August 4. 1997

Comments on Polverosa Risk Assessment

Scott,

Since I found some errors in the hand calculation, they did some revisions and the updated calculations seems to be fine. On page 6, they summarized the results (SSTL's) based on the revised calcualtions. The concentrations on site for both soil (based on a maximum of 0.77) and groundwater (based on a maximum of .9 ppb) are below the calculated SSTL's for a risk of 10-5. Hopefully the maximum values they have stated in the risk assessment are acceptable to you based on site information. Also, in the revised calculation, they went back to using the default values for the air exchange rate as they did not have reference document to provide us. I left a message for Eric Nichols to go ahead and mail you a good copy (without scratches) of the risk assessment.

Madhulla

LEVINE-FRICKE

To Madhulla Logan	From Eric Nichols
Co. ACDEH	Emeryville Office
Dept. 567-6764	Phone No (510) 652-4500
Fax No. 337-9335	Fax No (510) 652-2246

No. of Pages 15

rections / revisions 8/5/97 EMN

LFR 1204.03

Risk-Based Corrective Action (RBCA) Evaluation
for
Polvorosa Business Park
1555 Doolittle Drive
San Leandro, California

Based on a request from Alameda County Department of Environmental Health (ACDEH), Levine-Fricke-Recon (LFR) has prepared this Risk-Based Corrective Action (RBCA) evaluation for the Polvorosa Business Park site (hereafter referred to as "the Site"). This evaluation is derived from the Standard RBCA method applied to petroleum release sites (American Society for Testing of Materials, ASTM standard method E-1739-95). In the absence of specific state policy and guidance concerning RBCA, we have used the example policies presented in the Appendices of ASTM E-1739, modified as noted.

Step 1: Initial Site Assessment

The site investigation was conducted in several phases subsequent to UST removal in 1986. The groundwater characterization was completed by Levine-Fricke in 1988. The most current soil quality data is from samples collected by Groundwater Technology in October, 1986.

The fuel types of concern are gasoline- and diesel-range fuel hydrocarbons. The thickness of free-phase hydrocarbons on groundwater was measured when encountered. Groundwater quality samples were analyzed for TPHg, TPHd, benzene, toluene, ethylbenzene, and xylenes. Groundwater samples were not analyzed for the above analytes when free-phase hydrocarbons were detected. Soil samples (collected in 1986) were analyzed for motor fuels, benzene, toluene, and total xylenes.

Step 2: Site Classification and Initial Response Action

Using Table 1 of ASTM Standard E 1739-95, the site falls under Classification 3 - Long-term threat to human health, safety, or sensitive environmental receptors. (This conclusion was drawn from both pre- and post-remediation conditions)

Interim Remedial Action

During UST removal activities in 1986, some unsaturated-zone hydrocarbon-affected soils in the immediate vicinity of the USTs were removed. However, the quantity of soils which

were removed was not recorded. Based on available records, the volume of soils excavated may have been several hundred cubic yards.

From August, 1989 to August, 1993, a total fluids groundwater capture system was operated in the area where free-phase hydrocarbons were encountered. Approximately 766,000 gallons of total fluids were removed, including about 283 gallons of free-phase hydrocarbons.

Step 3: Tier 1 Evaluation

The following is a brief summary of the rationale used in screening of reasonable sources, pathways, and exposures for evaluation.

Primary Sources:

The tanks and piping were removed in 1986.

Secondary Sources:

Based on existing data, the following secondary sources are present at the site:

- impacted subsurface soils
- dissolved groundwater plume
- free-phase liquid plume (limited extent based on observation of hydrocarbon sheen)

Transport Mechanisms:

The site is presently covered with asphalt and building structures. A one-story warehouse building overlies much of the more affected area. A landscaped area, without pavement, exists near the hydrocarbon-affected area, and is estimated at about 10% of the building footprint. Downgradient wells on the Site indicate that the plume has had little or no additional migration after the cessation of ground water capture.

The following transport mechanisms were judged to be significant:

- volatilization and atmospheric dispersion (through landscaped areas around the parking area)
- volatilization, migration of vapors through the building foundation, and enclosed-space accumulation

The following transport mechanisms were not considered significant as noted:

- wind erosion and atmospheric dispersion (because only a small portion of the site is unpaved)
- leaching and groundwater transport (because ground water is not extracted for human uses in the general vicinity of the Site)
- mobile free-liquid migration (because the source and mobile free-phase hydrocarbons were removed)
- stormwater/surfacewater transport (because the affected area does not include any affected surface soils or any large underground lines)

The receptors at the Site were characterized as:

- commercial/industrial
- construction workers

Applicable Risk-Based Screening Levels (RBSLs) from Tier 1 Look-up Table

Using the modified example ASTM RBCA table provided to us by ACDEH, the following is a comparison of applicable values for commercial/industrial sites:

SOIL-BASED EXPOSURE PATHWAYS
RBSLS and available site data

Exposure Pathway	Target Risk Level	Benzene (mg/kg)	Toluene (mg/kg)	Xylenes (total) (mg/kg)
Volatilization to outdoor air	**Cancer 1x10^{-6}**	**0.133**		
	Cancer 1x10^{-4}	**13.3**		
	Chronic Hazard		**RES**	**RES**
Vapor intrusion into buildings	**Cancer 1x10^{-6}**	**0.00155**		
	Cancer 1x10^{-4}	**0.155**		
	Chronic Hazard		**54.5**	**RES**
Max conc. detected (1986)		0.77	0.27	1.2
Mean over affected area @ 10.5' bgs (1986)*		0.23	0.11	0.28

GROUNDWATER-BASED EXPOSURE PATHWAYS
RBSLs and available site data

mg/L

Exposure Pathway	Target Risk Level	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (total)
Volatilization to outdoor air	Cancer $1x10^{-6}$	5.34			
	Cancer $1x10^{-4}$	>S			
	Chronic Hazard		>S	>S	>S
Vapor intrusion into buildings	Cancer $1x10^{-6}$	0.0069			
	Cancer $1x10^{-4}$	0.69			
	Chronic Hazard		54.5	>S	RES
Max. conc. detected (1995)		0.0009**	<MDL	<MDL	<MDL
Estimated max. – based on free-phase HCs		54	83	20	198

EXPLANATION:
RES – the selected risk level is not exceeded for pure compound selected in any concentration
>S – the selected risk level is not exceeded for all possible dissolved levels
<MDL – the analyte was not detected above the lab minimum detection level
bgs = below ground surface (depth)
*the mean calculated was an arithmetic mean of soil sample data at the approximate depth of shallow ground water over the area and immediate vicinity of Building C
** the 0.0009 mg/L benzene concentration detected was in a well upgradient of the most affected area; well LF-12 was not sampled in May 1995 due to the measurement of 0.02 feet of free-phase hydrocarbons
The estimated maximum concentrations for benzene was based on a mole fraction of 0.03 and a pure-compound solubility of 1800 mg/L. The estimated maximum concentrations of toluene and xylenes were estimated from section X1.6 and Table X1.2 of ASTM E-1739.

- The lightly shaded cells of RBSL values are those exceeded at the Tier 1 screening level.

Step 4: Decision Tree/Comparison with RBSLs

also used 10^{-5} as shown below

Based on our conversations with ACDEH, we considered a $1x10^{-4}$ (1 in ten thousand) excess cancer risk as the appropriate target risk level for the commercial/industrial receptors at the Site.

Chemical(s) of concern concentrations exceed RBSLs? - Yes, benzene (both soil and ground water into indoor air) and toluene (soil and ground water into indoor air). Both of the groundwater RBSLs were exceeded based on the assumption of free-phase hydrocarbons rather than the actual values detected.

Remediation to Tier 1 RBSLs practicable? - No

Interim remedial action appropriate? - Yes, but to further evaluate whether remaining concentrations pose an acceptable risk, we completed a Tier 2 evaluation to derive Site Specific Target Levels (SSTLs).

Step 5: Tier 2 Calculation of SSTLs

Based on the attached calculations, the groundwater-to-outdoor air pathway is well below the applicable commercial/industrial SSTL values using a combination of default and site-specific assumptions.

Table 1 shows the Site-specific assumptions used to calculate the SSTLs. Other input parameters were taken from the default parameters presented in ASTM E1739.

Tables 2, 3 and 4 are the calculations used to derive the SSTLs for the indoor air exposure pathway. The SSTLs calculated are summarized below:

	Benzene		**Toluene**
Media	risk=10^{-4}	risk=10^{-5}	HI=1
Soil (mg/kg)	204	20.4	20,300.
Groundwater (mg/L)	20.4	2.0 200 ppb	770.

Step 6: Comparison with SSTLs

The calculated benzene and toluene concentrations in soil and groundwater necessary to exceed the indoor air SSTLs are well above those detected. The SSTLs calculated are also well above the soil and groundwater concentrations that would be expected adjacent to a

fresh liquid hydrocarbon sheen, based on equilibrium partitioning. A comparison of the calculated SSTL values above to the estimated maximum concentrations based on free-phase hydrocarbons expressed in the above groundwater RBSL table supports this conclusion.

Conclusion

We recommend no further corrective action at the Site. It is our opinion that the possible exposure pathways have been considered and evaluated to pose an insignificant risk using Site data. This conclusion is consistent with existing current State of California guidelines, since benzene has not been detected at concentrations greater than 1 mg/L at the Site and the Site is greater than 750 feet from the nearest drinking water well.

LEVINE·FRICKE
CONSULTING ENGINEERS AND HYDROGEOLOGISTS

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Site-Specific Input Parameters

SHEET ~~Table 1~~ p.1 OF 1, Calcs 1/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Symbol	Definition of Parameter	Tier 1 Default Value	Tier 2 Site-Specific Value	Reason for Modification
θ_{as}	volumetric air content vadose zone soils	0.26 $\frac{cm^3 air}{cm^3 soil}$	0.18 $\frac{cm^3 air}{cm^3 soil}$	fine-grained soils under buildings are typically at least 50% saturated
θ_{ws}	volumetric water content vadose zone soils	0.12 "	0.20 "	" "
$\theta_{a\,crack}$	volumetric air content foundation cracks	0.26 "	0.18 "	foundation cracks are typically partially filled with soil and/or water
$\theta_{w\,crack}$	volumetric water content foundation cracks	0.12 "	0.20 "	" "
h_v	thickness of vadose zone	295 cm	305 cm	the approximate depth to ground water is about 9 feet at the site
L_{GW}	depth to ground water	300 cm	310 cm	$L_{GW} = h_v + h_{cap}$
L_s	depth to subsurface soil sources	100 cm	170 cm	in 1986, some hydrocarbons were detected at 5.5 feet bgs
ER	enclosed-space air exchange rate	0.00014/sec	~~0.0028/sec~~ used 0.00014 as default, revision 8/4/97	~~an exchange rate of 10 volumes per hour was used based on the use of the building as a warehouse with large doors open much of the time~~
η	areal fraction of cracks in foundation	0.01	0.001	the building is relatively new (about 10 years) and was constructed with a polyethylene moisture barrier below the foundation slab

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SHEET Table 2, p. 1 OF 3, Calcs 2/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of diffusion Coefficients
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Diffusion Coefficient Soil – Vapor, D_s^{eff}

$$D_s^{eff} \cong D_v^{air} \frac{\theta_{as}^{3.33}}{\theta_T^{2.0}} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^{2.0}}$$

For benzene,

$$D_s^{eff} \cong 0.093 \frac{(0.18)^{3.33}}{(0.38)^{2.0}} + (1.1 \times 10^{-5}) \frac{1}{0.22} \frac{(0.18)^{3.33}}{(0.38)^{2.0}}$$

$$\cong 0.093 \frac{0.0033}{0.1444} + (1.1 \times 10^{-5})(4.54) \frac{0.0033}{0.1444}$$

$$\cong 0.0021 \; \cancel{0.21} + 1 \times 10^{-6}$$

$$\cong \cancel{0.21} \; 0.0021$$

For toluene,

$$D_s^{eff} \cong 0.093 \frac{(0.18)^{3.33}}{(0.38)^{2.0}} + (9.4 \times 10^{-6}) \frac{1}{0.26} \frac{(0.18)^{3.33}}{(0.38)^{2.0}}$$

$$\cong 0.0021 \; \cancel{0.21} + 1 \times 10^{-6}$$

$$\cong \cancel{0.21} \; 0.0021$$

corrections/revisions 8/4/97 EMN

Diffusion Coefficient through foundation cracks, D_{crack}^{eff}

$$D_{crack}^{eff} \cong D^{air} \frac{\theta_{acrack}^{3.33}}{\theta_T^{2}} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^{2}}$$

For benzene,

$D_{crack}^{eff} \cong$ same as D_s^{eff} for benzene $= \cancel{0.21}$ 0.0021

For toluene,

$D_{crack}^{eff} \cong$ same as D_s^{eff} for toluene $= \cancel{0.21}$ 0.0021

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~~SHEET~~ Table 2, p. 2 OF 3, Calcs 3/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
COMPUTED BY: J. Sturman
SUBJECT: Calculation of diffusion coefficients
CHECKED BY: E. Nichols

Diffusion Coefficient through capillary fringe, D^{eff}_{cap}

$$D^{eff}_{cap} = D^{air} \frac{\theta_{a\,cap}^{3.33}}{\theta_T^{2}} + D^{wat} \frac{1}{H} \frac{\theta_{w\,cap}^{3.33}}{\theta_T^{2.0}}$$

For benzene,

$$D^{eff}_{cap} = 0.093 \frac{(0.038)^{3.33}}{(0.38)^{2.0}} + 1.1\times10^{-5} \frac{1}{0.22} \frac{(0.342)^{3.33}}{(0.38)^{2.0}}$$

$$= 0.093 \frac{0.000019}{0.1444} + 1.1\times10^{-5} \frac{1}{0.22} \frac{0.028}{0.1444}$$

$$= 1.2\times10^{-5} + 9.7\times10^{-6}$$

$$= 2.2\times10^{-5}$$

For toluene,

$$D^{eff}_{cap} = 0.093 \frac{(0.038)^{3.33}}{(0.38)^{2.0}} + 9.4\times10^{-6} \frac{1}{0.26} \frac{(0.342)^{3.33}}{(0.38)^{2.0}}$$

$$= 0.093 \frac{0.000019}{0.1444} + 9.4\times10^{-6} \frac{1}{0.26} \frac{0.028}{0.1444}$$

$$= 1.2\times10^{-5} + 7.0\times10^{-6}$$

$$= 1.9\times10^{-5}$$

corrections/revisions 8/4/97 EMJ

Diffusion Coefficient between ground water and soil surface D^{eff}_{ws}

$$D^{eff}_{ws} = (h_{cap} + h_v)\left(\frac{h_{cap}}{D^{eff}_{cap}} + \frac{h_v}{D_s^{eff}}\right)^{-1}$$

For benzene

$$D^{eff}_{ws} = \frac{(5+305)}{\left(\frac{5}{2.2\times10^{-5}} + \frac{305}{\cancel{0.21}\ 0.0021}\right)} = \frac{310}{2.27\times10^{5} + 1.45\times10^{5}} = \cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}$$

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SHEET Table 2, p.3 OF 3, Calcs 4/18
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
COMPUTED BY: J. Sturman
SUBJECT: Calculation of diffusion coefficients
CHECKED BY: E. Nickols

For toluene

$$D_{ws}^{eff} = \frac{(5+305)}{\frac{5}{1.9\times10^{-5}} + \frac{305}{\cancel{0.21}\ 0.0021}} = \frac{310}{2.63\times10^{5} + 1.45\times10^{3}} = \cancel{1.1\times10^{-3}}\ 7.6\times10^{-4}$$

corrections/revisions
8/4/97 EMN

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~~SHEET~~ Table 3, p.1 OF 2, Calcs 5/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of Volatilization Factors
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Volatilization Factor, Soil to indoor air VF_{sesp}

$$VF_{sesp} = \frac{\dfrac{H\rho_s}{[\theta_{ws} + K_s\rho_s + H\theta_{as}]}\left[\dfrac{D_s^{eff}/L_s}{ER \cdot L_B}\right]}{1 + \left[\dfrac{D_s^{eff}/L_s}{ER\ L_B}\right] + \left[\dfrac{D_s^{eff}/L_s}{(D_{crack}^{eff}/L_{crack})\eta}\right]} \times 10^3$$

For benzene,

numerator terms $= \dfrac{0.22(1.7)}{0.20 + 0.38(1.7) + 0.22(0.18)} \quad \dfrac{\cancel{0.21}\ .0021/170}{0.0028 \cdot 300}$

$= 0.42 \quad \cancel{0.0015}\ .000015 = 6.21\times10^{\cancel{-4}\,-6}$

denominator terms $= 1 + \left[\dfrac{\cancel{0.21}\ .0021/170}{0.0028 \cdot 300}\right] + \dfrac{\cancel{0.21}\ .0021/170}{\cancel{0.21}\ .0021/15\ (0.001)}$

$\cancel{88.2}$

$1 + \cancel{0.0015}\ .000015 + 88.2 = 89.2$ ✓ok

$VF_{sesp} = \dfrac{6.21\times10^{-4}}{89.2} \times 10^3 = 7.0\times10^{\cancel{-3}\,-5}\ \dfrac{mg/m^3\ air}{mg/kg\ soil}$

Corrections/revisions 8/4/97 EMJ

For toluene,

numerator terms $= \dfrac{0.26(1.7)}{0.20 + 1.35(1.7) + 0.26(0.18)} \quad \dfrac{\cancel{0.21}\ .0021/170}{0.0028/300}$

$= 0.173 \quad \cancel{0.0015}\ .000015 = 2.56\times10^{\cancel{-4}\,-6}$

denominator terms = same as benzene, above

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~~SHEET~~ Table 3, p.2 OF 2, Calcs 6/8.
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
COMPUTED BY: J. Sturman
SUBJECT: Calculation of volatilization Factors
CHECKED BY: E. Nichols

toluene $VF_{SESP} = \frac{2.56\times10^{-4}}{89.2} \times 10^{3} = 2.87\times10^{\cancel{-6}\,-5}\ \frac{mg/m^3\ air}{mg/kg\ soil}$

Volatilization Factor, groundwater to indoor air, VF_{WESP}

$$VF_{WESP} = \frac{H\left[\frac{D^{eff}_{ws}/L_{GW}}{ER\ L_B}\right]}{1+\left(\frac{D^{eff}_{ws}/L_{GW}}{ER\ L_B}\right)+\left(\frac{D^{eff}_{ws}/L_{GW}}{(D^{eff}_{crack}/L_{crack})\eta}\right)} \times 10^{3}$$

Corrections / revisions 8/4/97 EMN

For benzene, numerator terms $= 0.22\ \frac{\cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}/310}{\cancel{0.0028}\ 0.00014 \cdot 300} = \cancel{1.1\times10^{-6}}\ 1.4\times10^{-5}$

denominator terms $= 1 + \left(\frac{\cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}/310}{\cancel{0.0028}\ .00014\ 300}\right) + \frac{\cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}/310}{\cancel{0.21}\ 0.0021/15 \cdot 0.001}$

$= 1 + \cancel{5.2\times10^{-6}}\ 6.4\times10^{-3} + \cancel{0.31}\ 19.1 = \cancel{1.31}\ 20.1$

$VF_{WESP}\ \frac{\cancel{1.1\times10^{-6}}\ 1.4\times10^{-5}}{\cancel{1.31}\ 20.1} \times 10^{3} = \cancel{8.4\times10^{-4}}\ 7.0\times10^{-4}\ \frac{mg/m^3\ air}{mg/L \cdot H_2O}$

For toluene, numerator terms $= 0.26\ \frac{\cancel{1.1\times10^{-3}}\ 7.6\times10^{-4}/310}{\cancel{0.0028}\ 0.00014\ 300} = \cancel{1.1\times10^{-6}}\ 1.5\times10^{-5}$ 4×10^{-6}

denominator terms $= 1 + \left(\frac{\cancel{1.1\times10^{-3}}\ 7.6\times10^{-4}/310}{\cancel{0.0028}\ 0.00014\ 300}\right) + \frac{\cancel{1.1\times10^{-3}}\ 7.6\times10^{-4}/310}{\cancel{0.21}\ .0021/15 \cdot 0.001} = \cancel{1.25}\ 18.5$

$VF_{WESP} = \frac{\cancel{1.1\times10^{-6}}\ 1.4\times10^{-5}}{\cancel{1.25}\ 18.5} \times 10^{3} = \cancel{8.8\times10^{-4}}\ 7.6\times10^{-4}\ \frac{mg/m^3\ air}{mg/L \cdot H_2O}$

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SHEET Table 4, p.1 OF 2, Calcs
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
COMPUTED BY: J. Sturman
SUBJECT: Calculation of SSTLs
CHECKED BY: E. Nichols

Calculation of Site-Specific Target Levels

Benzene

Using $C_{air} = 1.43 \times 10^{1}$ µg/m³ as the maximum acceptable level based on the Tier 1 look-up table,

For soil

$$C_{T\,soil}^{Ben} = \frac{C_{air}}{VF_{SESP}} = \frac{1.43 \times 10^{1}\ \mu g/m^3}{7.0 \times \cancel{10^{-5}}\,10^{-3}\ \frac{mg/m^3\ air}{mg/kg\ soil}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= \cancel{2.04}\ mg/kg\ soil$$

204.0

~~10^-4 ... 59.66 ... 10^-5 ... 5.9 ... 10^-5~~

20.4 for 10^{-5} risk

For ground water

$$C_{T\,gw}^{Ben} = \frac{C_{air}}{VF_{WESP}} = \frac{1.43 \times 10^{1}\ \mu g/m^3}{8.4 \times 10^{-4}\ (\cancel{7.05 \times 10^{-4}})\ \frac{mg/m^3\ air}{mg/L \cdot H_2O}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= \cancel{0.20}\ \cancel{17.0}\ 20.4\ mg/L\ \cancel{ground\ water}$$

= 2.04 for 10^{-5}

Toluene

For soil

$C_{air} = 5.84 \times 10^{2}$ µg/m³ as above (HQ = 1)

$$C_{T\,soil}^{Tol} = \frac{C_{air}}{VF_{SESP}} = \frac{5.84 \times 10^{2}\ \mu g/m^3}{2.87 \times 10^{-\cancel{3}5}\ \frac{mg/m^3\ air}{mg/kg\ soil}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= 203\ mg/kg\ soil$$

20300

Corrections / revisions 8/4/97 EmJ

March 21, 1997

LFR 1204.00.03

Mr. Scott Seery
Hazardous Materials Specialist
Local Oversight Program
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502-6577

Subject: Transmittal of Risk-Based Corrective Action (RBCA) Evaluation for Polvorosa Business Park Site, San Leandro, CA

Dear Mr. Seery:

As you requested, Levine-Fricke-Recon (LFR) prepared a Risk-Based Corrective Action (RBCA) evaluation for the underground storage tank release at the Polvorosa Business Park site in San Leandro, California. This RBCA evaluation was prepared in accordance with the American Society for Testing of Materials (ASTM) standard E-1739-95.

Based on the results of this evaluation, it is our recommendation that the fuel leak case be closed.

A copy of this transmittal was sent to you via fax earlier this week. We would appreciate a timely response to this evaluation. If you have any questions, please contact me at (908) 526-1000 extension 538 or Eric Nichols, P.E. at (510) 652-4500.

Sincerely,

John Sturman, P.E., R.G.
Senior Engineer

cc: Mr. Steven Chamberlain, Chamberlain Associates

March 19, 1997 LFR 1204.03

Risk-Based Corrective Action (RBCA) Evaluation
for
Polvorosa Business Park
1555 Doolittle Drive
San Leandro, California

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The site investigation was conducted in several phases subsequent to UST removal in 1986. The groundwater characterization was completed by Levine·Fricke in 1988. The most current soil quality data is from samples collected by Groundwater Technology in October, 1986.

The fuel types of concern are gasoline- and diesel-range fuel hydrocarbons. The thickness of free-phase hydrocarbons on groundwater was measured when encountered. Groundwater quality samples were analyzed for TPHg, TPHd, benzene, toluene, ethylbenzene, and xylenes. Groundwater samples were not analyzed for the above analytes when free-phase hydrocarbons were detected. Soil samples (collected in 1986) were analyzed for motor fuels, benzene, toluene, and total xylenes.

Step 2: Site Classification and Initial Response Action

Using Table 1 of ASTM Standard E 1739-95, the site falls under Classification 3 - Long-term threat to human health, safety, or sensitive environmental receptors. (This conclusion was drawn from both pre- and post-remediation conditions)

Interim Remedial Action

During UST removal activities in 1986, some unsaturated-zone hydrocarbon-affected soils in the immediate vicinity of the USTs were removed. However, the quantity of soils which

were removed was not recorded. Based on available records, the volume of soils excavated may have been several hundred cubic yards.

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The following is a brief summary of the rationale used in screening of reasonable sources, pathways, and exposures for evaluation.

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Based on existing data, the following secondary sources are present at the site:

- impacted subsurface soils
- dissolved groundwater plume
- free-phase liquid plume (limited extent based on observation of hydrocarbon sheen)

Transport Mechanisms:

The site is presently covered with asphalt and building structures. A one-story warehouse building overlies much of the more affected area. A landscaped area, without pavement, exists near the hydrocarbon-affected area, and is estimated at about 10% of the building footprint. Downgradient wells on the Site indicate that the plume has had little or no additional migration after the cessation of ground water capture.

The following transport mechanisms were judged to be significant:

ok ✓ - volatilization and atmospheric dispersion (through landscaped areas around the parking area)

✓ - volatilization, migration of vapors through the building foundation, and enclosed-space accumulation

The following transport mechanisms were not considered significant as noted:

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- leaching and groundwater transport (because ground water is not extracted for human uses in the general vicinity of the Site)
- mobile free-liquid migration (because the source and mobile free-phase hydrocarbons were removed)
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The receptors at the Site were characterized as:

ok ✓ • commercial/industrial

✓ • construction workers

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RBSLS and available site data

Exposure Pathway	Target Risk Level	Benzene (mg/kg)	Toluene (mg/kg)	Xylenes (total) (mg/kg)
Volatilization to outdoor air	**Cancer 1x10^{-6}**	**0.133**		
	Cancer 1x10^{-4}	**13.3**		
	Chronic Hazard		**RES**	**RES**
Vapor intrusion into buildings	**Cancer 1x10^{-6}**	**0.00155**		
	Cancer 1x10^{-4}	**0.155**		
	Chronic Hazard		**54.5**	**RES**
Max conc. detected (1986)		**0.77**	**0.27**	**1.2**
Mean over affected area @ 10.5' bgs (1986)*		**0.23**	**0.11**	**0.28**

- Max detected benzene @ 10.5' BG (1986) exceeds 1E-4 RBSL for vapor intrusion into buildings from soil. However, fine grained sediments (silty clay; gravelly clay, etc.) generally comprise the upper ~6' of soil column.
- 1E-4 RBSL for volatilization to outdoor air is not exceeded.

GROUNDWATER-BASED EXPOSURE PATHWAYS
RBSLs and available site data

Exposure Pathway	Target Risk Level	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (total)
Volatilization to outdoor air	Cancer 1x10^{-6}	5.34			
	Cancer 1x10^{-4}	>S			
	Chronic Hazard		>S	>S	>S
Vapor intrusion into buildings	Cancer 1x10^{-6}	0.0069			
	Cancer 1x10^{-4}	0.69			
	Chronic Hazard		54.5	>S	RES
Max. conc. detected (1995)		0.0009**	<MDL	<MDL	<MDL
Estimated max. - based on free-phase HCs		54	83	20	198

EXPLANATION:

RES -- the selected risk level is not exceeded for pure compound selected in any concentration

>S -- the selected risk level is not exceeded for all possible dissolved levels

<MDL -- the analyte was not detected above the lab minimum detection level

bgs = below ground surface (depth)

*the mean calculated was an arithmetic mean of soil sample data at the approximate depth of shallow ground water over the area and immediate vicinity of Building C

** the 0.0009 mg/L benzene concentration detected was in a well ~~up~~downgradient of the most affected area; well LF-12 was not sampled in May 1995 due to the measurement of 0.02 feet of free-phase hydrocarbons

The estimated maximum concentrations for benzene was based on a mole fraction of 0.03 and a pure-compound solubility of 1800 mg/L. The estimated maximum concentrations of toluene and xylenes were estimated from section X1.6 and Table X1.2 of ASTM E-1739.

The lightly shaded cells of RBSL values are those exceeded at the Tier 1 screening level.

Step 4: Decision Tree/Comparison with RBSLs

Based on our conversations with ACDEH, we considered a 1×10^{-4} (1 in ten thousand) excess cancer risk as the appropriate target risk level for the commercial/industrial receptors at the Site.

Chemical(s) of concern concentrations exceed RBSLs? - Yes, benzene (both soil and ground water into indoor air) and toluene (soil and ground water into indoor air). Both of the groundwater RBSLs were exceeded based on the assumption of free-phase hydrocarbons rather than the actual values detected.

Remediation to Tier 1 RBSLs practicable? - No

Interim remedial action appropriate? - Yes, but to further evaluate whether remaining concentrations pose an acceptable risk, we completed a Tier 2 evaluation to derive Site Specific Target Levels (SSTLs).

Step 5: Tier 2 Calculation of SSTLs

Based on the attached calculations, the groundwater-to-outdoor air pathway is well below the applicable commercial/industrial SSTL values using a combination of default and site-specific assumptions.

Table 1 shows the Site-specific assumptions used to calculate the SSTLs. Other input parameters were taken from the default parameters presented in ASTM E1739.

Tables 2, 3 and 4 are the calculations used to derive the SSTLs for the indoor air exposure pathway. The SSTLs calculated are summarized below:

Media	Benzene	Toluene
Soil (mg/kg)	2.04	203
Groundwater (mg/L)	17.0	663

Step 6: Comparison with SSTLs

The calculated benzene and toluene concentrations in soil and groundwater necessary to exceed the indoor air SSTLs are well above those detected. The SSTLs calculated are also well above the soil and groundwater concentrations that would be expected adjacent to a

fresh liquid hydrocarbon sheen, based on equilibrium partitioning. A comparison of the calculated SSTL values above to the estimated maximum concentrations based on free-phase hydrocarbons expressed in the above groundwater RBSL table supports this conclusion.

Conclusion

We recommend no further corrective action at the Site. It is our opinion that the possible exposure pathways have been considered and evaluated to pose an insignificant risk using Site data. This conclusion is consistent with existing current State of California guidelines, since benzene has not been detected at concentrations greater than 1 mg/L at the Site and the Site is greater than 750 feet from the nearest drinking water well.

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PROJECT: Palvorosa Site RBCA Evaluation
SUBJECT: Site-Specific Input Parameters

SHEET Table 1, p. 1 OF 1, Calcs 1/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Symbol	Definition of Parameter	Tier 1 Default Value	Tier 2 Site-Specific Value	Reason for Modification
θ_{as}	volumetric air content vadose zone soils	0.26 $\frac{cm^3\ air}{cm^3\ soil}$	0.18 $\frac{cm^3\ air}{cm^3\ soil}$	fine-grained soils under buildings are typically at least 50% saturated
θ_{ws}	volumetric water content vadose zone soils	0.12 "	0.20 "	" "
$\theta_{a\ crack}$	volumetric air content foundation cracks	0.26 "	0.18 "	foundation cracks are typically partially filled with soil and/or water
$\theta_{w\ crack}$	volumetric water content foundation cracks	0.12 "	0.20 "	" "
h_v	thickness of vadose zone	295 cm	305 cm	the approximate depth to ground water is about 9 feet at the site
L_{GW}	depth to ground water	300 cm	310 cm	$L_{GW} = h_v + h_{cap}$
L_s	depth to subsurface soil sources	100 cm	170 cm	in 1986, some hydrocarbons were detected at 5.5 feet bgs
ER	enclosed-space air exchange rate	0.00014/sec 0.5	0.0028/sec 10	an exchange rate of 10 volumes per hour was used based on the use of the building as a warehouse with large doors open much of the time
η	areal fraction of cracks in foundation	0.01	0.001	the building is relatively new (about 10 years) and was constructed with a polyethylene moisture barrier below the foundation slab

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~~SHEET~~ Table 2, p.1 OF 3, Calcs 2/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of diffusion Coefficients

Diffusion Coefficient Soil-Vapor; D_s^{eff}

$$D_s^{eff} \cong D_v^{air} \frac{\theta_{as}^{3.33}}{\theta_T^{2.0}} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^{2.0}}$$

For benzene,

$$D_s^{eff} \cong 0.093 \frac{(0.18)^{3.33}}{(0.38)^{2.0}} + (1.1\times10^{-5}) \frac{1}{0.22} \frac{(0.18)^{3.33}}{(0.38)^{2.0}} \Big\} .02285$$

4.545

$$\cong 0.093 \frac{0.0033}{0.1444} + (1.1\times10^{-5})(4.54)\frac{0.0033}{0.1444}$$

.0021 + 1.14 × 10⁻⁶

$$\cong 0.21 + 1\times10^{-6}$$

$$\cong \cancel{0.21} \text{ cm}^2/\text{sec} = .0021$$

.0021 +

For toluene,

$$D_s^{eff} \cong 0.093 \frac{(0.18)^{3.33}}{(0.38)^{2.0}} + (9.4\times10^{-6}) \frac{1}{0.26} \frac{(0.18)^{3.33}}{(0.38)^{2.0}}$$

$$\cong 0.21 + 1\times10^{-6}$$

$$\cong 0.21 \text{ cm}^2/\text{sec}$$

Diffusion Coefficient through foundation cracks, D_{crack}^{eff}

$$D_{crack}^{eff} \cong D^{air} \frac{\theta_{acrack}^{3.33}}{\theta_T^{2}} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^{2}}$$

For benzene,

$D_{crack}^{eff} \cong$ same as D_s^{eff} for benzene $= 0.21$ cm²/sec

For toluene,

$D_{crack}^{eff} \cong$ same as D_s^{eff} for toluene $= 0.21$ cm²/sec

POLVOROSA

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of diffusion coefficients

Diffusion Coefficient through capillary fringe, D^{eff}_{cap}

$$D^{eff}_{cap} = D^{air} \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{wcap}^{3.33}}{\theta_T^{2.0}}$$

For benzene,

$$D^{eff}_{cap} = 0.093 \frac{(0.038)^{3.33}}{(0.38)^{2.0}} + 1.1\times10^{-5} \frac{1}{0.22} \frac{(0.342)^{3.33}}{(0.38)^{2.0}}$$

$$= 0.093 \frac{0.000019}{0.1444} + 1.1\times10^{-5} \frac{1}{0.22} \frac{0.028}{0.1444}$$

$$= 1.2\times10^{-5} + 9.7\times10^{-6}$$

$$= 2.2\times10^{-5} \text{ cm}^2/\text{sec}$$ ✓

For toluene,

$$D^{eff}_{cap} = 0.093 \frac{(0.038)^{3.33}}{(0.38)^{2.0}} + 9.4\times10^{-6} \frac{1}{0.26} \frac{(0.342)^{3.33}}{(0.38)^{2.0}}$$

$$= 0.093 \frac{0.000019}{0.1444} + 9.4\times10^{-6} \frac{1}{0.26} \frac{0.028}{0.1444}$$

$$= 1.2\times10^{-5} + 7.0\times10^{-6}$$

$$= 1.9\times10^{-5} \text{ cm}^2/\text{sec}$$ ✓

Diffusion Coefficient between ground water and soil surface D^{eff}_{ws}

$$D^{eff}_{ws} = (h_{cap} + h_v)\left(\frac{h_{cap}}{D^{eff}_{cap}} + \frac{h_v}{D_s^{eff}}\right)^{-1}$$

For benzene

$$D^{eff}_{ws} = \frac{(5+305)}{\left(\frac{5}{2.2\times10^{-5}} + \frac{305}{\cancel{0.21}\ .0021}\right)} = \frac{310}{2.27\times10^5 + 1.45\times10^3} = \cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}$$

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~~SHEET~~ Table 2, p.3 OF 3, Calcs 4/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
PROJECT: Polvorosa Site RBCA Evaluation
COMPUTED BY: J. Sturman
SUBJECT: Calculation of diffusion coefficients
CHECKED BY: E. Nichols

For toluene

$$D_{ws}^{eff} = \frac{(5+305)}{\frac{5}{1.9\times10^{-5}} + \frac{305}{0.21}} = \frac{310}{2.63\times10^{5} + 1.45\times10^{3}} = 1.1\times10^{-3} \ cm^2/sec$$

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SHEET Table 3, p.1 OF 2, Calcs 5/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of Volatilization Factors

Volatilization Factor, Soil to indoor air VF_{SESP}

$$VF_{SESP} = \frac{\dfrac{H\rho_s}{[\theta_{ws} + k_s\rho_s + H\theta_{as}]}\left[\dfrac{D_s^{eff}/L_s}{ER\cdot L_B}\right]}{1 + \left[\dfrac{D_s^{eff}/L_s}{ER\ L_B}\right] + \left[\dfrac{D_s^{eff}/L_s}{(D_{crack}^{eff}/L_{crack})\eta}\right]} \times 10^3$$

For benzene,

numerator terms $= \dfrac{0.22(1.7)}{0.20 + 0.38(1.7) + 0.22(0.18)} \quad \dfrac{\cancel{0.21}\ .0021/170}{0.0028\cdot 300}$

$0.646 \quad + 0.0396$

$\dfrac{0.374}{0.8856} = 0.42 \qquad = .0000015 \quad \cdot\ 0.0015 = 6.21\times 10^{-4}$ 6.3×10^{-4}

denominator terms $= 1 + \left[\dfrac{\cancel{0.21}\ .0021/170}{0.0028\cdot 300}\right] + \dfrac{\cancel{0.21}\ .0021/170}{\cancel{0.21}\ .0021/15\ (0.001)}$

$1 + \ .000015\ \ 0.0015 + 88.2 = 89.2$

$VF_{SESP} = \dfrac{6.21\times10^{-6}}{89.2}\times 10^3 = 7.0\times10^{-5}\ \dfrac{mg/m^3\ air}{mg/kg\ soil}$

7.0×10^{-5}

For toluene,

numerator terms $= \dfrac{0.26(1.7)}{0.20 + 1.35(1.7) + 0.26(0.18)} \quad \dfrac{\cancel{0.21}\ .0021/170}{0.0028/300}$

$= 0.173 \qquad \cdot\ 0.0015 - 2.56\times10^{-4}$

denominator terms = same as benzene, above

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~~SHEET~~ Table 3, p.2 OF 2, Calcs 6/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of Volatilization Factors

toluene $VF_{SESP} = \frac{2.56\times10^{-4}}{89.2}\times10^{3} = 2.87\times10^{-3}$ (10^{-5}) $\frac{mg/m^3\ air}{mg/kg\ soil}$

Volatilization Factor, groundwater to indoor air, VF_{WESP}

$$VF_{WESP} = \frac{H\left[\frac{D^{eff}_{ws}/L_{GW}}{ER\ L_B}\right]}{1+\left(\frac{D^{eff}_{ws}/L_{GW}}{ER\ L_B}\right)+\left(\frac{D^{eff}_{ws}/L_{GW}}{(D^{eff}_{crack}/L_{crack})\eta}\right)}\times10^{3}$$

For benzene, numerator terms $= 0.22\ \frac{\cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}/310}{\cancel{0.0028}\cdot300} = \cancel{1.1\times10^{-6}}\ 1.4\times10^{-5}$

denominator terms $= 1+\left(\frac{\cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}/310}{\cancel{0.0028}\ .00014\cdot300}\right)+\frac{\cancel{1.36\times10^{-3}}\ 8.3\times10^{-4}/310}{\cancel{0.21}\ .0021/15\cdot0.001} = 2.6\times10^{-6}\ /\ 1.4\times10^{-7}$ (.00014)

$= 1+\cancel{5.2\times10^{-6}}\ 6.3\times10^{-5}+\cancel{0.31}\ 18.5 = \cancel{1.31}\ 19.5$

$VF_{WESP} = \frac{\cancel{1.1\times10^{-6}}\ 1.4\times10^{-5}}{\cancel{1.31}\ 19.5}\times10^{3} = \cancel{8.4\times10^{-4}}\ 7.0\times10^{-4}\ \frac{mg/m^3\ air}{mg/L\cdot H_2O}$

For toluene, numerator terms $= 0.26\ \frac{1.1\times10^{-3}/310}{0.0028\cdot300} = 1.1\times10^{-6}$ 1×10^{-5}

denominator terms $= 1+\left(\frac{1.1\times10^{-3}/310}{0.0028\cdot300}\right)+\frac{1.1\times10^{-3}/310}{0.21/15\cdot0.001} = 1.25$

$VF_{WESP} = \frac{1.1\times10^{-6}}{1.25}\times10^{3} = 8.8\times10^{-4}\ \frac{mg/m^3\ air}{mg/L\cdot H_2O}$

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PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of SSTLs

SHEET Table 4, p.1 OF 2, Calcs 7/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Calculation of Site-Specific Target Levels

Benzene

Using $C_{air} = 1.43 \times 10^{1}$ µg/m³ as the maximum acceptable level based on the Tier 1 look-up table,

For soil

$$C_{T\,soil}^{Ben} = \frac{C_{air}}{VF_{SESP}} = \frac{1.43 \times 10^{1}\ \mu g/m^3}{7.0 \times 10^{-3}\ \frac{mg/m^3\ air}{mg/kg\ soil}} \times 10^{-3}\ \frac{mg}{\mu g}$$

7.0×10^{-5}

$= 2.04$ mg/kg soil   4.33

204 – 10^{-4}
20.4 – 10^{-5}

For groundwater

$$C_{T\,gw}^{Ben} = \frac{C_{air}}{VF_{WESP}} = \frac{1.43 \times 10^{1}\ \mu g/m^3}{8.4 \times 10^{-4}\ \frac{mg/m^3\ air}{mg/L\cdot H_2O}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$= 17.0$ mg/L groundwater

Tolvene

For soil

$C_{air} = 5.84 \times 10^{2}$ µg/m³ as above (HQ=1)

$$C_{T\,soil}^{Tol} = \frac{C_{air}}{VF_{SESP}} = \frac{5.84 \times 10^{2}\ \mu g/m^3}{2.87 \times 10^{-3}\ \frac{mg/m^3\ air}{mg/kg\ soil}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$= 203$ mg/kg soil

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PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of SSTLs

~~SHEET~~ Table 4, p.2 OF 2, calcs 8/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Toluene in groundwater

$$C_{T\,GW}^{Tol} = \frac{C_{air}}{VF_{WESP}} = \frac{5.84 \times 10^{2}\ \mu g/m^3}{8.8 \times 10^{-4}\ \frac{mg/m^3\ air}{mg/L \cdot H_2O}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= 663\ mg/L \cdot H_2O \text{ groundwater}$$

Output Table 1

Site Name. Polverosa
Site Location San Leandro

Job Identification.
Date Completed
Completed By. madhulla Logan

Software. GSI RBCA Spreadsheet
Version' v 1 0

NOTE. values which differ from Tier 1 default values are shown in bold italics and underlined

DEFAULT PARAMETERS

Exposure Parameter	Definition (Units)	Residential Adult	Residential (1-6yrs)	Residential (1-16 yrs)	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
ATc	Averaging time for carcinogens (yr)	70				
ATn	Averaging time for non-carcinogens (yr)	30	6	16	25	1
BW	Body Weight (kg)	70	15	35	70	
ED	Exposure Duration (yr)	30	6	16	25	1
EF	Exposure Frequency (days/yr)	350			250	180
EF.Derm	Exposure Frequency for dermal exposure	350			250	
IRgw	Ingestion Rate of Water (l/day)	2			1	
IRs	Ingestion Rate of Soil (mg/day)	100	200		50	100
IRadj	Adjusted soil ing rate (mg•yr/kg•d)	1 1E+02			9 4E+01	
IRa in	Inhalation rate indoor (m^3/day)	15			20	
IRa out	Inhalation rate outdoor (m^3/day)	20			20	10
SA	Skin surface area (dermal) (cm^2)	5 8E+03		2.0E+03	5 8E+03	5 8E+03
SAadj	Adjusted dermal area (cm^2•yr/kg)	2 1E+03			1 7E+03	
M	Soil to Skin adherence factor	1				
AAFs	Age adjustment on soil ingestion	FALSE			FALSE	
AAFd	Age adjustment on skin surface area	FALSE			FALSE	
tox	Use EPA tox data for air (or PEL based)	TRUE				
gwMCL?	Use MCL as exposure limit in groundwater?	FALSE				

Matrix of Exposed Persons to Complete Exposure Pathways		Residential	Commercial/Industrial Chronic	Commercial/Industrial Constrctn
Groundwater Pathways:				
GW i	Groundwater Ingestion	FALSE	FALSE	
GW v	Volatilization to Outdoor Air	FALSE	FALSE	
GW b	Vapor Intrusion to Buildings	FALSE	TRUE	
Soil Pathways				
S v	Volatiles from Subsurface Soils	FALSE	FALSE	
SS v	Volatiles and Particulate Inhalation	FALSE	FALSE	TRUE
SS d	Direct Ingestion and Dermal Contact	FALSE	FALSE	FALSE
S l	Leaching to Groundwater from all Soils	FALSE	FALSE	
S b	Intrusion to Buildings - Subsurface Soils	FALSE	TRUE	

Matrix of Receptor Distance and Location on- or off-site		Residential Distance	Residential On-Site	Commercial/Industrial Distance	Commercial/Industrial On-Site
GW	Groundwater receptor (cm)		FALSE		FALSE
S	Inhalation receptor (cm)		FALSE		FALSE

Matrix of Target Risks		Individual	Cumulative
TRab	Target Risk (class A&B carcinogens)	***<u>1.0E-05</u>***	
TRc	Target Risk (class C carcinogens)	1 0E-05	
THQ	Target Hazard Quotient	1 0E+00	
Opt	Calculation Option (1, 2, or 3)	2	
Tier	RBCA Tier	2	

Surface Parameters	Definition (Units)	Residential	Commercial/Industrial Chronic	Commercial/Industrial Construction
t	Exposure duration (yr)	30	25	1
A	Contaminated soil area (cm^2)	2.2E+06		1.0E+06
W	Length of affected soil parallel to wind (cm)	1 5E+03		1.0E+03
W.gw	Length of affected soil parallel to groundwater (c	1 5E+03		
Uair	Ambient air velocity in mixing zone (cm/s)			
delta	Air mixing zone height (cm)			
Lss	Definition of surficial soils (cm)	1.0E+02		
Pe	Particulate areal emission rate (g/cm^2/s)			

Groundwater	Definition (Units)	Value
delta gw	Groundwater mixing zone depth (cm)	
I	Groundwater infiltration rate (cm/yr)	
Ugw	Groundwater Darcy velocity (cm/yr)	
Ugw tr	Groundwater Transport velocity (cm/yr)	
Ks	Saturated Hydraulic Conductivity(cm/s)	
grad	Groundwater Gradient (cm/cm)	
Sw	Width of groundwater source zone (cm)	
Sd	Depth of groundwater source zone (cm)	
BC	Biodegradation Capacity (mg/L)	
BIO?	Is Bioattenuation Considered	FALSE
phi eff	Effective Porosity in Water-Bearing Unit	
foc sat	Fraction organic carbon in water-bearing unit	

Soil	Definition (Units)	Value		
hc	Capillary zone thickness (cm)	5 0E+00		
hv	Vadose zone thickness (cm)	***<u>3.0E+02</u>***		
rho	Soil density (g/cm^3)	1 7		
foc	Fraction of organic carbon in vadose zone	0 01		
phi	Soil porosity in vadose zone	0 38		
Lgw	Depth to groundwater (cm)	***<u>3.1E+02</u>***		
Ls	Depth to top of affected soil (cm)	***<u>1.7E+02</u>***		
Lsubs	Thickness of affected subsurface soils (cm)	***<u>1.3E+02</u>***		
pH	Soil/groundwater pH	6.5		
		capillary	**vadose**	**foundation**
phi.w	Volumetric water content	0.342	***<u>0.2</u>***	***<u>0.2</u>***
phi a	Volumetric air content	0 038	***<u>0.18</u>***	***<u>0.18</u>***

Building	Definition (Units)	Residential	Commercial
Lb	Building volume/area ratio (cm)	2 0E+02	3.0E+02
ER	Building air exchange rate (s^-1)	1 4E-04	2 3E-04
Lcrk	Foundation crack thickness (cm)	1 5E+01	
eta	Foundation crack fraction	***<u>0.001</u>***	

Dispersive Transport Parameters	Definition (Units)	Residential	Commercial
Groundwater			
ax	Longitudinal dispersion coefficient (cm)		
ay	Transverse dispersion coefficient (cm)		
az	Vertical dispersion coefficient (cm)		
Vapor			
dcy	Transverse dispersion coefficient (cm)		
dcz	Vertical dispersion coefficient (cm)		

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ENGINEERS, HYDROGEOLOGISTS & APPLIED SCIENTISTS

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FAX TRANSMISSION: This cover page plus 15 page(s).

Time	
Date	20 March 1997
From	John Sturman
LFR Project No.	1204.00.03

Deliver To	Name Of Firm	FAX Number
Mr. Scott Seery	Alameda County - Environ Health	510-337-9335

Comments: This fax contains a RBCA evaluation of the Polvorosa site in San Leandro. Seven pages of text and eight pages of calculations are enclosed. The hard copy is being sent to you via regular mail. I'll give you a call in a couple weeks to check with you on your schedule for review. If you have any questions, please call me at 908-526-1000, extension 538. Thank you

March 19, 1997 LFR 1204.03

Risk-Based Corrective Action (RBCA) Evaluation
for
Polvorosa Business Park
1555 Doolittle Drive
San Leandro, California

Based on a request from Alameda County Department of Environmental Health (ACDEH), Levine-Fricke-Recon (LFR) has prepared this Risk-Based Corrective Action (RBCA) evaluation for the Polvorosa Business Park site (hereafter referred to as "the Site"). This evaluation is derived from the Standard RBCA method applied to petroleum release sites (American Society for Testing of Materials, ASTM standard method E-1739-95). In the absence of specific state policy and guidance concerning RBCA, we have used the example policies presented in the Appendices of ASTM E-1739, modified as noted.

Step 1: Initial Site Assessment

The site investigation was conducted in several phases subsequent to UST removal in 1986. The groundwater characterization was completed by Levine-Fricke in 1988. The most current soil quality data is from samples collected by Groundwater Technology in October, 1986.

The fuel types of concern are gasoline- and diesel-range fuel hydrocarbons. The thickness of free-phase hydrocarbons on groundwater was measured when encountered. Groundwater quality samples were analyzed for TPHg, TPHd, benzene, toluene, ethylbenzene, and xylenes. Groundwater samples were not analyzed for the above analytes when free-phase hydrocarbons were detected. Soil samples (collected in 1986) were analyzed for motor fuels, benzene, toluene, and total xylenes.

Step 2: Site Classification and Initial Response Action

Using Table 1 of ASTM Standard E 1739-95, the site falls under Classification 3 - Long-term threat to human health, safety, or sensitive environmental receptors. (This conclusion was drawn from both pre- and post-remediation conditions)

Interim Remedial Action

During UST removal activities in 1986, some unsaturated-zone hydrocarbon-affected soils in the immediate vicinity of the USTs were removed. However, the quantity of soils which

were removed was not recorded. Based on available records, the volume of soils excavated may have been several hundred cubic yards.

From August, 1989 to August, 1993, a total fluids groundwater capture system was operated in the area where free-phase hydrocarbons were encountered. Approximately 766,000 gallons of total fluids were removed, including about 283 gallons of free-phase hydrocarbons.

Step 3: Tier 1 Evaluation

The following is a brief summary of the rationale used in screening of reasonable sources, pathways, and exposures for evaluation.

Primary Sources:

The tanks and piping were removed in 1986.

Secondary Sources:

Based on existing data, the following secondary sources are present at the site:

- impacted subsurface soils
- dissolved groundwater plume
- free-phase liquid plume (limited extent based on observation of hydrocarbon sheen)

Transport Mechanisms:

The site is presently covered with asphalt and building structures. A one-story warehouse building overlies much of the more affected area. A landscaped area, without pavement, exists near the hydrocarbon-affected area, and is estimated at about 10% of the building footprint. Downgradient wells on the Site indicate that the plume has had little or no additional migration after the cessation of ground water capture.

The following transport mechanisms were judged to be significant:

- volatilization and atmospheric dispersion (through landscaped areas around the parking area)
- volatilization, migration of vapors through the building foundation, and enclosed-space accumulation

The following transport mechanisms were not considered significant as noted:

- wind erosion and atmospheric dispersion (because only a small portion of the site is unpaved)
- leaching and groundwater transport (because ground water is not extracted for human uses in the general vicinity of the Site)
- mobile free-liquid migration (because the source and mobile free-phase hydrocarbons were removed)
- stormwater/surfacewater transport (because the affected area does not include any affected surface soils or any large underground lines)

The receptors at the Site were characterized as:

- commercial/industrial
- construction workers

Applicable Risk-Based Screening Levels (RBSLs) from Tier 1 Look-up Table

Using the modified example ASTM RBCA table provided to us by ACDEH, the following is a comparison of applicable values for commercial/industrial sites:

SOIL-BASED EXPOSURE PATHWAYS
RBSLS and available site data

Exposure Pathway	Target Risk Level	Benzene (mg/kg)	Toluene (mg/kg)	Xylenes (total) (mg/kg)
Volatilization to outdoor air	Cancer $1x10^{-6}$	0.133		
	Cancer $1x10^{-4}$	13.3		
	Chronic Hazard		RES	RES
Vapor intrusion into buildings	Cancer $1x10^{-6}$	0.00155		
	Cancer $1x10^{-4}$	0.155		
	Chronic Hazard		54.5	RES
Max conc. detected (1986)		0.77	0.27	1.2
Mean over affected area @ 10.5' bgs (1986)*		0.23	0.11	0.28

GROUNDWATER-BASED EXPOSURE PATHWAYS
RBSLs and available site data

Exposure Pathway	Target Risk Level	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylenes (total)
Volatilization to outdoor air	Cancer 1×10^{-6}	5.34			
	Cancer 1×10^{-4}	>S			
	Chronic Hazard		>S	>S	>S
Vapor intrusion into buildings	Cancer 1×10^{-6}	0.0069			
	Cancer 1×10^{-4}	0.69			
	Chronic Hazard		54.5	>S	RES
Max. conc. detected (1995)		0.0009**	<MDL	<MDL	<MDL
Estimated max. - based on free-phase HCs		54	83	20	198

EXPLANATION:

RES -- the selected risk level is not exceeded for pure compound selected in any concentration

>S -- the selected risk level is not exceeded for all possible dissolved levels

<MDL -- the analyte was not detected above the lab minimum detection level

bgs = below ground surface (depth)

*the mean calculated was an arithmetic mean of soil sample data at the approximate depth of shallow ground water over the area and immediate vicinity of Building C

** the 0.0009 mg/L benzene concentration detected was in a well upgradient of the most affected area; well LF-12 was not sampled in May 1995 due to the measurement of 0.02 feet of free-phase hydrocarbons

The estimated maximum concentrations for benzene was based on a mole fraction of 0.03 and a pure-compound solubility of 1800 mg/L. The estimated maximum concentrations of toluene and xylenes were estimated from section X1.6 and Table X1.2 of ASTM E-1739.

The lightly shaded cells of RBSL values are those exceeded at the Tier 1 screening level.

Step 4: Decision Tree/Comparison with RBSLs

Based on our conversations with ACDEH, we considered a 1×10^{-4} (1 in ten thousand) excess cancer risk as the appropriate target risk level for the commercial/industrial receptors at the Site.

Chemical(s) of concern concentrations exceed RBSLs? - Yes, benzene (both soil and ground water into indoor air) and toluene (soil and ground water into indoor air). Both of the groundwater RBSLs were exceeded based on the assumption of free-phase hydrocarbons rather than the actual values detected.

Remediation to Tier 1 RBSLs practicable? - No

Interim remedial action appropriate? - Yes, but to further evaluate whether remaining concentrations pose an acceptable risk, we completed a Tier 2 evaluation to derive Site Specific Target Levels (SSTLs).

Step 5: Tier 2 Calculation of SSTLs

Based on the attached calculations, the groundwater-to-outdoor air pathway is well below the applicable commercial/industrial SSTL values using a combination of default and site-specific assumptions.

Table 1 shows the Site-specific assumptions used to calculate the SSTLs. Other input parameters were taken from the default parameters presented in ASTM E1739.

Tables 2, 3 and 4 are the calculations used to derive the SSTLs for the indoor air exposure pathway. The SSTLs calculated are summarized below:

Media	Benzene	Toluene
Soil (mg/kg)	2.04	203
Groundwater (mg/L)	17.0	663

Step 6: Comparison with SSTLs

The calculated benzene and toluene concentrations in soil and groundwater necessary to exceed the indoor air SSTLs are well above those detected. The SSTLs calculated are also well above the soil and groundwater concentrations that would be expected adjacent to a

fresh liquid hydrocarbon sheen, based on equilibrium partitioning. A comparison of the calculated SSTL values above to the estimated maximum concentrations based on free-phase hydrocarbons expressed in the above groundwater RBSL table supports this conclusion.

Conclusion

We recommend no further corrective action at the Site. It is our opinion that the possible exposure pathways have been considered and evaluated to pose an insignificant risk using Site data. This conclusion is consistent with existing current State of California guidelines, since benzene has not been detected at concentrations greater than 1 mg/L at the Site and the Site is greater than 750 feet from the nearest drinking water well.

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SHEET Table 2, p. 1 OF 3, Calcs 2/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of diffusion Coefficients

Diffusion Coefficient Soil-Vapor; D_s^{eff}

$$D_s^{eff} \cong D_v^{air} \frac{\theta_{as}^{3.33}}{\theta_T^{2.0}} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^{2.0}}$$

For benzene,

$$D_s^{eff} \cong 0.093 \frac{(0.18)^{3.33}}{(0.38)^{2.0}} + (1.1 \times 10^{-5}) \frac{1}{0.22} \frac{(0.18)^{3.33}}{(0.38)^{2.0}}$$

$$\cong 0.093 \frac{0.0033}{0.1444} + (1.1 \times 10^{-5})(4.54) \frac{0.0033}{0.1444}$$

$$\cong 0.21 + 1 \times 10^{-6}$$

$$\cong 0.21$$

For toluene,

$$D_s^{eff} \cong 0.093 \frac{(0.18)^{3.33}}{(0.38)^{2.0}} + (9.4 \times 10^{-6}) \frac{1}{0.26} \frac{(0.18)^{3.33}}{(0.38)^{2.0}}$$

$$\cong 0.21 + 1 \times 10^{-6}$$

$$\cong 0.21$$

Diffusion Coefficient through foundation cracks, D_{crack}^{eff}

$$D_{crack}^{eff} \cong D^{air} \frac{\theta_{acrack}^{3.33}}{\theta_T^{2}} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^{2}}$$

For benzene,

$D_{crack}^{eff} \cong$ same as D_s^{eff} for benzene $= 0.21$

For toluene,

$D_{crack}^{eff} \cong$ same as D_s^{eff} for toluene $= 0.21$

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SHEET Table 2, p. 2 OF 3, Calcs 3/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvoresa Site RBCA Evaluation
SUBJECT: Calculation of diffusion coefficients

Diffusion Coefficient through capillary fringe, D_{cap}^{eff}

$$D_{cap}^{eff} = D^{air} \frac{\theta_{acap}^{3.33}}{\theta_T^{2}} + D^{wat} \frac{1}{H} \frac{\theta_{wcap}^{3.33}}{\theta_T^{2.0}}$$

For benzene,

$$D_{cap}^{eff} = 0.093 \frac{(0.038)^{3.33}}{(0.38)^{2.0}} + 1.1\times10^{-5} \frac{1}{0.22} \frac{(0.342)^{3.33}}{(0.38)^{2.0}}$$

$$= 0.093 \frac{0.000019}{0.1444} + 1.1\times10^{-5} \frac{1}{0.22} \frac{0.028}{0.1444}$$

$$= 1.2\times10^{-5} + 9.7\times10^{-6}$$

$$= 2.2\times10^{-5}$$

For toluene,

$$D_{cap}^{eff} = 0.093 \frac{(0.038)^{3.33}}{(0.38)^{2.0}} + 9.4\times10^{-6} \frac{1}{0.26} \frac{(0.342)^{3.33}}{(0.38)^{2.0}}$$

$$= 0.093 \frac{0.000019}{0.1444} + 9.4\times10^{-6} \frac{1}{0.26} \frac{0.028}{0.1444}$$

$$= 1.2\times10^{-5} + 7.0\times10^{-6}$$

$$= 1.9\times10^{-5}$$

Diffusion Coefficient between ground water and soil surface D_{ws}^{eff}

$$D_{ws}^{eff} = (h_{cap} + h_v)\left(\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right)^{-1}$$

For benzene

$$D_{ws}^{eff} = \frac{(5+305)}{\left(\frac{5}{2.2\times10^{-5}} + \frac{305}{0.21}\right)} = \frac{310}{2.27\times10^{5} + 1.45\times10^{3}} = 1.36\times10^{-3}$$

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~~SHEET~~ Table 2, p.3 OF 3, Calcs 4/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of diffusion coefficients

For toluene

$$D_{ws}^{eff} = \frac{(5+305)}{\frac{5}{1.9\times10^{-5}} + \frac{305}{0.21}} = \frac{310}{2.63\times10^{5} + 1.45\times10^{3}} = 1.1\times10^{-3}$$

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~~SHEET~~ Table 3, p.1 OF 2, Calcs 5/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of Volatilization Factors

Volatilization Factor, Soil to indoor air VF_{SESP}

$$VF_{SESP} = \frac{\dfrac{H\rho_s}{[\theta_{ws} + K_s\rho_s + H\theta_{as}]}\left[\dfrac{D_s^{eff}/L_s}{ER \cdot L_B}\right]}{1 + \left[\dfrac{D_s^{eff}/L_s}{ER\ L_B}\right] + \left[\dfrac{D_s^{eff}/L_s}{(D_{crack}^{eff}/L_{crack})\eta}\right]} \times 10^3$$

For benzene,

numerator terms $= \dfrac{0.22\,(1.7)}{0.20 + 0.38(1.7) + 0.22(0.18)} \quad \dfrac{0.21/170}{0.0028 \cdot 300}$

$= 0.42 \quad \cdot 0.0015 = 6.21 \times 10^{-4}$

denominator terms $= 1 + \left[\dfrac{0.21/170}{0.0028 \cdot 300}\right] + \dfrac{0.21/170}{0.21/15\ (0.001)}$

$1 + 0.0015 + 88.2 = 89.2$

$VF_{SESP} = \dfrac{6.21 \times 10^{-4}}{89.2} \times 10^3 = 7.0 \times 10^{-3} \ \dfrac{mg/m^3\ air}{mg/kg\ soil}$

For toluene,

numerator terms $= \dfrac{0.26\,(1.7)}{0.20 + 1.35(1.7) + 0.26(0.18)} \quad \dfrac{0.21/170}{0.0028/300}$

$= 0.173 \quad \cdot 0.0015 = 2.56 \times 10^{-4}$

denominator terms = Same as benzene, above

toluene $$VF_{SESP} = \frac{2.56\times10^{-4}}{89.2} \times 10^{3} = 2.87\times10^{-3} \ \frac{mg/m^3 \text{ air}}{mg/kg \text{ soil}}$$

Volatilization Factor, groundwater to indoor air, VF_{WESP}

$$VF_{WESP} = \frac{H\left[\frac{D^{eff}_{ws}/L_{GW}}{ER\ L_B}\right]}{1+\left(\frac{D^{eff}_{ws}/L_{GW}}{ER\ L_B}\right)+\left(\frac{D^{eff}_{ws}/L_{GW}}{(D^{eff}_{crack}/L_{crack})\eta}\right)} \times 10^{3}$$

For benzene,

numerator terms $= 0.22\ \frac{1.36\times10^{-3}/310}{0.0028\cdot300} = 1.1\times10^{-6}$

denominator terms $= 1+\left(\frac{1.36\times10^{-3}/310}{0.0028\cdot300}\right)+\frac{1.36\times10^{-3}/310}{0.21/15\cdot0.001}$

$= 1 + 5.2\times10^{-6} + 0.31 = 1.31$

$$VF_{WESP} = \frac{1.1\times10^{-6}}{1.31}\times10^{3} = 8.4\times10^{-4}\ \frac{mg/m^3 \text{ air}}{mg/L\cdot H_2O}$$

For toluene,

numerator terms $= 0.26\ \frac{1.1\times10^{-3}/310}{0.0028\cdot300} = 1.1\times10^{-6}$ 1×10^{-6}

denominator terms $= 1+\left(\frac{1.1\times10^{-3}/310}{0.0028\cdot300}\right)+\frac{1.1\times10^{-3}/310}{0.21/15\cdot0.001} = 1.25$

$$VF_{WESP} = \frac{1.1\times10^{-6}}{1.25}\times10^{3} = 8.8\times10^{-4}\ \frac{mg/m^3 \text{ air}}{mg/L\cdot H_2O}$$

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PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of SSTLs

SHEET Table 4, p.1 OF 2, Calcs 7/8
JOB NO.: 1204.00.03
DATE: 18 March 1997
COMPUTED BY: J. Sturman
CHECKED BY: E. Nichols

Calculation of Site-Specific Target Levels

Benzene

Using $C_{air} = 1.43 \times 10^{1}$ µg/m³ as the maximum acceptable level based on the Tier 1 look-up table,

For soil

$$C_{T\,soil}^{Ben} = \frac{C_{air}}{VF_{SESP}} = \frac{1.43 \times 10^{1}\ \mu g/m^3}{7.0 \times 10^{-3}\ \frac{mg/m^3\ air}{mg/kg\ soil}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= 2.04\ mg/kg\ soil$$

For groundwater

$$C_{T\,gw}^{Ben} = \frac{C_{air}}{VF_{WESP}} = \frac{1.43 \times 10^{1}\ \mu g/m^3}{8.4 \times 10^{-4}\ \frac{mg/m^3\ air}{mg/L \cdot H_2O}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= 17.0\ mg/L\ ground\ water$$

Toluene

For soil $C_{air} = 5.84 \times 10^{2}$ µg/m³ as above (HQ=1)

$$C_{T\,soil}^{Tol} = \frac{C_{air}}{VF_{SESP}} = \frac{5.84 \times 10^{2}\ \mu g/m^3}{2.87 \times 10^{-3}\ \frac{mg/m^3\ air}{mg/kg\ soil}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= 203\ mg/kg\ soil$$

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~~SHEET~~ Table 4, p.2 OF 2, Calcs 8/8
JOB NO.: 1204.00.03
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PROJECT: Polvorosa Site RBCA Evaluation
SUBJECT: Calculation of SSTLs

Toluene in ground water

$$C_{T\,GW}^{tol} = \frac{C_{air}}{VF_{WESP}} = \frac{5.84 \times 10^{2}\ \mu g/m^3}{8.8 \times 10^{-4}\ \frac{mg/m^3\ air}{mg/L \cdot H_2O}} \times 10^{-3}\ \frac{mg}{\mu g}$$

$$= 663\ mg/L \cdot H_2O \text{ ground water}$$