

**Empirical VI Database
Background Indoor Air Review
Updated J&E Spreadsheet Model**

**Some New Tools for
Vapor Intrusion Assessment**

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**Modified and Presented by William E. Wertz, Ph.D
NYSDEC, Albany, NY**

EPA's Technical Update Papers

Technical Updates to 2002 EPA Draft Vapor Intrusion Guidance

[Lilian Abreu](#)

Conceptual Site Model - update and expanded

[Helen Dawson](#)

- **Database** of vapor intrusion observations
- **Background** levels of contaminant in indoor air
- **Johnson & Ettinger Model** - improvements in inputs

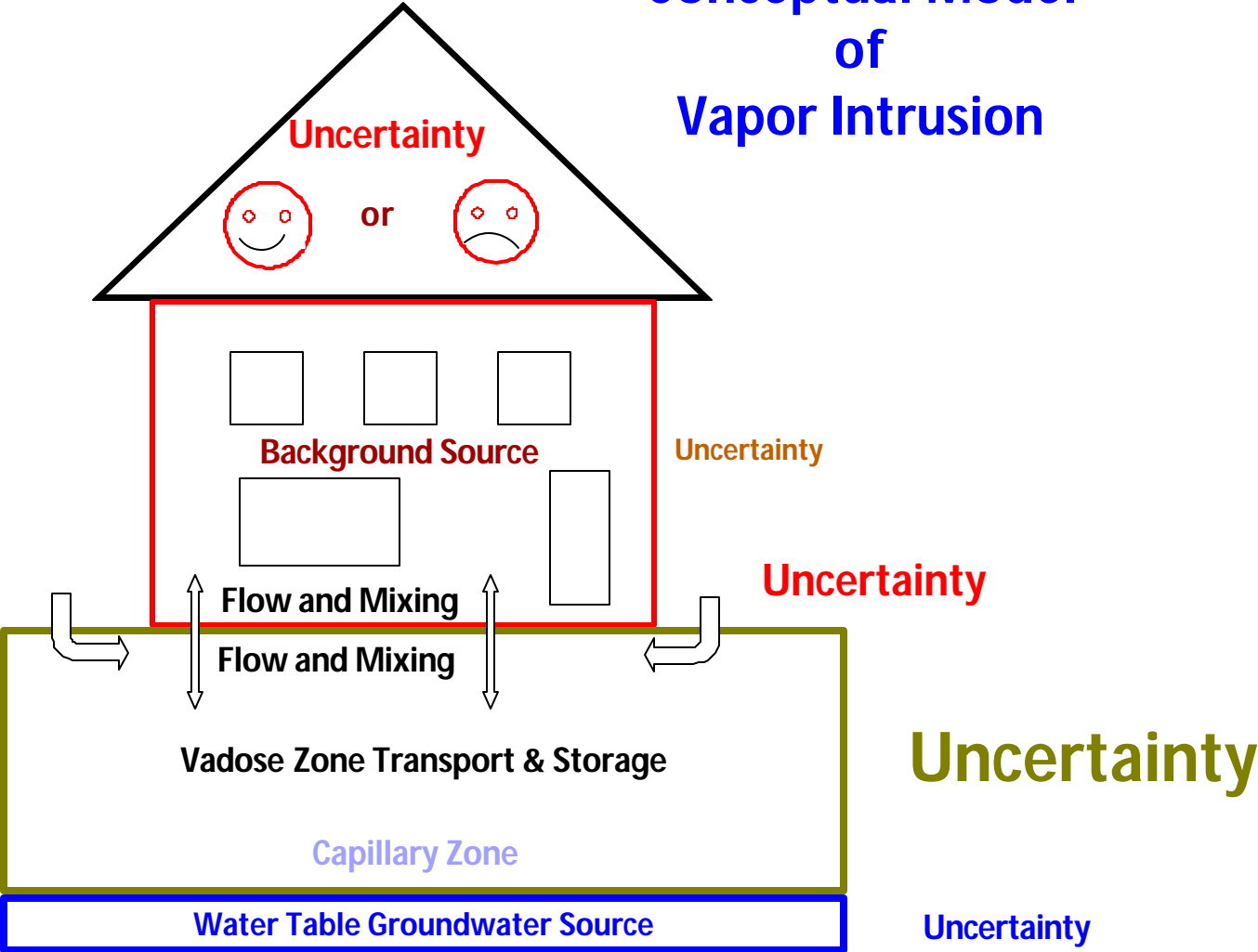
With Support From The EPA VI Workgroup

Disclaimer

Presented by William Wertz at the request of Helen Dawson

**Does not represent the official policy of either
the USEPA or the NYSDEC**

Conceptual Model of Vapor Intrusion



**The New Tools Help Provide Insight
Into The Expected Range of Outcomes
i.e. Am I In The Right Ballpark ?**

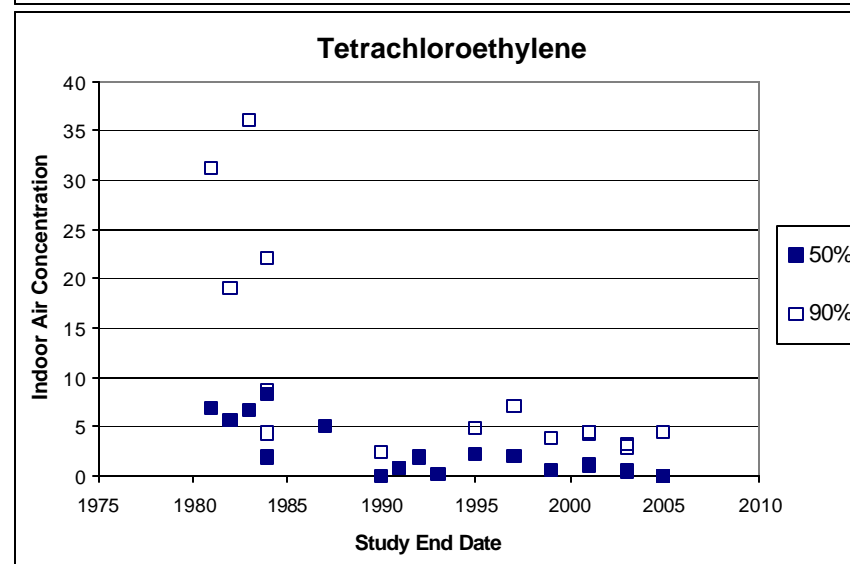
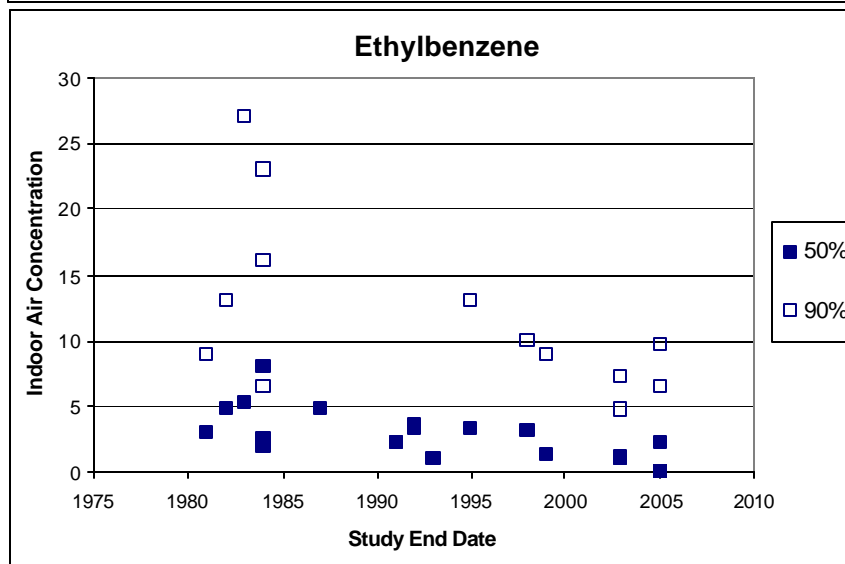
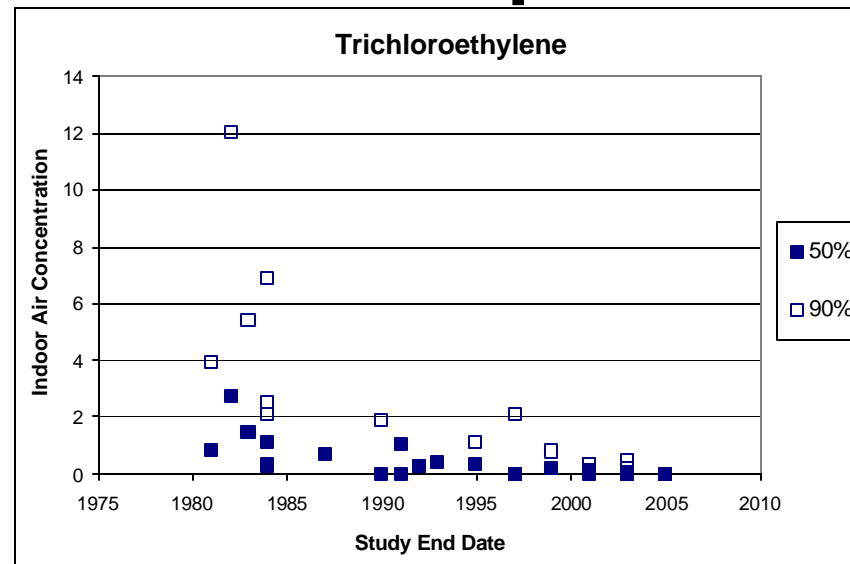
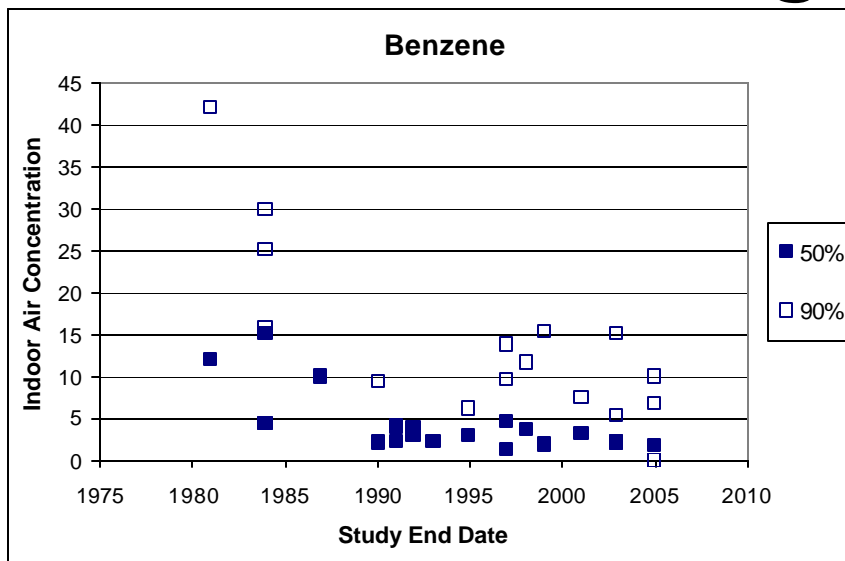
Background Sources

- Consumer products
 - Cleaners, air fresheners, aerosols, mothballs, scented candles, insect repellants
- Building materials
 - Carpets, insulation, paint, wood finishing products
- Combustion processes
 - Smoking, cooking, home heating
- Occupant activities
 - Craft hobbies

Literature Review

- Studies compiled: 18 indoor air quality studies
- Sample dates: range from 1970 – 2005
- Sample sizes: range from 9 – 2128
- Collection devices: Summa canister & multi-sorbent samplers
- Collection periods: 2 hours – 6 days
- Analytical methods: EPA TO-14/14; GC/MS
- Data compiled: order statistics (percentiles)

Background vs Sample Date

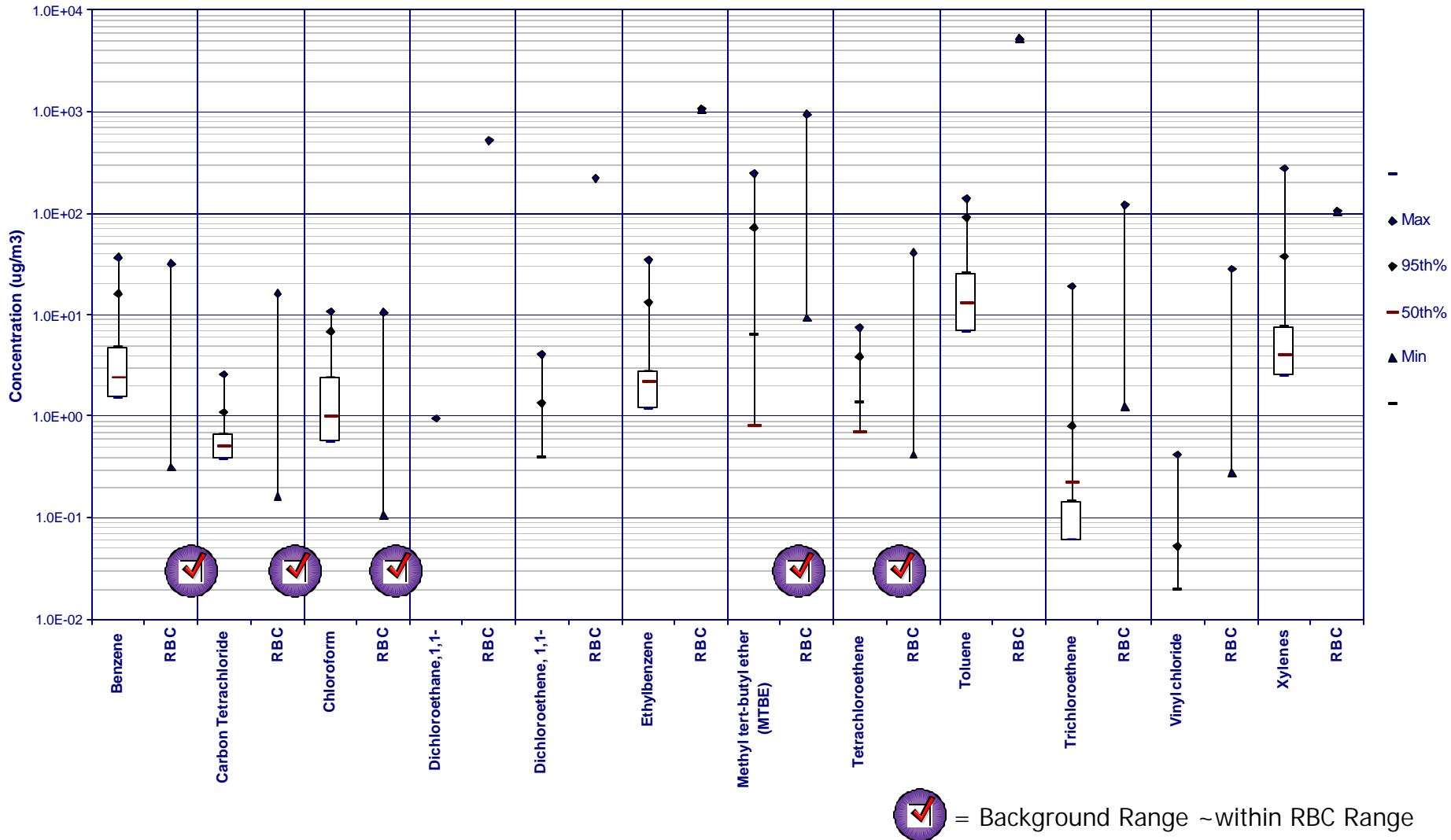


1990 "Cutoff Date"

Summary Table

Compound	N Studies	N Samples	%Detect	RL Range	25%	N	50%	N	75%	N	90%	N	95%	N	Max	N
Benzene	14	2615	87	0.05 - 1.6	1.9	7	2.5	13	4.5	9	10	11	17	5	93	10
Carbon Tetrachloride	5	873	88	0.15 - 0.25	0.3	2	0.5	5	0.7	2	0.8	4	1.1	1	2.7	3
Chloroform	10	2178	73	0.02 - 2.4	0.5	4	1.1	9	2.2	6	3.9	8	6.0	5	20.2	7
Dichloroethane,1,1-	5	1309	0.3	0.08 - 2.0	<RL	5	<RL	5	<RL	5	<RL	5	<RL	4	0.9	5
Dichloroethene, 1,1-	5	957	10	0.01 - 2.0	<RL	4	<RL	5	<RL	5	<RL	5	<RL	3	86.8	5
Dichloroethene, cis 1,2-	4	975	3	0.25 - 2.0	<RL	4	<RL	4	<RL	4	<RL	4	<RL	3	3.7	4
Dichloroethene, trans 1,2-	3	575	0	0.8 - 2.0	<RL	3	<RL	3	<RL	3	<RL	3	<RL	2	<RL	3
Ethylbenzene	10	1484	81	0.01 - 2.2	0.8	4	2.0	9	3.0	5	8.6	7	14	3	126	8
Methyl tert-butyl ether (MTBE)	4	502	47	0.05 - 1.8	<RL	3	1.2	4	5.7	4	26	4	72	2	242	4
Methylene chloride	7	1,649	73	0.4 - 3.5	0.42	3	1.10	7	3.6	5	10	7	20	4	506	6
Tetrachloroethene	13	2312	64	0.03 - 3.4	<RL	7	0.9	10	1.8	6	4.0	9	7.4	5	171.2	8
Toluene	12	2065	96	0.03 - 1.9	9	5	13	12	27	7	51	9	106	4	547	9
Trichloro-1,2,2-trifluoroethane, 1,1.	1	400	56	0.25	<RL	1	0.5	1	1.1	1	1.8	1	3.4	1	7	1
Trichloroethane, 1,1,1-	9	1877	60	0.12 - 2.7	0.5	7	1.9	9	2.7	7	5.5	7	10.2	5	196	8
Trichloroethene	13	2403	44	0.02 - 2.7	<RL		0.3	10	0.3	6	0.9	8	1.6	5	84	10
Vinyl chloride	6	1684	7	0.01 - 1.3	<RL	6	<RL	6	<RL	6	0.03	2	0.05	2	0.8	6
Xylene, m/p-	10	1920	90	0.4 - 2.2	2.9	6	5.5	10	9.4	7	27	9	41	4	593	8
Xylene, o-	12	2004	85	0.11 - 2.2	1.4	6	2.2	11	3.9	7	10	9	16	4	196	10

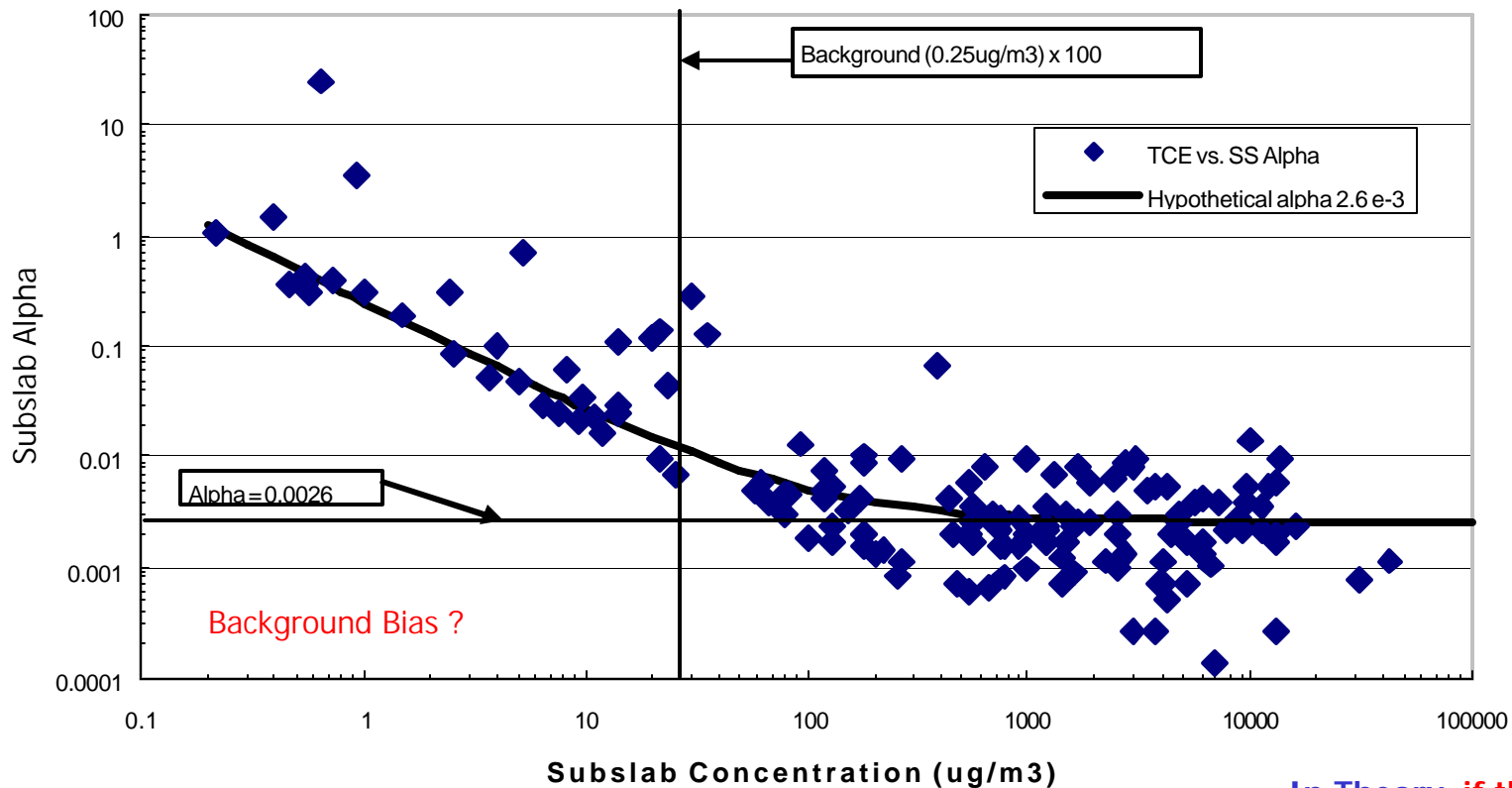
Background Indoor Air Concentrations vs Risk Based Concentrations (RBCs)



Why Is Knowledge of Background Data Important?

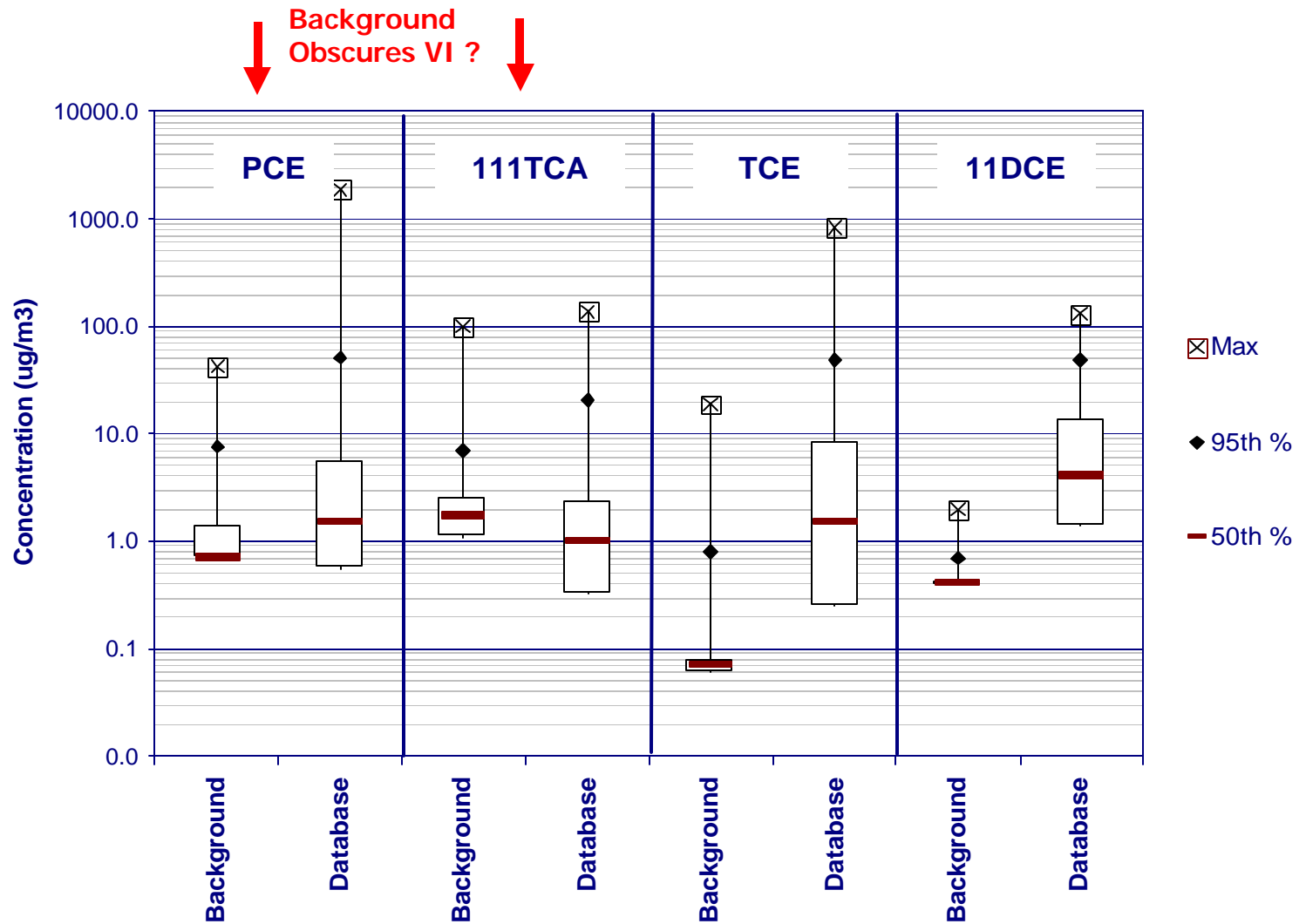
Influence of Background Concentrations on Observed Alphas

TCE Subslab Concentration vs. Alpha Endicott NY



In Theory, if there were no background sources, the Alpha Should be Independent of the Source Concentration

Background Indoor Air Concentrations vs Indoor Air Concentrations at Vapor Intrusion Sites



Lets Look at The USEPA Database and
A Site Example From
New York

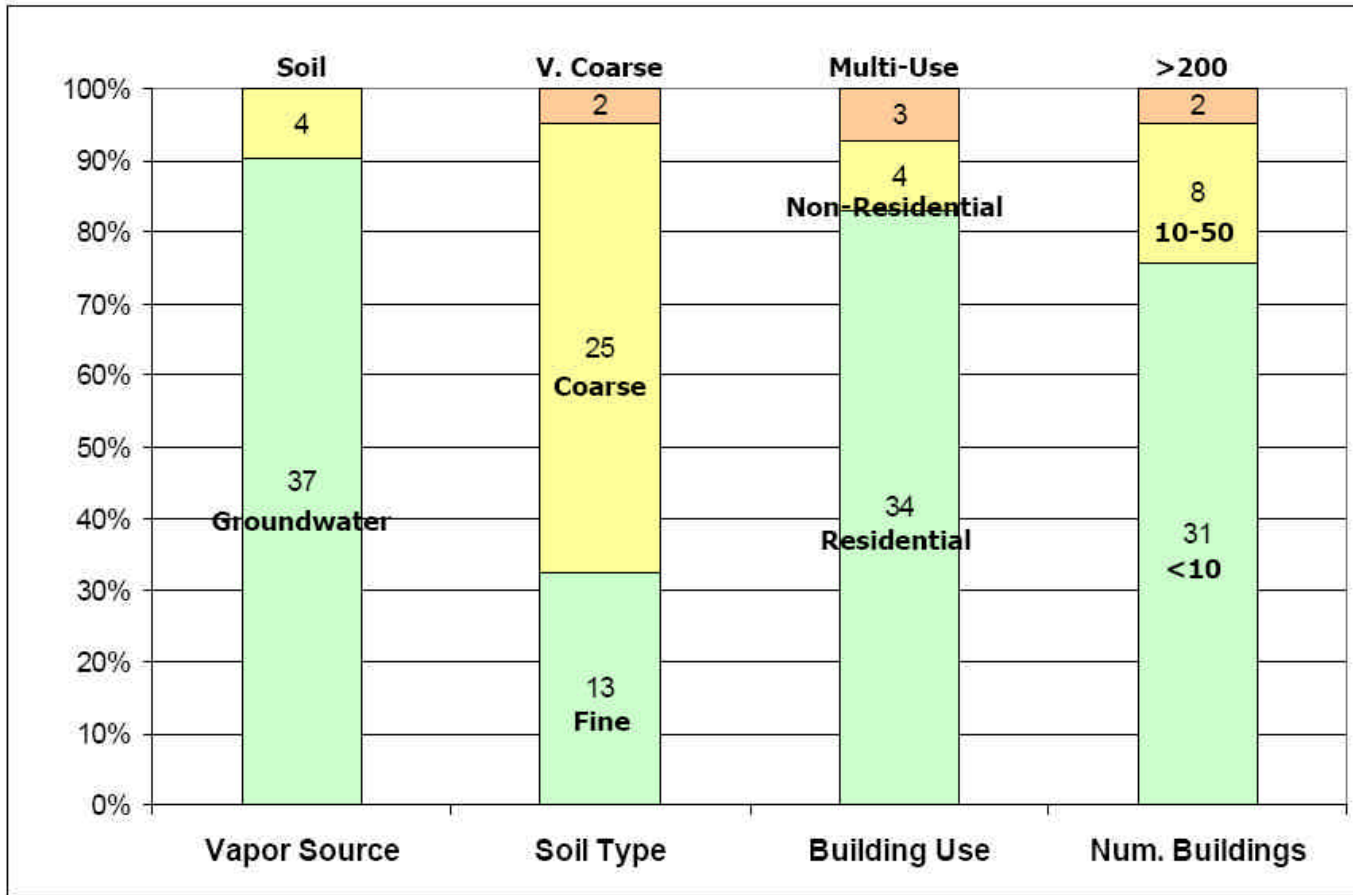


What is in the 2008 VI database?

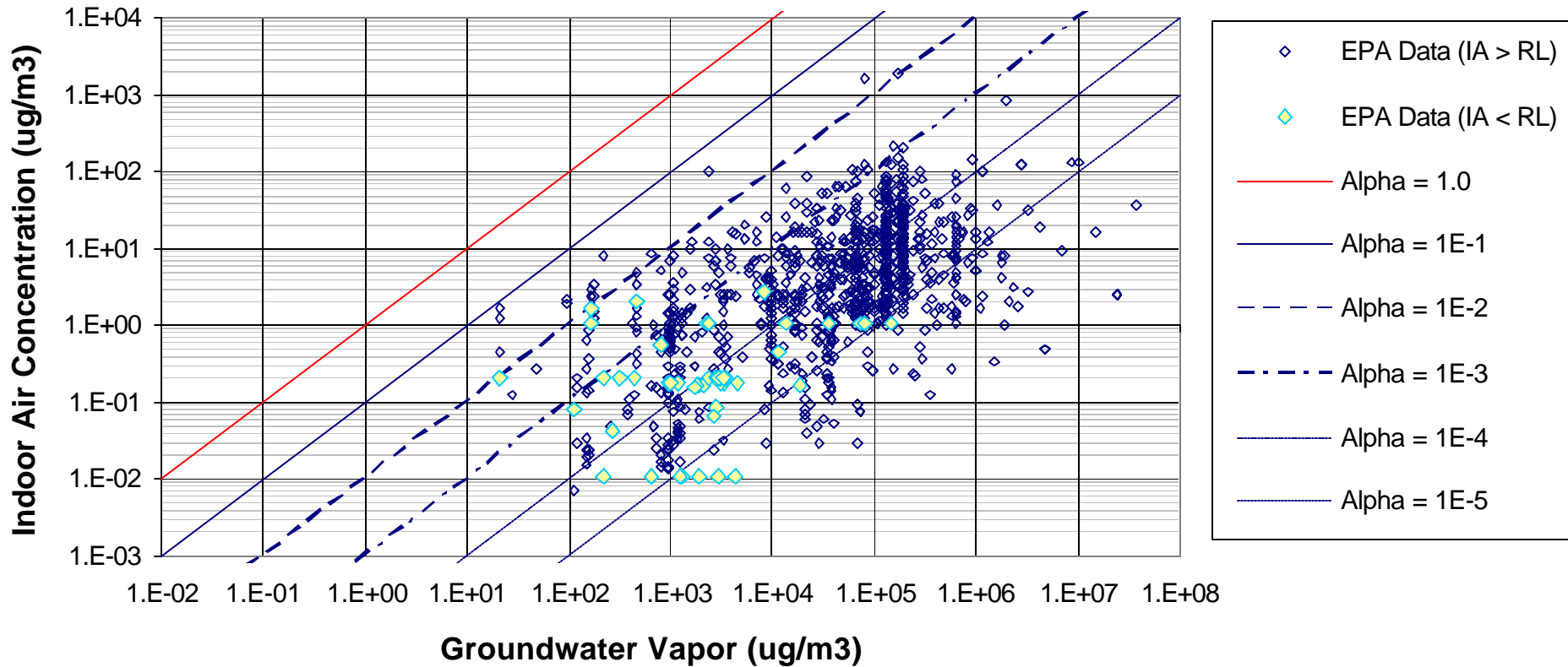
- 15 States <http://iavi.rti.org/login.cfm?pageID=login>
- 41 Sites
- 21 Chemicals
 - 97% chlorinated hydrocarbons
 - 3% petroleum hydrocarbons
- 913 Buildings
 - 85% residential
 - 10% institutional or commercial
 - 5% multi-use (residential and non-residential)
- 2989 Paired indoor air and subsurface concentration measurements
 - 35% paired groundwater and indoor air measurements
 - 8% paired soil gas and indoor air measurements
 - 53% paired subslab and indoor air measurements
 - 4% paired crawlspace and indoor air measurements



Summary of Compiled Data



Summary Plots

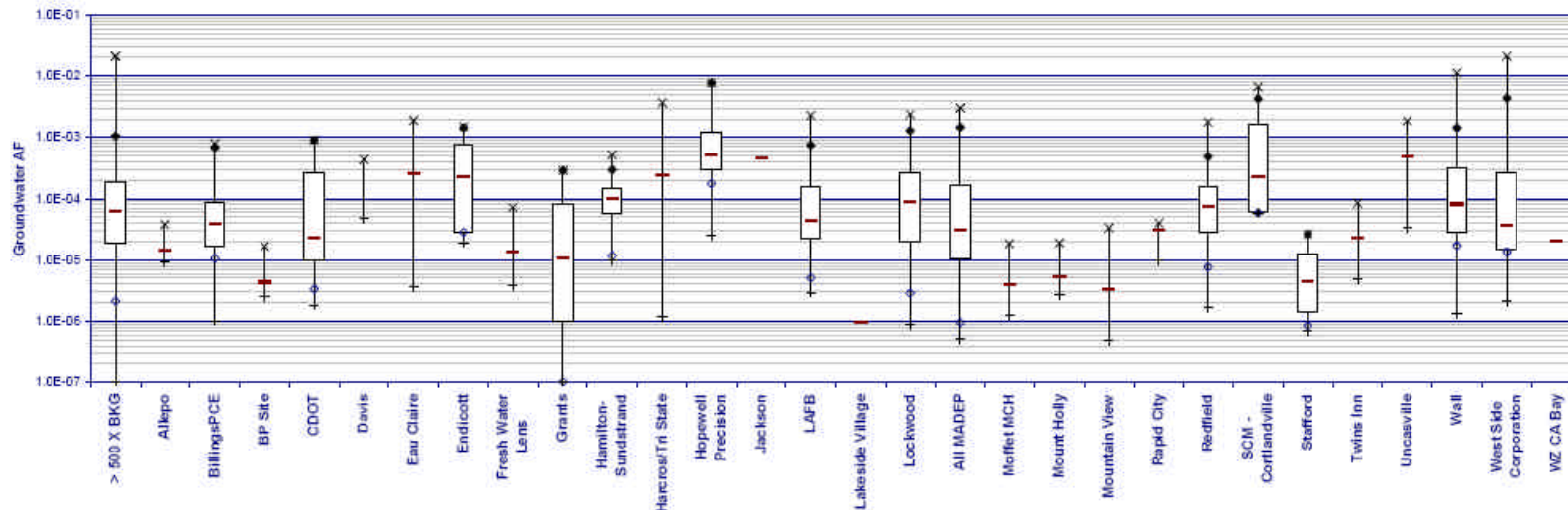


Note: ~3 Orders of Magnitude IA /Groundwater Vapor Concentrations

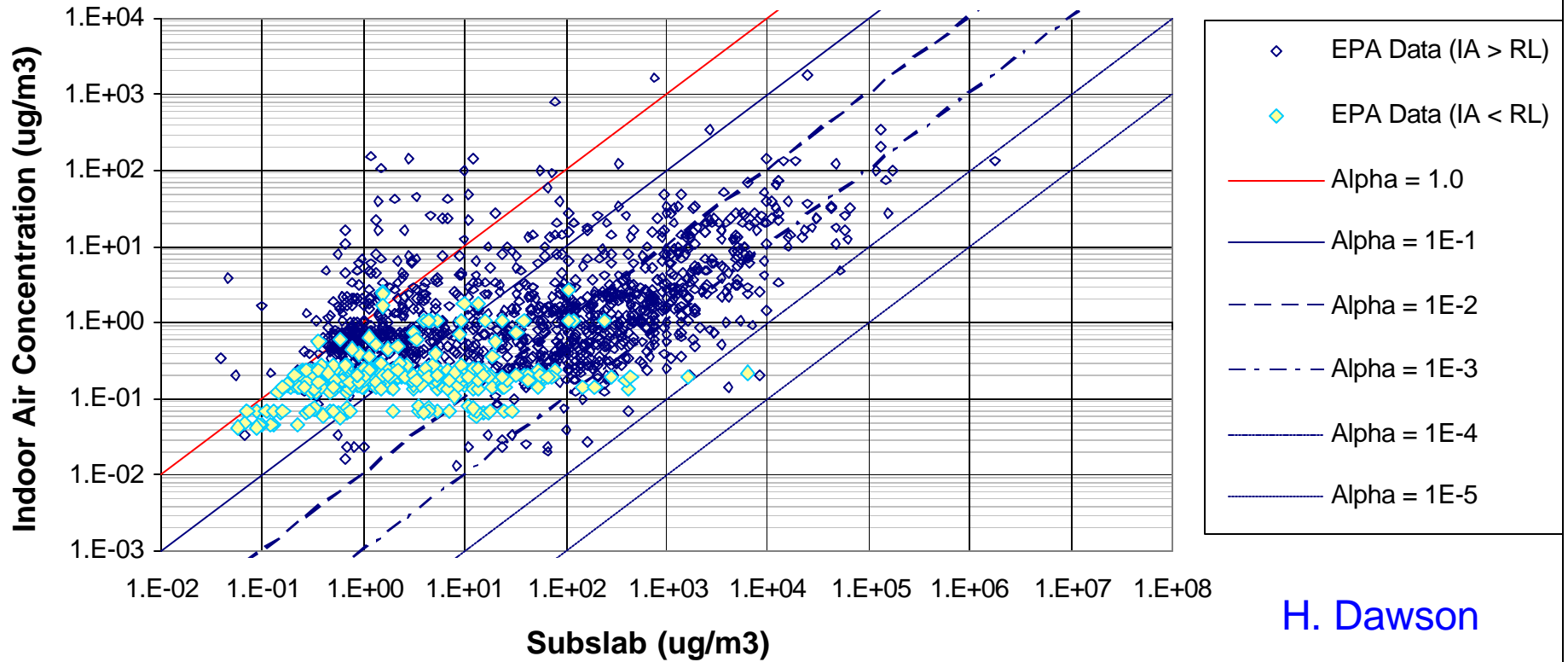


Groundwater-to-Indoor Air Attenuation Individual Site Box Whisker Plots

Groundwater AF for Individual Sites



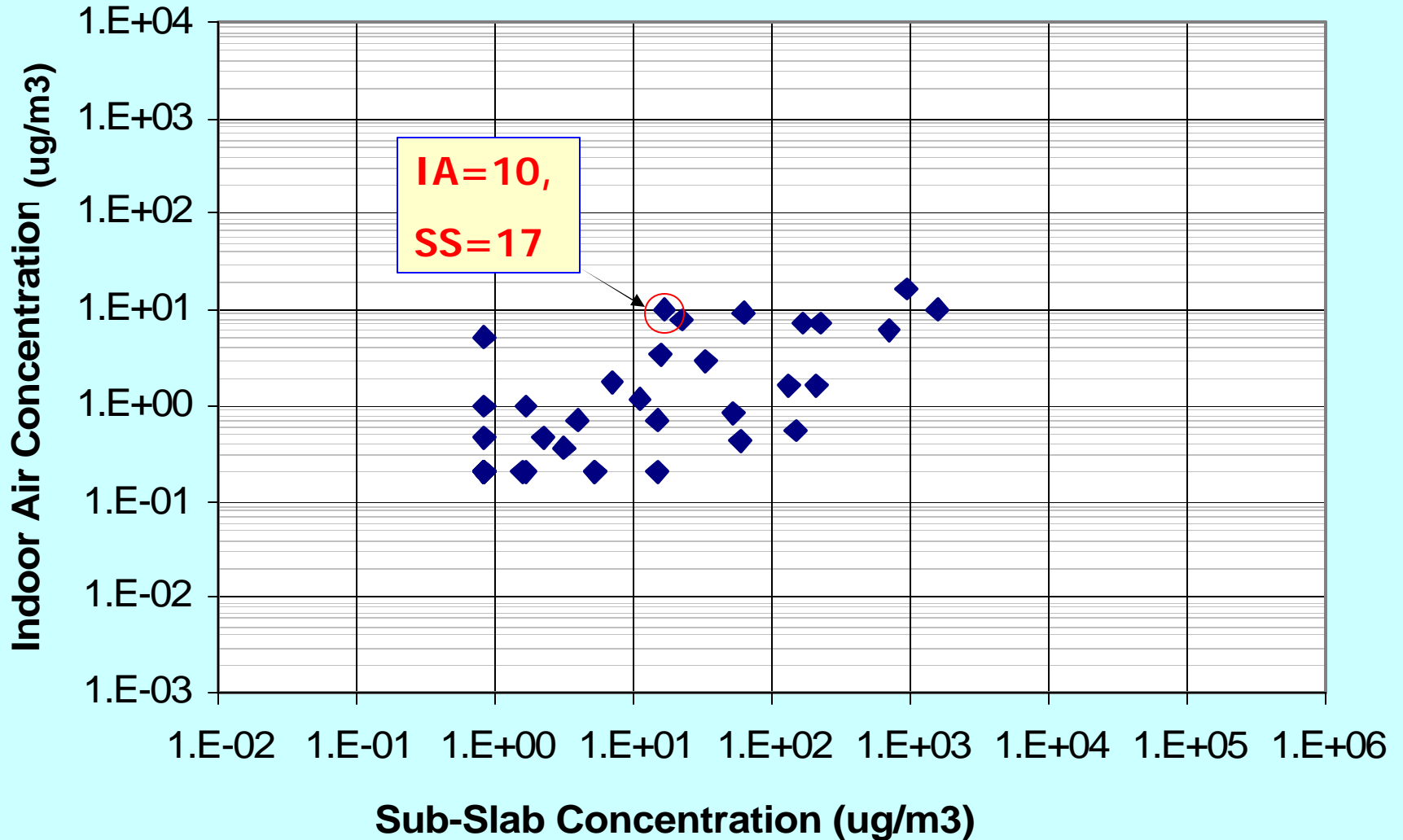
Summary Plots



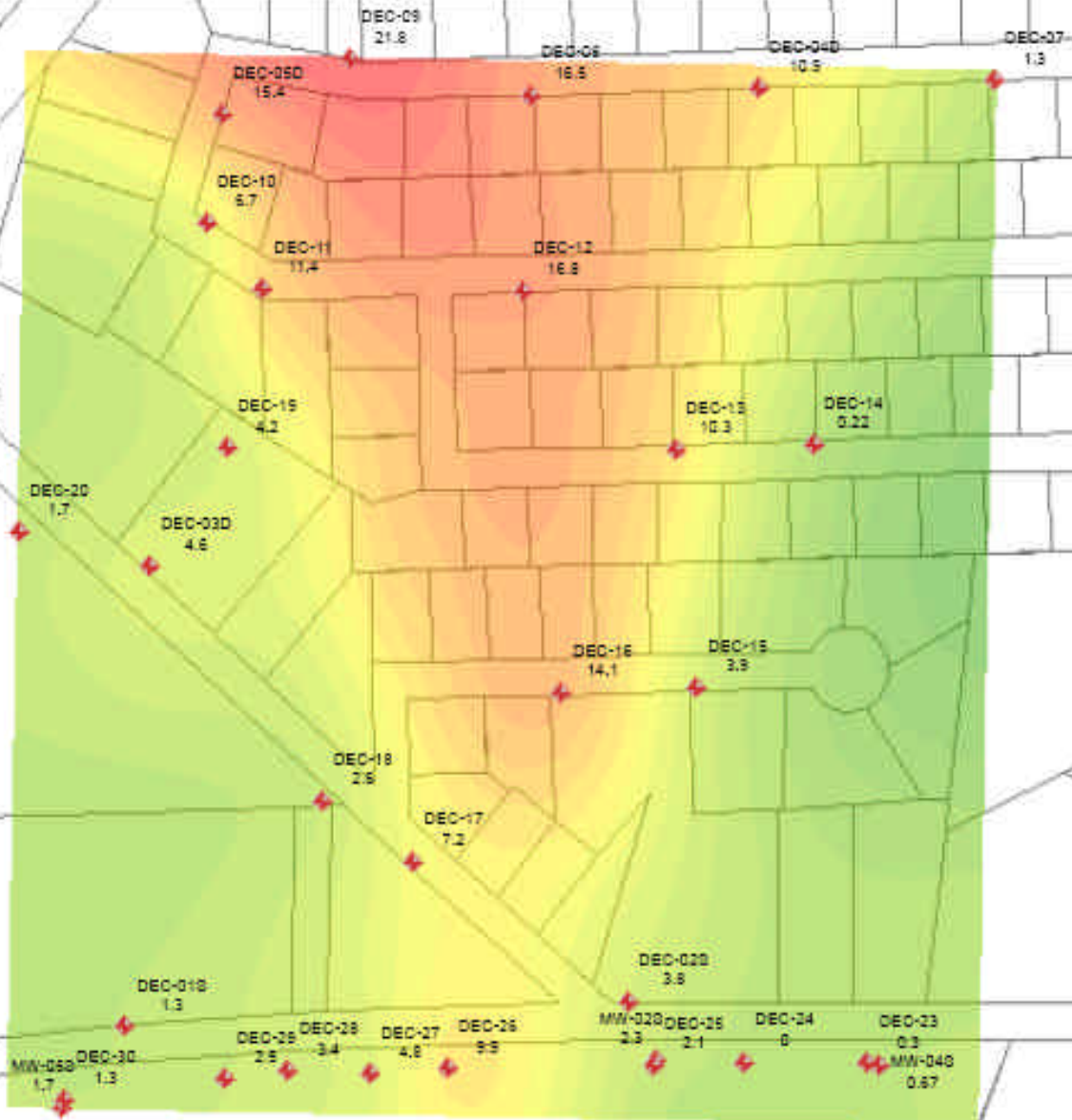
Note: ~3 Orders of Magnitude IA /Subslab Vapor Concentrations

Indoor Air vs Sub-Slab Concentration

Cortlandville



TCE GROUNDWATER CONCENTRATIONS



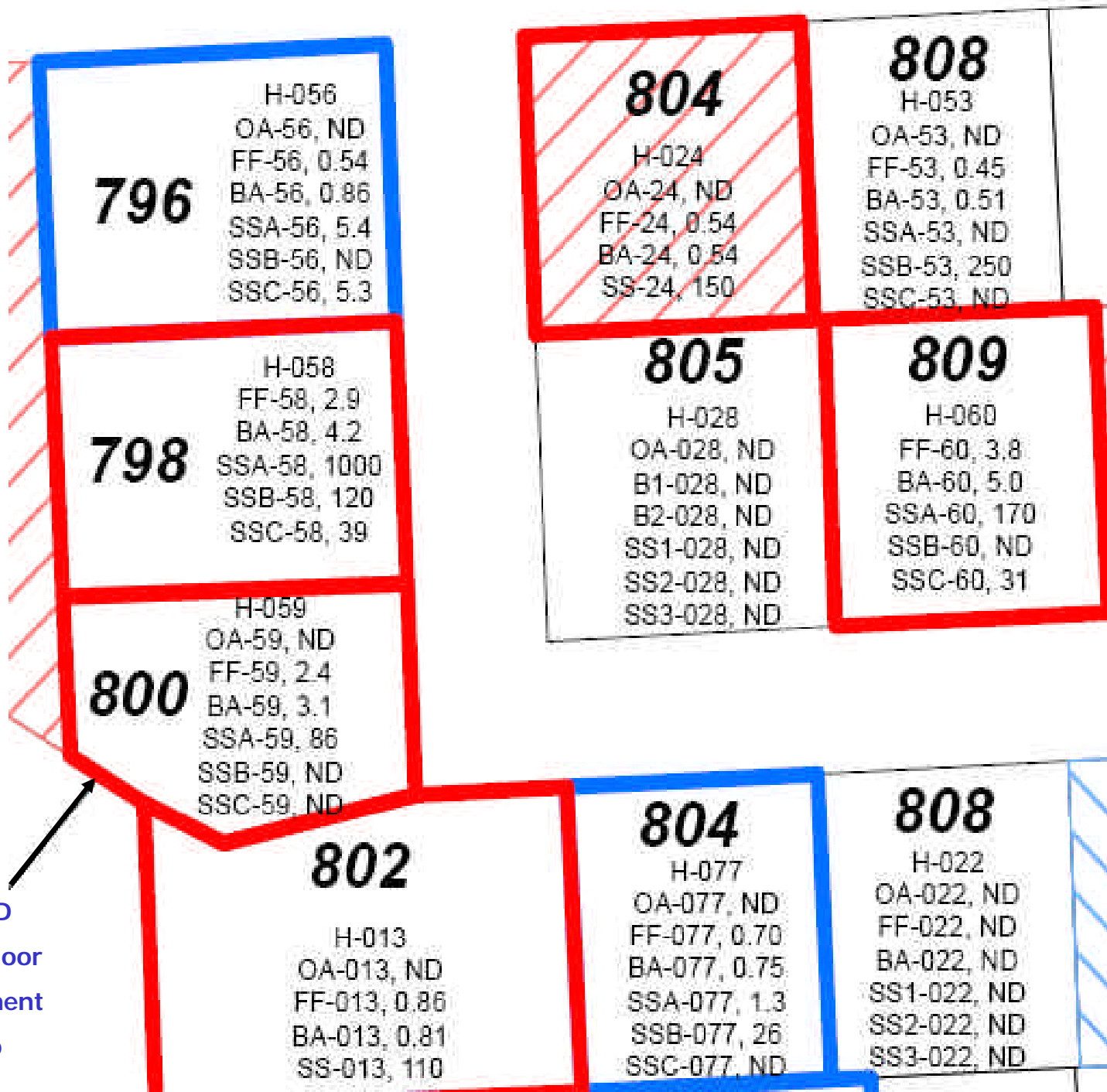
Map Details

Created in ArcGIS 9.2

Created by: [Name]

WALTON COUNTY, GEORGIA
 VIA DIVISION OF ENVIRONMENTAL
 QUALITY CONTROL, STATE OF





796

H-056
 OA-56, ND
 FF-56, 0.54
 BA-56, 0.86
 SSA-56, 5.4
 SSB-56, ND
 SSC-56, 5.3

798

H-058
 FF-58, 2.9
 BA-58, 4.2
 SSA-58, 1000
 SSB-58, 120
 SSC-58, 39

800

H-059
 OA-59, ND
 FF-59, 2.4
 BA-59, 3.1
 SSA-59, 86
 SSB-59, ND
 SSC-59, ND

802

H-013
 OA-013, ND
 FF-013, 0.86
 BA-013, 0.81
 SS-013, 110

804

H-024
 OA-24, ND
 FF-24, 0.54
 BA-24, 0.54
 SS-24, 150

805

H-028
 OA-028, ND
 B1-028, ND
 B2-028, ND
 SS1-028, ND
 SS2-028, ND
 SS3-028, ND

804

H-077
 OA-077, ND
 FF-077, 0.70
 BA-077, 0.75
 SSA-077, 1.3
 SSB-077, 26
 SSC-077, ND

808

H-053
 OA-53, ND
 FF-53, 0.45
 BA-53, 0.51
 SSA-53, ND
 SSB-53, 250
 SSC-53, ND

809

H-060
 FF-60, 3.8
 BA-60, 5.0
 SSA-60, 170
 SSB-60, ND
 SSC-60, 31

808

H-022
 OA-022, ND
 FF-022, ND
 BA-022, ND
 SS1-022, ND
 SS2-022, ND
 SS3-022, ND

H = House ID
 FF = First Floor
 BA = Basement
 SS = Subslab

SERUTAN

What is The Alpha ?

Subslab ∞

$$4.2 / 1000 = .0042$$

$$4.2 / 120 = .035$$

$$4.2 / 39 = 0.11$$

4.2

120

1000

39

Variable Sub-Slab VOC Concentrations

J&E Spreadsheet

Are We in The Same Ballpark ?

J&E Spreadsheet

Parameter	Units	Symbol	Value	Default	Flag
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Source Characteristics:

Source medium		Source	Groundwater		
Soil vapor concentration	(ug/m3)	Cmedium	15		
Depth below grade to soil gas sample	(m)	Ls	2.50		
Average vadose zone temperature	(°C)	Ts	11	15	
Calc: Source vapor concentration	(ug/m3)	Cs	3		

Chemical:

Chemical Name		Chem	Trichloroethylene		
CAS No.		CAS	79016		

Toxicity Factors

Unit risk factor	(ug/m ³) ⁻¹	URF	1.10E-04	1.10E-04	
Reference concentration	(ug/m ³)	RfC	4.00E+01	4.00E+01	

Building Characteristics:

Building setting		Bldg_Setting	Residential	Residential	
Foundation type		Found_Type	Basement w/ slab	1.500	
Depth below grade to base of foundation	(m)	Lb	1.50	2.00	
Foundation thickness	(m)	Lf	0.10	0.10	
Fraction of foundation area with cracks	(-)	eta	1.00E-03	1.00E-03	
Enclosed space floor area	(m2)	Ab	150	150	
Enclosed space mixing height	(m)	Hb	3.66	3.66	
Indoor air exchange rate	(1/hr)	ach	0.50	0.50	
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.020	0.020	
Calc: Building ventilation rate	(m3/hr)	Qb	274.50	274.50	
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	5.49	5.49	

Source to Indoor Air Attenuation Factor

Ground water to indoor air attenuation coefficient	(-)	alpha	7.07E-04	8.62E-04	
Predicted Indoor Air Concentration					
Indoor air concentration due to vapor intrusion	(ug/m3)	Cia	2.30E+00	2.80E+00	

Summary

- Background indoor air concentrations of some chemicals exceed RBC ($1E-06$) (e.g., benzene, carbon tetrachloride, chloroform, MTBE, PCE).
- Concentrations of some chemicals at vapor intrusion sites fall within the range of background indoor air concentrations (e.g., PCE, 111TCA).
- The Updated EPA J & E Spreadsheet will be a useful tool for “ballparking” your site.
- Think in terms of ranges not points.