

# Vapor Intrusion Update



**Ross Steenson**  
**SAM Forum**  
**October 11, 2017**



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**San Francisco Bay Regional Water Quality Control Board**

# Outline

- 1) Overview**
- 2) Background**
- 3) Scope of CalEPA VI Guidance**
- 4) Technical Issues**
- 5) Anticipated Rollout**

# Overview

- **Attenuation Factors**
  - **Consistent Attenuation Factors**
  - **Capture Data Going Forward into a Database**
- **Need to Update Existing Agency Guidance**
  - **DTSC – Vapor Intrusion Guidance, Vapor Intrusion Mitigation Advisory**
  - **SF Bay Regional Board – Environmental Screening Levels and Vapor Intrusion Framework**

# DTSC/Water Boards VI Workgroup

*(At the request of Gina Solomon)* 

## Department of Toxic Substances Control

- Claudio Sorrentino (co-chair)
- Dan Gallagher
- Barbara Renzi



## State Water Resources Control Board

- Steve McMasters
- Karen Kramer



## San Francisco Regional Water Quality Control Board

- Cheryl Prowell (co-chair)
- Nicole Fry
- Ross Steenson

# Background – TCE Short-Term Toxicity

- **December 2013 – USEPA Region 9 letter to SF Bay Regional Board with short-term response levels for TCE in indoor air**
- **July 2014 – USEPA Region 9 memo setting short-term response levels for TCE**
- **August 2014 – DTSC Human Health Risk Assessment Note 5**
- **October 2014 – Region 2 TCE VI Framework**

# Background – CalEPA Workgroup

- **Fall 2014 – Workgroup formed in response to the TCE short-term toxicity concerns and debate over the key toxicity study. Two subgroups: 1) toxicity; 2) fate and transport.**
- **2014 – Toxicity subgroup agreed to remain consistent with USEPA regarding TCE toxicity**
- **2015 – Fate and transport subgroup continued meeting regarding attenuation factors (model vs. empirical)**
- **2016 – CalEPA request: DTSC and Water Boards develop a consensus approach to attenuation factors**

# Motivations for Change

- **Desire for consistency:**
  - **Attenuation factors between agencies**
  - **In decision-making, between agencies and case manager to case manager**
- **Increased awareness:**
  - **Temporal and spatial variability in VI data**
  - **Sewer airspace as route of vapor transport separate from traditional soil vapor intrusion migration**
- **J&E model removed from EPA website in late 2015.**

# Process

- **Multi-disciplinary Team**
  - **DTSC, Regional Board (R2, R4), and State Board**
  - **Toxicologists, Geologists, and Engineers**
- **Discussion**
  - **Mix of full day in person meetings and Global Meet**
  - **Meetings in 2017 have been bi-weekly now weekly**



# Tradeoffs Considered



- **Protective**
- **Captures variability**
- **Is it scientifically defensible?**

- **Practical**
- **Allows fast decision making**
- **Is this too resource intensive?**

**Need a new database to balance the scales for better decisions**

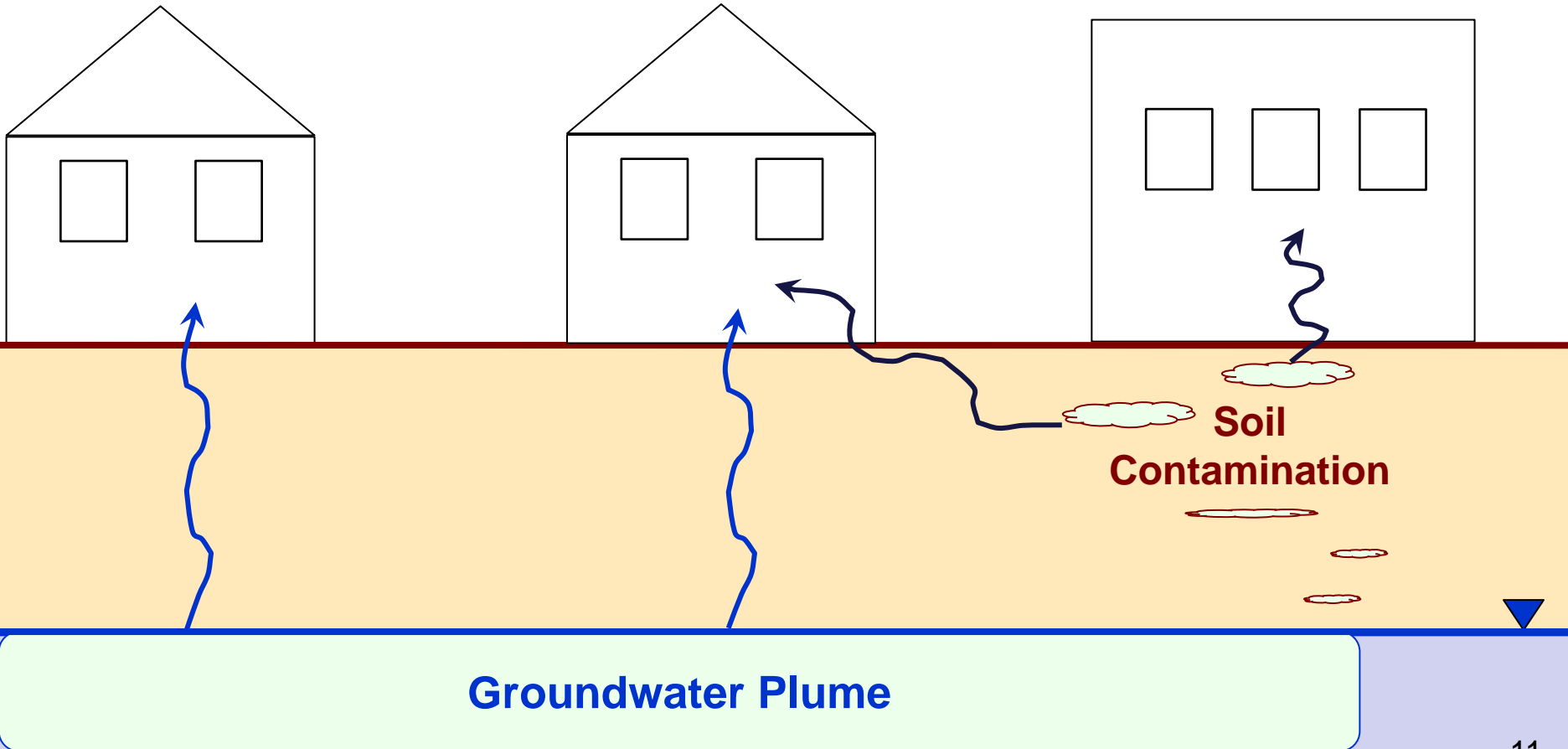
# Scope

- **Interim guidelines until existing agency guidance can be updated.**
- **Adopt consistent attenuation factors**
- **Expedite evaluation of current VI exposure at buildings while site characterization not yet complete**
- **Capture VI data and information going forward in a database**

# Conceptual Model Scenarios

Part of overall investigation and cleanup

Screen each building separately – worst first



# Screening Process

- **Stepwise process to screen and evaluate a building during sitewide investigation**
- **Steps 2 and 3 have multiple sampling rounds**  
**If a round indicates a threat, skip to next step**
- **If exposure is identified risk and mitigation decisions should be made promptly**

**Step 1: Build CSM and prioritize buildings for VI evaluation**



**Step 2: Screening with soil gas**



**Step 3: Sample indoor air**



**Step 4: Risk Management Decisions**

# Key Elements of New Approach

- **Locations and frequency for soil gas, subslab, indoor air, outdoor air, and sewer air sampling**
- **Empirical attenuation factors for screening of buildings**  
**(no more J&E)**
- **Sewers as a preferential pathway**
- **Risk management decision framework**
- **Prospective California VI database**

# Risk Management Decisions

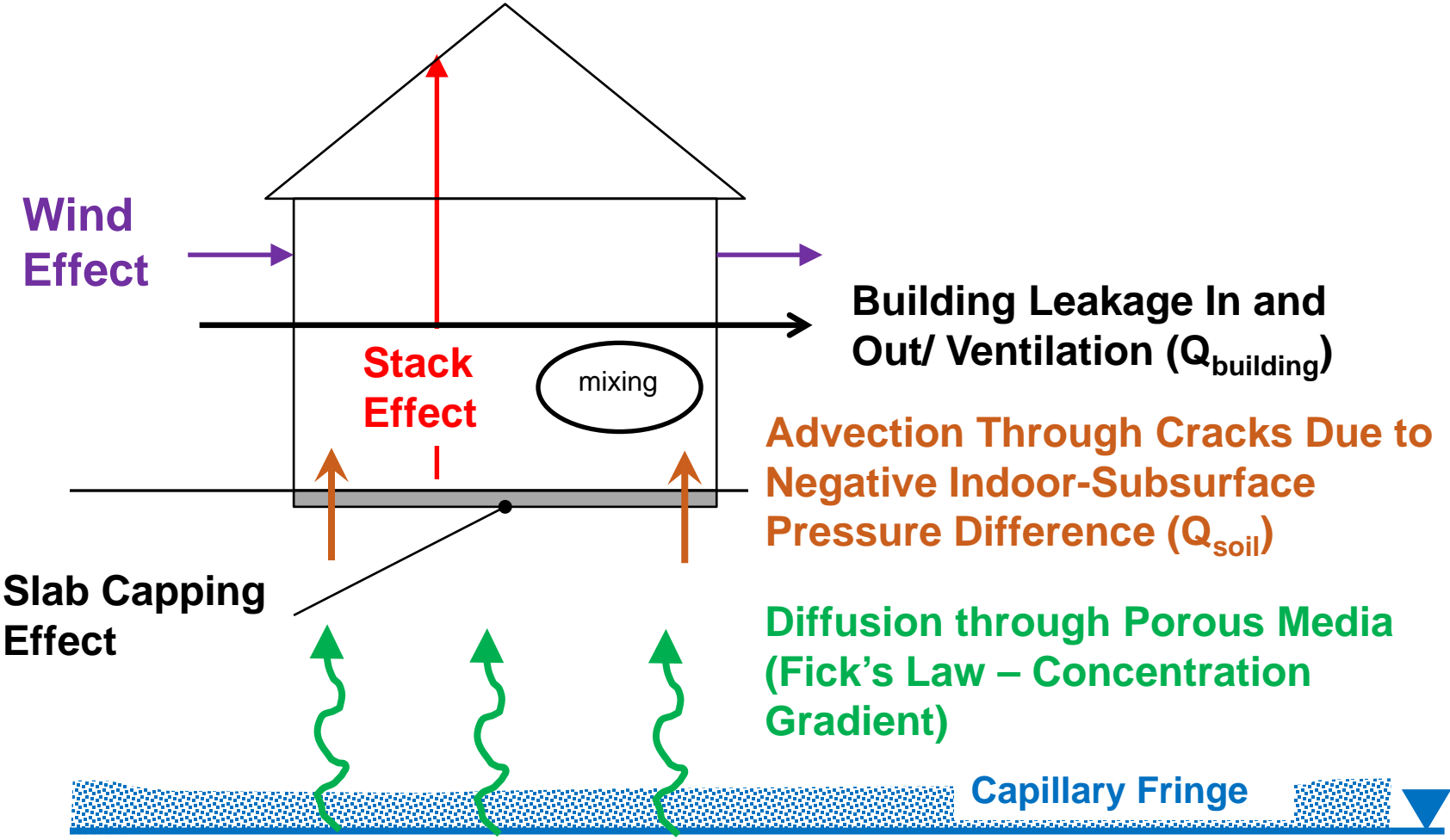
**Current Risk: Estimate VI risk**  
primarily using **measured indoor air**

Current Risk?	Indoor Air Risk & Hazard
No	Risk < $1 \times 10^{-6}$ <u>and</u> HI < 1
Site Specific	Risk from $1 \times 10^{-6}$ to $1 \times 10^{-4}$ <u>and</u> HI $\leq$ 1
Yes	Risk > $1 \times 10^{-4}$ <u>or</u> HI > 1

**Future Risk: Estimate VI risk**  
primarily using **subslab / soil gas** data

Future Risk?	Subslab / Soil Gas VI Risk & Hazard
No	Risk < $1 \times 10^{-6}$ <u>and</u> HI < 1
Site Specific	Risk from $1 \times 10^{-6}$ to $1 \times 10^{-4}$ <u>and</u> HI $\leq$ 1
Yes	Risk > $1 \times 10^{-4}$ <u>or</u> HI > 1

# Traditional Conceptual Model of Soil Vapor Intrusion



Groundwater VOC Vapor Source

*Diffusion in Water << Diffusion in Air*

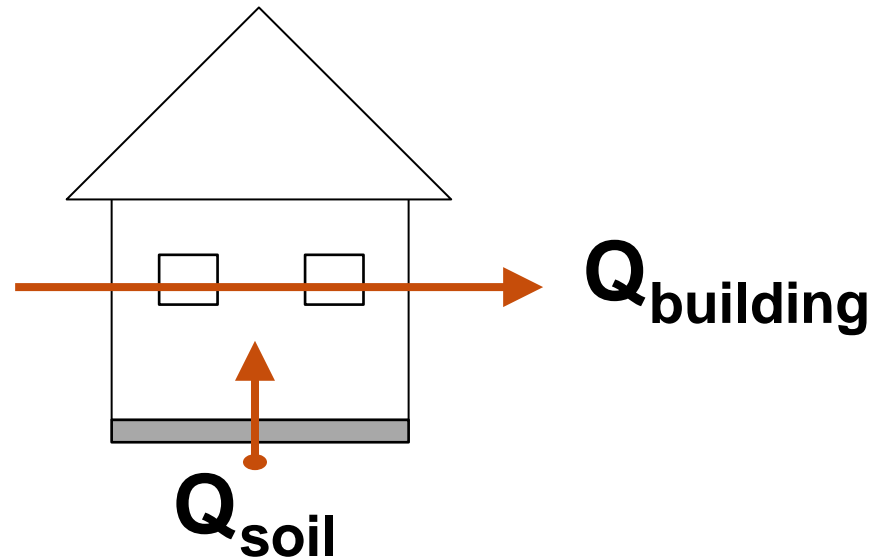
# Vapor Intrusion ESLs Since 2000

## Soil Gas ESLs Since 2003

**Soil Gas Attenuation Factor (AF) =  $Q_{\text{soil}}/Q_{\text{building}}$**

Convective transport from a source located immediately beneath the building (Johnson and Ettinger 1991).

- **Default size building**  
(10m x 10m x 2.44m)
- **Vapor entry rate ( $Q_{\text{soil}}$ )**
- **Bldg. ventilation rate ( $Q_{\text{building}}$ )**



**J&E model building entry and indoor mixing component**



# Limitations of the J&E Model

- There are a large number of inputs (building and subsurface).
- Many inputs are not measured in site investigations (e.g.,  $Q_{soil}$  and  $Q_{building}$ , etc.).
- Assumes homogeneous conditions in each subsurface layer.
- Cannot account for preferential pathways.
- The model has never undergone formal validation (calibration using field data).

**But wait, it's back as of 10/6/17!**

# The USEPA Empirical VI Database

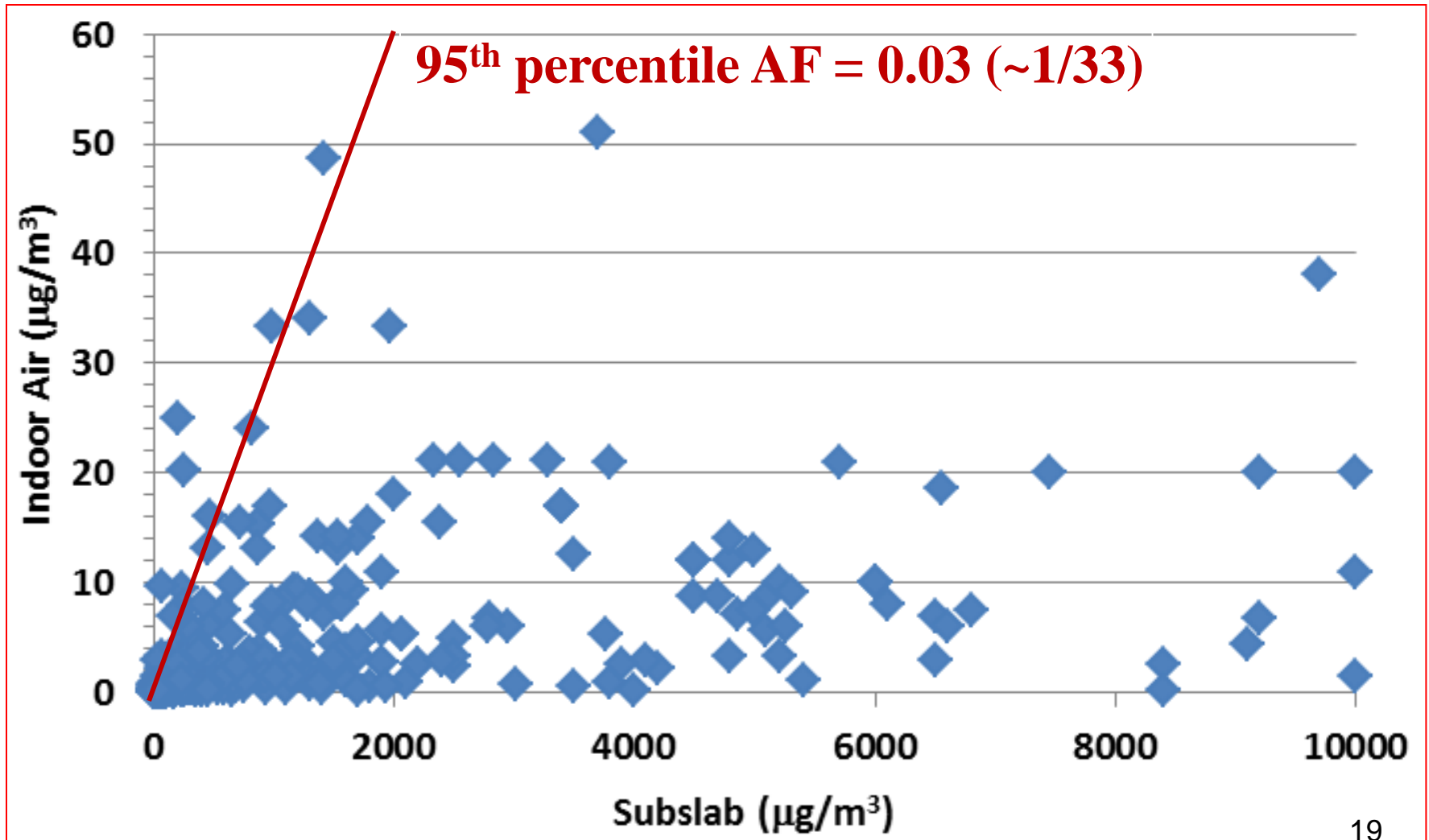
- **2002 – The USEPA Draft VI Guidance employed generic AFs based on a statistical analysis of data from a limited number of sites.**

**.....USEPA continued to compile data to improve AFs.....**

- **2008 – Preliminary VI Database report.**
- **2012 – Final VI Database report.**
- **2015 – Final OSWER “VI Tech Guide” includes generic AFs based on analysis the Final VI Database.**

# USEPA Empirical VI DB

431 Buildings' Data used to Calculate Generic SS AF (0.03)



# 2010/11 Draft ESL Update

- **Considered adoption of empirical AFs from the USEPA 2008 Preliminary VI Database**
- **Subslab/soil gas AF of 0.05 (1/20)**
- **Would have lowered the soil gas ESLs by 50x**
- **Sought feedback from an Outside Advisory Group**

**ESL update was shelved**  
**Empirical AFs not adopted**

# Outside Advisory Group Feedback

- **National DB not appropriate given CA climate**
- **Bay Area AFs often less than 0.001**
- **Criticism of unresolved indoor sources and data filtering processes**
- **Empirical AFs generally favored over model AFs**
- **Limitations of subslab data**
- **Develop a CA database**

# Current Status of J&E Model

- **Using conservative input values, the models produce AFs that are an order of magnitude less conservative than the USEPA empirical AFs.**
- **USEPA 2015 Final OSWER VI Tech Guide omits references to USEPA spreadsheet version of the J&E model.**
- **Late 2015 – J&E model removed from USEPA website.**
- **Responses to inquiries – USEPA no longer supports or endorses their spreadsheet J&E model.**

# VI Attenuation Factors for Existing Slab-on-Grade Residences

SF Bay Regional Water Board (R2), DTSC, USEPA

	R2 (2016)	DTSC (2011)	USEPA (2015)
SS	<b>0.002 (1/500)</b> J&E Model-Subslab	<b>25x</b> <b>0.05 (1/20)</b> EPA Prelim DB 2008 Subslab Data Set	<b>0.03 (~1/30)</b> EPA Final DB 2012 Subslab Data Set
SG (deep or exterior)	<b>0.002 (1/500)</b> J&E Model-Subslab	<b>0.002 (1/500)</b> Average of 16 VOCs from OEHHA 2004 J&E Model-Subslab	<b>0.03 (~1/30)</b> EPA Final DB 2012 Subslab Data Set
GW	<b>0.0003 (~1/3,300)</b> J&E Model-Sand-5'	<b>0.002 (1/500)</b> same as SG Henry's Law Conversion	<b>0.001 (1/1,000)</b> EPA Final DB 2012 GW Data Set

**Blue = model-based; Green = empirical**

# Building a Consensus Approach

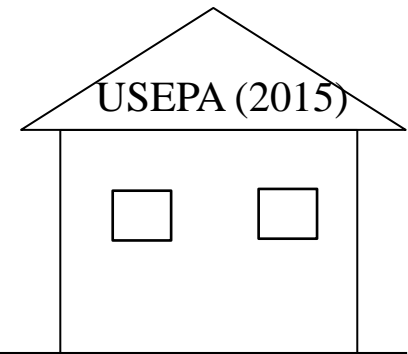
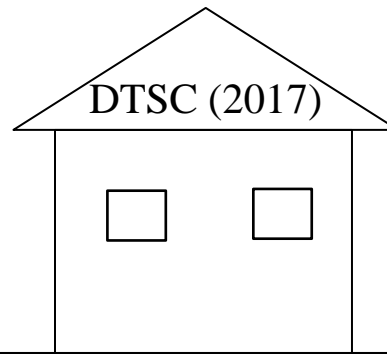
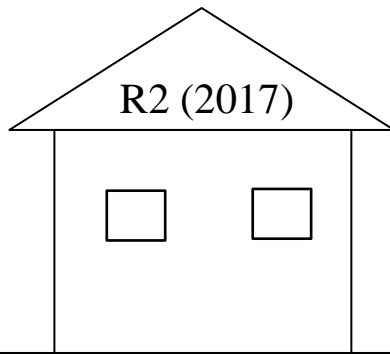


**Recalling our Advisory Group comments, we recommended building a prospective CA VI Database.**

1. Minimum data requirements based on current science to improve on USEPA's retrospective database.
2. Database structure and system to capture and house the data (GeoTracker).
3. Periodic data review and analysis to improve VI evaluations and develop CA-specific AFs.



# Proposed VI Attenuation Factors for Existing/Future Slab-on-Grade Buildings



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**SS**      **0.03 (~1/30) USEPA Final DB 2012 Subslab Data Set**

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**SG**      **0.03 (~1/30) USEPA Final DB 2012 Subslab Data Set**  
(deep or exterior)

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**GW**      **0.001 (1/1,000) USEPA Final DB 2012 GW Data Set**

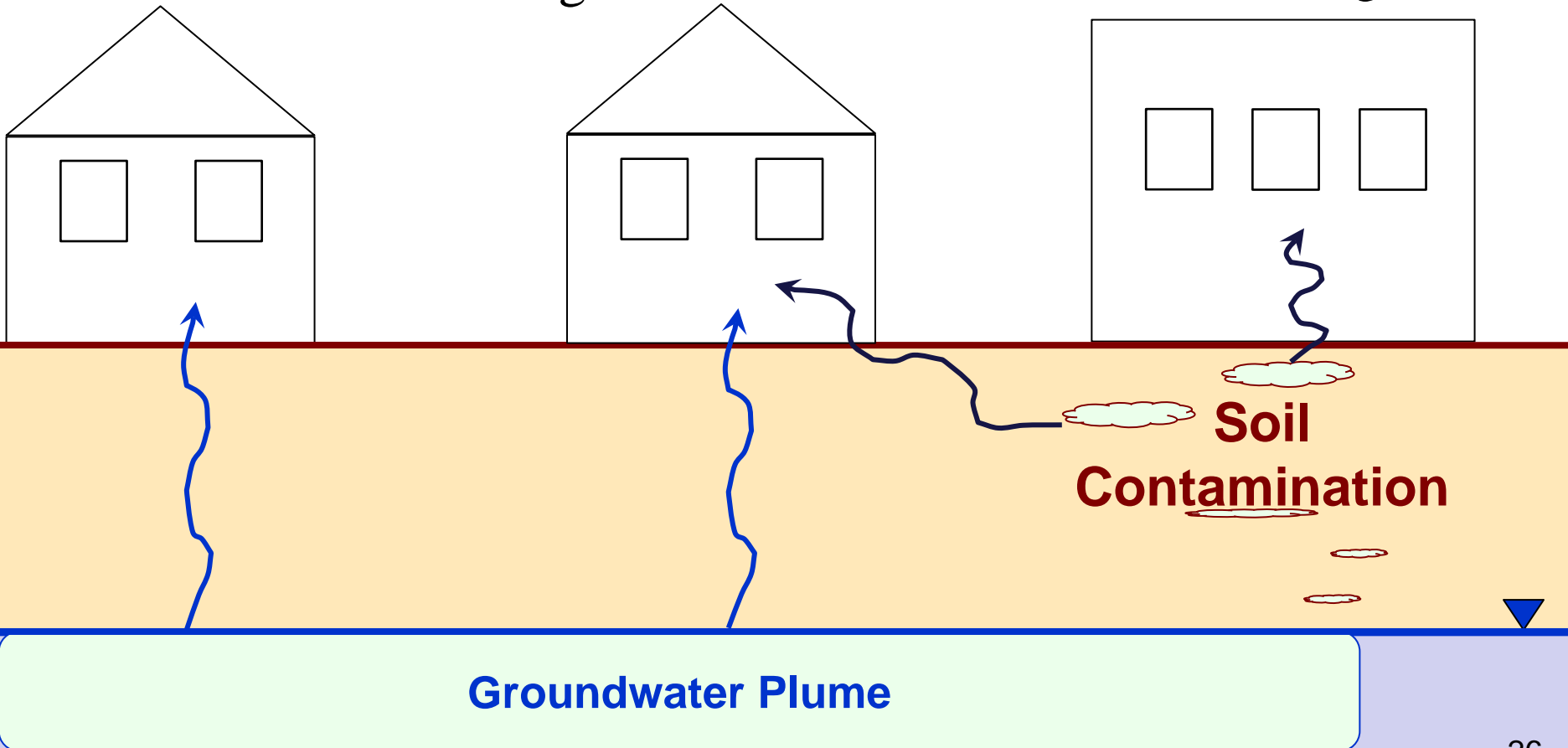
**Blue = model-based; Green = empirical**

# Scenario

Start with Step 1:

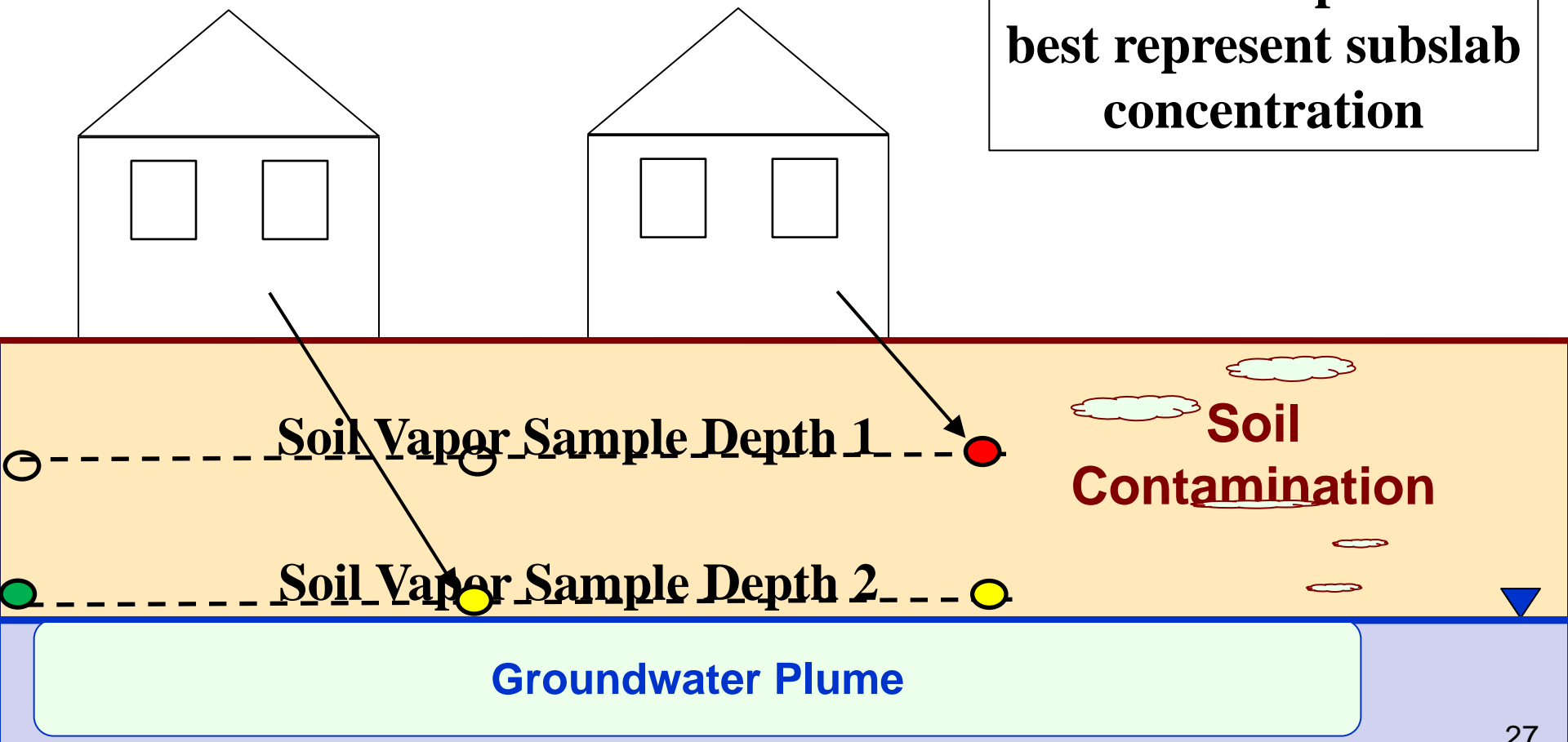
**Soil or GW**  
**Vapor Source**  
near building

Skip to Step 2:  
**Soil Vapor Source**  
*Directly Beneath*  
Building

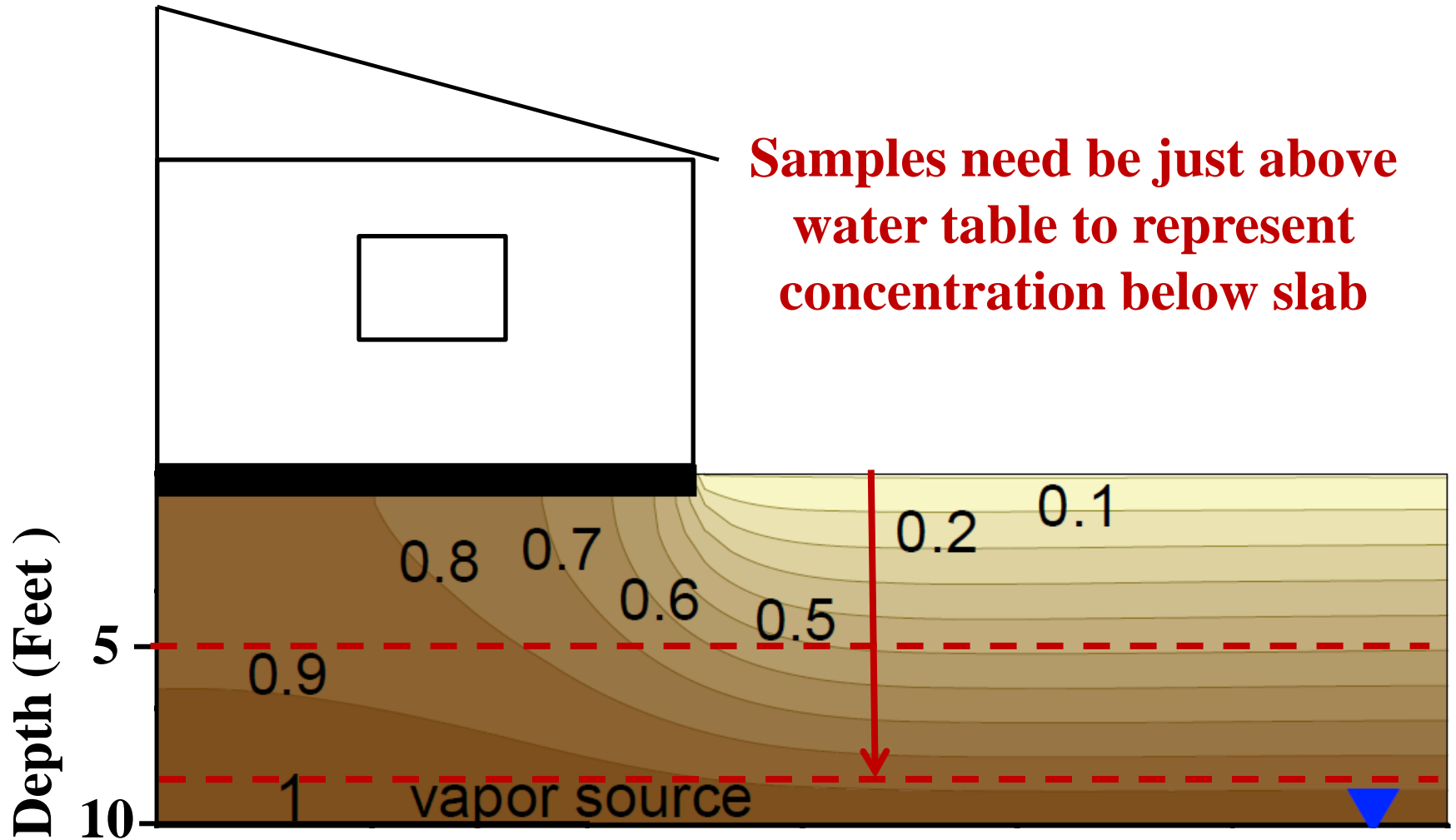


# Which SG Sample for Risk Calculation?

Soil Gas samples that best represent subslab concentration

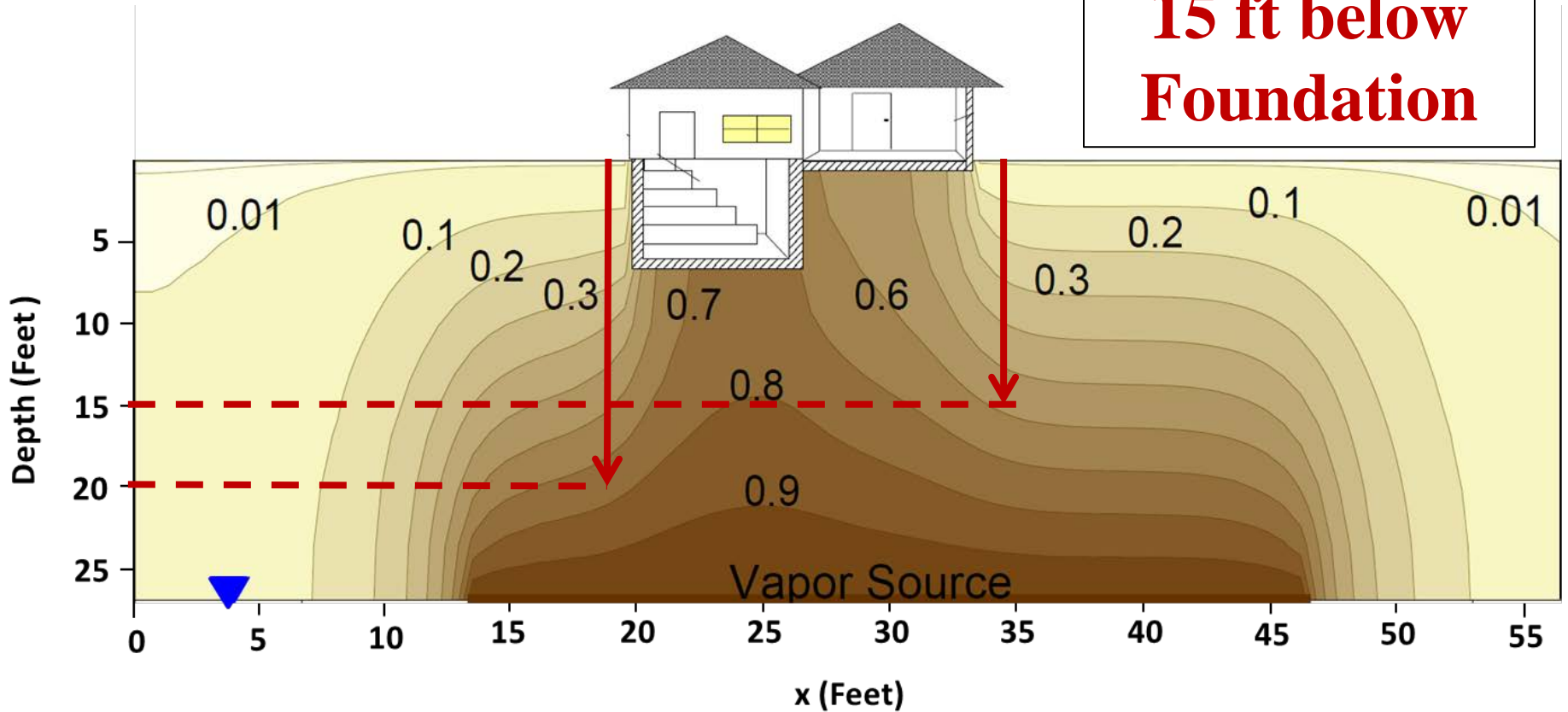


# Building Capping Effects

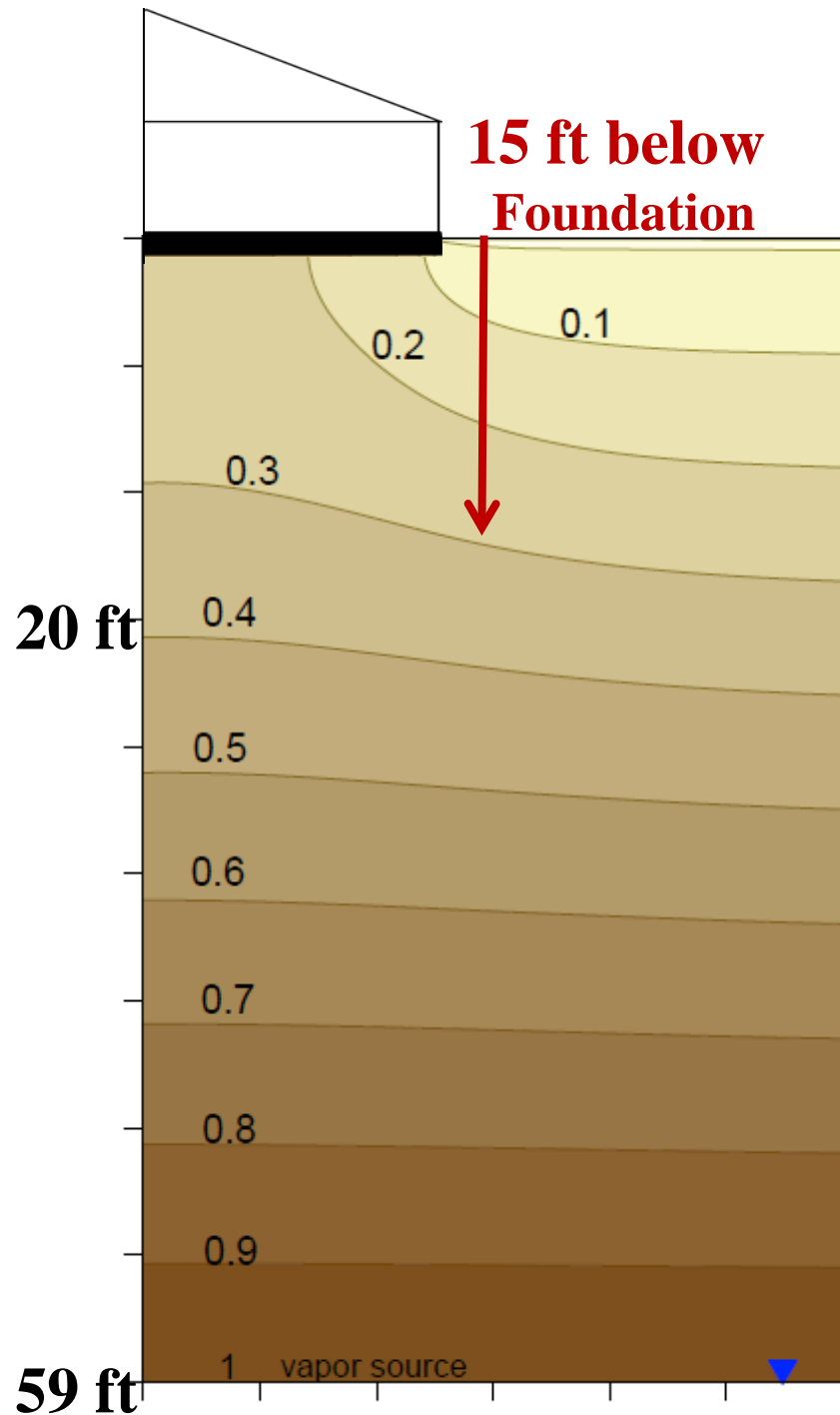


# What Depth Soil Gas for Deep Groundwater Plumes?

**Answer:  
15 ft below  
Foundation**



# Very deep groundwater plumes?



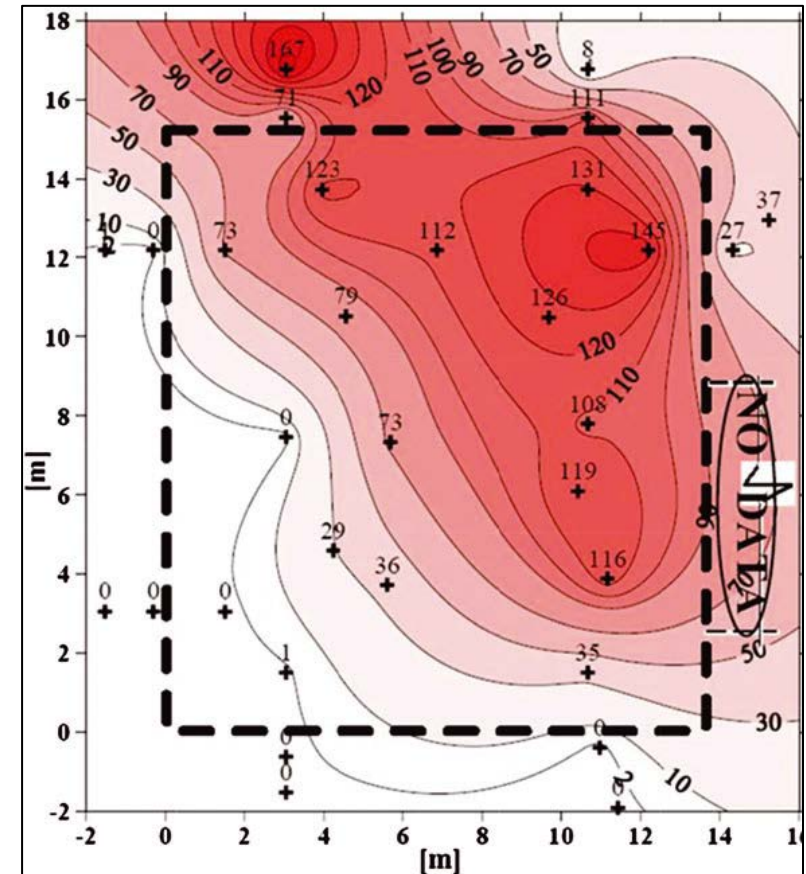
Conceptual Model Scenarios for the Vapor Intrusion Pathway - USEPA 2012

# Spatial and Temporal Variability of Indoor Air and Subslab Soil Gas

## Observations from SDM

Media and Depth	Spatial Variations	Temporal Variations
Indoor Air (lower level)	Unknown	1000X
Sub-slab Soil Gas	10X – 100X	10X

Johnson, 2014



Luo et al., 2009

# California VI Database

- **Goal: capture data collected under agency oversight to:**
  - better understand factors influencing VI
  - potentially develop CA-specific attenuation factor(s)
- **Modify GeoTracker to distinguish between types of vapor data**
- **Utilize existing functionality for uploading laboratory Electronic Data Format (EDF)**
- **Submitted data will be extractable and available for statistical analysis**



# Rollout Process

- **Issue as Interim Final for 6-month public comment**
- **Public Workshops in northern and southern CA**
- **Issue as Final**
- **Update Existing Agency Guidance**
  - DTSC – Vapor Intrusion Guidance, Vapor Intrusion Mitigation Advisory
  - SF Regional Water Board – Environmental Screening Levels and Vapor Intrusion Framework

# Implementation

- **Training for Staff**
- **Training for regulated community**
- **Start using Interim Final during public comment period**
- **GeoTracker database development and use**

# Comments/Questions?

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