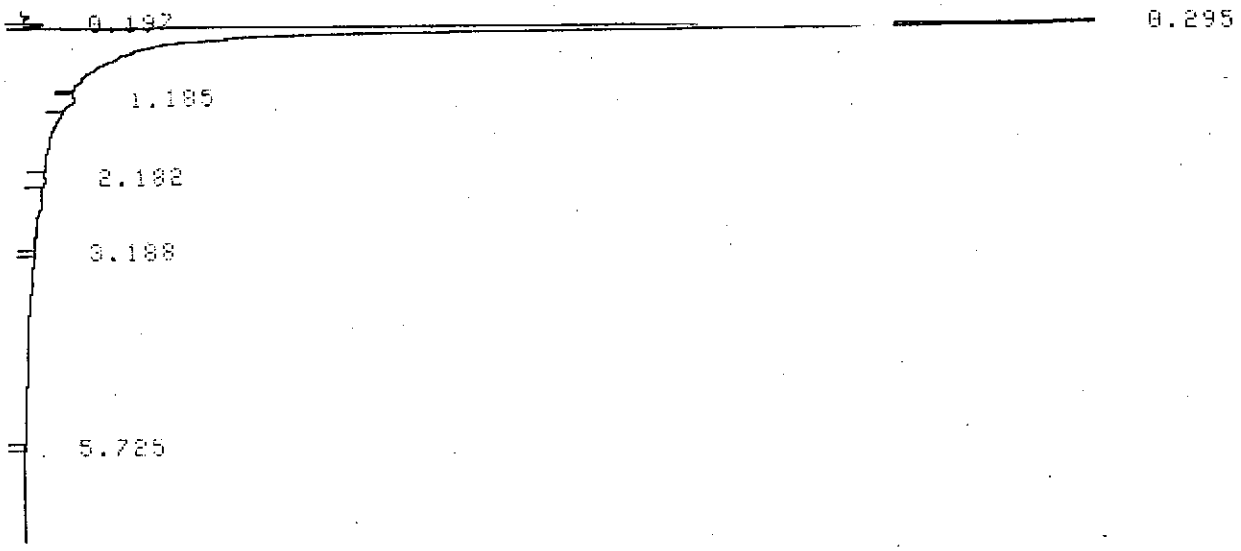
Project Number: CHV82X **Date:** 12/17/87

Sample: V4 **Analysts:** MAE/DP/AAV

Vol. Inj: 100 µl **Std. Vol. Inj:** 50 µl

Comments:

WARNING LEVEL OUT OF
12/17/87 12:17



CHROMATOGRAM 11 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1779

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.197	2556	E			
2	0.295	535828	E			
3	1.185	3455				
4	2.182	1266		2	0.0646	TOL
	TOTAL	543105			0.0646	

RUN 100
ERROR 9:UNDEF'D VARIABLE IN 103
RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNDI	TVH
14.2621	0	0.0323121	0
0	0	0.101954	14.3963

ERROR 16:UNDEF'D STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

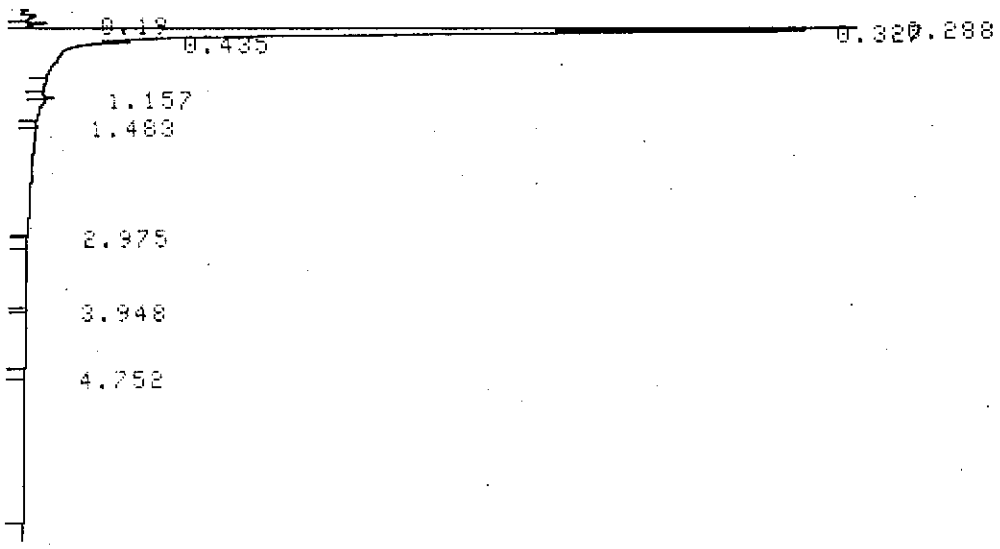
Project Number: CHV82X **Date:** 12/17/87

Sample: VS **Analysts:** MAE/DP/AAV

Vol. Injected: 100µl **Std. Vol. Inj:** 50µl

Comments:

START
12/17/87 12:28:07



CHROMATOGRAM 12 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1780

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.19	1319				
2	0.288	120302				
3	0.327	134084	V			
4	0.435	43956	V			
	TOTAL	299660			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PØB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
7.47146	0	0	0
0	0	-9.53674E-7	7.47146

ØØØØØØ* 12 UNDEFD STATEMENT IN 410

067

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

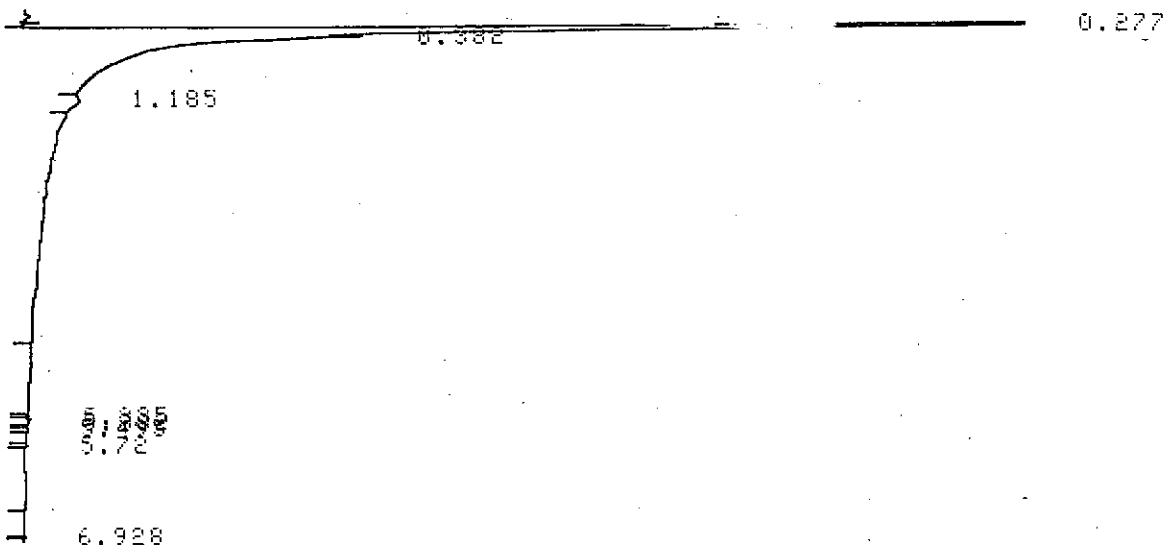
Sample: V6/A

Analysts: MAE/DP/AAY

Vol. Inj: 500µl

Std. Vol. Inj: 50µl

Comments:



CHROMATOGRAM 14 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1782

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.277	444396				
2	0.382	231897	V			
3	1.185	2842				
	TOTAL	679135			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PSB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
18.1849	0	0	0
0	0		18.2657

ERROR 16:UNDEF'D ST

⊕ Shinadzu 221-2512

069

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V6|B

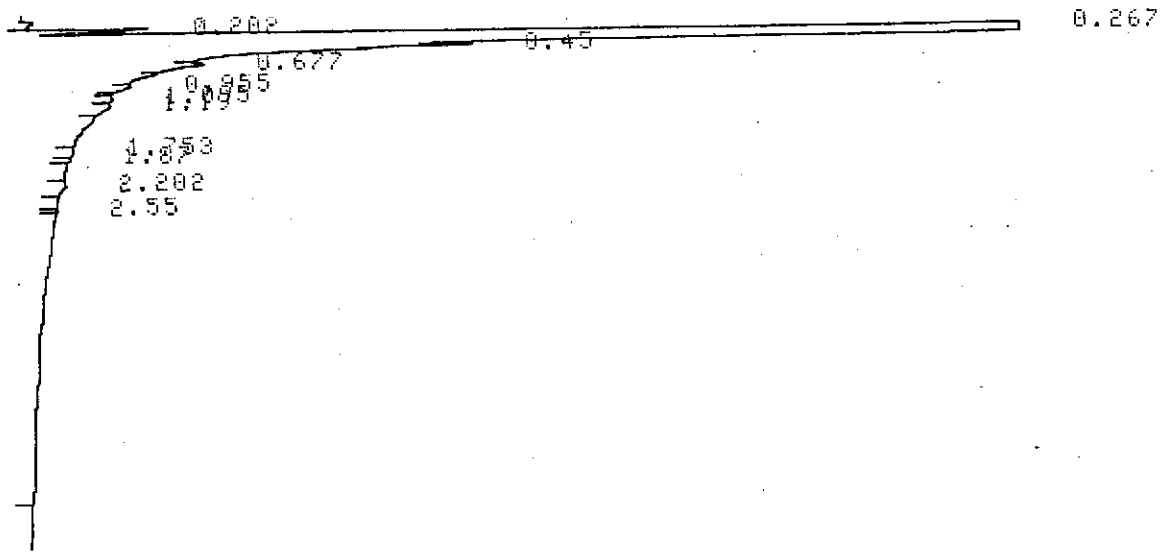
Analysts: MAE/DP/AAV

Vol. Inj: 100µl

Std. Vol. Inj: 50ul

Comments:

START
12/17/87 13:27:54



CHROMATOGRAM 16 MEMORIZED

CHROMATOPAC	C-R3A	FILE	0
SAMPLE NO	0	METHOD	24
REPORT NO	1784	SAMPLE WT	100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
138.882	0	0.0373112	0
0	0	0.0566067	138.976

ERROR 16:UNDEF'D STATEMENT IN 410

⊕ Shirad

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Sample: V6/C

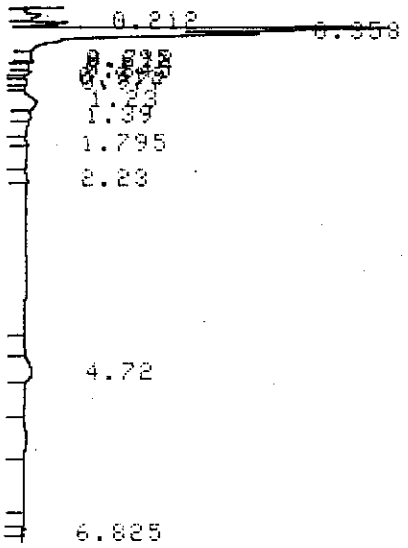
Vol. Inj: 100 µl

Date: 12/17/87

Analysts: MAE/DP/AAV

Std. Vol. Inj: 50 µl

START
12/17/87 13:59:10



CHROMATOGRAM 19 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1787

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.023	1094				
2	0.212	4842				
3	0.297	65813	V			
4	0.358	61041	V			
5	0.695	1708	V			
6	1.23	3900				
7	2.23	1167		2	0.0596	TOL
8	4.72	4693		4	0.2104	M,P-XY
	TOTAL	144259			0.27	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
2.7734	0	0.0297859	0
0.10521	0	0.142626	3.05102

ERROR 12:UNDEFD STATEMENT IN 410

⊕ Shimadzu

221-25412

073

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

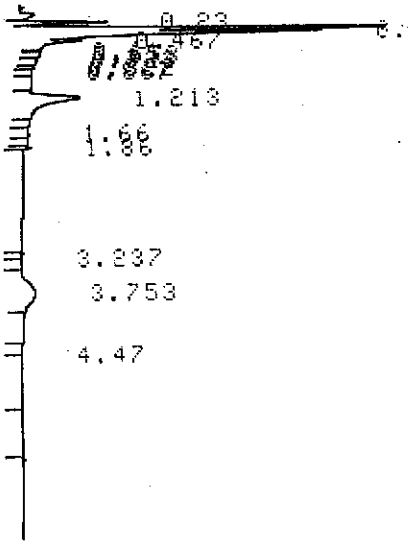
Sample: V7

Analysts: MAE/DP/AAY

Vol. Inj: 100µL

Std. Vol. Inj: 50µL

SAMPLE
12/17/87 14:09:34



CHROMATOGRAM 20 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1788

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.23	8553				
2	0.318	56530	V			
3	0.358	59597	V			
4	0.467	14326	V			
5	0.658	3215	V			
6	0.723	2499	V			
7	1.213	21718				
8	3.753	14040				
	TOTAL	180478			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.06412	0	0	0
0	0	1.01715	4.08128

ERROR RETURNED STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X **Date:** 12/17/87

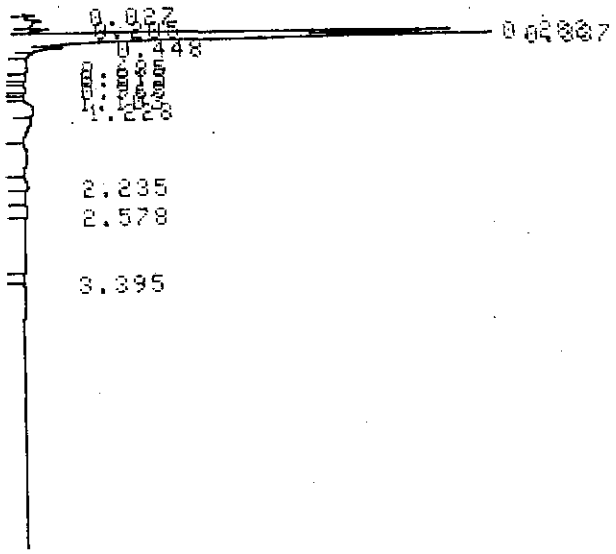
Sample: V8 **Analysts:** MAE/DP/AAV

Vol. Inj: 100 µl **Std. Vol. Inj:** 50 µl

221.25412

074

START
12/17/87 14:



CHROMATOGRAM 21 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1789

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.205	1897				
2	0.282	60217	V			
3	0.337	87054	SV			
4	0.448	1893	T			
5	0.685	1036				
6	1.228	3447				
7	2.235	1235		2	0.063	TOL
		---			---	
	TOTAL	156778			0.063	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.27396	0	0.0315207	0
0	0	0.101657	3.40714

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Sample: V9/A

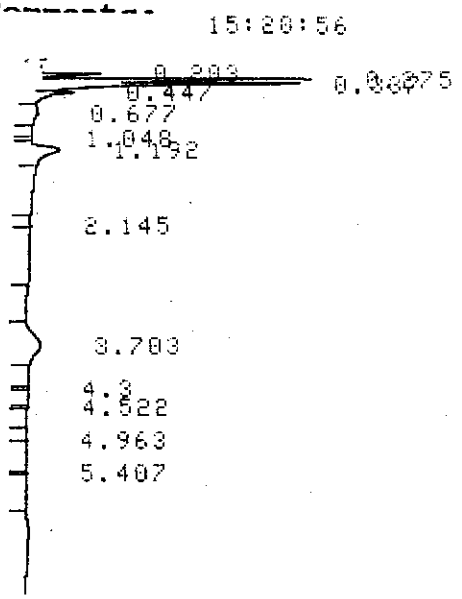
Vol. Inj: 100µL

Date: 12/17/87

Analysts: MAE/DP/AAY

Std. Vol. Inj: 50µL

Comments:



CHROMATOGRAM 23 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1791

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.203	9499				
2	0.275	35677	V			
3	0.337	44584	V			
4	0.447	10917	V			
5	0.677	4476	V			
6	1.192	12774				
7	3.703	13664				
	TOTAL	131592			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
1.93865	0	0	0
0	0	0.752052	2.6907

ERROR 16:UNDEF'D STATEMENT IN 410

⊕ Shimadzu 221-25412

076

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: V9|B

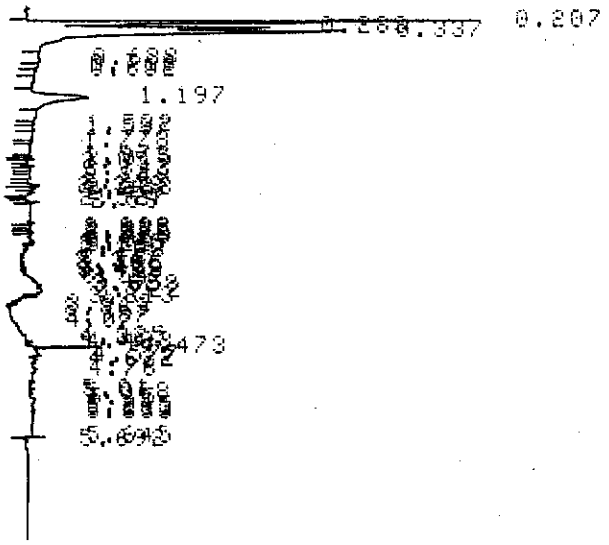
Analysts: MAE/DP/MAY

Vol. Inj: 100µl

Std. Vol. Inj: 50µl

Comments:

/87 15:59:20



CHROMATOGRAM 25 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1793

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.207	54440				
2	0.283	39034	V			
3	0.337	73726	V			
4	0.638	4499	V			
5	0.768	1161	V			

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.86455	0	0	0.0304209
0.0257443	0.0575416	0.825644	4.8039

ERROR 16:UNDEF'D STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Sample: V1D

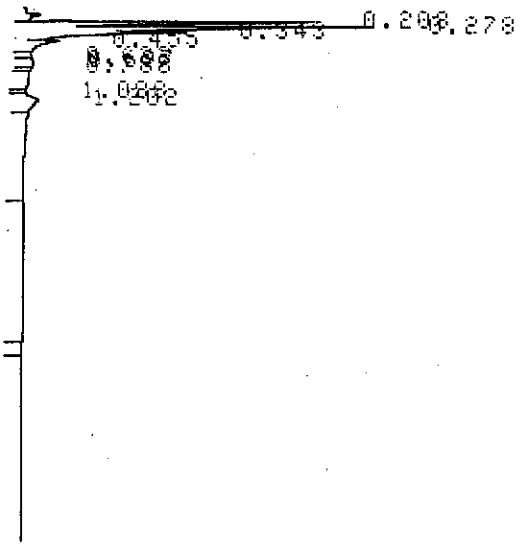
Vol. Inj: 100µl

Date: 12/17/87

Analysts: MAE/DP/AAV

Std. Vol. Inj: 50µl

START
12/17/87 14:46:50



CHROMATOGRAM 22 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1790

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.208	39306				
2	0.278	53906	V			
3	0.343	27338	V			
4	0.455	6657	V			
5	0.697	1724	V			
6	1.202	4451				
	TOTAL	133382			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
2.61501	0	0	0
0	0	0.126596	2.74161

⊕ Shimadzu 221 25412

075

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 17 DEC 1987

Sample: V11

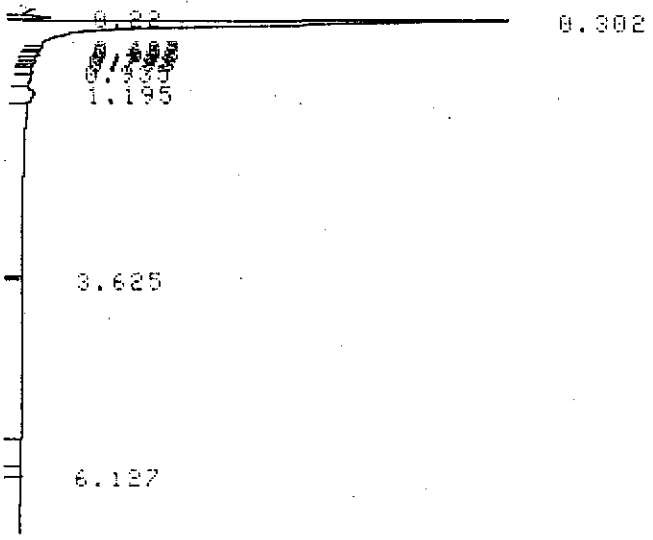
Analysts: Dgg MAE & LMS

Vol. Inj: 100µl

Std. Vol. Inj: 50µl

Comments:

START
12/17/8 15:33:22



CHROMATOGRAM 24 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1792

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.22	2764				
2	0.302	155772	SV			
3	1.195	3404				
	TOTAL	161940			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
3.45713	0	0	0
0	0	0.0968294	3.5539

ERROR 16:UNDEFND STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: BLANK

Analysts: MAE/DP/AAV

Vol. Inj: 100µl

Std. Vol. Inj: 50ul

Comments: Not used: reset integrator

221-2541?

054

CHROMATOGRAM 2 MEMORIZED
PEAK
START
12/17/87 09:28:17

8:878
1.232
STOP 9.999

CHROMATOGRAM 2 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1763

FILE 0
METHOD 24
SAMPLE WT 100

P<NO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.072	42607				
2	0.418	24464	V			
3	1.232	32401				
	TOTAL	79522			0	

WIDTH(0)
ANALYSIS PARAMETER FILE 0

WIDTH	3	SLOPE	4000
DRIFT	10000	MIN.AREA	1000
T.DBL	30	STOP.TM	7
PITEM	6	SPEED	10
METHOD#	24	FORMAT#	0
SPL.WT	100	IS.WT	1

SLOPE(0)=2000
START
12/17/87 09:33:23

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: BLANK

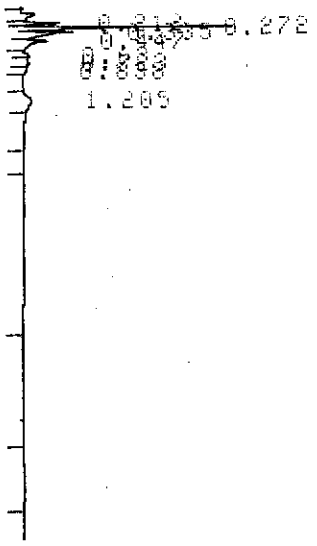
Analysts: MAE/DP/AAV

Vol. Inj: 100µL

Std. Vol. Inj: 50µL

Comments: _____

12/17/87 10:00:23



CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1766

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.212	2906				
2	0.272	19134	V			
3	0.335	8246	V			
4	0.447	4173	V			
5	0.63	1372	V			
6	0.723	1949	V			
7	1.205	3567				
	TOTAL	37287			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PSB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNDI	TVA
-0.482257	0	0	0
0	0	0.104271	-0.377986

Shimadzu 221-25412

056

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: BLANK

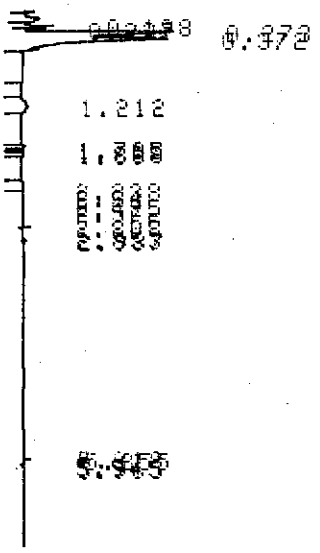
Analysts: MAE/DP/AAV

Vol. Inj: 100µL

Std. Vol. Inj: 50µL

Comments: _____

```
START
12/17/87          13:49:04
```




```
CHROMATOGRAM  18  MEMORIZED

CHROMATOPAC   C-R3A                    FILE          0
SAMPLE NO     0                        METHOD          24
REPORT NO     1786                     SAMPLE WT     100


PKNO       TIME       AREA   MK   IDNO      CONC        NAME

   1      0.198       2097
   2      0.273      28645   V
   3      0.372      41959   V
   4      1.212       2636
   5      2.853       1120
                  ---------              -------------
         TOTAL       76458                     0
RUN
VOLUME INJECTED (UL)
?  100
DILUTION
?  1
PBB                BEN                TOL                O-XYL
M,P-XYL            ET BEN             PNOI               TVH
 1.01553            0                  0                  0
 0                  0                  0.106853           1.12239
*ERROR* 16:UNDEF'D STATEMENT IN   410
```

B. Shinabu 221-25412 072

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X **Date:** 12/17/87

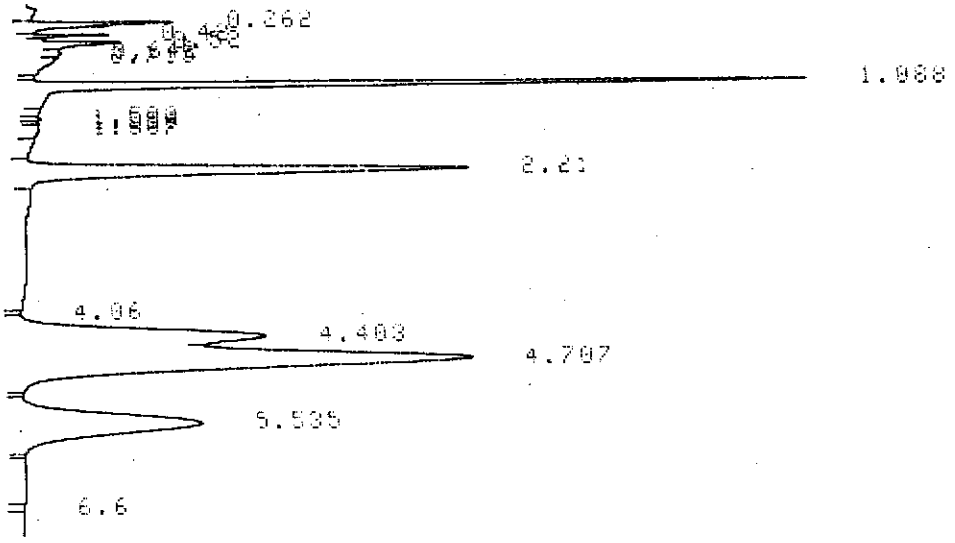
Sample: STANDARD **Analysts:** MAE/DP/AAV

Vol. Inj: 50µl **Std. Vol. Inj:** 50ul

Comments: DID NOT CALIBRATE

112

START
00/00/00 10:00:06



055

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1765

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.262	31064				
2	0.42	7847	V			
3	0.52	23635	V			
4	0.642	16547	V			
5	0.715	9841	V			
6	1.088	180433		1	10.7291	BEN
7	2.21	198629		2	10.5639	TOL
8	4.403	203031		3	9.5366	ET BEN
9	4.707	442257	V	4	19.149	M,P-XY
10	5.535	197266		5	8.8796	O-XYL
	TOTAL	1304551			58.8582	

DATE$="12/17/87"
TIME$="10/T.DBL(0)"
ERROR 2:ILLEGAL QUANTITY
TIME$="10/0A/00"

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

Date: 12/17/87

Sample: STANDARD

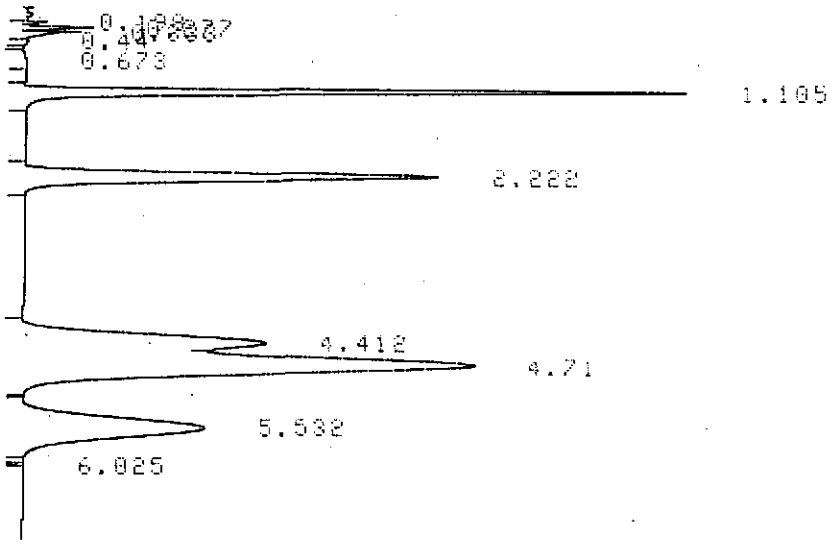
Analysts: MAE/DP/AAY

Vol. Inj: 50µl

Std. Vol. Inj: 50ul

Comments:

START
12/17/87 10:35:44



CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1769

FILE 0
METHOD 24
SAMPLE WT 100

CALIBRATION MADE IN IDENTIFICATION FILE 0
MODE# 1 WINDOW 5

IDNO	NAME	TIME	FACTOR	CONC
1	BEN	1.08	5.68907E-5	10
2	TOL	2.19	5.10622E-5	10
3	ET BEN	4.36	4.88282E-5	10
4	M,P-XY	4.66	0.000044839	20
5	O-XYL	5.5	4.87788E-5	10

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053

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

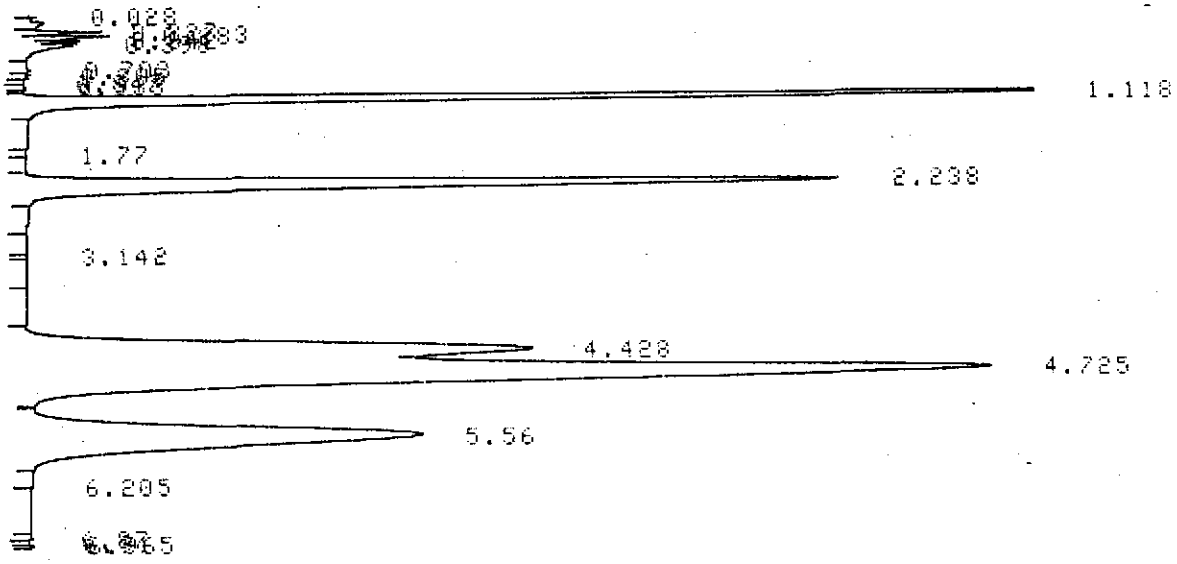
Project Number: CHV82X **Date:** 12/17/87

Sample: SD **Analysts:** MAE/DP/AAY

Vol. Inj: 100µL **Std. Vol. Inj:** 50µL

Comments:

```
START
12/17/87          13:39:05
```




```
CHROMATOGRAM  17  MEMORIZED

CHROMATOPAC    C-R3A                    FILE          0
SAMPLE NO      0                        METHOD          24
REPORT NO      1785                     SAMPLE WT     100


PKNO       TIME       AREA   MK   IDNO      CONC        NAME

   1       0.227       7437
         TOTAL     254/530                 122.4169
RUN
VOLUME INJECTED (UL)
?  100
DILUTION
?  1

PXB                   BEN                   TOL                   O-XYL
M+P-XYL               ET BEN                PNOI                  TVH
 0.0275047             9.7171                9.88129               10.5189
 20.8955               10.1956               10.177                71.4129
*ERROR* 16:UNDEF'D STATEMENT IN    410
```

071

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV82X

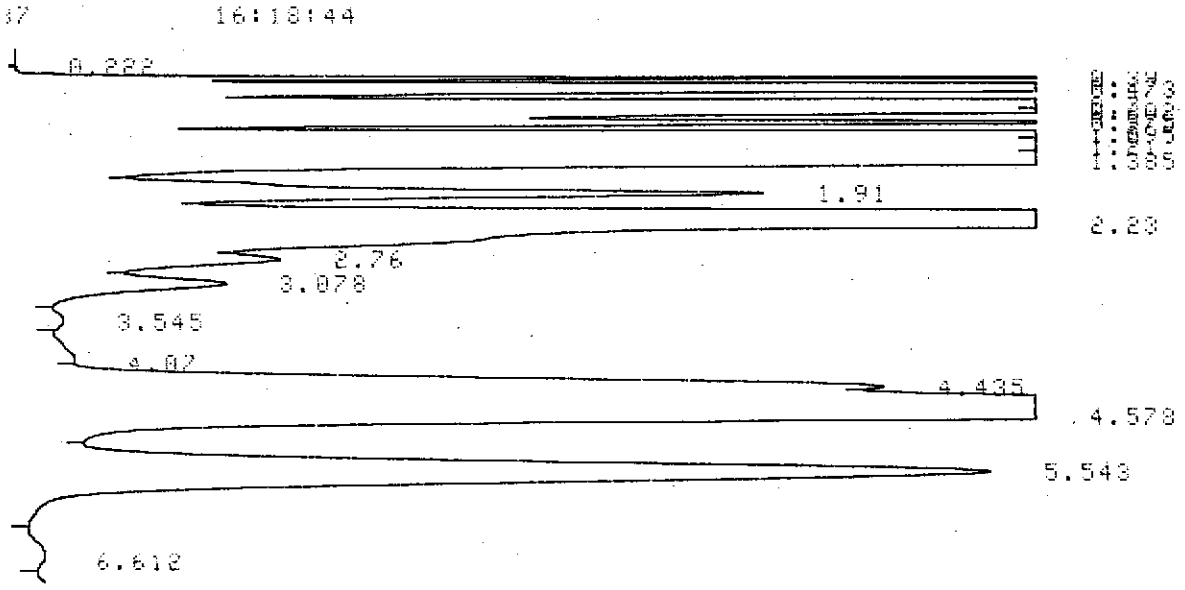
Date: 12/17/87

Sample: CHV Super Unleaded

Analysts: MAE/DP/AAV

Vol. Inj: 1 µL headspace

Std. Vol. Inj: 50uL



CHROMATOGRAM 26 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1794

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.39	3080965	VE			
2	0.473	12260967	VE			
3	0.7	11243367	VE			
4	0.802	7808135	VE			
5	0.975	6260802	VE			
6	1.095	8785352	VE	1	499.8049	BEN

RUN
VOLUME INJECTED (UL)
? 1
DILUTION
? 1

PBB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
115641	24990.2	77333.9	44246.2
76202	23509.9	177472	539396

ERROR 16:UNDEF'D STATEMENT IN 410

07

APPENDIX C

Use of Low-Molecular-Weight Standards To Identify Early-Eluting Compounds

APPENDIX C: USE OF LOW-MOLECULAR-WEIGHT STANDARDS TO IDENTIFY EARLY-ELUTING COMPOUNDS

As noted in the text, an unidentified peak was found in the chromatograms for soil gas samples from site SS 9-0020. The characteristics of the peak, a strong response, very short retention time, and longer tailing, suggests that the peak is the response to a low-molecular-weight, polar hydrocarbon. To identify the unknown constituents, a number of standards were made up (Table C-1 and following chromatograms) and run in the HNu 241 gas chromatograph. On the basis of the retention times and peak shapes of these standards, it is believed that the unidentified peaks (see site chromatograms, Appendix B) are responses to a small alcohol, a small alkane, or a combination of alcohols and alkanes coeluting. Small alkanes and alcohols were suspected because they can be formed from natural soil organics or petroleum hydrocarbons by microbial biodegradation. Studies of microbial decomposition show that alcohols, organic acids, and other small hydrocarbons can be formed from natural soil materials by aerobic or anaerobic processes (Odum 1971). The decomposition of petroleum-related aromatics (such as benzene, toluene, xylenes, and ethylbenzene) can also form small alkanes (API 1985). At the subject site, it is believed that natural soil organics are the precursors, because no detectable levels of the petroleum aromatics were found.

TABLE C-1 RESPONSE CHARACTERISTICS OF LOW-MOLECULAR-WEIGHT STANDARDS IN THE HNU421 GAS CHROMATOGRAPH

Compound	Retention Time (min.)	FID Sensitivity
Methanol	0.31 (with tailing)	Excellent
Ethanol	0.38 (with tailing)	Excellent
Methane	0.25	Excellent
Ethane	0.25	Excellent
Propane	0.25	Excellent
Butane	0.35	Excellent
Pentane	0.49	Excellent
Hexane	0.78	Excellent
Heptane	1.5	Excellent
Acetone	0.42	Excellent
Benzene	1.1	Excellent
Toluene	2.2	Excellent
Ethylbenzene	4.4	Excellent
m,p-Xylenes	4.8	Excellent
o-Xylene	5.6	Excellent
Ammonia	0.26	Poor
Hydrogen sulfide	0.26	Poor

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

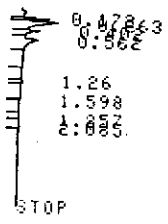
Project Number: C4U82L Date: 12/30/87

Sample: H_2S Analysts: MME

Vol. Inj: 100µL Std. Vol. Inj: 50µL

Comments: 27 PPM.

START
11/30/87 15:05:57



CHROMATOGRAM 2 MEMORIZED

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1691

FILE 0
METHOD 24
SAMPLE WT 100

ANAL
11/30/87 15:53:53

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1691

FILE 0
METHOD 14
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.175	1334				
2	0.265	12368	V			
3	0.405	3441	V			
4	0.565	5311	V			
	TOTAL	22454			0	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PRB	BEN	TOL	O-XYL
M/P-XYL	ET BEN	PNOI	TVH
-1.0151	0	0	0
0	0	1.19209E-7	-1.0151
*ERROR			

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

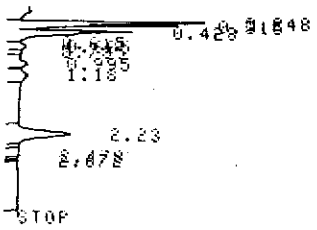
Project Number: CHV 836 (5-10% by wt) Date: 12/21/87

Sample: Parsons Ammonia Analysts: MMR

Vol. Inj: 100 µl Std. Vol. Inj: 50 µl

Comments: D.I = 200 ml / 40 ml

START
12/21/87 12:00:29



10%, 70°F

P_{NH_3} = 1.5 psia

$p = \frac{P_{NH_3}}{P_T} = .10$

= 100,000 ppm

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1827

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.248	42423				
2	0.315	29672	V			
3	0.428	38990	SV			
4	0.685	2724	TV			
5	0.995	2503	T			
6	1.18	3284				
7	2.23	32402		2	1.6766	TOL
	TOTAL	151998			1.6766	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PEB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
2.3233	0	0.838313	0
0	0	0.207035	3.36865

ERROR 16:UNDEF'D STATEMENT IN 410
RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 200

PEB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
464.66	0	167.663	0
0	0	41.4069	673.73

103

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV

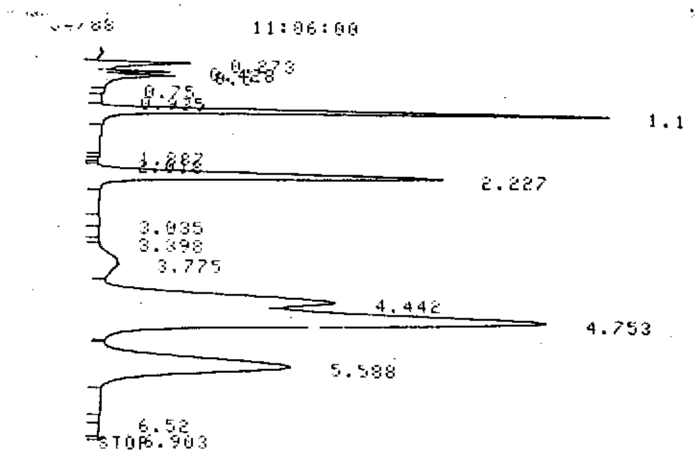
Sample: BTXE Std

Vol. Inj: 50ul

Date: 1/4/88

Analysts: MAE

Std. Vol. Inj: 50ul



BTXE Std
50µl

005

1	0.273	34780	
2	0.428	11411	V
3	0.5	35764	SV
4	1.1	179320	
5	2.227	216293	
6	3.775	27494	
7	4.442	262785	
8	4.753	590511	V
9	5.588	281721	
	TOTAL	1640078	

1	10	BEN
2	10	TOL
3	10	ET BEN
4	20	M,P-XY
5	10	O-XYL
	60	

RUN

VOLUME INJECTED (UL)

? 50

DILUTION

? 1

PBB

BEN TOL O-XYL

ET BEN PMOI TVH

20 10 26.6795 13

J STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV

Sample: Methanol (2)

Vol. Inj: 100 ml

Date: 1/4/88

Analysts: MAE

Std. Vol. Inj: 5 ml

Comments: 400:1 D.I. (100 ml / 40 ml) ~0.25 ppm

Report 1928 / 1929. 90,000 ppm / 40C

BP = 64.7°C

MeOH 9L
0.312 100µl / 40ml
100µl

$P^{25C}_{CH_3OH} \sim 70$ ppm

$p = \frac{P_{CH_3OH}}{P_T} = .09$

$= 90{,}000$ ppm

CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1928

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.248	29723				
2	0.312	484072	V			
3	0.45	73723	V			
4	0.568	8929	V			
5	0.777	4750	V			
6	0.972	2149	V			
7	1.148	6102		1	0.3403	BEN
	TOTAL	609447			0.3403	

```
RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

PKB                 BEN                 TOL                 O-XYL
M,P-XYL             ET BEN              PNOI                TVH
 15.0386             0.170131            0                   0
 0                   0                   -2.62266E-6         15.2087
*ERROR* 16:UNDEF'D STATEMENT IN  410
START
01/04/88            11:37:03
```

MeOH

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV

Date: 1/4/88

Sample: Ethanol (2)

Analysts: MHE

Vol. Inj: 100 µl

Std. Vol. Inj: 50 µl

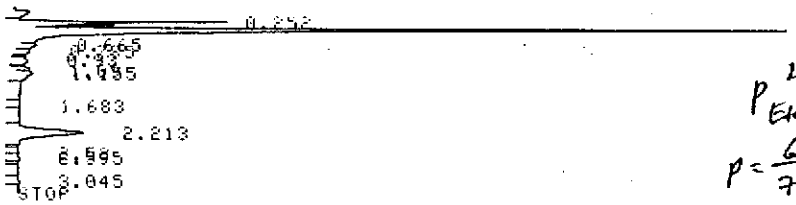
Comments: 400:1 Dilution. (100 µl / 40 mℓ) ~~2.5~~ ppm

Report No. 1930 / 1931 80,000 ppm

START
01/04/88 11:42:23

BP = 78.4°C

EtOH 100% / 100% 0.377 100%



$P_{EtOH}^{25°} \approx 60$ mm

$P = \frac{60}{760} = .08$

= 80,000 ppm

CHROMATOPAC C-R3A FILE 0
SAMPLE NO 0 METHOD 24
REPORT NO 1930 SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.252	48201				
2	0.377	473132	SV			
3	0.665	1093	T			
4	0.93	1653	T			
5	1.155	1765		1	0.0984	BEN
6	2.213	39835		2	1.8417	TOL
	TOTAL	565678			1.9401	

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1

P&B	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNDI	TVH
12.8284	0.0492011	0.920857	0
0	0	0.189863	13.9883

ERROR 16:UNDEF'D STATEMENT IN 410
START
01/04/88 11:46:32

EtOH 100% / 100%

011

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHU

Sample: Methane Std (2)

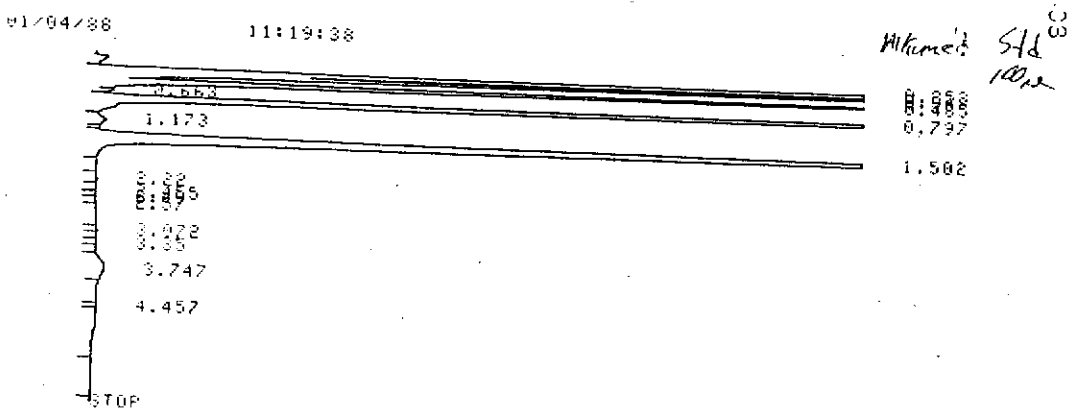
Vol. Inj: 100 µl

Date: 1/4/88

Analysts: MyAE

Std. Vol. Inj: 50 µl

Comments: Report No 1926/1927.



CHROMATOPAC C-R3A
SAMPLE NO 0
REPORT NO 1926

FILE 0
METHOD 24
SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME	Comp	PPM
1	0.253	539903						
2	0.348	375132	V			Methane	CH_4	13.6
3	0.485	465803	SV			Ethane	C_2H_6	13.9
4	0.663	1175	T			Propane	C_3H_8	14.1
5	0.797	525887	V			Butane	C_4H_{10}	14.9
6	1.173	3326				Pentane	C_5H_{12}	15.0
7	1.502	572404				Hexane	C_6H_{14}	15.6
8	2.22	1310		2	0.0606	Heptane	C_7H_{16}	15.0
9	3.747	9786						
	TOTAL	2494725			0.0606			

RUN
VOLUME INJECTED (UL)
? 100
DILUTION
? 1
PBB

M,P-XYL	BEN	TOL	O-XYL
	ET BEN	PNOI	TVH
51.4136	0	0.0302853	0
0	0	16.3322	67.7761

ERROR 16:UNDEF'D STATEMENT IN 410

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

HNU 421 Chromatogram report sheet

Project Number: CHV

Date: 1/4/88

Sample: Ethanol (2)

Analysts: MAE

Vol. Inj: 4 ml HS

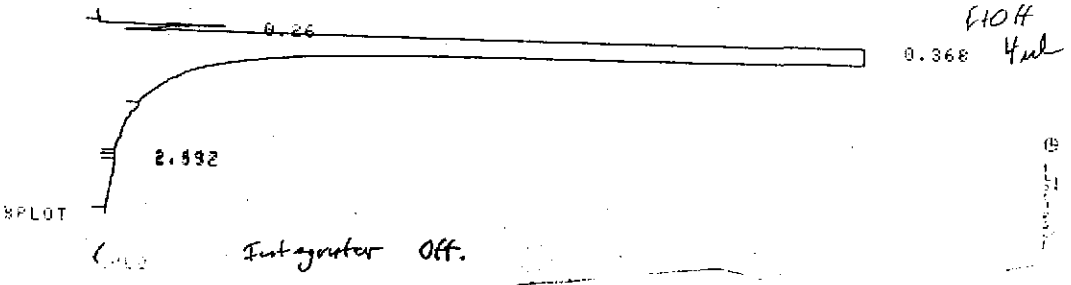
Std. Vol. Inj: 50 ml

Comments: Headspace, D.I = 1. ~66,500 ppm

ERROR (5:UNDEFD STATEMENT

START

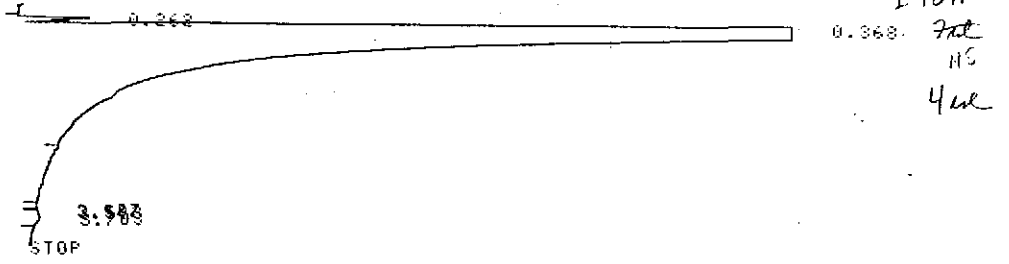
01/04/88 11:55:47



EtOH 4ml

Integrator Off.

00/00 00:07:35



EtOH Fast HS 4ml

CHROMATOPAC C-R3A FILE 0
SAMPLE NO 0 METHOD 24
REPORT NO 1935 SAMPLE WT 100

PKNO	TIME	AREA	MK	IDNO	CONC	NAME
1	0.262	23148				
2	0.368	10452969	VE			
3	3.703	2651				
	TOTAL	10478768			0	

RUN
VOLUME INJECTED (UL)
? 2
DILUTION
? 1

PEB	BEN	TOL	O-XYL
M,P-XYL	ET BEN	PNOI	TVH
14603.5	0	0	0
0	0	3.69531	14607.2

ERROR (5:UNDEFD STATEMENT

compound's concentration in the vapor phase to its concentration in the aqueous phase. The higher a compound's Henry's Law constant, the greater its tendency to volatilize from water into air.

Figure A-1 graphically illustrates the vapor pressure, aqueous solubility, and Henry's Law constants, and their relationships, for selected hydrocarbons typically found in gasoline. The Henry's Law constant is approximated here as the ratio of vapor pressure to solubility.

The Henry's Law constant is directly related to the tendency of compounds to volatilize, as opposed to solubilizing. Compounds with Henry's Law constants greater than 0.001 (atm· m^3/mole) volatilize from water into air very rapidly (Lyman et al. 1982); those with Henry's Law constants greater than 0.01 (atm· m^3/mole) are generally volatilized so rapidly that they are seldom found in gasoline-contaminated ground water. It may be observed (Figure A-1) that tetraethyl lead (TEL) has an extremely low solubility and a relatively low vapor pressure. As a result, this constituent would not be expected to solubilize and migrate in ground water, and although its low vapor pressure would indicate slow volatilization, its Henry's Law constant indicates that it may be more rapidly volatilized than solubilized. The fate of TEL would be expected to be long-term binding to the soil.

On the basis of these properties it can be seen that associated with any ground water, soil, or free-product contamination is vapor phase contamination. The SVCA technique takes advantage of this, and through the collection and analysis of soil vapor permits a rapid, cost-effective delineation of the extent of contamination.

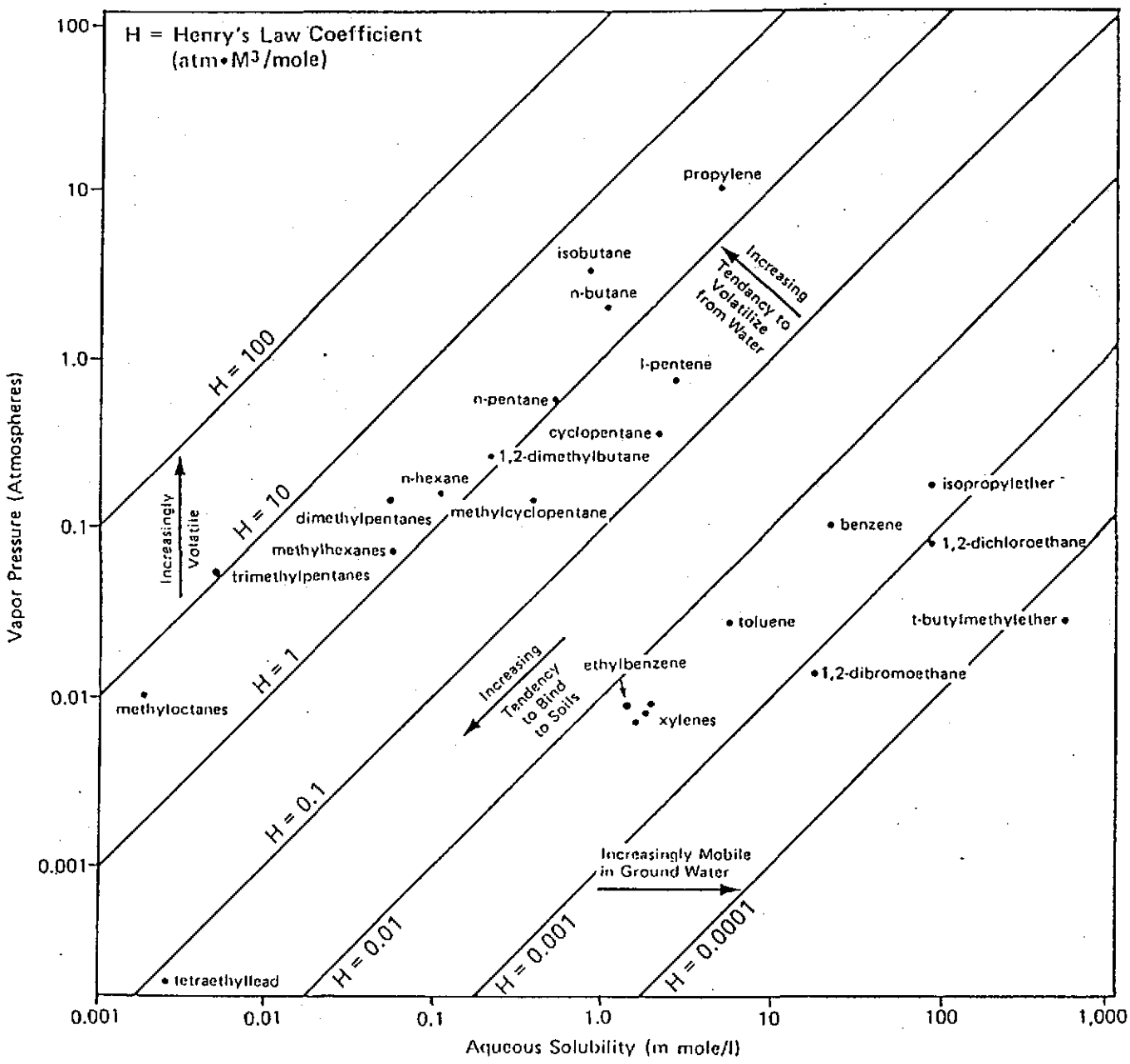


Figure A-1. Vapor pressures, solubilities, and corresponding Henry's Law constants for major constituents of gasoline.

APPENDIX B

SVCA Field Notes and Chromatograms

559-0020-004/F/23/12/97

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

SVCA DATA SHEET

Project Number: MW 82X
Project Manager:
Site Location: 17th & Harrison, Oakland, CA

Date: 17 Dec 1997
Analysts: AMG ME MS
Pump Number: 9-0020

	Grid Location	Time	Depth (ft)	OVA (ppm)	Purge Time	Vacuum Reading	Soil Type	Comments
1	~~STD~~ BLANK	9:33	—	—	—	—	—	RESET INTEGRATOR
2	STANDARD	00:00	—	—	—	—	—	DID NOT CALIBRATE
3	BLANK	10:00	—	—	—	—	—	
4	V1/A	10:25	3		10	22		TANK FIELD
5	STANDARD	10:35	—	—	—	—	—	CALIBRATED HERE
6	V3/A	10:49	3		10	4		
7	V1/B	1100	5.5		10	27		
8	V1/C	11:11	8		10	28		
9	V3/B	1121	5.5		10	20		HIT TOP OF TANKS at ~ 4.5 ft. MOVED 3ft away from tanks.
10	V1/D	1135	10.5		10	26	*	TOOK 1-2 min for vacuum to subside
11	V3/C	1146	8		10	26		
12	V1/E	1156	~~8~~ 13		10	26		
13	V3/D	1207	10.5		10	20		
14	V4 ~~A~~	1217	3		10	2		Hit concrete/hard layer at 4'.
15	V5	1228	3		10	20		
16	V2/A	1258	3		10	13		

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

SVCA DATA SHEET

Project Number: CHV82X
Project Manager: RH
Site Location: 17th and Harrison, Oak, CA

Date: 12/17/87
Analysts: MAE/AAY/MS
Pump Number: SS 9-0020

Grid Location	Time	Depth (ft)	OVA (ppm)	Purge Time	Vacuum Reading	Soil Type	Comments
V6/A	1307	3		10'	0.5		No flow.
V2/B	1319	8		10	25		
V6/B	1327	8		10	24		
STD	1339	—		—	—		100µL
BLANK	1349	—		—	—		
V6/C	1359	13		10	25		
V7	1409	3		10	13		
V8	1422	3		10	27		
V10	1446	8		10	25		
V9/A	1520	3		10	21		
V11	1533	8		10	27		
V9/B	1559	8		10	15		found mud sucked into probes after pulling out,
CHV Super Unleaded	~~1557~~ 1618	—		—	—		~~1 mL~~ 1 µL headspace