



EPA Update on Vapor Intrusion

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Vapor Intrusion Workshop – September 2008

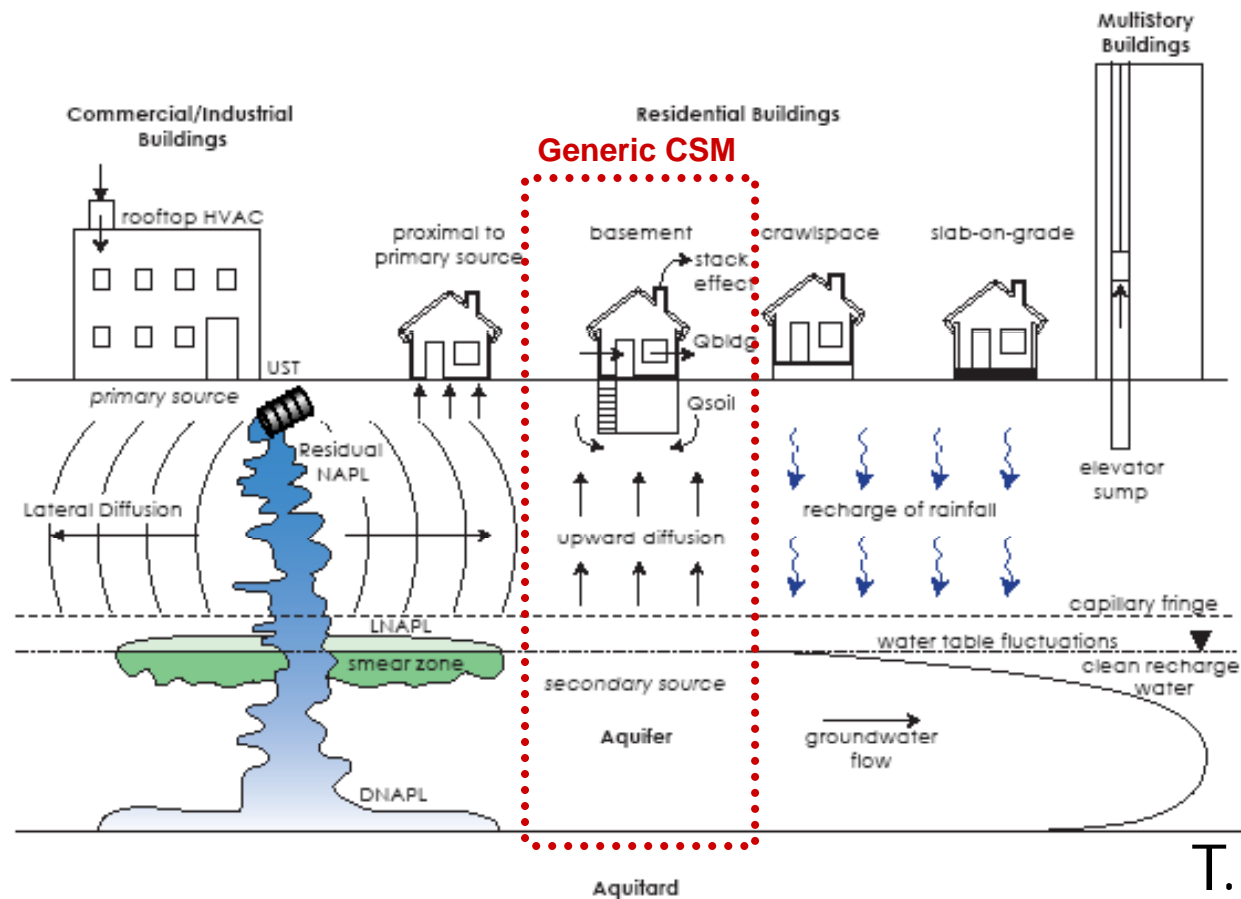


Presentation Outline

- Update on EPA VI Guidance
 - Background (Nov. 2002, Draft VI Guidance)
 - Current (2008) Status
- Update on EPA VI Database
 - Changes in database from 2002 to 2008
 - Database contents
 - Uses of the database



Vapor Intrusion Pathway Potential Scenarios



T. McAlary



EPA VI Guidance Background

- EPA VI Guidance (Nov. 2002)
Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. Washington, D.C.: Office of Solid Waste and Emergency Response.
(www.epa.gov/correctiveaction/eis/vapor/complete.pdf)
 - Tiered approach
 - EPA VI Database (Appendix F of 2002 VI Guidance)
 - JE Model (2003)



EPA VI Guidance Background

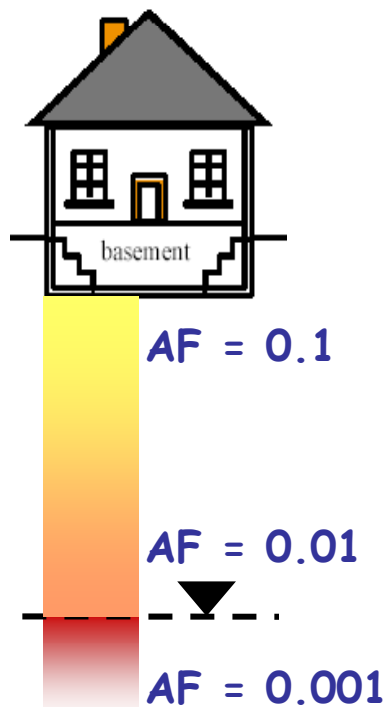
Tiered Approach

- Tiered approach to screening sites & buildings
 - Groundwater → Soil Gas → Subslab → Indoor Air
 - **1 - Primary (Q1, Q2, Q3):**
 - Identify potential for indoor air concerns and screen for obvious problems
 - **2 - Secondary (Q4, Q5):**
 - Compare subsurface data to generic and semi-site specific screening levels
 - Generic screening levels based on limited data set of empirical attenuation factors
 - Semi-site specific screening levels derived from JE model attenuation factors
 - **3 - Site-Specific Pathway Assessment (Q6):**
 - Site-specific modeling to identify “most-likely-to-be-impacted”
 - Building air measurements (sub-slab, crawlspace, indoor)



EPA VI Guidance Background

Generic Soil Gas & Groundwater Screening Levels



- Select indoor air target screening level
- Apply generic attenuation factors:
 - Shallow soil gas (and subslab) screening level is 10 times indoor air target screening level. $AF = 0.1$
 - Deep soil gas screening level is 100 times indoor air target level. $AF = 0.01$
 - Groundwater screening level is the aqueous concentration corresponding to a soil gas concentration 1000 times greater than the indoor air target level. $AF = 0.001$

Generic attenuation factors (AF) based on limited vapor intrusion data



2008 Perspective on EPA's 2002 VI Guidance

Outdated:

- Framework for screening out sites
 - 2002: Sequential use of single media/lines of evidence
 - 2008: Multiple lines of evidence (ITRC, 2007)

- Generic screening levels for subslab & soil gas
 - 2002: Subslab attenuation factor = 0.1; 2008?
 - 2002: Soil gas attenuation factor = 0.01; 2008?



2008 Perspective on EPA's 2002 Guidance (cont.)

Still Useful:

- Approaches for individual media (each line of evidence)
- Groundwater generic attenuation factor
 - 2002 generic value 0.001
 - 2008: 0.001 captures majority of observed data (US EPA VI Database 2008)
- Subslab generic attenuation factor
 - 2002 generic value 0.1
 - 2008: 0.1 captures majority of observed data (US EPA VI Database 2008)



EPA VI Guidance Current (2008) Status

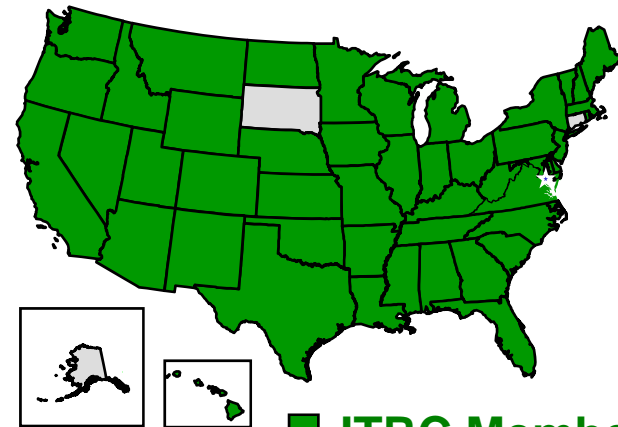
- Endorse multiple lines of evidence" approach:
 - E.g., ITRC. January 2007. Vapor Intrusion Pathway: A Practical Guide (http://www.itrcweb.org/gd_VI.asp)
 - Provides flexible framework for assessing VI pathway
 - Describes a variety of available tools



Interstate Technology & Regulatory Council

Latest Vapor Intrusion Guidance:

- ITRC. January 2007. *Vapor Intrusion Pathway: A Practical Guide*
- http://www.itrcweb.org/gd_VI.asp
- flexible framework
- variety of tools
- multiple-lines of evidence



■ ITRC Member State

Host Organization



Federal Partners



DOE



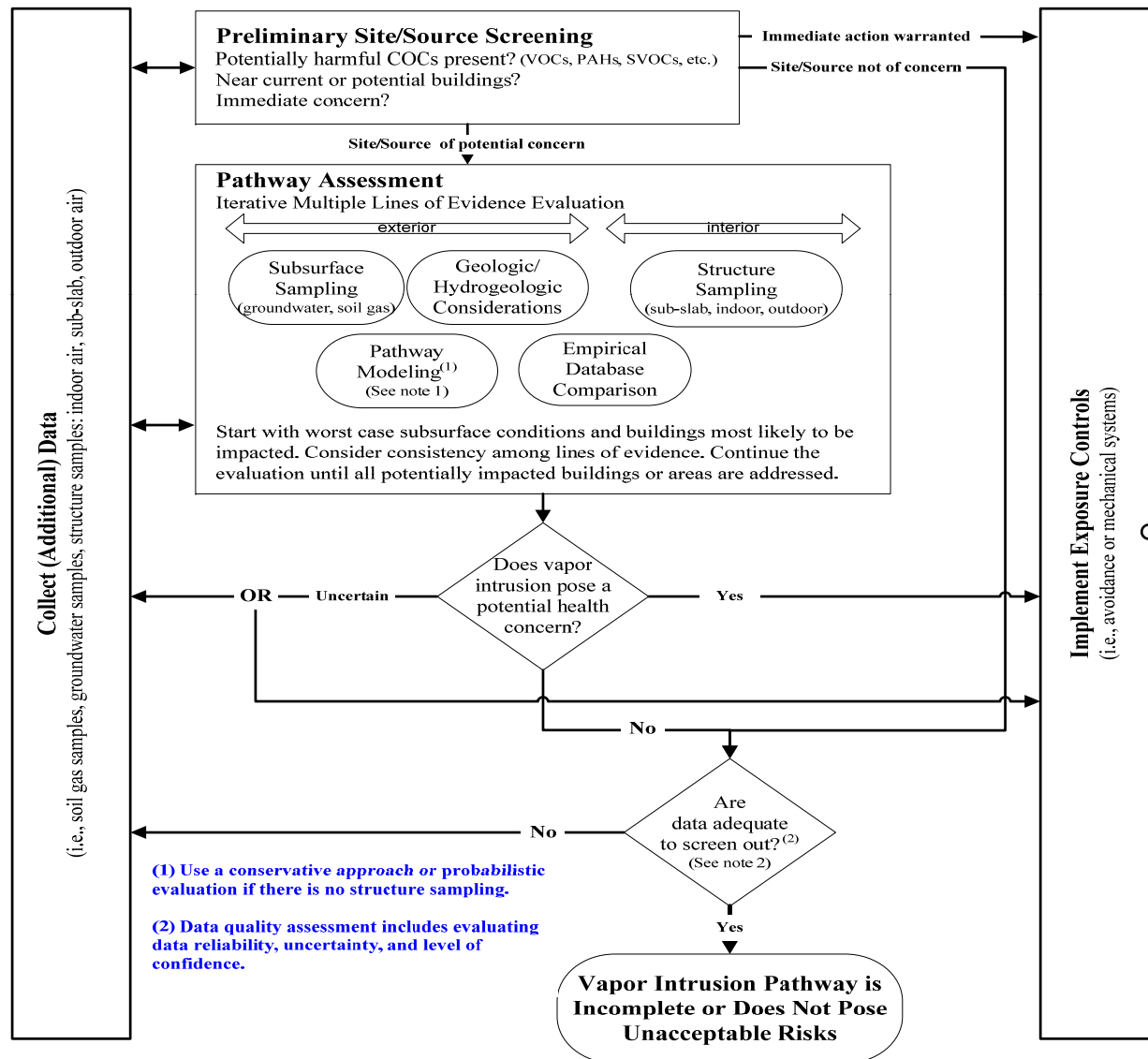
DOD



EPA



Multiple Lines of Evidence Investigative Approach



Mitigation can take place anytime



Why is a multiple lines of evidence approach needed?

- Spatial (and temporal) variability

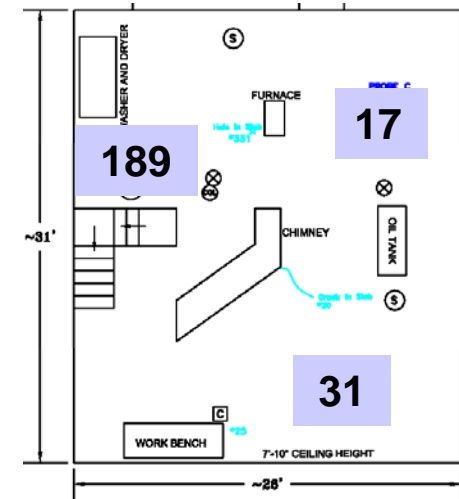
Groundwater (1,1-DCE ug/L)



Indoor Air (1,1-DCE ug/m³)



Sub-Slab (TCE ug/m³)





EPA VI Guidance Current (2008) Status, cont'd

- Provide supplemental technical information
 - Database of vapor intrusion observations
 - Background levels of contaminant in indoor air
 - Conceptual Site Model - updated and expanded
 - Johnson & Ettinger Model - improvements in inputs



Vapor Intrusion Database

- Database and technical document
 - Indoor air concentrations paired with concentrations in:
 - Groundwater
 - Soil gas (exterior to bldg)
 - Subslab
 - Crawlspace
 - Draft version Currently available for review <http://iavi.rti.org> (register for access to database, and click on "Other Documents" for the "Preliminary Evaluation of Attenuation Factors")
 - Final version in late 08/early 09



Background Indoor Air Concentrations

- Compilation of background indoor air concentration studies in North American residences
 - Compiles recent data: 1990 – 2005
 - Provides statistical distribution of concentrations

- Draft version available for review late 08
- Final version available 2009



Conceptual Site Model

- Theoretical overview of vapor intrusion processes
 - 3D model scenarios
 - Factors affecting vapor migration
 - Sources of temporal and spatial variability
 - Influence of building on subsurface concentrations

- Draft version available for review late 08
- Final version available 2009



J&E Model Update

- Technical update will provide improved model spreadsheets
 - More accurate ranges for inputs
 - Ensures compatibility of inputs

- Draft version late 2008
- Final version first half of 2009



Non-Residential Settings

- US EPA Nov. 2002 Draft VI Guidance:
 - OSHA standards apply in workplaces where workers are handling hazardous chemicals (e.g., manufacturing facilities) similar to or different from those in subsurface contamination, as well as other workplaces, such as administrative and other office buildings where chemicals are not routinely handled in daily activities.
 - However, the guidance recommends that regional or State authorities notify a facility of the potential for the vapor intrusion pathway to cause a hazard and suggest that they consider any potential risk that may result.

- Many state agencies:
 - Require that occupational exposure be based on risk-based screening values and not OSHA standards when workplace-related vapors are not expected because the hazardous vapor-forming chemicals are not being used in the building being investigated.



Update on EPA's Vapor Intrusion Database

- 2002: US EPA draft vapor intrusion guidance released
 - Key feature of guidance – generic attenuation values (Tier 2 screening of concentrations in subsurface media) based on statistical analysis of a limited number of observations from a few sites (U.S. EPA, 2002, Appendix F).
- 2003
 - EPA met with a team of consultants and state regulators to lay out content, design, and quality assurance requirements for an expanded database
- 2004 - 2006
 - EPA held a series of national workshops to provide a forum to share data and experiences from a variety of vapor intrusion sites.
 - Data also gathered from state regulators and EPA's Regional offices.



Acknowledgments

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Changes in database from 2002 to 2008

Attenuation Factor Type	Sites		Buildings		Attenuation Factors	
	2002	2008	2002	2008	2002	2008
groundwater to indoor air	15	36	73	658	266	1,058
soil gas to indoor air	4	17	8	130	16	237
subslab to indoor air	1	15	9	424	86	1,584
crawlspace to indoor air	1	4	4	11	40	110
Total^a	15	41	73	913	408	2,989

^aTotal numbers of sites and buildings in the database are less than the totals of individual attenuation factor types because some sites and buildings have more than one type of attenuation factor.

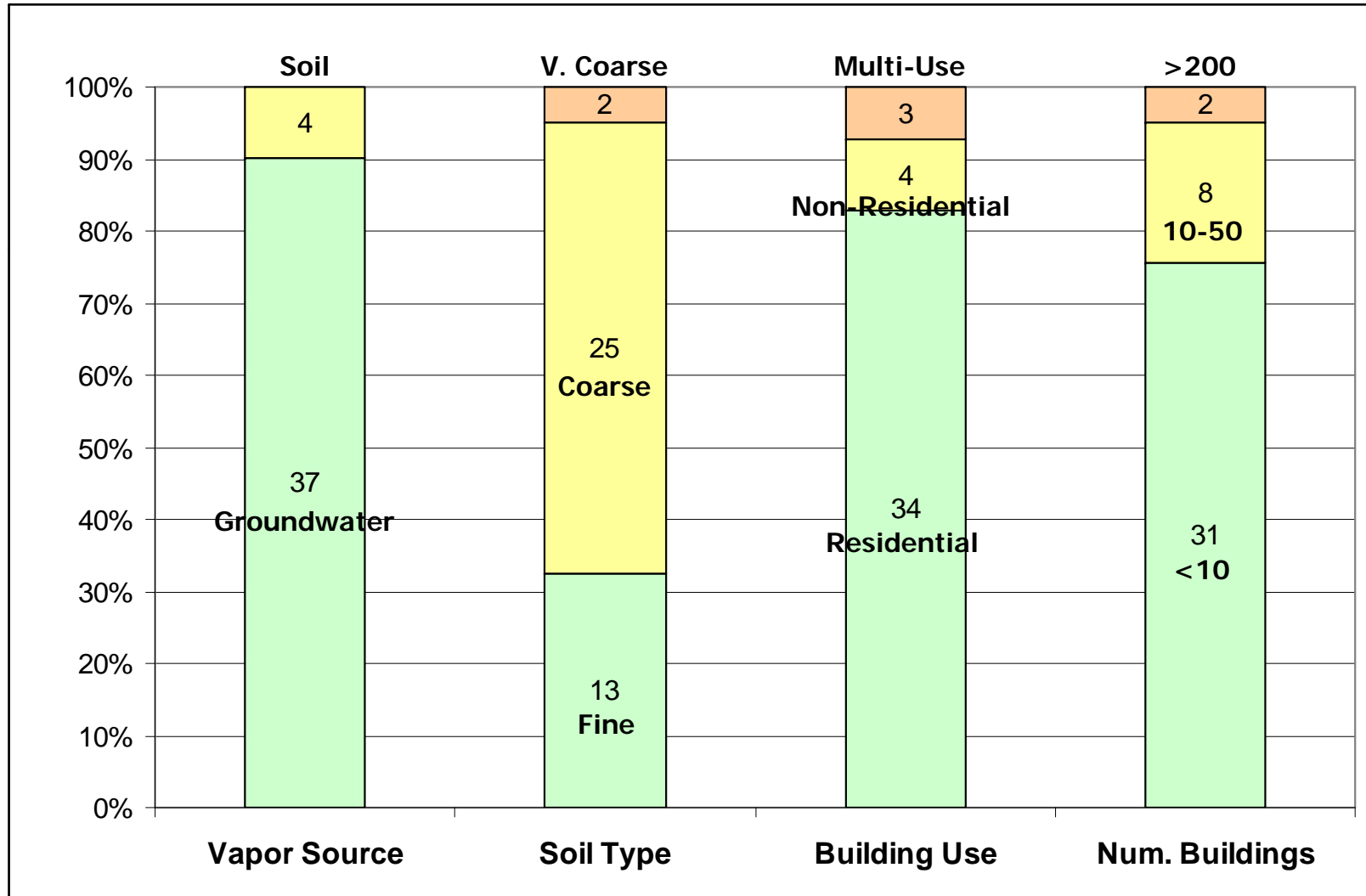


Database Contents

- 15 States
- 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





Database Fields

- Site information (hydrogeologic setting, vapor source type)
- Building characteristics (bldg use, foundation type, depth to source)
- Soil type (sand, silt, etc.)
- Chemical
- Sampling and analysis information (sample location, collection period, analytical method)
- Indoor air paired with groundwater, sub-slab, soil gas, and/or crawlspace samples
- Calculated Attenuation Factor (AF)
 - $AF = C_{\text{air}}/C_{\text{subsurface}}$
 - $AF < 1.0$



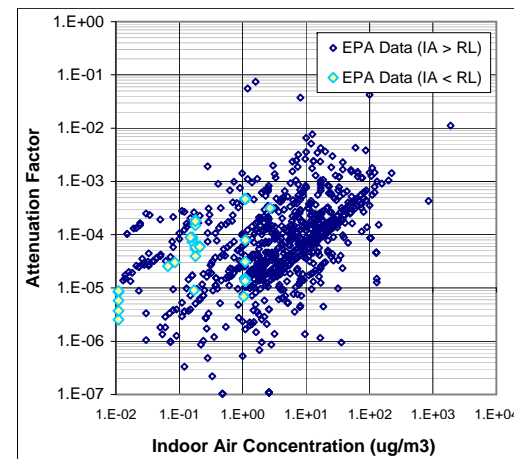
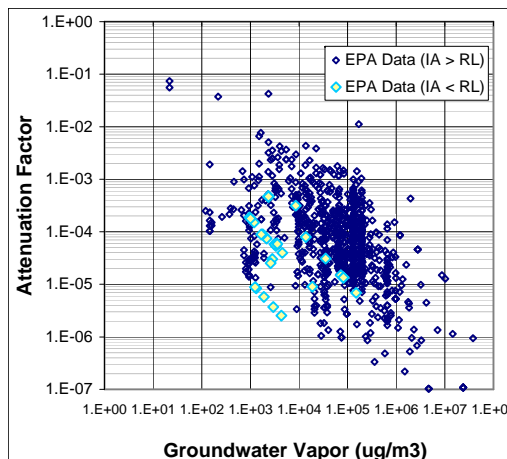
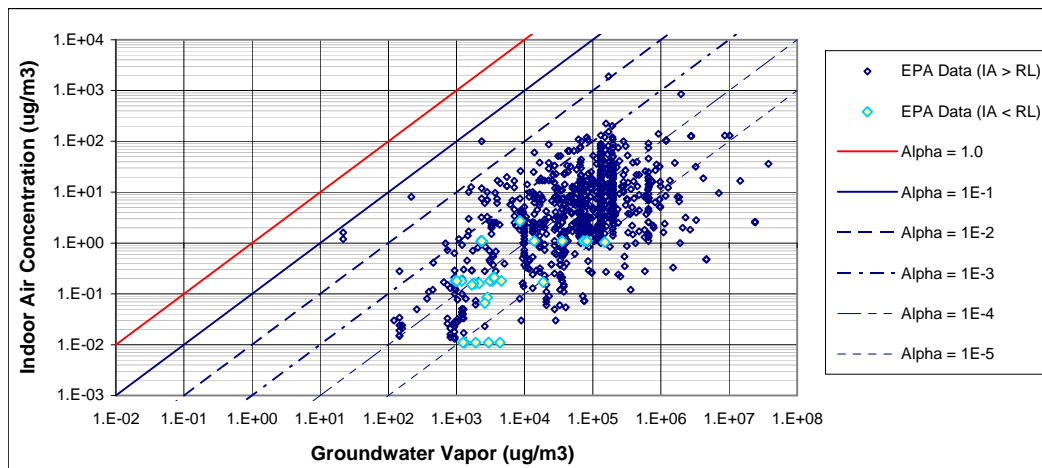
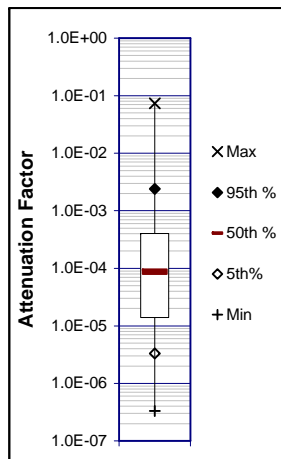
Spreadsheet Database

US EPA Vapor Intrusion Database: Attenuation Factor Analysis

Site Name: All Sites
 ChemName: All Chemicals
 Chem Type: All Chemical Types
 Soil Texture Code: All Soil Textures
 Soil Type: All Soil Types
 Bldg Use: All Building Uses
 Foundation Type: All Foundation Types

Subsurface Media: Groundwater Vapor (ug/m3)

Stats	EXCEL	KMStats
Min	3.3E-07	3.3E-07
5%	3.6E-06	3.3E-06
25%	1.6E-05	1.4E-05
50%	8.8E-05	8.7E-05
75%	4.0E-04	4.0E-04
95%	2.4E-03	2.4E-03
Max	7.4E-02	7.4E-02
Mean	1.2E-03	1.2E-03
StdDev	6.7E-03	6.7E-03
95UCL	8.9E-04	1.9E-03
Count All	218	218
Count D		201
Count ND		17



Filter Criteria

Site, Chemical, Soil, and Building Filters

GW Filters

SS Filters

SG Filters

CS Filters

Counts Visible Data-->

IA Filters

910

Selected Data



QA Checks

- Sampling design reviewed
 - Representative samples?
 - Concurrent paired samples?

- Sampling and analysis QA/QC reviewed
 - EPA TO-14, TO-15, TO-17, 8260B
 - EPA QA/QC protocols

- Indoor survey reviewed (if available)

- Data consistency evaluated (if multiple chemicals reported)

- Data entry validation



Handling Data Below Reporting Limits

- All data below reporting limits flagged
- Subsurface data $< RL$ excluded from statistical analysis
 - $AF = C_{air}/C_{subsurface}$
- Indoor air data $< RL$ included in statistical analysis using Kaplan Meier method (Helsel, 2005)
 - Kaplan Meier: robust non-parametric method capable of considering data sets with substantial proportions of data below reporting limits, as well as multiple reporting limits and J-qualified values.

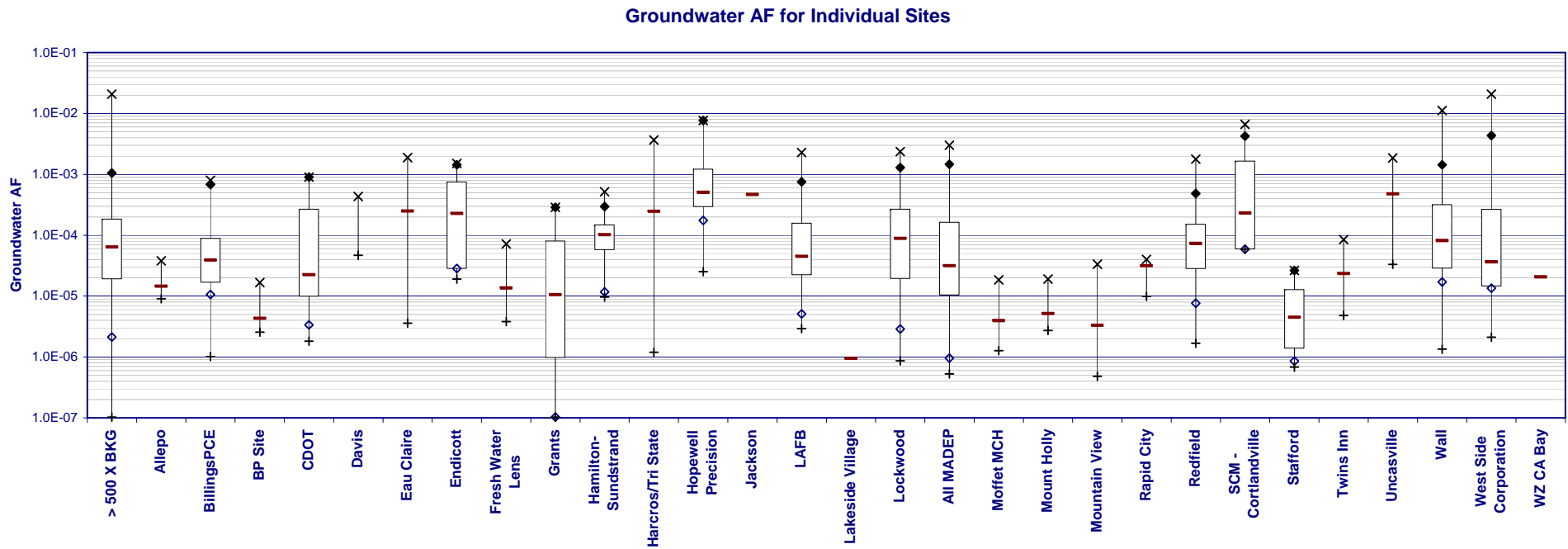


How can you use the Vapor Intrusion Database?

- Provide an empirical line of evidence to aid in decision-making regarding site characterization, remediation, and risk management.
- Compare site data to a compiled data set of “proven” vapor intrusion sites.
- Evaluate the relationships between vapor source concentrations, indoor air concentrations, and site conditions.
- Develop screening levels.



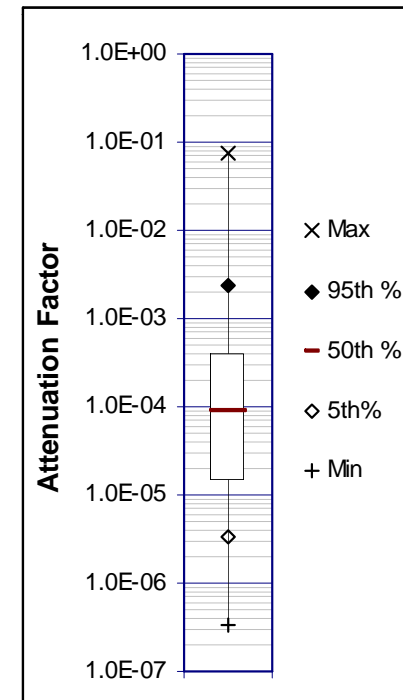
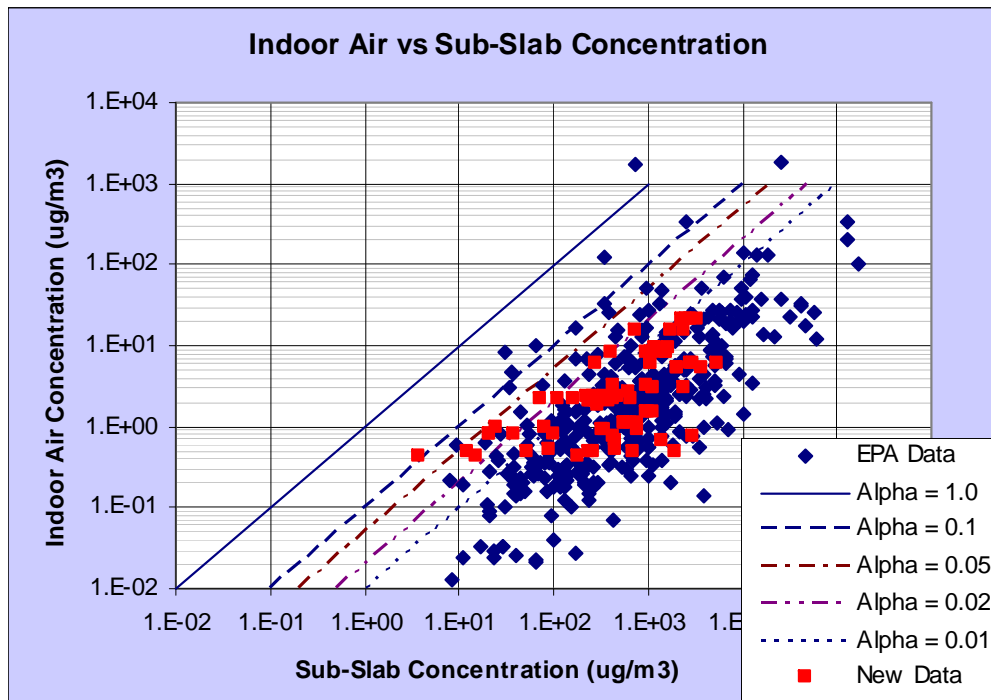
Groundwater-to-Indoor Air Attenuation Individual Site Box Whisker Plots





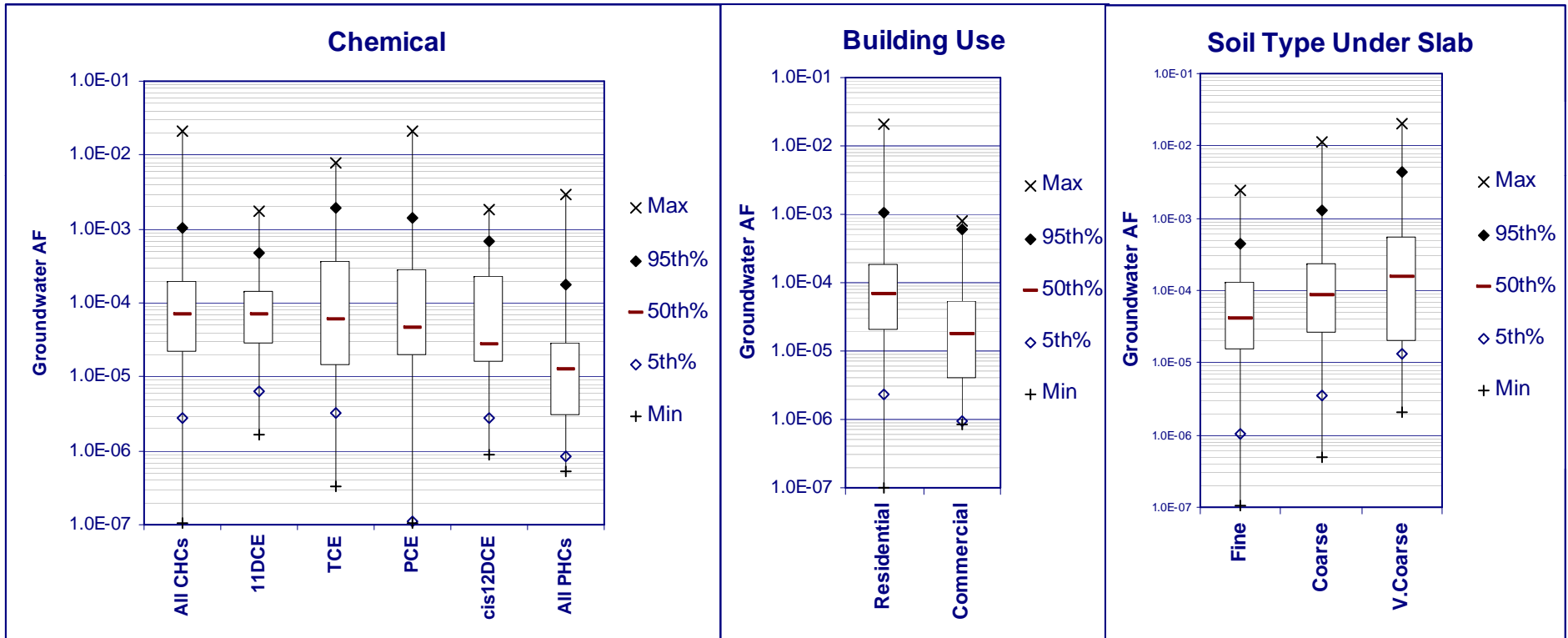
Compare Site Data to Database

- Allows for inclusion of spatial and temporal variability in the decision-making process.



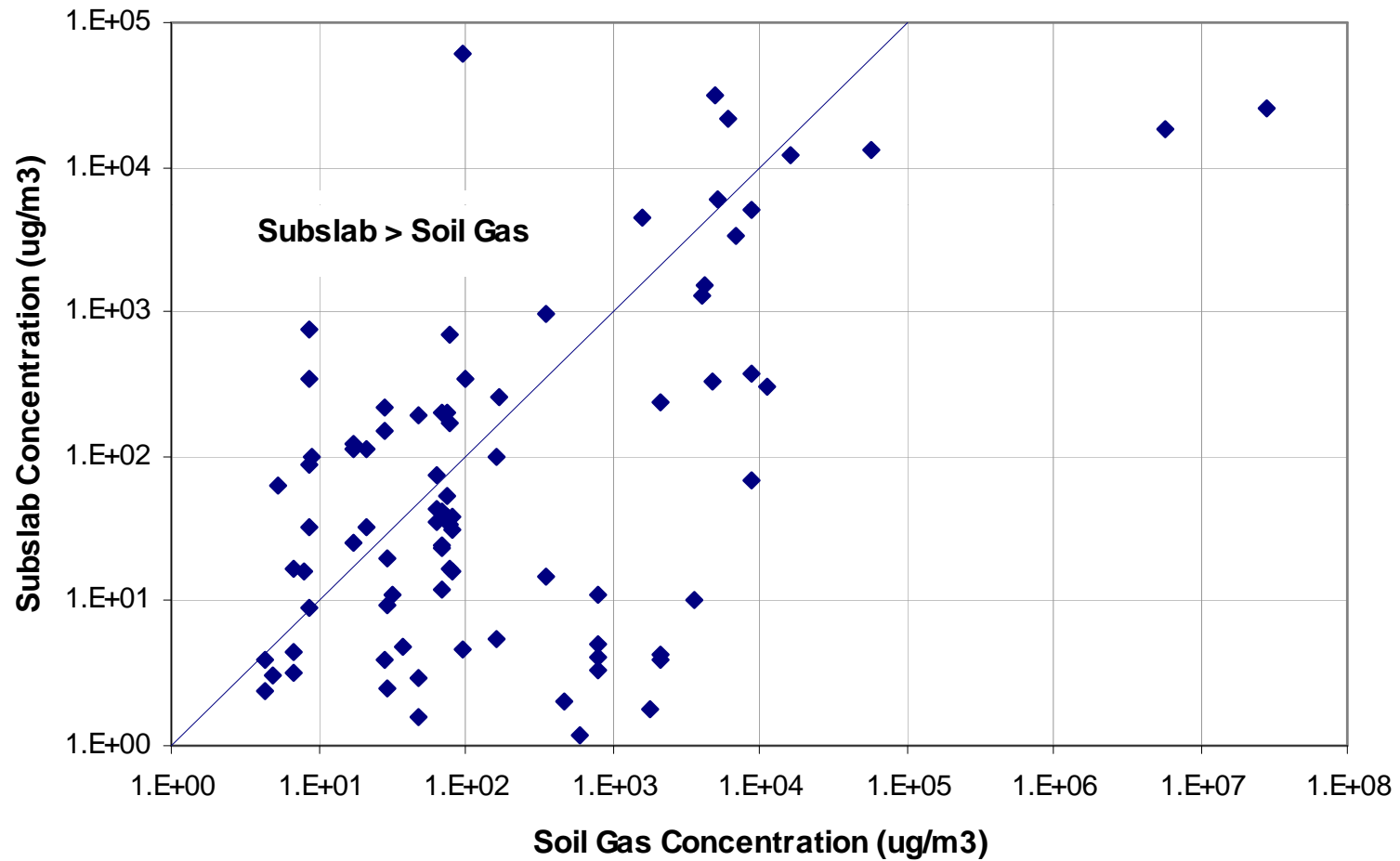


Groundwater-to-Indoor Air Attenuation





Exterior Soil Gas vs Subslab





Summary of EPA's Vapor Intrusion Database

42 Total sites

- GW: Groundwater (36 sites)
- SG: Soil gas (14 sites)
- SS: Subslab (19 sites)
- CS: Crawlspace (4 sites)
- 3,162 paired measurements
 - SS: 50%, GW: 39%, SG: 8%, CS: 3%
 - Residential: 86 %, Commercial: 9 %, Multi-use: 5%
 - Chlorinated hydrocarbons: 97%
 - Petroleum hydrocarbons: 3%

