Weiss Associates *Environmental and Geologic Services*

5500 Shellmound Street, Emeryville, CA 94608-2411 *FAX: 510-547-5043 Phone: 510-450-6000*

TRANSMITTAL

To: Scott Seery **Date:** 7/14

Company: ACDEH **Project #:** 81-1227

From: Steve L. **Phone:** (510) 567-6783
Fax: (510) 337-9335

Enclosed Please Find: Vapor SSTL Calc's.

Via:	**Fax:**	**As:**	**For:**
☑ Fax	# of pages: 3 (including this cover)	☐ Per our phone call	☐ Your information
☐ 1st Class Mail	☐ Hard Copy to follow	☐ You requested	☐ Return to you
☐ Overnight Delivery		☐ Is required	☐ Your action
☐ UPS (Surface)		☐ We believe you may be interested	☐ Your review & comments
☐ Courier			

Comments: Scott:

We ran straight vapor calcs for SSTL's for soils at 2 ft and 4 ft. The calcs [redacted] the SSTL's don't change much between 2 ft and 4 ft. because the soils is much lower in permeability. Please give me a call if you have questions.

Steve

Please call (510) 450-6000 if there are any problems with transmission.

SSTL For Benzene in Vapor at 2 Feet Below Ground Surface

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1106, 15275 Washington Avenue, San Leandro, CA.

	Soil Specific Parameters		
ASTM 95	ρ_b	1.7	Bulk Density(g/cm^3) or (kg/L)
Site Specific	θ_{as}	0.21	Air Content (v/v)
Site Specific	θ_{acrack}	0.21	Air Content in foundation cracks(v/v)
Site Specific	θ_{ws}	0.04	Water Content (v/v)
Site Specific	θ_{wcrack}	0.04	Water Content in foundation cracks(v/v)
Site Specific	θ_T	0.25	Porosity (v/v)
Actual	d	61	**Depth to (location of) vapor sample (cm) - 2 foot depth**
	Diffusivity Parameters		
ASTM 95	H	0.22	Henry's Constant for Benzene
ASTM 95	D^{air}	9.30E-02	Air Diffusion Coefficient (cm^2/s)
ASTM 95	D^{wat}	1.10E-05	Water Diffusion Coefficient (cm^2/s)
Calculated	D^{eff}_s	0.0082337	Effective Diffusion Coefficient soil (cm^2/s)
Calculated	D^{eff}_{crack}	0.0082337	Effective Diffusion Coefficient through foundation cracks (cm^2/s)
	Prediction of Flux From Benzene Concentration in Soil Vapor		
Iterative Calc	$C_{v,max}$	6.02E	**SSTL Benzene Concentration in Vapor (ug/m³)**
Calculated	F_{max}	8.14E-07	Maximum Diffusive Vapor Flux Predicted by Benzene Concentration in Soil Vapor (ug/cm²-sec)
	Indoor Air Concentration		
ASTM 95	Lb	200	Enclosed Space Volume/Infiltration Area Ratio (cm)
ASTM 95	$ER_{air-indoor}$	0.00014	Enclosed Space Air Exchange Rate (sec⁻¹)
ASTM 95	L_{crack}	15	Enclosed Space Foundation Thickness (cm)
ASTM 95	n	0.01	Areal Fraction of Cracks in Foundation (cm²/cm²)
Calculated	C_{indoor}	1.136E-06	Enclosed Space Air Concentration (ug/cm³)
	Dose		
ASTM 95	$IR_{air-indoor}$	15	Daily Indoor Inhalation Rate (m³/day)
ASTM 95	EF	350	Exposure Frequency (days/year)
ASTM 95	ED	30	Exposure Duration (years)
Calculated	Dose	178.85	Dose (mg)
	Risk		
CAL EPA	SF_i	0.1	California Cancer Slope Factor for Benzene (kg-day/mg)
ASTM 95	BW	70	Body Weight (kg)
ASTM 95	AT_c	70	Averaging Time for Carcinogens (years)
Calculated	Risk	1.00E-05	Risk (positives/population)

Formulas

$$D_s^{eff} = D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat}\frac{1}{H}\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

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

$$F_{max} = D_s^{eff}\frac{C_{v,max}}{d}$$

$$C_{indoor} = \frac{\left[\frac{F_{max}}{ER_{air-indoor} \times L_b}\right]}{\left[1 + \left(\frac{D_s^{eff}/d}{ER_{air-indoor} L_b}\right) + \left(\frac{D_s^{eff}/d}{\left(D_{crack}^{eff}/L_{crack}\right)n}\right)\right]}$$

$$Dose = C_{indoor} \times IR_{air-indoor} \times EF \times ED$$

$$Risk = \frac{Dose \times SF_i}{BW \times AT}$$

Notes:

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

Calculations: Effective diffusivity, diffusive vapor flux, enclosed space air concentration, dose and risk calculations from ASTM 95 guidance. Formulas presented above. Maximum allowable vapor concentration calculated by iteration to achieve acceptable risk level.

SSTL For Benzene in Vapor at 4 Feet Below Ground Surface

Site Specific RBCA Tier 2 Analysis, Former Shell Service Station, WIC#204-6852-1108, 15275 Washington Avenue, San Leandro, CA.

		Soil Specific Parameters	
ASTM 95	ρ_s	1.7	Bulk Density(g/cm^3) or (kg/L)
Site Specific	θ_{as}	0.21	Air Content (v/v)
Site Specific	θ_{acrack}	0.21	Air Content in foundation cracks(v/v)
Site Specific	θ_{ws}	0.04	Water Content (v/v)
Site Specific	θ_{wcrack}	0.04	Water Content in foundation cracks(v/v)
Site Specific	θ_t	0.25	Porosity (v/v)
Actual	d	122	**Depth to (location of) vapor sample (cm) - 4 feet bgs depth**
		Diffusivity Parameters	
ASTM 95	H	0.22	Henry's Constant for Benzene
ASTM 95	D^{air}	9.30E-02	Air Diffusion Coefficient (cm^2/s)
ASTM 95	D^{wat}	1.10E-05	Water Diffusion Coefficient (cm^2/s)
Calculated	D^{eff}_s	0.00823368	**Effective Diffusion Coefficient soil** (cm^2/s)
Calculated	D^{eff}_{crack}	0.00823368	**Effective Diffusion Coefficient through foundation cracks** (cm^2/s)
		Predication of Flux From Benzene Concentration in Soil Vapor	
Iterative Calc	$C_{s,max}$	6,264	**SSTL Benzene Concentration in Vapor (ug/m³)**
Calculated	F_{max}	4.23E-07	Maximum Diffusive Vapor Flux Predicted by Benzene Concentration in Soil Vapor (ug/cm²-sec)
		Indoor Air Concentration	
ASTM 95	Lb	200	Enclosed Space Volume/Infiltration Area Ratio (cm)
ASTM 95	ER_{air}-indoor	0.00014	Enclosed Space Air Exchange Rate (sec^{-1})
ASTM 95	L_{crack}	15	Enclosed Space Foundation Thickness (cm)
ASTM 95	n	0.01	Areal Fraction of Cracks in Foundation (cm²/cm²)
Calculated	C_{indoor}	1.1355E-06	Enclosed Space Air Concentration (ug/cm³)
		Dose	
ASTM 95	IR_{air}-indoor	15	Daily Indoor Inhalation Rate (m³/day)
ASTM 95	EF	350	Exposure Frequency (days/year)
ASTM 95	ED	30	Exposure Duration (years)
Calculated	Dose	178.838176	Dose (mg)
		Risk	
CAL EPA	SF_i	0.1	California Cancer Slope Factor for Benzene (kg-day/mg)
ASTM 95	BW	70	Body Weight (kg)
ASTM 95	AT_c	70	Averaging Time for Carcinogens (years)
Calculated	Risk	1.00E-05	Risk (positives/population)

residential

Formulas

$$D_s^{eff} = D^{air}\frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat}\frac{1}{H}\frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

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

$$F_{max} = D_s^{eff}\frac{C_{s,max}}{d}$$

$$C_{indoor} = \frac{\left[\frac{F_{max}}{ER_{air-indoor}\times L_b}\right]}{\left[1+\left(\frac{D_s^{eff}/d}{ER_{air-indoor}L_b}\right)+\left(\frac{D_s^{eff}/d}{\left(D_{crack}^{eff}/L_{crack}\right)n}\right)\right]}$$

$$Dose = C_{indoor}\times IR_{air-indoor}\times EF\times ED$$

$$Risk = \frac{Dose\times SF_i}{BW\times AT}$$

Notes:

ASTM 95 = American Society for Testing and Materials, 1995. Standard Guide for Risk Based Corrective Action Applied at Petroleum Release Sites, E 1739-95.

Calculations: Effective diffusivity, diffusive vapor flux, enclosed space air concentration, dose and risk calculations from ASTM 95 guidance. Formulas presented above. Maximum allowable vapor concentration calculated by iteration to achieve acceptable risk level.