APPENDIX E

TIER 1 VAPOR MODELING RESULTS

Methods

The Johnson and Ettinger Model (JEM) is used to calculate indoor air concentrations based on EPCs determined for soil, soil gas and groundwater. The JEM is a one-dimensional (1-D) analytical solution that describes the relationship between indoor air concentrations and subsurface vapor concentrations. The model considers 1-D VOC diffusion in soil vapor and soil moisture through the vadose zone, vapor convection due to indoor-outdoor pressure difference, and mixing of the contaminants migrating from the subsurface within the ventilated building. The model requires input of chemical properties of the contaminant, soil properties of the unsaturated soils and structural properties of the building. The JEM calculates a vapor intrusion attenuation factor, α:

$$\alpha = \frac{C_{indoor}}{C_{vs}} = \frac{\left[\frac{D_T^{eff} A_B}{Q_B L_T}\right] \exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} \eta A_B}\right)}{\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} \eta A_B}\right) + \left[\frac{D_T^{eff} A_B}{Q_B L_T}\right] + \left[\frac{D_T^{eff} A_B}{Q_{soil} L_T}\right]\left(\exp\left(\frac{Q_{soil} L_{crack}}{D_{crack}^{eff} \eta A_B}\right) - 1\right)}$$

Where:

D_T^{eff} = "overall" effective diffusion coefficient [cm^2/s]
D^{eff}_{crack} = effective diffusion coefficient through cracks in foundation [cm^2/s]
C_{vs} = vapor concentration at the source [g/cm^3]
C_{indoor} = indoor air concentration [g/cm^3]
L_T = distance from source to basement [cm]
A_B = cross-sectional area of foundation available for vapor flux [cm^2]
Q_{soil} = volumetric flow rate of soil gas into the building [cm^3/s]
L_{crack} = thickness of the foundation [cm]
A_{crack} = area of cracks or openings through which vapors enter building [cm^2]
Q_B = building ventilation rate [m^3/s]
η = the "crack factor" = A_{crack}/A_B

The vapor concentration at the source is calculated from soil concentrations using the relationship proposed by Feenstra et al. (1991):

$$C_{vs} = C_s \frac{P_b}{\left[\left(\frac{\theta_w}{K_H}\right) + \left(\theta_t - \theta_w\right) + \left(\frac{P_b K_d}{K_H}\right)\right]}$$

Where:

C_s = total soil concentration
K_d = soil-organic carbon distribution coefficient

P_b = bulk density
θ_w = soil moisture content
θ_t = total porosity
K_H = dimensionless Henry's law constant

While this approach does provide for larger data sets for the risk assessment, the partitioning relationship used to correlate soil and soil gas concentrations does have limitations.

- The soil-organic carbon distribution coefficient is dependent on the fractional organic carbon content of the soils. The property will vary from sample to sample. However, for these calculations, a typical value suggested in the USEPA Soil Screening Guidance (1996) is assumed.
- Studies comparing the relationship between soil and soil gas concentrations from data collected across the country do not demonstrate a good correlation between these concentrations (USEPA, 2002b and DTSC, 2005). This may be due to the loss of VOCs during sampling or a result of the variability of VOC concentrations in soil samples.
- The partitioning equation does not consider the presence of a residual NAPL phase. If residual NAPL is present, then the estimated soil gas concentrations from soil concentrations may be biased high and the estimated soil concentrations from soil gas concentrations biased low.

Consequently, the soil gas and soil matrix conversion may over- or under- estimate the calculated concentrations.

The vapor concentration at the source is calculated from groundwater concentrations, C_{gw}, using Henry's Law relationship:

$$C_{vs} = K_H C_{gw}$$

JEM Inputs

A combination of conservative default and site-specific parameters are used as inputs for the JEM in the Tier 1 evaluation. The parameter values and rationale for selection are listed in Table E-1. The key site-specific parameters included in the Tier 1 evaluation are the soil physical properties. Soil property values for the inputs were based on the geometric mean of measured physical parameters (e.g., porosity and soil moisture content). These measured parameters are summarized in Table E-2.

The soils have been characterized based on review of site boring logs and have been classified as sandy clay loam and sandy loam. The measured soil moisture content from site soils is higher

than default values presented in EPA spreadsheets. Consequently, the Tier 1 site-specific attenuation factors in this evaluation are lower than default values.

The transport modeling for vapor migration from shallow soils assumes the source depth to be 7.5 feet bgs. Samples from this zone may have been collected from depths less than or greater than this assumed depth. A sensitivity analysis on the affect of sample depth on the vapor intrusion pathway demonstrates that the assumed 7.5 feet bgs source will result in over-estimation of the attenuation factor for samples deeper than this assumed level and under-estimation of the attenuation factor for samples less than 7.5 feet bgs. However, for sample depths ranging from 5 to 15 feet, this variability in sample depths will result in changes to the calculated risk by a factor ranging from 0.5 to 1.5. Similarly, for the vapor migration from deep soils evaluation, samples collected from depths less than or greater than the assumed depth of 30 feet bgs will result in over-estimation and under-estimation of the attenuation factor.

The air exchange rate value (0.9 exchanges per hour) used for the evaluation of vapor intrusion to commercial buildings is commonly assumed for vapor intrusion assessments and is consistent with ASHRAE standards (ASHRAE, 1999) and USEPA, DTSC, and ASTM guidance (USEPA, 2002; DTSC, 2005; ASTM 1995, 1998). This suggests that the air exchange rate used in the vapor intrusion calculations is a reasonable conservative value for the buildings at the site. However, as with many other parameters used in the vapor intrusion modeling, the value used for the air exchange rate is general and not specific to the buildings. Higher air exchange rates will result in lower attenuation factors and lower air exchange rates will result in higher attenuation factors.

JEM Results

The vapor intrusion attenuation factors were calculated using the USEPA JEM spreadsheets. Note that these spreadsheets were used to only calculate the attenuation factors and indoor air concentrations. Risks were not calculated using the USEPA spreadsheets. The methods and assumptions described in Sections 4.3 and 6.0 are used to calculate risks. An example of the Tier 1 Model calculations for shallow soils and the commercial scenario is provided in the attached spreadsheet. The calculated attenuation factors for the shallow soil/soil gas, deep soil/soil gas, and groundwater source scenarios are summarized in Table E-3. The average attenuation factors for the different scenarios examined are summarized in the following table:

Source Media	Residential Scenario	Commercial Scenario
Shallow Soil/Soil Gas	9.2E-05	3.9E-05
Deep Soil/Soil Gas	3.6E-05	1.5E-05
Groundwater	2.2E-05	9.5E-06

Table E-1
Summary of Model Input Parameters
Baseline Risk Assessment
Del Amo Site

Model Input Parameter	Value Used	Rationale
Soil Properties		
Average Soil / Groundwater Temperature (Ts), ^{o}C	18	Area-Specific Value
Depth below grade to bottom of enclosed space floor (L_F), cm	15	Slab construction
Depth below grade to top of shallow contamination (Lt), cm	228	Shallow, assumes infinite source impacts start at 7.5 ft bgs
Depth below grade to top of deep contamination (Lt), cm	914	Deep, assumes infinite source impacts start at 30 ft bgs
Depth below grade to bottom of contamination (Lb), cm	0	Assume infinite source
Depth below grade to water table (Lwt), cm	1435	Site-Specific, 47 feet bgs
Thickness of soil stratum A (h_A), cm	458	Site-Specific Value, 15 feet bgs
Thickness of soil stratum B (h_B), cm	458	Site-Specific Value, 15-30 feet bgs
Thickness of soil stratum C (h_C), cm	519	Site-Specific Value, 30-47 feet bgs
Soil stratum A SCS soil type	SCL	Site-Specific based on boring logs
Soil stratum directly above water table	C	Site-Specific based on boring logs
SCS soil type directly above water table	SL	Sandy-Loam based on USCS soil classification for Stratum C
Stratum A soil dry bulk density, gm/cm^3	1.6317	Geomean, Site-Specific Value based on soil physical property testing - 0 to 458 cm bgs
Stratum A soil total porosity, unitless	0.3794	Geomean, Site-Specific Value based on soil physical property testing - 0 to 458 cm bgs
Stratum A soil water-filled porosity, cm^3/cm^3	0.2526	Geomean, Site-Specific Value based on soil physical property testing - 0 to 458 cm bgs
Startum A soil organic carbon fraction (f_{oc}^A), unitless	0.006	Default Assumption
Stratum B soil dry bulk density, gm/cm^3	1.5388	Geomean, Site-Specific Value based on soil physical property testing - >458 to 916 cm bgs
Stratum B soil total porosity, unitless	0.4136	Geomean, Site-Specific Value based on soil physical property testing - >458 to 916 cm bgs
Stratum B soil water-filled porosity, cm^3/cm^3	0.1760	Geomean, Site-Specific Value based on soil physical property testing - >458 to 916 cm bgs
Stratum B soil organic carbon fraction (f_{oc}^B), unitless	0.006	Default Assumption
Stratum C soil dry bulk density, gm/cm^3	1.5614	Geomean, Site-Specific Value based on soil physical property testing - >916 to 1435 cm bgs
Stratum C soil total porosity, unitless	0.3995	Geomean, Site-Specific Value based on soil physical property testing - >916 to 1435 cm bgs
Stratum C soil water-filled porosity, cm^3/cm^3	0.2193	Geomean, Site-Specific Value based on soil physical property testing - >916 to 1435 cm bgs
Stratum C soil organic carbon fraction (f_{oc}^B), unitless	0.006	Default Assumption
Residential Building Parameters		
Enclosed space floor thickness (L_{crack}), cm	10	Default assumption
Soil-building pressure differential, $g/cm\text{-}sec^2$	40	Default assumption
Enclosed space floor length (L_B), cm	1000	Default residential building dimension
Enclosed space floor width (W_B), cm	1000	Default residential building dimension
Enclosed space height (H_B), cm	244	Default residential building dimension for slab-on-grade, 8 feet
Floor-wall seam crack width (w), cm	0.1	Default assumption
Indoor air exchange rate (ER), $hour^{-1}$	0.5	50th percentile from a comprehensive US study (USPEA 2003)
Average vapor flow rate into building (Qsoil), L/m	5	Default residential assumption
Commercial Building Parameters		
Enclosed space floor thickness (L_{crack}), cm	10	Default assumption
Soil-building pressure differential, $g/cm\text{-}sec^2$	40	Default assumption
Enclosed space floor length (L_B), cm	5400	Assume commercial building length ~ 180 feet
Enclosed space floor width (W_B), cm	3000	Site-specific commercial building width ~ 98 feet
Enclosed space height (H_B), cm	305	Assume commercial building ceiling height = 10 feet
Floor-wall seam crack width (w), cm	0.1	Default assumption
Indoor air exchange rate (ER), $hour^{-1}$	0.9	0.15 cfm/ft^2 (California Energy Commission, 2001)
Average vapor flow rate into building (Qsoil), L/m	80	Calculated based on site-specific building dimensions

Table E-2
Summary of Soil Physical Parameters
Baseline Risk Assessment
Del Amo Site

Stratum A Borings	Sample Depth (ft)	Bulk Density (g/cc)	Grain Density (g/cc)	Total Porosity (% vb)	Moisture Content (% wt)
SV68-4	4	1.64	2.63	36.7	17.8
SV58b-4	4	1.7	2.63	36.3	9.2
SBL0066	5				14.9
SBL0065	5				9.9
SBL0068	7	1.58	2.7	41.6	
SBL0038	8				12.61
SBL0038	8	1.64			
SBL0069	8	1.74	2.68	34.7	
SV57b-9	9	1.44	2.67	44.2	25.8
SBL0065	10				16.7
SBL0066	10				18.5
SBL0070	10	1.66	2.73	39.2	
SBL0073	13	1.64	2.71	39.4	
SV68-13	13	1.56	2.63	34.4	20.3
SV57b-14	14	1.74	2.63	36.1	9.8
SBL0065	15				19
SBL0066	15				17.4
Stratum A GeoMean =		1.63	2.67	37.94	15.26
			Water-filled Porosity =	25.26	
			Air-filled Porosity =	12.68	
min		1.44	2.63	34.40	9.20
max		1.74	2.73	44.20	25.80

Stratum B Borings	Sample Depth (ft)	Bulk Density (g/cc)	Grain Density (g/cc)	Total Porosity (% vb)	Moisture Content (% wt)
SBL0068	20	1.43	2.67	46.4	
SBL0027	25				6.22
SBL0027	25	1.63	2.63	35.9	
SBL0068	25	1.7	2.72	37.6	
SBL0070	26	1.48	2.72	45.5	
SBL0071	27	1.49	2.63	43.3	
SBL0012	30				20.63
SBL0012	30	1.48	2.5	40.9	
SBL0069	30	1.58	2.68	41	
Stratum B GeoMean =		1.54	2.65	41.36	11.33
			Water-filled Porosity =	17.60	
			Air-filled Porosity =	23.76	
min		1.43	2.50	35.90	6.22
max		1.70	2.72	46.40	20.63

Table E-2
Summary of Soil Physical Parameters
Baseline Risk Assessment
Del Amo Site

Stratum C Borings	Sample Depth (ft)	Bulk Density (g/cc)	Grain Density (g/cc)	Total Porosity (% vb)	Moisture Content (% wt)
SBL0013	31				3.6
SBL0013	31	1.51	2.65	43.3	
SBL0014	34				18.0944
SBL0014	34	1.63	2.62	37.7	
SBL0015	34				25.2408
SBL0015	34	1.62	2.61	38.1	
SBL0071	34	1.7	2.69	36.7	
SBL0022	35				16.5187
SBL0022	35	1.43	2.59	43.18	
SBL0032	37				10.58
SBL0032	37	1.55	2.67	39.8	
SBL0035	37				29.61
SBL0035	37	1.4	2.63	45.7	
SBL0034	39				18.45
SBL0034	39	1.51	2.64	40.2	
SBL0030	40				9.2
SBL0030	40	1.51	2.67	42	
SBL0070	40	1.37	2.67	48.7	
SBL0020	42				15
SBL0020	42	1.73	2.59	33.14	
SBL0069	43	1.56	2.69	42.1	
SBL0016	45				12.6057
SBL0016	45	1.83	2.66	31.1	
SBL0029	46				12.44
SBL0029	46	1.61	2.67	37.9	
SBL0069	47	1.53	2.71	43.5	
Stratum C GeoMean =		1.56	2.65	39.95	13.78
			Water-filled Porosity =	21.93	
			Air-filled Porosity =	18.02	
min		1.37	2.59	31.10	3.60
max		1.83	2.71	48.70	29.61

Notes:

Water-filled porosity (% vb) = (1 - total porosity) x (moisture content) x (grain density)

Air-filled porosity (% vb) = (total porosity - water filled porosity)

Table E-3
Infinite Source Vapor Intrusion Attenuation Coefficient
Baseline Risk Assessment
Del Amo Site

COPC	Shallow Soil Source		Deep Soil Source		Groundwater Source	
	Residential α	Commercial α	Residential α	Commercial α	Residential α	Commercial α
1,1,1-Trichloroethane	**7.96E-05**	**3.39E-05**	**3.39E-05**	**1.44E-05**	**2.15E-05**	**9.16E-06**
1,1,2-Trichloroethane	NC	NC	**3.51E-05**	**1.49E-05**	NC	NC
1,1-Dichloroethane	NC	NC	NC	NC	**2.07E-05**	**8.82E-06**
1,1-Dichloroethylene	NC	NC	**3.90E-05**	**1.66E-05**	**2.47E-05**	**1.05E-05**
1,2,4-Trimethylbenzene	**6.26E-05**	**2.67E-05**	**2.65E-05**	**1.13E-05**	**1.69E-05**	**7.21E-06**
1,2-Dichlorobenzene	NC	NC	NC	NC	**1.98E-05**	**8.44E-06**
1,2-Dichloroethane	NC	NC	**4.61E-05**	**1.96E-05**	**3.02E-05**	**1.29E-05**
1,2-Dichloropropane	NC	NC	NC	NC	**2.20E-05**	**9.39E-06**
1,3,5-Trimethylbenzene	**6.23E-05**	**2.66E-05**	NC	NC	**1.69E-05**	**7.19E-06**
1,4-Dichlorobenzene	**7.17E-05**	**3.06E-05**	NC	NC	**1.96E-05**	**8.36E-06**
2-Hexanone	**9.63E-05**	**4.10E-05**	NC	NC	NC	NC
4-Ethyltoluene	**7.19E-05**	**3.06E-05**	NC	NC	NC	NC
Acetone	**2.10E-04**	**8.98E-05**	NC	NC	**5.66E-05**	**2.41E-05**
Acetonitrile	**2.67E-04**	**1.14E-04**	NC	NC	NC	NC
Benzene	**8.98E-05**	**3.83E-05**	**3.83E-05**	**1.63E-05**	**2.45E-05**	**1.04E-05**
Bromodichloromethane	**3.32E-05**	**1.42E-05**	NC	NC	**9.24E-06**	**3.93E-06**
Carbon disulfide	**1.05E-04**	**4.47E-05**	NC	NC	NC	NC
Carbon tetrachloride	**7.95E-05**	**3.39E-05**	NC	NC	NC	NC
Chlorobenzene	NC	NC	NC	NC	**2.05E-05**	**8.74E-06**
Chloroform	**1.06E-04**	**4.50E-05**	**4.52E-05**	**1.93E-05**	**2.89E-05**	**1.23E-05**
Chloromethane	**1.26E-04**	**5.37E-05**	NC	NC	NC	NC
cis-1,2-Dichloroethylene	NC	NC	NC	NC	**2.07E-05**	**8.82E-06**
Cumene	**6.65E-05**	**2.84E-05**	NC	NC	**1.79E-05**	**7.60E-06**
Cyclohexane	**7.50E-05**	**3.20E-05**	NC	NC	**2.02E-05**	**8.60E-06**
Ethylbenzene	**7.68E-05**	**3.27E-05**	**3.27E-05**	**1.39E-05**	**2.08E-05**	**8.85E-06**
Freon 11 (TCFM)	**8.83E-05**	**3.76E-05**	NC	NC	**2.39E-05**	**1.02E-05**
Freon 12 (DCDFM)	**6.80E-05**	**2.90E-05**	NC	NC	NC	NC
Heptane	**9.37E-05**	**3.99E-05**	NC	NC	NC	NC
Hexane	**1.94E-04**	**8.27E-05**	NC	NC	NC	NC
Isopropyltoluene	**6.65E-05**	**2.84E-05**	NC	NC	NC	NC
Methyl ethyl ketone (MEK)	NC	NC	NC	NC	**3.66E-05**	**1.56E-05**
Methyl isobutyl ketone (MIBK)	**9.60E-05**	**4.09E-05**	NC	NC	NC	NC
Methylene chloride	**1.03E-04**	**4.41E-05**	**4.42E-05**	**1.88E-05**	NC	NC
MTBE	**1.08E-04**	**4.62E-05**	NC	NC	NC	NC
m-Xylene	**7.19E-05**	**3.06E-05**	NC	NC	NC	NC
Naphthalene	**6.67E-05**	**2.84E-05**	**2.80E-05**	**1.19E-05**	**1.88E-05**	**8.02E-06**
n-Butylbenzene	**5.88E-05**	**2.50E-05**	NC	NC	NC	NC
n-Propylbenzene	**6.19E-05**	**2.64E-05**	NC	NC	**1.67E-05**	**7.10E-06**
o-Xylene	**8.89E-05**	**3.79E-05**	NC	NC	NC	NC
p-Xylene	**7.87E-05**	**3.36E-05**	**3.35E-05**	**1.43E-05**	**2.13E-05**	**9.08E-06**
sec-Butylbenzene	**6.93E-05**	**2.95E-05**	NC	NC	**1.96E-05**	**8.34E-06**
Styrene	**7.35E-05**	**3.13E-05**	**3.12E-05**	**1.33E-05**	**2.01E-05**	**8.55E-06**
tert-Butylbenzene	NC	NC	NC	NC	**1.57E-05**	**6.68E-06**
Tetrachloroethylene	**7.36E-05**	**3.14E-05**	**3.13E-05**	**1.33E-05**	**1.99E-05**	**8.46E-06**
Toluene	**8.87E-05**	**3.78E-05**	**3.78E-05**	**1.61E-05**	**2.41E-05**	**1.03E-05**
trans-1,2-Dichloroethylene	NC	NC	NC	NC	**1.96E-05**	**8.37E-06**
Trichloroethylene	**8.07E-05**	**3.44E-05**	**3.43E-05**	**1.46E-05**	**2.18E-05**	**9.30E-06**
Minimum	3.32E-05	1.42E-05	2.65E-05	1.13E-05	9.24E-06	3.93E-06
Mean	9.20E-05	3.92E-05	3.58E-05	1.53E-05	2.23E-05	9.51E-06
Maximum	2.67E-04	1.14E-04	4.61E-05	1.96E-05	5.66E-05	2.41E-05

NC - Not Calculated

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

DTSC / HERD
Version 3.0-mod1; 07/03

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (µg/kg)	Chemical
95636	2420	1,2,4-Trimethylbenzene
108678	335	1,3,5-Trimethylbenzene
622968	2230	4-Ethyltoluene
67641	519000	Acetone
71432	11200	Benzene
67663	15600	Chloroform
100414	703000	Ethylbenzene
91203	143	Naphthalene
100425	786000	Styrene
127184	11200	Tetrachloroethylene
108883	11200	Toluene
79016	11300	Trichloroethylene
106423	32400	p-Xylene

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Totals must add up to value of L_t (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
18	15	228	0	228	0	0	SCL		

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)
SCL	1.6317	0.3794	0.2526	0.006		1.5388	0.4136	0.1760	0.006

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	5400	3000	305	0.1	0.9	80

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)	
6.06E-02	7.92E-06	6.1E-03	25	9,369	442.30	649.17	1.4E+03	5.7E+01	0.0E+00	6.0E-03	1.2E+02	1,2,4-Trimethylbenzene
6.02E-02	8.67E-06	5.9E-03	25	9,321	437.89	637.25	1.4E+03	2.0E+00	0.0E+00	6.0E-03	1.2E+02	1,3,5-Trimethylbenzene
7.00E-02	7.80E-06	7.3E-03	25	8,523	412.27	617.05	4.1E+02	1.6E+02	0.0E+00	7.0E-01	1.1E+02	4-Ethyltoluene
1.24E-01	1.14E-05	3.9E-05	25	6,955	329.20	508.10	5.8E-01	1.0E+06	0.0E+00	3.2E+00	5.8E+01	Acetone
8.80E-02	9.80E-06	5.5E-03	25	7,342	353.24	562.16	5.9E+01	1.8E+03	2.9E-05	6.0E-02	7.8E+01	Benzene
1.04E-01	1.00E-05	3.7E-03	25	6,988	334.32	536.40	4.0E+01	7.9E+03	5.3E-06	3.0E-01	1.2E+02	Chloroform
7.50E-02	7.80E-06	7.9E-03	25	8,501	409.34	617.20	3.6E+02	1.7E+02	0.0E+00	2.0E+00	1.1E+02	Ethylbenzene
5.90E-02	7.50E-06	4.8E-04	25	10,373	491.14	748.40	2.0E+03	3.1E+01	0.0E+00	9.0E-03	1.3E+02	Naphthalene
7.10E-02	8.00E-06	2.7E-03	25	8,737	418.31	636.00	7.8E+02	3.1E+02	0.0E+00	9.0E-01	1.0E+02	Styrene
7.20E-02	8.20E-06	1.8E-02	25	8,288	394.40	620.20	1.6E+02	2.0E+02	5.9E-06	3.5E-02	1.7E+02	Tetrachloroethylene
8.70E-02	8.60E-06	6.6E-03	25	7,930	383.78	591.79	1.8E+02	5.3E+02	0.0E+00	3.0E-01	9.2E+01	Toluene
7.90E-02	9.10E-06	1.0E-02	25	7,505	360.36	544.20	1.7E+02	1.5E+03	2.0E-06	6.0E-01	1.3E+02	Trichloroethylene
7.69E-02	8.44E-06	7.6E-03	25	8,525	411.52	616.20	3.9E+02	1.9E+02	0.0E+00	7.0E-01	1.1E+02	p-Xylene

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (µg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	
7.9E+08	213	0.127	0.238	0.180	0.599	2.1E-09	0.592	1.2E-09	16,800	2.4E+03	1.2E+06	1,2,4-Trimethylbenzene
										3.4E+02		1,3,5-Trimethylbenzene
										2.2E+03		4-Ethyltoluene
										5.2E+05		Acetone
										1.1E+04		Benzene
										1.6E+04		Chloroform
										4.0E+05		Ethylbenzene
										1.4E+02		Naphthalene
										7.9E+05		Styrene
										1.1E+04		Tetrachloroethylene
										1.1E+04		Toluene
										1.1E+04		Trichloroethylene
										3.2E+04		p-Xylene

Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
1.6E+07	1.0E-04	15	11,592	3.8E-03	1.6E-01	1.8E-04	4.4E-04	0.0E+00	0.0E+00	4.4E-04	213	15
			11,574	3.7E-03	1.5E-01		4.4E-04	0.0E+00	0.0E+00	4.4E-04		
			10,161	4.8E-03	2.0E-01		5.0E-04	0.0E+00	0.0E+00	5.0E-04		
			7,460	2.9E-05	1.2E-03		1.6E-03	0.0E+00	0.0E+00	1.6E-03		
			8,040	4.0E-03	1.7E-01		6.3E-04	0.0E+00	0.0E+00	6.3E-04		
			7,471	2.7E-03	1.1E-01		7.5E-04	0.0E+00	0.0E+00	7.5E-04		
			10,063	5.2E-03	2.2E-01		5.4E-04	0.0E+00	0.0E+00	5.4E-04		
			12,830	2.9E-04	1.2E-02		4.7E-04	0.0E+00	0.0E+00	4.7E-04		
			10,362	1.8E-03	7.5E-02		5.2E-04	0.0E+00	0.0E+00	5.2E-04		
			9,472	1.2E-02	5.2E-01		5.2E-04	0.0E+00	0.0E+00	5.2E-04		
			9,067	4.6E-03	1.9E-01		6.3E-04	0.0E+00	0.0E+00	6.3E-04		
			8,458	7.3E-03	3.1E-01		5.7E-04	0.0E+00	0.0E+00	5.7E-04		
			10,155	5.1E-03	2.1E-01		5.5E-04	0.0E+00	0.0E+00	5.5E-04		

Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	**Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)**	Finite source β term (unitless)	Finite source ψ term $(sec)^{-1}$	Time for source depletion, τ_D (sec)	Exposure duration > time for source depletion (YES/NO)	
8.1E+00	4.7E+04	0.10	1.3E+03	4.4E-04	1.7E+03	#NUM!	2.7E-05	**1.3E+00**	NA	NA	NA	NA	1,2,4-Trimethylbenzene
8.1E+00	6.2E+03			4.4E-04		#NUM!	2.7E-05	**1.6E-01**	NA	NA	NA		1,3,5-Trimethylbenzene
2.4E+00	1.7E+05			5.0E-04		#NUM!	3.1E-05	**5.3E+00**	NA	NA	NA		4-Ethyltoluene
3.5E-03	3.9E+06			1.6E-03		#NUM!	9.0E-05	**3.5E+02**	NA	NA	NA		Acetone
3.5E-01	3.6E+06			6.3E-04		#NUM!	3.8E-05	**1.4E+02**	NA	NA	NA		Benzene
2.4E-01	4.4E+06			7.5E-04		#NUM!	4.5E-05	**2.0E+02**	NA	NA	NA		Chloroform
2.2E+00	3.7E+07			5.4E-04		#NUM!	3.3E-05	**1.2E+03**	NA	NA	NA		Ethylbenzene
1.2E+01	1.4E+02			4.7E-04		#NUM!	2.8E-05	**4.0E-03**	NA	NA	NA		Naphthalene
4.7E+00	1.2E+07			5.2E-04		#NUM!	3.1E-05	**3.9E+02**	NA	NA	NA		Styrene
9.3E-01	5.2E+06			5.2E-04		#NUM!	3.1E-05	**1.6E+02**	NA	NA	NA		Tetrachloroethylene
1.1E+00	1.7E+06			6.3E-04		#NUM!	3.8E-05	**6.4E+01**	NA	NA	NA		Toluene
1.0E+00	2.9E+06			5.7E-04		#NUM!	3.4E-05	**1.0E+02**	NA	NA	NA		Trichloroethylene
2.3E+00	2.7E+06			5.5E-04		#NUM!	3.4E-05	**9.2E+01**	NA	NA	NA		p-Xylene

Finite source indoor attenuation coefficient, $<\alpha>$ (unitless)	Mass limit bldg. conc., $C_{building}$ ($\mu g/m^3$)	Finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Final finite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	
NA	NA	NA	NA	NA	6.0E-03	1,2,4-Trimethylbenzene
NA	NA	NA	NA	NA	6.0E-03	1,3,5-Trimethylbenzene
NA	NA	NA	NA	NA	7.0E-01	4-Ethyltoluene
NA	NA	NA	NA	NA	3.2E+00	Acetone
NA	NA	NA	NA	2.9E-05	6.0E-02	Benzene
NA	NA	NA	NA	5.3E-06	3.0E-01	Chloroform
NA	NA	NA	NA	NA	2.0E+00	Ethylbenzene
NA	NA	NA	NA	NA	9.0E-03	Naphthalene
NA	NA	NA	NA	NA	9.0E-01	Styrene
NA	NA	NA	NA	5.9E-06	3.5E-02	Tetrachloroethylene
NA	NA	NA	NA	NA	3.0E-01	Toluene
NA	NA	NA	NA	2.0E-06	6.0E-01	Trichloroethylene
NA	NA	NA	NA	NA	7.0E-01	p-Xylene