A Review of Vapor Intrusion Guidelines by State

Laurent C. Levy, Ph.D., P.E., Senior Project Manager
Gradient, Cambridge, Mass.

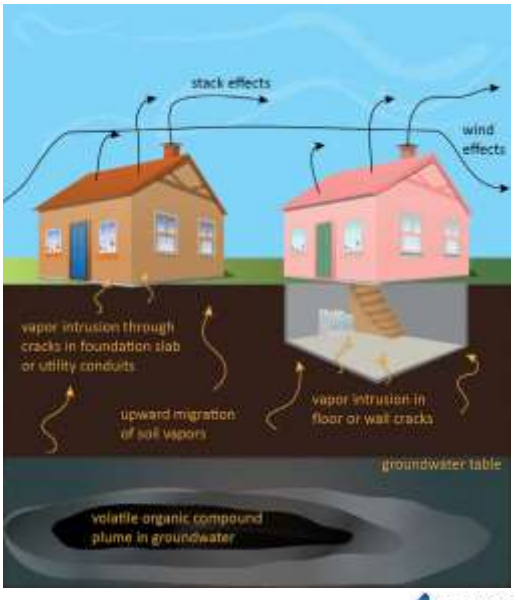
Vermont Vapor Intrusion Updates Workshop
Vermont Department of Environmental Conservation (VTDEC),
Northeast Waste Management Officials' Association (NEWMOA),
and Brown University Superfund Research Program

Tuesday, May 13, 2014 – Montpelier, VT

GRADIENT

What is Vapor Intrusion?

- **Vapor Intrusion (VI):** The migration of volatile chemicals from the subsurface into overlying buildings (EPA, draft VI guidance, 2002).
- The **VI Pathway** may pose unacceptable risks of long-term exposure via inhalation of chemicals present in indoor air resulting from VI.
- A **complicating factor** for VI investigations is the common presence of those same volatile chemicals within buildings unrelated to VI ("background levels").



2

GRADIENT

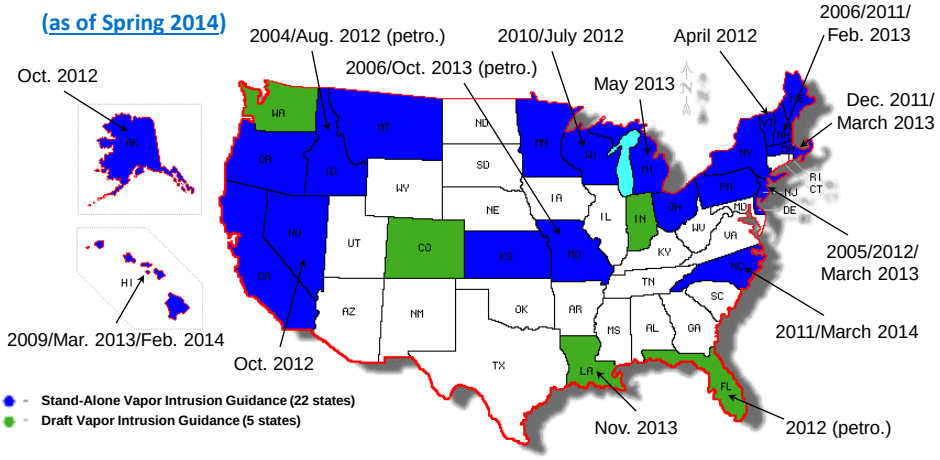
A Brief History of Vapor Intrusion

- 1970s – Primary focus on intrusion of fuel vapors into buildings, potential fire/explosion, and acute effects.
- 1980s – Focus on residential indoor air quality and radon intrusion. Early stages of vapor intrusion/inhalation pathway.
- 1990s – Regulatory focus on chronic VI (e.g., Superfund, certain states). Johnson and Ettinger 1-D Diffusion/Advection Model developed in 1991 to "risk away" VI as a concern. In 1995, ASTM publishes risk-based corrective action (RBCA) standard to assess petroleum releases (three-tiered approach).
- 2000s – Large scale VI sites (e.g., Endicott, NY; Redfield, Denver, CO). Draft EPA VI Guidance published in 2002. Several states develop their own guidance (e.g., NY, NJ). In 2007, ITRC develops a comprehensive VI guidance document.

3

States with Final or Draft VI Guidance

(as of Spring 2014)

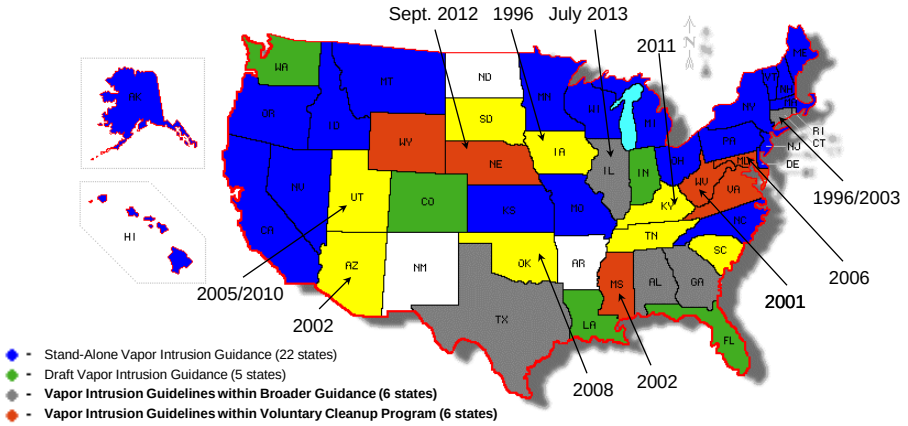


- Final, final interim, or draft stand-alone VI guidance document or appendix
- Most guidance documents published after 2006
- VI focus in the northeastern states (industrial legacy, climate, property)
- Several states have updated existing final guidance (e.g., CA, NC, NJ, NH, WS…)

4

States with VI Guidelines within Cleanup Program

(as of Spring 2014)



- Varying degree of detail…
- Often found in risk-based corrective action documents (e.g., AL, OK, IA, UT) where vapor inhalation pathway is typically addressed as part of a Tier 2 approach
- Volatilization criteria provided for gw, soil and/or soil gas (CT, IL, VA, TX, IA, SD, TN)

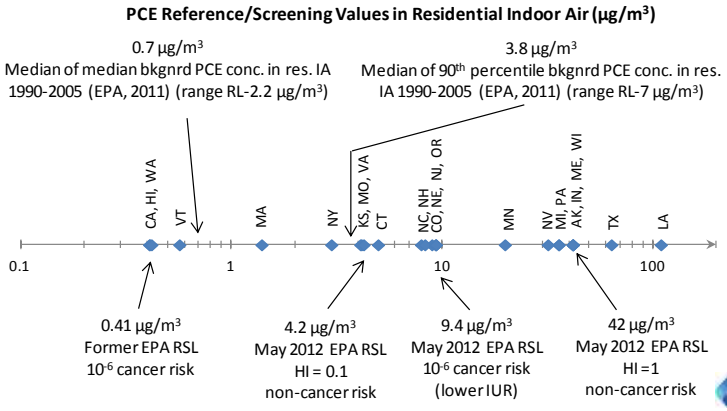
Typical Approach Found in VI Guidance

- Use of a multi-step or tiered approach (consistent with EPA 2002 draft guidance)
- Rely on multiple lines of evidence approach, incl.
  - groundwater, soil, soil gas, subslab vapor, indoor air data
  - outdoor air data, flux data, tracer data (e.g., radon, cDCE)
  - NAPL presence, spatial/temporal variability of data
  - differential pressure data; building characteristics

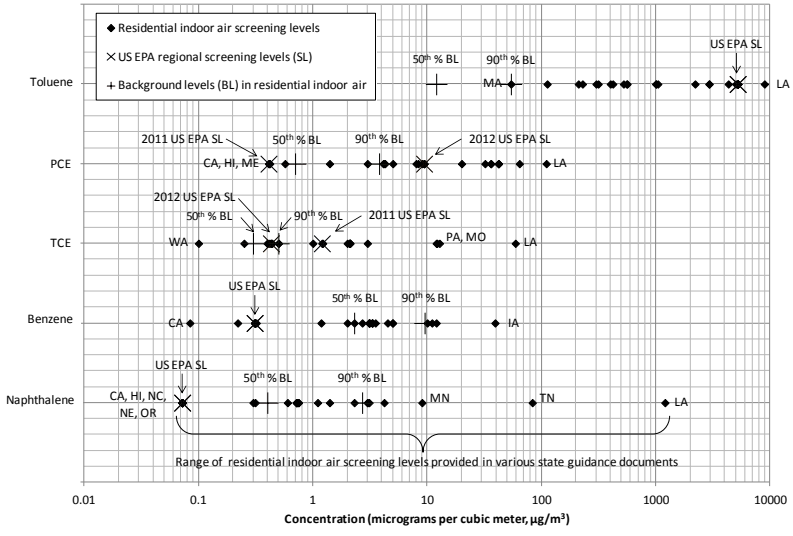
1. Conduct preliminary screening and assess VI potential (is VI pathway potentially complete?)
2. Address imminent hazards
3. Develop CSM and sampling work plan
4. **Conduct subslab vapor sampling and compare to screening/target levels (use of attenuation factor)**
5. Conduct expanded investigation (indoor air)
6. Remediate or mitigate (engineering controls)
7. Long-term monitoring and termination

Indoor Air Screening Levels Vary Broadly Between States

- Typically health-based criteria (10^{-5} or 10^{-6} cancer risk and HI = 0.1, 0.2, or 1.0)
- Sometimes based on background level studies (e.g., MA, CT, NH, NY, PA, VA, VT)
- Occasionally based on TO-15 reporting limits (e.g., MA, NH)
- State-specific toxicity study or study interpretation (e.g., CA, MA, VT)
- Example for tetrachloroethene (PCE). Range of screening values spans two orders of magnitude.



Indoor Air Screening Levels (Continued)

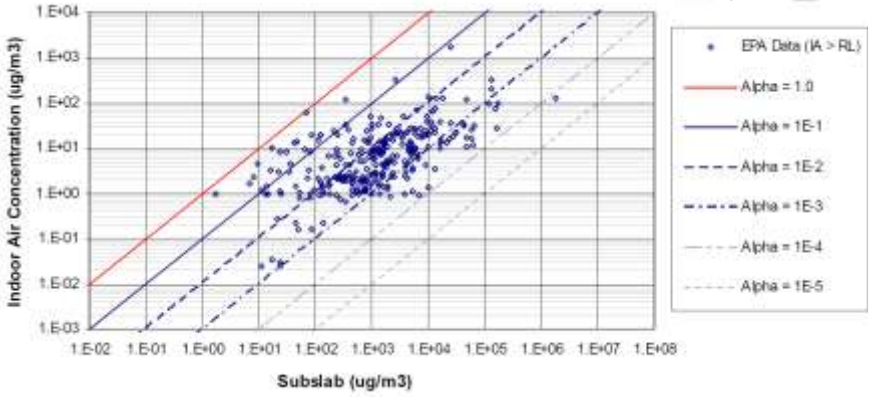


- Range of two orders of magnitude or more (varying risk levels, non risk-based SL, NC/C)
- TCE less common in background than PCE although certain SL are below background
- Most SL for benzene and naphthalene within or below background

Attenuation Factors

The ratio of indoor air to subslab vapor concentration

$$AF = \frac{C_{\text{indoor air}}}{C_{\text{subslab vapor}}}$$

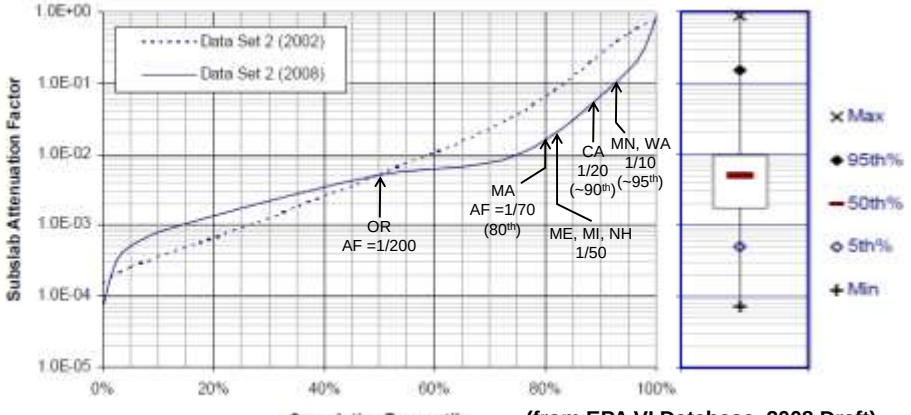


311 paired subslab vapor-to-indoor air data points from 13 sites (after **EPA VI Database, Draft 2008**, Finalized in March 2012)

→ **For most data pairs, AF is less than 0.1**

GRADIENT

Attenuation Factors (continued)

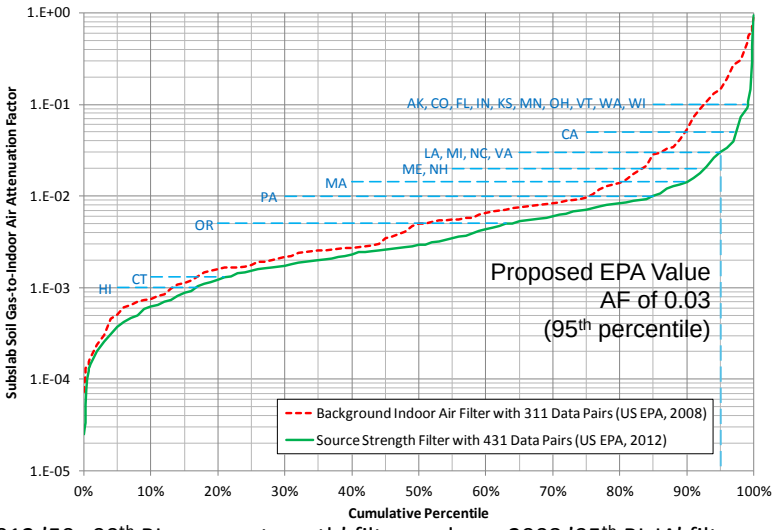


(from EPA VI Database, 2008 Draft)

- Indoor air concentration predictions using subslab vapor data and assumed AF
- Most states use <u>AF of 0.1 (1/10)</u> based on EPA 2002 draft VI guidance recommendation (AK, CO, IN, KS, OH, VT, WI)
- Several states have relied on results from EPA VI database study (2008 draft) to use less conservative AF
- A few states use lower AF (i.e., more attenuation) for commercial buildings

GRADIENT

Attenuation Factors — from EPA 2008 to EPA 2012



- 2012 '50x 90th BL source strength' filter replaces 2008 '95th BL IA' filter
- Remaining data pairs show more attenuation than previously derived
- Accordingly, generic AF are more conservative than originally thought

VI Screening Levels for Groundwater – An Illustration for Benzene

	Vermont	New Hampshire
Indoor Air Screening Level	1.18 µg/m^3 (Background Study)	3.3 µg/m^3 (Background Study)
Groundwater-to-Indoor Air Attenuation Factor	10^{-3} (EPA 2002 Draft VI Guidance)	10^{-4}
Biodegradation for Petroleum Compounds	No	Yes (attenuation of 0.1)
Dimensionless Henry's Constant	Assume standard water temperature of 25°C H = 0.227	Assume groundwater temperature of 10°C H = 0.116
Resulting Groundwater Screening Level	**5.2 µg/L**	**2,900 µg/L**

EPA Final VI Guidance is Coming

- Final EPA VI guidance was due to be released at the end of 2012 ten years after draft was published
- Draft final guidance released for comments on April 16, 2013 (http://www.epa.gov/oswer/vaporintrusion)
- Draft final guidance:
  - Draws from EPA VI database study (e.g., less conservative subslab-to-indoor air AF, limitations associated with exterior soil gas data)
  - Differentiates between VI by chlorinated hydrocarbons and VI by petroleum hydrocarbons ("PVI") (vadose zone aerobic biodegradation may result in lower AF)
    → **separate PVI Guidance**
  - Does not recommend modeling as a single line of evidence to rule out the VI pathway (i.e., empirical evidence preferred)
- Will States follow suit ?
  (if they have not already done so)

Nov. 2002

Dec. 2009

April 2013

13

GRADIENT

Questions?

Laurent C. Levy, Ph.D., P.E.
Senior Project Manager
Gradient
20 University Road
Cambridge, MA 02138
E-mail: llevy@gradientcorp.com
Tel: 617-395-5566
http://gradientcorp.com/

Vapor intrusion resources for each state available at: http://vapor-intrusion.blogspot.com/

14

GRADIENT