APPENDIX H

Evaluation of the Effect on the Draft SSLs of the Johnson and Ettinger Model (EQ, 1994a)

ENVIRONMENTAL QUALITY MANAGEMENT, INC.

MEMORANDUM

TO:	Janine Dinan	**DATE:**	October 7, 1994
SUBJECT:	Evaluation of the Effect on the Draft SSLs of the Johnson and Ettinger (1991) Model for the Intrusion of Contaminant Vapors Into Buildings	**FROM:**	Craig S. Mann
FILE:	5099-3	**cc:**	

Under U.S. Environmental Protection Agency (EPA) Contract No. 68-D3-0035, Task order No. 0-25, Environmental Quality Management, Inc. (EQ) was directed to evaluate the effect on the draft soil screening levels (SSLs) of employing the Johnson and Ettinger (1991) model for estimating the intrusion rate of contaminant vapors from soil into buildings. This memorandum summarizes the evaluation.

Model Review:

Johnson and Ettinger (1991) is a closed-form analytical solution for both convective and diffusive transport of vapor-phase contaminants fully incorporated in soil into enclosed structures. The nondimensionalized mass balance is written as:

$$\frac{\partial \sum_i \epsilon_i C_i^*}{\partial t^*} - \left(\frac{L_p}{L_D}\right)\left(\nabla^* P^*\right) \cdot \left(\nabla^* C_v^*\right) = \nabla^* \cdot \left[\frac{D^{eff} \mu L_p}{k_v \Delta P_r L_D}\right] \nabla^* C_v^* + \sum_i R_i^* \qquad (1)$$

where * = Nondimensional variables

ϵ_i = Volume fraction of phase i, unitless

C_i = Concentration of contaminant in phase i, g/cm^3

t = Time, s

L_P = Convection path length, cm

L_D = Diffusion path length, cm

P = Pressure in vapor-phase, $g/cm\text{-}s^2$

∇ = Del operator, 1/cm

C_v = Contaminant concentration in vapor phase, g/cm3

D^{eff} = Effective diffusion coefficient, cm^2/s

μ = Vapor viscosity, g/cm-s

k_v = Soil permeability to vapor flow, cm^2

ΔP_r = Reference indoor-outdoor pressure differential, $g/cm\text{-}s^2$

R_i = Formation rate of contaminant in phase i, $g/cm^3\text{-}s$

and,

$C_i^* = C_i/C_r$

$\nabla^* = L_D \nabla$

$P^* = P/\Delta P_r$

$t^* = t\,(k_v \Delta P_r / L_D L_P \mu)$

$R_i^* = R_i L_D L_P \mu / C_r k_r \Delta P_r$

where C_r, L_P and L_D are characteristic concentration, convection pathway length, and diffusion pathway length, chosen to give the dependent concentration variable and derivatives of C_i^* and P^* magnitudes of order unity.

The mass balance solution includes the following assumptions:

1. The soil column is isotropic within any horizontal plane.
2. The effective diffusion coefficient is constant within any horizontal plane.
3. Concentration at the soil-air interface is zero (i.e., boundary layer resistance is zero).
4. No loss of contaminant occurs across the lower boundary (i.e., no leaching).
5. Source degradation and transformation are not considered.
6. Convective vapor flow near the building foundation is uniform.
7. Contaminant vapors enter the building primarily through openings in the walls and foundation at or below grade.
8. Convective velocities decrease with increasing contaminant source-building distance.
9. All contaminant vapors directly below a basement will enter the basement, unless the floor and walls are perfect vapor barriers.

10. The building contains no other contaminant sources or sinks, and the air volume is well mixed.

Therefore,

$$Q_{building}\, C_{building} = E \tag{2}$$

where $Q_{building}$, $C_{building}$, and E represent the volumetric flow rate or ventilation rate of the building (cm^3/s), contaminant concentration within the building (g/cm^3), and rate of contaminant entry (g/s), respectively.

Also,

$$\alpha = Q_{building}/C_{source} \tag{3}$$

where C_{source} is the vapor-phase contaminant concentration within the soil at the source, and α represents the attenuation coefficient. C_{source} is written as:

$$C_{source} = \frac{H\, C_s\, \rho_b}{\Theta_w + K_d \rho_b + H\Theta_a} \tag{4}$$

where H = Henry's law constant, unitless

C_s = Soil bulk concentration, g/g

ρ_b = Soil dry bulk density, g/cm^3

Θ_w = Soil water-filled porosity, unitless

K_d = Soil-water partion coefficient, cm^3/g

Θ_a = Soil air-filled porosity, unitless.

The authors derive a solution for α for both steady-state conditions (i.e., depth of contamination, $z = \infty$) and for quasi-steady-state conditions ($0 < z < L$). For steady-state conditions α is written as:

$$\alpha = \left[\left[\frac{D^{eff}\, A_B}{Q_{building}\, L_T}\right] x \exp\left(\frac{Q_{soil}\, L_{crack}}{D^{crack}\, A_{crack}}\right)\right] /$$

$$\left[\exp\left(\frac{Q_{soil}\, L_{crack}}{D^{crack}\, A_{crack}}\right) + \left[\frac{D^{eff}\, A_B}{Q_{building}\, L_T}\right] + \left[\frac{D^{eff}\, A_B}{Q_{soil}\, L_T}\right]\left[\exp\left(\frac{Q_{soil}\, L_{crack}}{D^{crack}\, A_{crack}}\right) - 1\right]\right] \tag{5}$$

where D^{eff} = Effective diffusion coefficient, cm^2/s

A_B = Area of basement, cm^2

L^T = Source-building separation, cm

Q_{soil} = Volumetric flow rate of soil gas into the building, cm^3/s

L_{Crack} = Building foundation thickness, cm

D^{Crack} = Effective diffusion coefficient through crack, cm^2/s ($D^{Crack} = D^{eff}$)

A_{Crack} = Area of crack, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s.

For quasi-steady-state conditions the long-term average attenuation coefficient <a> is:

$$<\alpha> = \frac{\rho_b C_R \Delta H_C A_B}{Q_{building} C_{source} \tau} \left(\frac{L_T^0}{\Delta H_C}\right)\left[\left(\beta^2 + 2\Psi\tau\right)^{1/2} - \beta\right] \quad (6)$$

where ρ_b = Soil dry bulk density, g/cm^3

C_R = Average contaminant level in soil, g/g

ΔH_c = Thickness of depth over which contaminant is distributed, cm

A_B = Area of basement, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s

C_{source} = Vapor-phase soil concentration at source, g/cm^3

τ = Exposure averaging period, s

L_T^0 = Source-building separation at t=0, cm

and,

$$\beta = \left(\frac{D^{eff} A_B}{L_T^0 Q_{soil}}\right)\left[1 - \exp\left(-\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)\right] + 1 \quad (7)$$

$$\Psi = D^{eff} C_{source}/\left(L_T^0\right)^2 \rho_b C_R \quad (8)$$

The time required to deplete a finite source (τ_D) of depth ΔH_c is given as:

$$\tau_D = \frac{[\Delta H_C / L_T^0 + \beta] - \beta^2}{2\Psi} \quad (9)$$

If the exposure period (τ) is greater than τ_D, the average emission rate into the building <E> is given as a simple mass balance:

$$<E> = \rho_b C_R \Delta H_C A_B / \tau \quad (10)$$

and the average building concentration ($C_{building}$) is:

$$C_{building} = <E>/Q_{building} \quad (11)$$

Evaluation

In order to evaluate the effects of using the model on the SSLs for volatile contaminants, a case example was constructed which best estimates a reasonable high end exposure point concentration for residential land use. Where possible, values of model variables were taken directly from Johnson and Ettinger (1991).

The case example assumes that a residential dwelling with a basement is constructed within the area of homogeneous residual contamination such that the contaminant source lies directly below the basement floor at t = 0. Therefore, the diffusion and convection path lengths were set equal to the thickness of the basement slab (15 cm). Soil permeability to vapor flow from the basement floor to the bottom of contamination was set equal to 1.0 x 10^{-8} cm^2 (1 darcy) which is representative of silty to fine sand. Soil column-building pressure differential was set equal to 1 pascal (10g/cm-s^2) as a reasonable long-term average value (Johnson and Ettinger, 1991). Values for all other soil properties were set equal to those of the Generic SSLs in the July 1994 Technical Background Document for Draft Soil Screening Level Framework (TBD). Building variables, i.e., basement area, ventilation rate, etc., were taken from Johnson and Ettinger (1991).

In the analysis, the values for $C_{building}$ (kg/m^3) were calculated for the 42 chemicals in the TBD for which human health benchmarks are available. Please note that the values of C_{source} and $C_{building}$ were calculated for an initial soil concentration of 1 mg/kg instead of 1 x 10^{-6} g/g. This was done to facilitate reverse calculation of the SSL in units of mg/kg. Therefore, these values are artificially high by a factor of 1 x 10^6. The inverse of the value of $C_{building}$ (m^3/kg) was used as the indoor volatilization factor (VF_{indoor}) and substituted into Equations 2-4 or 2-5 of the TBD as appropriate to calculate the resulting carcinogenic and noncarcinogenic inhalation SSLs. SSLs were calculated for both steadystate conditions (infinite source depth) and quasi-steady-state conditions (finite source depth). In each case were the exposure period exceeded the time required for source depletion (finite source depth), the volatilization factor was normalized to an average contaminant level in soil (C_r) of 1 mg/kg. For quasi-steady-state conditions, the depth to the bottom of contamination was set equal to 2 meters below the basement floor.

The value of the indoor SSL for each contaminant was compared to the respective SSL calculated for outdoor exposures of the same duration using the Generic SSL calculations found in the TBD. The outdoor SSLs were computed for a 30 acre square area source of emissions. Table 1 summarizes the results of this comparison. The attachment to this memorandum gives the detailed computations for this evaluation.

TABLE 1.
SUMMARY OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Indoor SSL, infinite source (mg/kg)	Indoor SSL, finite source (mg/kg)	Outdoor SSL, infinite source (mg/kg)
Aldrin	0.4	0.4	0.5
Benzene	0.002	0.02	0.5
Bis(2-chloroethyl)ether	0.02	0.05	0.3
Bromoform	0.8	0.9	43
Carbon disulfide	0.03	0 7	11
Carbon tetrachloride	0.0007	0.01	0.2
Chlordane	51	53	54
Chlorobenzene	0.7	2	87
Chloroform	0.001	0.007	0.2
DDT	5[a]	5[a]	5[a]
1,2-Dichlorobenzene	26	65	297[a]
1,4-Dichlorobenzene	102	235[a]	235[a]
1,1-Dichloroethane	4	35	939
1,2-Dichloroethane	0.002	0.007	0.3
1,1-Dichloroethylene	0.0001	0.003	0.04
1,2-Dichloropropane	0.06	0.3	10
1,3-Dichloropropene	0.0007	0.004	0.1
Dieldrin	3	4	2
Ethylbenzene	21	69	257[a]
Heptachlor	0.04	0.04	0.3
Heptachlor epoxide	1	1	1
Hexachloro-1,3-butadiene	0.03	0.05	1
Hexachlorobenzene	0.3	0.6	1
HCH-alpha(alpha-BHC)	0.5	0.6	0.9
HCH-beta(beta-BHC)	7[a]	7[a]	7[a]
Hexachlorocyclopentadiene	0.06	0.07	2
Hexachloroethane	0.6	0.6	45
Methyl bromide	0.01	0.3	3
Methylene chloride	0.04	0.3	7
Nitrobenzene	9	25	100
Styrene	185	472	1439[a]
1,1,2,2-Tetrachloroethane	0.007	0.02	0.4
Tetrachloroethylene	0.05	0.3	11
Toluene	6	28	521[a]
Toxaphene	2	2	2[a]
1,2,4-Trichlorobenzene	6	9	214
1,1,1-Trichloroethane	5	69	980[a]
1,1,2-Trichloroethane	0.009	0.02	1
Trichloroethylene	0.01	0.09	3
2,4,6-Trichlorophenol	64	94	190
Vinyl acetate	5	14	351
Vinyl chloride	0.00002	0.002	0.01

[a] = SSL based on C_{sat}

As can be seen from Table 1, results on a chemical-specific basis indicate a rate of change as high as three orders of magnitude between the outdoor SSL and the infinite source indoor SSLs in the case of highly volatile contaminants. For very persistent contaminants, the relative difference was considerably less, and in some cases there was no difference in SSL concentrations.

This variability is due to: 1) the variability in the human health benchmarks used to calculate the risk-based SSLs, and 2) the apparent diffusion coefficient of each compound. The apparent diffusion coefficient can be expressed as the effective diffusion coefficient through soil divided by the liquid-phase partition coefficient (Jury et al., 1983). The apparent diffusion coefficient (D_A) is given here so as not to be confused with the effective diffusion coefficient (D^{eff}) from Johnson and Ettinger (1991):

$$DA = \left[\left(\Theta_a^{10/3} D_a H + \Theta_w^{10/3} D_w\right) / \Theta_t^2\right] / (\rho_b K_d + \Theta_w + \Theta_a H) \qquad (12)$$

where D_A = Apparent diffusion coefficient, cm^2/s

Θ_a = Air-filled soil porosity, unitless

D_a = Diffusivity in air, cm^2/s

H = Henry's law constant, unitless

Θ_w = Water-filled soil porosity, unitless

D_w = Diffusivity in water, cm^2/s

Θ_t = Total soil porosity, unitless

ρ_b = Soil dry bulk density, g/cm^3

K_d = Soil-water partition coefficient, cm3/g.

With all nonchemical-specific variables held constant, Figure 1 shows the exponential relationship between the apparent diffusion coefficient and the building concentration for quasi-steady-state conditions (finite source).

For nonchemical-specific variables, a sensitivity analysis was performed for soil permeability to vapor flow (k_v), soil-building pressure differential (Δ P), depth of contamination (ΔH_c), source-building separation at t = 0 (L_T^0), crack-to-total area ratio (η), and building ventilation rate ($Q_{building}$).

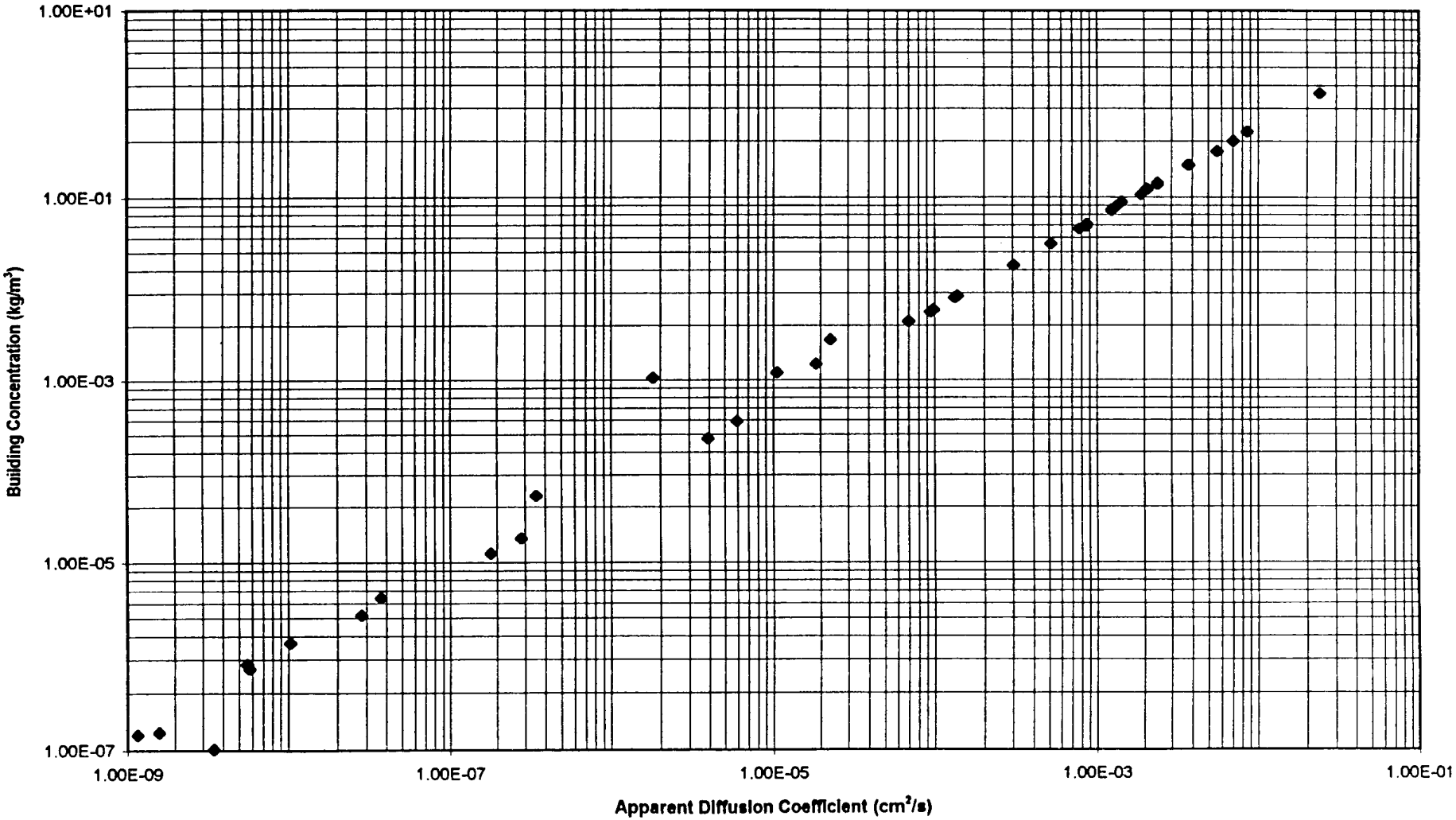

Figure 1
Building Concentration Versus Apparent Diffusion Coefficient

Table 2 shows the results of the sensitivity analysis for the quasi-steady-state condition (finite source). As can be seen from Table 2, the effect of the building ventilation rate is linear if the value of C_{sat} is not included in limiting the value of the SSL. Depth of contamination (ΔH_c) has the greatest effect for contaminants with higher apparent diffusion coefficients (e.g., benzene, chloroform, vinyl chloride, etc.), in that as ΔH_c increases, the time required for source depletion (τ_D) also increases. Therefore, with greater initial contaminant mass in the soil, these compounds are emitted for a longer period of time thus reducing the SSL. For the more persistent contaminants, an increase in k_v or ΔP produces the greatest results. This is to be expected as values of τ_D for these contaminants exceed the exposure duration. Table 2 also indicates that an order of magnitude change in values Of L_T^0 and η produce same order of magnitude results. It must be remembered, however, that in the case of L_T^0, the model assumes isotropic soil conditions from the point of building entry to the bottom of contamination. As L_T^0 increases, α decreases until diffusion not convection limits the rate of contaminant vapor transport. The effect of changes in the value of η decrease as values of k_v decrease such that for very permeable soils and convection-dominated vapor transport, the effect of crack size is relatively insignificant.

Conclusions

Use of the Johnson and Ettinger (1991) model to calculate SSLs based on indoor chronic exposures can have significant impacts on the values of the SSLs for contaminants with high apparent diffusion coefficients. When comparing the infinite source indoor model to the infinite source outdoor model for these contaminants, values of the SSL differ by orders of magnitude for case example conditions. Under these conditions, diffusion is the limiting transport mechanisms for all but one contaminant for both steady-state and quasi-steady-state conditions. To effect case example conditions, the following must be true:

1. The contaminant source must be relatively close or directly beneath the structure.

2. The soil between the structure and the source must be very permeable (k_v, $\geq 10^{-8}$ cm^2).

3. The structure must be underpressurized.

4. The air within the structure must be well mixed (i.e., little or no soil-air boundary layer resistance).

5. The combination of diffusion coefficient through the cracks, area of the cracks, and building underpressurization must offer no more resistance than the soil column beneath the structure.

From this evaluation, the four most important factors affecting the average long-term building concentration and thus the SSL are building ventilation rate, source-building separation, soil permeability to vapor flow, and source depth. If the source of contamination is relatively deep and close to the building, and if the soil between the source and the building is very permeable, building concentrations of contaminants with relatively high apparent diffusion coefficients will increase dramatically.

TABLE 2.
MODEL SENSITIVITY TO NONCHEMICAL SPECIFIC VARIABLES

			Ratio of Variable-to-Test Condition SSL					
Chemical	Apparent diffusion coefficient, D_A (cm^2/s)	Test condition SSL, (mg/kg)	Soil vapor permeability, k_v x 10	Soil-bldg. pressure differential, ΔP x 10	Depth to source lower boundary, ΔH_c x 10	Source-bldg. separation at t=0, L_T^0 x 10	Inverse of crack-to-total area ratio, 1/η x 10	Bldg. ventilation rate, $Q_{building}$ x 10
DDT	1.16E-09	5[a]	1	1	1	1	1	1.0
Dieldrin	1.59E-09	4	0.1	0.1	1	1.2	1.5	3.4
HCH-beta(beta-BHC)	3.54E-09	7[a]	0.8	0.8	1	1	1	1.0
Chlordane	5.63E-09	53	0.1	0.1	1	1.3	1.3	1.3
Heptachlor epoxide	5 78E-09	1	0.1	0.1	1	1.3	1.5	8.4
Aldrin	1.03E-08	0.4	0.1	0.1	1	1.2	1.5	10
HCH-alpha(alpha-BHC)	2.81E-08	0.6	0.1	0.1	1	1.2	1.5	10
Toxaphene	3.69E-08	2	0.1	0.1	1	1.1	1.1	1.1
2,4,6-Trichlorophenol	1.81E-07	94	0.1	0.1	1	1.1	1.5	10
Hexachlorobenzene	284E-07	0.6	0.1	0.1	1	1.1	1.5	3.2
Heptachlor	3.52E-07	0.04	0.1	0.1	1	1.3	1.5	10
Hexachloroethane	1.80E-06	0.6	0.3	0.3	1	2	1.4	10
Nitrobenzene	3.92E-06	25	0.1	0.1	1	1	1.5	10
Bis(2-chloroethyl)ether	5.94E-06	0.05	0.1	0.1	1	1	1.5	10
Hexachlorocyclo-pentadiene	1.06E-05	0.07	0.2	0.2	1	1.2	1.5	10
1,2,4-Trichlorobenzene	1.89E-05	9	0.1	0.1	1	1.1	1.5	10
Bromoform	2.32E-05	0.9	0.2	0.2	1	1.2	1.5	10
Hexachloro-1,3-butadiene	6.97E-05	0.05	0.1	0.1	1	1.1	1.5	10
Styrene	9.50E-05	472	0.1	0.1	1	1	1 5	3.0
1,1,2,2-Tetrachloroethane	9.89E-05	0.02	0.2	0 2	1	1	1 5	10
1,2-Dichlorobenzene	1.34E-04	65	0.2	0.2	1	1	1.5	4.5
1,4-Dichlorobenzene	1.38E-04	235[a]	0.2	0.2	1	1	1	1.0
1,1,2-Trichloroethane	3.04E-04	0.02	0.4	0.4	1	1	1.5	10
Chlorobenzene	5.18E-04	2	0.8	0.8	1	1	1.5	10
Vinyl acetate	7.79E-04	14	1	1	1	1	1.5	10
1,2-Dichloropropane	8.57E-04	0.007	0.9	0.9	1	1	1.5	10
Ethylbenzene	8.64E-04	69	1	1	0.8	1	1.2	3.7
1,2-Dichbropropane	1.24E-03	0.3	1	1	0.6	1	1	10
Toluene	1.25E-03	28	1	1	0.7	1	1	10
Tetrachloroethylene	1.34E-03	0.3	1	1	0.5	1	1	10
1,3-Dichloropropene	1.44E-03	0.004	1	1	0.4	1	1	10
Chloroform	1.91E-03	0.007	1	1	0.5	1	1	10
1,1-Dichloroethane	2.08E-03	35	1	1	0.4	1	1	10
Benzene	2.12E-03	0.02	1	1	0.4	1	1	10
Trichloroethylene	2.44E-03	0.09	1	1	0.3	1	1	10
Methylene chloride	2.45E-03	0.3	1	1	0.4	1	1	10
1,1,1-Trichioroethane	3.79E-03	69	1	1	0.2	1	1	10
Carbon tetrachloride	3.82E-03	0.01	1	1	0.2	1	1	10
Carbon disulfide	5.67E-03	0.7	1	1	0.2	1	1	10
1,1-Dichloroethylene	7.09E-03	0.003	1	1	0.1	1	1	10
Methyl bromide	8.56E-03	0.3	1	1	0.1	1	1	10
Vinyl chloride	2.40E-02	0.002	1	1	0.1	1	1	10

[a] = SSL based C_{sat}

It should be noted, however, that soil permeability, k_v, is the most variable parameter at any given site, and may vary by three orders of magnitude across a typical residential lot (Johnson and Ettinger, 1991). For this reason, the overall effective diffusion coefficient should be determined by integration across each soil type. Overall diffusion/convection vapor transport will therefore be limited by the soil stratum offering the greatest resistance to vapor flow.

References

Johnson, Paul C., and Robert A. Ettinger. 1991. Heuristic model for predicting the intrusion rate of contaminant vapors into buildings. Environ. Sci. Technol., 25(8):1445-1452.

Jury, W. A., W. J. Farmer, and W. F. Spencer. 1983. Behavior Assessment Model for Trace Organics in Soil, l, Model description. J. Environ. Qual., 12:558-564.

Attachment

ATTACHMENT

DETAILED MODEL EVALUATION

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	CAS No.	Soil bulk density, ρ_b (g/cm^3)	Soil moisture, w (g/g)	Soil moisutre, Θ_w (cm^3/cm^3)	Soil total porosity, η (unitless)	Soil air-filled porosity, Θ_a (unitless)	Soil water-filled porosity, Θ_w (unitless)	Diffusivity in air, D_a (cm^2/s)	Diffusity in water, D_w (cm^2/s)	Effective diffusion coeffi-cient, D_o (cm^2/s)	Soil vapor permea-bility, K_v (cm^2)	Soil-bldg. pressure differen-tial ΔP ($g/cm\text{-}s^2$)	Diffusion path length, L_d (cm)	Convec-tion path length, L_p (cm)	Vapor viscosity, μ (g/cm-s)	Peclet number, Pe (unitless)	Henry's law constant, H (unitless)	Organic carbon partition coeffi-cient, K_{oc} (cm^3/g)
Aldrin	309-00-2	1.5	0.1	0.15	0.434	0.284	0.150	1.32E-02	4.86E-06	1.05E-03	1.00E-08	10	15	15	1.80E-04	0.53	4.20E-03	4.84E+04
Benzene	71-43-2	1.5	0.1	0.15	0.434	0.284	0.150	8.70E 02	9.80E-066	6.95E-03	1.00E-08	10	15	15	1.80E-04	0.08	2.20E-01	5.70E+01
Bis(2-chloroethyl)ether	111-44-4	1.5	0.1	0.15	0.434	0.284	0.150	6.92E-02	7.53E-06	5.53E-03	1.00E-08	10	15	15	1.80E-04	0.10	8.80E-04	7.60E+01
Bromoform	75-25-2	1.5	0.1	0.15	0.434	0.284	0.150	1.49E-02	1.03E-05	1.19E-03	1.00E-08	10	15	15	1.80E-04	0.47	2.50E-02	1.26E+02
Carbon disulfide	75-15-0	1.5	0.1	0.15	0.434	0.284	0.150	1.04E-01	1.00E-05	8.31E-03	1.00E-08	10	15	15	1.80E-04	0.07	5.20E-01	5.20E+01
Carbon tetrachloride	56-23-5	1.5	0.1	0.15	0.434	0.284	0.150	7.80E-02	8.80E-06	6.23E-03	1.00E-08	10	15	15	1.80E-04	0.09	1.20E+00	1.64E+02
Chlordane	57-74-9	1.5	0.1	0.15	0.434	0.284	0.150	1.18E-02	4.37E-06	9.43E-04	1.00E-08	10	15	15	1.80E-04	0.59	2.70E-03	5.13E+04
Chlorobenzene	108-90-7	1.5	0.1	0.15	0.434	0.284	0.150	7.30E-02	8.70E-06	5.83E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.80E-01	2.04E+02
Chloroform	67-66-03	1.5	0.1	0.15	0.434	0.284	0.150	1.04E-01	1.00E-05	8.31E-03	1.00E-08	10	15	15	1.80E-04	0.07	1.60E-01	5.60E+01
DDT	50-29-3	1.5	0.1	0.15	0.434	0.284	0.150	1.37E-02	4.95E-06	1.09E-03	1.00E-08	10	15	15	1.80E-04	0.51	2.20E43	2.37E+05
1,2-Dichlorobenzene	95-50-1	1.5	0.1	0.15	0.434	0.284	0.150	6.90E-02	7.90E-06	5.51E-03	1.00E-08	10	15	15	1.00E-04	0.10	8.60E-02	3.76E+02
1,4-Dichlorobenzene	106-46-7	1.5	0.1	0.15	0.434	0.284	0.150	6.90E-02	7.90E-06	5.51E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.20E-01	5.16E+02
1,1-Dichloroethane	75-34-3	1.5	0.1	0.15	0.434	0.284	0.150	7.42E-02	1.04E-05	5.93E-03	1.00E-08	10	15	15	1.80E-04	0.09	2.40E41	5.20E+01
1,2-Dichloroethane	107-06-2	1.5	0.1	0.15	0.434	0.284	0.150	1.04E-01	9.90E-06	8.31E-03	1.00E-08	10	15	15	1.80E-04	0.07	5.20E-02	3.80E+01
1,1-Dichloroethylene	75-35 -4	1.5	0.1	0.15	0.434	0.284	0.150	9.00E-02	1.04E-05	7.19E-03	1.00E-08	10	15	15	1.80E-04	0.08	1.00E+00	6.50E+01
1,2-Dichloropropane	78-87-5	1.5	0.1	0.15	0.434	0.284	0.150	7.82E-02	8.73E-06	6.25E-03	1.00E-08	10	15	15	1.80E-04	0.09	1.20E-01	4.70E+01
1,3-Dichloropropene	542-75-6	1.5	0.1	0.15	0.434	0.284	0.150	6.26E-02	1.00E-05	5.00E-03	1.00E-08	10	15	15	1.80E-04	0.11	1.20E-01	2.60E+01
Dieldrin	60-57-1	1.5	0.1	0.15	0.434	0.284	0.150	1.25E-02	4.74E4-6	9.99E-04	1.00E-08	10	15	15	1.80E-04	0.56	1.10E-04	1.09E+04
Ethylbenzene	100-41-4	1.5	0.1	0.15	0.434	0.284	0.150	7.50E-02	7.80E-06	5.99E-03	1.00E-08	10	15	15	1.80E-04	0.09	3.20E-01	2.21E+02
Heptachlor	76-44-8	1.5	0.1	0.15	0.434	0.284	0.150	1.12E-02	5.69E-06	8.95E-04	1.00E-08	10	15	15	1.80E-04	0.62	2.40E-02	6.81E+03
Heptachlor epoxide	1024-57-3	1.5	0.1	0.15	0.434	0.284	0.150	1.22E-02	4.68E-06	9.75E-04	1.00E-08	10	15	15	1.80E-04	0.57	3.40E-04	7.24E+03
Hexachloro-1,3-butadiene	87-68-3	1.5	0.1	0.15	0.434	0.284	0.150	5.61E-02	6.16E-06	4.48E-03	1.00E-08	10	15	15	1.80E-04	0.12	9.80E-01	6.99E+03
Hexachlorobenzene	118-74-1	1.5	0.1	0.15	0.434	0.284	0.150	5.42E-02	5.91E-06	4.33E-03	1.00E-08	10	15	15	1.80E-04	0.13	220E-02	3.75E+04
HCH-alpha(alpha-BHC)	319-84-6	1.5	0.1	0.15	0.434	0.284	0.150	1.76E-02	5.57E-06	1.41E-03	1.00E-08	10	15	15	1.80E-04	0.39	2.80E-04	1.76E+03
HCH-beta(beta-BHC)	319-85-7	1.5	0.1	0.15	0.434	0.284	0.150	1.76E-02	5.57E-06	1.41E-03	1.00E-08	10	15	15	1.80E-04	0.39	1.40E-05	2.28E+03
Hexachlorocyclopentadiene	77-47-4	1.5	0.1	0.15	0.434	0.284	0.150	1.61E-02	7.21E-06	1.29E-03	1.00E-08	10	15	15	1.80E-04	0.43	7.10E-01	9.59E+03
Hexachloroethane	67-72-1	1.5	0.1	0.15	0.434	0.284	0.150	2.49E-03	6.80E-06	1.99E-04	1.00E-08	10	15	15	1.80E-04	2.79	1.50E-01	1.83E+03
Methyl bromide	74-83-9	1.5	0.1	0.15	0.434	0.284	0.150	7.28E-02	1.21E-05	5.82E-03	1.00E-08	10	15	15	1.80E-04	0.10	5.80E-01	9.00E+00
Methylene chloride	75-09-2	1.5	0.1	0.15	0.434	0.284	0.150	1.01E-01	1.17E-05	8.07E-03	1.00E-08	10	15	15	1.80E-04	0.07	9.70E-02	1.60E+01
Nitrobenzene	98-95-3	1.5	0.1	0.15	0.434	0.284	0.150	7.60E-02	8.60E-06	6.07E-03	1.00E-08	10	15	15	1.80E-04	0.09	8.40E-04	1.31E+02
Styrene	100-42-5	1.5	0.1	0.15	0.434	0.284	0.150	7.10E-02	8.00E-06	5.67E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.40E-01	9.12E+02
1,1,2,2-Tetrachloroethane	79-34-5	1.5	0.1	0.15	0.434	0.284	0.150	7.10E-02	7.90E-06	5.67E-03	1.00E-08	10	15	15	1.80E-04	0.10	1.50E-02	7.90E+01
Tetrachloroethylene	127-18-4	1.5	0.1	0.15	0.434	0.284	0.150	7.20E-02	8.20E-06	5.75E-03	1.00E-08	10	15	15	1.80E-04	0.10	7.10E-01	3.00E+02
Toluene	108-88-3	1.5	0.1	0.15	0.434	0.284	0.150	8.70E-02	8.60E-06	6.95E-03	1.00E-08	10	15	15	1.80E-04	0.08	2.50E-01	1.31E+02
Toxaphene	8001-35-2	1.5	0.1	0.15	0.434	0.284	0.150	1.16E-02	4.34E-06	9.27E-04	1.00E-08	10	15	15	1.80E-04	0.60	1.40E-04	5.01E+02
1,2,4-Trichlorobenzene	120-82-1	1.5	0.1	0.15	0.434	0.284	0.150	3.00E-02	8.23E-06	2.40E-03	1.00E-08	10	15	15	1.80E-04	0.23	1.10E-01	1.54E+03
1,1,1-Trichloroethane	71-55-6	1.5	0.1	0.15	0.434	0.284	0.150	7.80E-02	8.80E-06	6.23E-03	1.00E-08	10	15	15	1.80E-04	0.09	7.60E-01	9.90E+01
1,1,2-Trichloroethane	79-00-5	1.5	0.1	0.15	0.434	0.284	0.150	7.80E-02	8.80E-06	6.23E-03	1.00E-08	10	15	15	1.80E-04	0. 09	4.10E-02	7.60E+01
Trichloroethylene	79-01-6	1.5	0.1	0.15	0.434	0.284	0.150	7.90E-02	9.10E-06	6.31E-03	1.00E-08	10	15	15	1.80E-04	0.09	4.30E-01	9.40E+01
2,4,6-Trichlorophenol	88-06-2	1.5	0.1	0.15	0.434	0.284	0.150	3.14E-02	6.36E-06	2.51E-03	1.00E-08	10	15	15	1.80E-04	0.22	1.70E-04	2.83E+02
Vinyl acetate	108-05-4	1.5	0.1	0.15	0.434	0.284	0.150	8.50E-02	9.20E-06	6.79E-03	1.00E-08	10	15	15	1.80E-04	0.08	2.30E-02	5.00E+00
Vinyl chloride	75-01-4	1.5	0.1	0.15	0.434	0.284	0.150	1.06E-01	1.23E-05	8.47E-03	1 00E-08	10	15	15	1.80E-04	0.07	3.50E+00	1.10E+01

NA = not appilcable

[a] = SSL based on C_{sat}

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Soil organic carbon fraction, f_{oc} (unitless)	Soil-water partition coefficient K_a (cm^3/g)	Initial soil conc., C_i (mg/kg)	Source vapor conc., C_{source} (g/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)	Crack depth below grade, Z_{crack} (cm)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg. Q_{soil} (cm^3/s)	Source-bldg. separation at t=0, L_t^o (cm)	Indoor ψ	Area of base-ment, A_s (cm^2)	Bldg. foundation thick-nesses, L_{crack} (cm)	Crack effective diffusion coeffi-cient, D_{crack} (cm^2/s)	Crack-to-total area ratio, η	Area of crack, A_{crack} (cm^2)	Indoor β	Buiilding ventilation rate, $Q_{building}$ (cm^3/s)	Depth to source lower boundary, ΔH_c (cm)	Exposure duration, τ (sec)
Aldrin	0.006	2.90E+02	1.00E+00	1.45E-05	3400	200	4.06	2.59	15	4.52E-11	1.38E+06	15	1.05E-03	0.01	1.38E+04	3.85E+01	2.90E+04	200	9.46E+08
Benzene	0.006	3.42E-01	1.00E+00	4.55E-01	3400	200	4.06	2.59	15	9.37E-06	1.38E+06	15	6.95E-03	0.01	1.38E+04	2.48E+02	2.90E+04	200	9.46E+08
Bis(2-chloroethyl)ether	0.006	4.56E-01	1.00E+00	1.58E-03	3400	200	4.06	2.59	15	2.59E-08	1.38E+06	15	5.53E-03	0.01	1.38E+04	1.98E+02	2.90E+04	200	9.46E+08
Bromoform	0.006	7.56E-01	1.00E+00	2.90E-02	3400	200	4.06	2.59	15	1.02E-07	1.38E+06	15	1.19E-03	0.01	1.38E+04	4.34E+01	2.90E+04	200	9.46E+08
Carbon disulfide	0.006	3.12E-01	1.00E+00	1.02E+00	3400	200	4.06	2.59	15	2.51E-05	1.38E+06	15	8.31E-03	0.01	1.38E+04	2.97E+02	2.90E+04	200	9.46E+08
Carbon tetrachloride	0.006	9.84E-01	1.00E+00	9.15E-01	3400	200	4.06	2.59	15	1.69E-05	1.38E+06	15	6.23E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
Chlordane	0.006	3.08E+02	1.00E+00	8.77E-06	3400	200	4.06	2.59	15	2.45E-11	1.38E+06	15	9.43E-04	0.01	1.38E+04	3.46E+01	2.90E+04	200	9.46E+08
Chlorobenzene	0.006	1.22E+00	1.00E+00	1.33E-01	3400	200	4.06	2.59	15	2.29E-06	1.38E+06	15	5.83E-03	0.01	1.38E+04	2.09E+02	2.90E+04	200	9.46E+08
Chloroform	0.005	3.36E-01	1.00E+00	3.43E-01	3400	200	4.06	2.59	15	8.45E-06	1.38E+06	15	8.31E-03	0.01	1.38E+04	2.97E+02	2.90E+04	200	9.46E+08
DDT	0.006	1.42E+03	1.00E+00	1.55E-06	3400	200	4.06	2.59	15	5.02E-12	1.38E+06	15	1.09E-03	0.01	1.38E+04	4.00E+01	2.90E+04	200	9.46E+08
1,2-Dichlorobenzene	0.006	2.26E+00	1.00E+00	3.63E-02	3400	200	4.06	2.59	15	5.92E-07	1.38E+06	15	5.51E-03	0.01	1.38E+04	1.97E+02	2.90E+04	200	9.46E+08
1,4-Dichlorobenzene	0.006	3.10E+00	1.00E+00	3.73E-02	3400	200	4.06	2.59	15	6.09E-07	1.38E+06	15	5.51E-03	0.01	1.38E+04	1.97E+02	2.90E+04	200	9.46E+08
1,1-Dichloroethane	0.006	3.12E-01	1.00E+00	5.25E-01	3400	200	4.06	2.59	15	9.22E-06	1.38E+06	15	5.93E-03	0.01	1.38E+04	2.12E+02	2.90E+04	200	9.46E+08
1,2-Dichloroethane	0.006	2.28E-01	1.00E+00	1.54E-01	3400	200	4.06	2.59	15	3.79E-06	1.38E+06	15	8.31E-03	0.01	1.38E+04	2.97E+02	2.90E+04	200	9.46E+08
1,1-Dichloroethylene	0.006	3.90E-01	1.00E+00	1.47E+00	3400	200	4.06	2.59	15	3.14E-05	1.38E+06	15	7.19E-03	0.01	1.38E+04	2.57E+02	2.90E+04	200	9.46E+08
1,2-Dichloropropane	0.006	2.82E-01	1.00E+00	2.97E-01	3400	200	4.06	2.59	15	5.49E-06	1.38E+06	15	6.25E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
1,3-Dichloropropene	0.006	1.56E-01	1.00E+00	4.31E-01	3400	200	4.06	2.59	15	6.38E-06	1.38E+06	15	5.00E-03	0.01	1.38E+04	1.79E+02	2.90E+04	200	9.46E+08
Dieldrin	0.006	6.54E+01	1.00E+00	1.68E-06	3400	200	4.06	2.59	15	4.97E-12	1.38E+06	15	9.99E-04	0.01	1.38E+04	3.66E+01	2.90E+04	200	9.46E+08
Ethylbenzene	0.006	1.33E+00	1.00E+00	2.15E-01	3400	200	4.06	2.59	15	3.82E-06	1.38E+06	15	5.99E-03	001	1.38E+04	2.14E+02	2.90E+04	200	9.46E+08
Heptachlor	0.006	4.09E+01	1.00E+00	5.86E-04	3400	200	4.06	2.59	15	1.55E-09	1.38E+06	15	8.95E-04	001	1.38E+04	3.29E+01	2.90E+04	200	9.46E+08
Heptachlor epoxide	0.006	4.34E+01	1.00E+00`	7.81E-06	3400	200	4.06	2.59	15	2.26E-11	1.38E+06	15	9.75E-04	0.01	1.38E+04	3.57E+01	2.90E+04	200	9.46E+08
Hexachloro-1,3-butadiene	0.006	4.19E+01	1.00E+00	2.32E-02	3400	200	4.06	2.59	15	3.08E-07	1.38E+06	15	4.48E-03	0.01	1.38E+04	1.61E+02	2.90E+04	200	9.46E+08
Hexachlorobenzene	0.006	2.25E+02	1.00E+00	9.77E-05	3400	200	4.06	2.59	15	1.25E-09	1.38E+06	15	4.33E-03	0.01	1.38E+04	1.55E+02	2.90E+04	200	9.46E+08
HCH-alpha(alpha-BHC)	0.006	1.06E+01	1.00E+00	2.63E-05	3400	200	4.06	2.59	15	1.09E-10	1.38E+06	15	1.41E-03	001	1.38E+04	5.11E+01	2.90E+04	200	9.46E+08
HCH-beta(beta-BHC)	0.006	1.37E+01	1.00E+00	1.02E-06	3400	200	4.06	2.59	15	4.23E-12	1.38E+06	15	1.41E-03	0.01	1.38E+04	5.11E+01	2.90E+04	200	9.46E+08
Hexachlorocyclopentadiene	0.006	5.75E+01	1.00E+00	1.23E-02	3400	200	4.06	2.59	15	4.69E-08	1.38E+06	15	1.29E-03	0.01	1.38E+04	4.68E+01	2.90E+04	200	9.46E+08
Hexachloroethane	0.006	1.10E+01	1.00E+00	1.35E-02	3400	200	4.06	2.59	15	7.96E-09	1.38E+06	15	1.99E-04	0.01	1 38E+04	8.08E+00	2.90E+04	200	9.46E+08
Methyl bromide	0.006	5.40E-02	1.00E+00	2.20E+00	3400	200	4.06	2.59	15	3.79E-05	1.38E+06	15	5.82E-03	0.01	1.38E+04	2.08E+02	2.90E+04	200	9.46E+08
Methylene chloride	0.006	9.60E-02	1.00E+00	4.53E-01	3400	200	4.06	2.59	15	1.08E-05	1.38E+06	15	8.07E-03	0.01	1.38E+04	2.88E+02	2.90E+04	200	9.46E+08
Nitrobenzene	0.006	7.86E-01	1.00E+00	9.48E-04	3400	200	4.06	2.59	15	1.71E-08	1.38E+06	15	6.07E-03	0 01	1 38E+04	2.17E+02	2.90E+04	200	9.46E+08
Styrene	0.006	5.47E+00	1.00E+00	2.50E-02	3400	200	4.06	2.59	15	4.20E-07	1.38E+06	15	5.67E-03	0.01	1.38E+04	2.03E+02	2.90E+04	200	9.46E+08
1,1,2,2-Tetrachloroethane	0.006	4.74E-01	1.00E+00	2.60E-02	3400	200	4.06	2.59	15	4.37E-07	1.38E+06	15	5.67E-03	0.01	1.38E+04	2.03E+02	2.90E+04	200	9.46E+08
Tetrachloroethylene	0.006	1.80E+00	1.00E+00	3.49E-01	3400	200	4.06	2.59	15	5.95E-06	1.38E+06	15	5.75E-03	0.01	1.38E+04	2.06E+02	2.90E+04	200	9.46E+08
Toluene	0.006	7.86E-01	1.00E+00	2.68E-01	3400	200	4.06	2.59	15	5.52E-06	1.38E+06	15	6.95E-03	0.01	1.38E+04	2.48E+02	2.90E+04	200	9.46E+08
Toxaphene	0.006	3.01E+00	1.00E+00	4.51E-05	3400	200	4.06	2.59	15	1.24E-10	1.38E+06	15	9.27E-04	0.01	1.38E+04	3.40E+01	2.90E+04	200	9.46E+08
1,2,4-Trichlorobenzene	0.006	9.24E+00	1.00E+00	1.18E-02	3400	200	4.06	2.59	15	8.35E-08	1.38E+06	15	2.40E-03	0.01	1.38E+04	8.63E+01	2.90E+04	200	9.46E+08
1,1,1-Trichloroethane	0.006	5.94E-01	1.00E+00	9.07E-01	3400	200	4.06	2.59	15	1.68E-05	1.38E+06	15	6.23E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
1,1,2-Trichloroethane	0.006	4.56E-01	1.00E+00	7.27E-02	3400	200	4.06	2.59	15	1.34E-06	1.38E+06	15	6.23E-03	0.01	1.38E+04	2.23E+02	2.90E+04	200	9.46E+08
Trichloroethylene	0.006	5.64E-01	1.00E+00	5.77E-01	3400	200	4.06	2.59	15	1.08E-05	1.38E+06	15	6.31E-03	0.01	1.38E+04	2.26E+02	2.90E+04	200	9.46E+08
2,4,6-Trichlorophenol	0.006	1.70E+00	1.00E+00	9.45E-05	3400	200	4.06	2.59	15	7.03E-10	1.38E+06	15	2.51E-03	0.01	1.38E+04	9.03E+01	2.90E+04	200	9.46E+08
Vinyl acetate	0.006	3.00E-02	1.00E+00	1.71E-01	3400	200	4.06	2.59	15	3.45E-06	1.38E+06	15	6.79E-03	0.01	1.38E+04	2.43E+02	2.90E+04	200	9.46E+08
Vinyl chloride	0.006	6.60E-02	1.00E+00	4.22E+00	3400	200	4.06	2.59	15	1.06E-04	1.38E+06	15	8.47E-03	0.01	1.38E+04	3.02E+02	2.90E+04	200	9.46E+08

NA = not appilcable

[a] = SSL based on C_{sat}

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Infinite source indoor attenuation coefficient, α (unitless)	Finite source indoor attenuation coefficient, α (unitless)	Time for source depletion, Indoor τ_D (sec)	Exposure duration > time for depletion (yes/no)	Infinite source bldg. conc., $C_{building}$ (kg/m^3)	Finite source bldg. conc., $C_{building}$ (kg/m^3)	Infinite source indoor volatilization factor VF_{indoor} (m^3/kg)	Finite source indoor volatilization factor VF_{indoor} (m^3/kg)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Infinite source indoor SSL, carcinogen (mg/kg)	Infinite source indoor SSL, non-carcinogen (mg/kg)	Finite source indoor SSL, carcinogen (mg/kg)	Finite source indoor SSL, non-carcinogen (mg/kg)	Infinite soure risk-based indoor SSL, (mg/kg)	Finite soure risk-based indoor SSL, (mg/kg)	Outdoor apparent diffusion coefficient, α (cm^2/s)	Outdoor volalitization factor, $VF_{outdoor}$ (m^3/kg)
Aldrin	9.32E-05	8.68E-05	1.33E+13	no	1.35E-06	1.26E-06	7.42E+05	7.97E+05	4.90E-03	NA	3.69E-01	NA	3.96E-01	NA	3.69E-.01	3.96E-01	1.99E-09	9.84E+05
Benzene	2.65E-04	8.32E-05	3.63E+08	yes	1.20E-01	1.51E-02	8.30E+00	6.63E+01	8.30E-06	NA	2.43E-03	NA	1.94E-02	NA	2.43E-03	1.94E-02	5.82E-04	1.82E+03
Bis(2-chloroethyl)ether	2.21E-04	8.87E-05	1.05E+11	no	3.50E-04	1.40E-04	2.86E+03	7.13E+03	3.30E-04	NA	2.11E-02	NA	5.26E-02	NA	2.11E-02	5.26E-02	1.39E-06	3.72E+04
Bromoform	9.59E-05	8.50E-05	6.51E+09	no	2.79E-03	2.47E-03	3.59E+02	4.05E+02	1.10E-06	NA	7.94E-01	NA	8.96E-01	NA	7.94E-01	8.96E-01	5.13E-06	1.94E+04
Carbon disulfide	3.07E-04	7.93E-05	1.61E+08	yes	3.13E-01	1.51E-02	3.20E+00	6.63E+01	NA	1.00E-02	NA	3.33E-02	NA	6.91E-01	3.33E-02	6.91E-01	1.80E-03	1.03E+03
Carbon tetrachloride	2.43E-04	7.78E-05	1.81E+08	yes	2.22E-01	1.51E-02	4.50E+00	6.63E+01	1.50E-05	NA	7.31E-04	NA	1.08E-02	NA	7.31E-04	1.08E-02	9.90E-04	1.39E+03
Chlordane	9.11E-05	8.66E-05	2.24E+13	no-	7.99E-07	7.59E-07	1.25E+06	1.32E+06	6.00E-05	NA	5.08E+01	NA	5.34E+01	NA	5.08E+01	5.34E+01	1.08E-09	1.34E+06
Chlorobenzene	2.30E-04	8.66E-05	1.25E+09	no	3.05E-02	1.15E-02	3.28E+01	8.71E+01	NA	2.00E-02	NA	6.83E-01	NA	1.82E+00	6.83E-01	1.82E+00	1.12E-04	4.15E+03
Chloroform	3.07E-04	8.51E-05	4.79E+08	yes	1.05E-01	1.51E-02	9.49E+00	6.63E+01	2.30E-05	NA	1.00E-03	NA	7.01E-03	NA	1 00E-03	7.01E-03	5.15E-04	1.93E+03
DDT	9.40E-05	8.69E-05	1.24E+14	no	1.45E-07	1.34E-07	6.88E+06	7.44E+06	9.70E-05	NA	1.73E+02	NA	1.87E+02	NA	1.73E+02	1.87E+02	2.21E-10	2.95E+06
1,2-Dichlorobenzene	2.20E-04	8.81E-05	4.59E+09	no	7.99E-03	3.19E-03	1.25E+02	3.13E+02	NA	2.00E-01	NA	2.61E+01	NA	6.53E+01	2.61E+01	6.53E+01	2.74E-05	8.38E+03
1,4-Dichlorobenzene	2.20E-04	8.81E-05	4.46E+09	no	8.22E-03	3.28E-03	1.22E+02	3.05E+02	NA	8.00E-01	NA	1.02E+02	NA	2.54E+02	1.02E+02	2.54E+02	2.78E-05	8.32E+03
1,1-Dichloroethane	2.33E-04	8.15E-05	3.16E+08	yes	1.22E-01	1.51E-02	8.17E+00	6.63E+01	NA	5.00E-01	NA	4.26E+00	NA	3.46E+01	4.26E+00	3.46E+01	5.94E-04	1.80E+03
1,2-Dichloroethane	3.07E-04	8.71E-05	1.07E+09	no	4.73E-02	1.34E-02	2.12E+01	7.46E+01	2.60E-05	NA	1.98E-03	NA	6.98E-03	NA	1.98E-03	6.98E-03	2.47E-04	2.79E+03
1,1-Dichloroethylene	2.72E-04	7.47E-05	1.12E+08	yes	4.01E-01	1.51E-02	2.49E+00	6.63E+01	5.00E-05	NA	1.21E-04	NA	3.23E-03	NA	1.21E-04	3.23E-03	2.40E-03	8.95E+02
1,2-Dichloropropane	2.43E-04	8.46E-05	5.59E+08	yes	7.21E-02	1.51E-02	1.39E+01	6.63E+01	NA	4.00E-03	NA	5.79E-02	NA	2.76E-01	5.79E-02	2.76E-01	3.46E-04	2.36E+03
1,3-Dichloropropene	2.05E-04	8.16E-05	3.88E+08	yes	8.82E-02	1.51E-02	1.13E+01	6.63E+01	3.70E-05	2.00E-02	7.46E-04	2.37E-01	4.36E-03	1.38E+00	7.46E-04	4.36E-03	5.01E-04	1.96E+03
Dieldrin	9.21E-05	8.67E-05	1.16E+14	no	1.55E-07	1.46E-07	6.47E+06	6.87E+06	4.60E-03	NA	3.42E+00	NA	3.63E+00	NA	3.42E+00	3.63E+00	2.19E-10	2.97E+06
Ethylbenzene	2.35E-04	8.55E-05	7.71E+08	yes	5.06E-02	1.51E-02	1.97E+01	6.63E+01	NA	1.00E+00	NA	2.06E+01	NA	6.91E+01	2.06E+01	6.91E+01	1.88E-04	3.20E+03
Heptachlor	9.02E-05	8.64E-05	3.39E+11	no	5.29E-05	5.06E-05	1.89E+04	1.98E+04	1.30E-03	NA	3.54E-02	NA	3.70E-02	NA	3.54E-02	3.70E-02	6.84E-08	1.68E+05
Heptachlor epoxide	9.16E-05	8.67E-05	2.50E+13	no	7.16E-07	6.77E-07	1.40E+06	1.48E+06	2.60E-03	NA	1.31E+00	NA	1.38E+00	NA	1.31E+00	1.38E+00	9.93E-10	1.39E+06
Hexachloro-1,3-butadiene	1.89E-04	8.81E-05	7.23E+09	no	4.38E-03	2.04E-03	2.28E+02	4.89E+02	2.20E-05	NA	2.52E-02	NA	5.41E-02	NA	2.52E-02	5.41E-02	1.36E-05	1.19E+04
Hexachlorobenzene	1.84E-04	8.86E-05	1.72E+12	no	1.80E-05	8.66E-06	5.55E+04	1.16E+05	4.60E-04	NA	2.94E-01	NA	6.11E-01	NA	2.94E-01	6.11E-01	5.51E-08	1.87E+05
HCH-alpha(alpha-BHC)	1.01E-04	8.74E-05	7.03E+12	no	2.65E-06	2.30E-06	3.78E+05	4.36E+05	1.80E-03	NA	5.11E-01	NA	5.89E-01	NA	5.11E-01	5.89E-01	4.85E-09	6.29E+05
HCH-beta(beta-BHC)	1.01E-04	8.74E-05	1.82E+14	no	1.02E-07	8.88E-08	9.76E+06	1.13E+07	5.30E-04	NA	4.48E+01	NA	5.17E+01	NA	4.48E+01	5.17E+01	1.87E-10	3.20E+06
Hexachlorocyclopentadiene	9.80E-05	8.64E-05	1.52E+10	no	1.20E-03	1.06E-03	8.30E+02	9.42E+02	NA	7.00E-05	NA	6.06E-02	NA	6.88E-02	6.06E-02	6.88E-02	2.07E-06	3.05E+04
Hexachloroethane	7.81E-05	7.41E-05	2.47E+10	no	1.05E-03	1.00E-03	9.48E+02	1.00E+03	4.00E-06	NA	5.77E-01	NA	6.08E-01	NA	5.77E-01	6.08E-01	3.54E-07	7.37E+04
Methyl bromide	2.30E-04	6.75E-05	7.55E+07	yes	5.05E-01	1.51E-02	1.98E+00	6.63E+01	NA	5.00E-03	NA	1.03E-02	NA	3.46E-01	1.03E-02	3.46E-01	8.13E-03	4.86E+02
Methylene chloride	3.00E-04	8.40EE-05	3.63E+08	yes	1.36E-01	1.51E-02	7.38E+00	6.63E+01	4.70E-07	3.00E+00	3.82E-02	2.31E+01	3.43E-01	2.07E+02	3.82E-02	3.43E-01	1.06E-03	1.35E+03
Nitrobenzene	2.38E-04	8.87E-05	1.75E+11	no	2.25E-04	8.41E-05	4.44E+03	1.19E+04	NA	2.00E-03	NA	9.26E+00	NA	2.48E+01	9.26E+00	2.48E+01	8.45E-07	4.77E+04
Styrene	2.25E-04	8.83E-05	6.65E+09	no	5.64E-03	2.21E-03	1.77E+02	4.53E+02	NA	1.00E+00	NA	1.85E+02	NA	4.72E+02	1.85E+02	4.72E+02	1.89E-05	1.01E+04
1,1,2,2-Tetrachloroethane	2.25E-04	8.83E-05	6.39E+09	no	5.86E-03	2.30E-03	1.71E+02	4.36E+02	5.80E-05	NA	7.16E-03	NA	1.83E-02	NA	7.16E-03	1.83E-02	2.34E-05	9.07E+03
Tetrachloroethylene	2.28E-04	8.35E-05	4.76E+08	yes	7.95E-02	1.51E-02	1.26E+01	6.63E+01	5.80E-07	NA	5.28E-02	NA	2.78E-01	NA	5.28E-02	2.78E-01	2.95E-04	2.55E+03
Toluene	2.65E-04	8.53E-05	6.16E+08	yes	7.10E-02	1.51E-02	1.41E+01	6.63E+01	NA	4.00E-01	NA	5.88E+00	NA	2.76E+01	5.88E+00	2.76E+01	2.88E-04	2.59E+03
Toxaphene	9.08E-05	8.65E-05	4.38E+12	no	4.09E-06	3.90E-06	2.44E+05	2.56E+05	3.20E-04	NA	1.86E+00	NA	1.95E+00	NA	1.86E+00	1.95E+00	5.62E-09	5.85E+05
1,2,4-Trichlorobenzene	1.27E-04	8.77E-05	1.49E+10	no	1.49E-03	1.03E-03	6.70E+02	9.71E+02	NA	9.00E-03	NA	6.29E+00	NA	9.11E+00	6.29E+00	9.11E+00	3.72E-06	2.28E+04
1,1,1-Trichloroethane	2.43E-04	7.79E-05	1.83E+08	yes	2.20E-01	1.51E-02	4.54E+00	6.63E+01	NA	1.00E+00	NA	4.74E+00	NA	6.91E+01	4.74E+00	6.91E+01	1.04E-03	1.36E+03
1,1,2-Trichloroethane	2.43E-04	8.76E-05	2.28E+09	no	1.76E-02	6.37E-03	5.67E+01	1.57E+02	1.60E-05	NA	8.62E-03	NA	2.39E-02	NA	8.62E-03	2.39E-02	7.30E-05	5.13E+03
Trichloroethylene	2.45E-04	8.13E-05	2.87E+08	yes	1.41E-01	1.51E-02	7.07E+00	6.63E+01	1.70E-06	NA	1.01E-02	NA	9.49E-02	NA	1.01E-02	9.49E-02	6.27E-04	1.75E+03
2,4,6-Trichlorophenol	1.30E-04	8.82E-05	1.84E+12	no	1.23E-05	8.34E-06	8.13E+04	1.20E+05	3.10E-06	NA	6.38E+01	NA	9.42E+01	NA	6.38E+01	9.42E+01	3.27E-08	2.43E+05
Vinyl acetate	2.60E-04	8.65E-05	9.65E+08	no	4.45E-02	1.48E-02	2.25E+01	6.76E+01	NA	2.00E-01	NA	4.69E+00	NA	1.41E+01	4.69E+00	1.41E+01	6.78E-04	1.68E+03
Vinyl chloride	3.12E-04	6.38E-05	3.89E+07	yes	1.32E+00	1.51E-02	7.59E-01	6.63E+01	8.40E-05	NA	2.20E-05	NA	1.92E-03	NA	2.20E-05	1.92E-03	5.85E-02	1.81E+02

NA = not appilcable
[a] = SSL based on C_{sat}

COMPARISON OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Outdoor SSL, carcinogen (mg/kg)	Outdoor SSL, non-carcinogen (mg/kg)	Risk-based outdoor SSL (mg/kg)	Pure component solubility, S (mg/L)	Soil saturation conc., C_{sat} (mg/kg)	Indoor SSL, infinite source (mg/kg)	Indoor SSL, finite source (mg/kg)	Outdoor SSL, infinite source (mg/kg)
Aldrin	4.89E-01	NA	4.89E-01	7.84E-02	2.28E+01	0.4	0.4	0.5
Benzene	5.33E-01	NA	5.33E-01	1.78E+03	8.61E+02	0.002	0.02	0.5
Bis(2-chloroethyl)ether	2.74E-01	NA	2.74E-01	1.18E+04	6.56E+03	0.02	0.05	0.3
Bromoform	4.29E+01	NA	4.29E+01	3.21E+03	2.76E+03	0.8	0.9	43
Carbon disulfide	NA	1.08E+01	1.08E+01	2.67E+03	1.36E+03	0.03	0.7	11
Carbon tetrachloride	2.26E-01	NA	2.26E-01	7.92E+02	1.04E+03	0.0007	0.01	0.2
Chlordane	5.42E+01	NA	5.42E+01	2.19E-01	6.74E+01	51	53	54
Chlorobenzene	NA	8.66E+01	8.66E+01	4.09E+02	5.55E+02	0.7	2	87
Chloroform	2.04E-01	NA	2.04E-01	7.96E+03	3.71E+03	0.001	0.007	0.2
DDT	7.41E+01	NA	7.41E+01	3.41E-03	4.85E+00	5[a]	5[a]	5[a]
1,2-Dichlorobenzene	NA	1.75E+03	1.75E+03	1.25E+02	2.97E+02	26	65	297[a]
1,4-Dichlorobenzene	NA	6.94E+03	6.94E+03	7.30E+01	2.35E+02	102	235	235[a]
1,1-Dichloroethane	NA	9.39E+02	9.39E+02	5.16E+03	2.36E+03	4	35	939
1,2-Dichloroethane	2.61E-01	NA	2.61E-01	8.31E+03	2.81E+03	0.002	0.007	0.3
1,1-Dichloroethylene	4.36E-02	NA	4.36E-02	3.00E+03	2.04E+03	0.0001	0.003	0.04
1,2-Dichloropropane	NA	9.83E+00	9.83E+00	2.68E+03	1.08E+03	0.06	0.3	10
1,3-Dichloropropene	1.29E-01	4.09E+01	1.29E-01	1.55E+03	4.32E+02	0.0007	0.004	0.1
Dieldrin	1.57E+00	NA	1.57E+00	1.87E-01	1.22E+01	3	4	2
Ethylbenzene	NA	3.33E+03	3.33E+03	1.73E+02	2.57E+02	21	69	257[a]
Heptachlor	3.14E-01	NA	3.14E-01	2.73E-01	1.12E+01	0.04	0.04	0.3
Heptachlor epoxide	1.30E+00	NA	1.30E+00	2.68E-01	1.17E+01	1	1	1
Hexachloro-1,3-butadiene	1.31E+00	NA	1.31E+00	2.54E+00	1.07E+02	0.03	0.05	1
Hexachlorobenzene	9.88E-01	NA	9.88E-01	8.62E-03	1.94E+00	0.3	0.6	1
HCH-alpha(alpha-BHC)	8.51E-01	NA	8.51E-01	2.40E+00	2.56E+01	0.5	0.6	0.9
HCH-beta(beta-BHC)	1.47E+01	NA	1.47E+01	5.42E-01	7.47E+00	7[a]	7[a]	7[a]
Hexachlorocyclopentadiene	NA	2.23E+00	2.23E+00	1.53E+00	8.84E+01	0.06	0.07	2
Hexachloroethane	4.48E+01	NA	4.48E+01	4.08E+01	4.53E+02	0.6	0.6	45
Methyl bromide	NA	2.54E+00	2.54E+00	1.45E+04	3.83E+03	0.01	0.3	3
Methylene chloride	6.97E+00	4.21E+03	6.97E+00	1.74E+04	3.73E+03	0.04	0.3	7
Nitrobenzene	NA	9.95E+01	9.95E+01	1.92E+03	1.70E+03	9	25	100
Styrene	NA	1.05E+04	1.05E+04	2.57E+02	1.44E+03	185	472	1439
1,1,2,2-Tetrachloroethane	3.81E-01	NA	3.81E-01	3.07E+03	1.77E+03	0.007	0.02	0.4
Tetrachloroethylene	1.07E+01	NA	1.07E+01	2.32E+02	4.72E+02	0.05	0.3	11
Toluene	NA	1.08E+03	1.08E+03	5.58E+02	5.21E+02	6	28	521[a]
Toxaphene	4.45E+00	NA	4.45E+00	6.79E-01	2.11E+00	2	2	2[a]
1,2,4-Trichlorobenzene	NA	2.14E+02	2.14E+02	3.07E+01	2.87E+02	6	9	214
1,1,1-Trichloroethane	NA	1.42E+03	1.42E+03	1.17E+03	9.80E+02	5	69	980[a]
1,1,2-Trichloroethane	7.81E-01	NA	7.81E-01	4.40E+03	2.48E+03	0.009	0.02	1
Trichloroethylene	2.51E+00	NA	2.51E+00	1.18E+03	8.80E+02	0.01	0.09	3
2,4,6-Trichlorophenol	1.90E+02	NA	1.90E+02	7.53E+02	1.35E+03	64	94	190
Vinyl acetate	NA	3.51E+02	3.51E+02	2.24E+04	3.01E+03	5	14	351
Vinyl chloride	5.25E-03	NA	5.25E-03	2.73E+03	2.26E+03	0.00002	0.002	0.01

NA = not appilcable

[a] = SSL based on C_{sat}