Methods to Assess VI

- Indoor Air Sampling
- Predictive Modeling
- Measure Flux Directly
- Soil Gas Sampling
- Supplemental Tools/Data

Fundamental Problems

- Vapor Intrusion is Tricky & Sticky
  - Regulations inconsistent & contradictory
  - Very site-specific
  - Generally takes lots of time
- General Lack of Expertise
  - Consultant, regulator, subs, public
  - Needlessly doing things (wrong levels)
- Ultra-Conservative Levels Means More Sites
  - 100x-1000x lower than soil & water MCLs
  - Can’t use soil data

Ingredients for Effective VI Assessments

- Investigatory Approach
- Determine Correct Screening Levels
- Sample & Analyze Properly
- Know & Use Supplemental Tools
- Demonstrating Bioattenuation

Some Key VI Assessment Issues

- Experience of the Collector/Consultant
  - Have they done this before?
  - Do they understand RBSLs?
  - Quality/experience of field staff? Sr or Jr?
- Get Enough Data Near/Around/Under
- Legal Perspective
  - How conservative to be or not be?

Approach Generalizations

- Indoor Air
  - Always find something
  - Multiple sampling rounds: time consuming & expensive
- Groundwater Data
  - Typically over-predicts risk
- Soil Gas Data
  - Transfer rate unknown
- Sub-slab Soil Gas Data
  - Transfer rate unknown
  - Intrusive

Indoor Air Measurement

- Pros:
  - Actual Indoor Concentration
- Cons:
  - Where From?
    - Inside sources (smoke, cleaners)
    - Outside sources (exhaust, cleaners)
  - No Control
  - Higher chance of false positives
  - Snapshot, limited data points
  - Expensive!!

Groundwater Data

- Preexisting Data Often Exist
  - Over proper well screen interval?
  - Coverage typically limited; interpolation
- Gather New Data
  - Well location, construction, sampling
- Perched/clean water layer?
- Likely Will Over-predict VI Risk

Soil Phase Data

- Soil data generally not acceptable in VI Assessment
- Existing soil data – line of evidence
  - Can “screen in” sites
  - Cannot be used alone to “screen out” sites
- Convert to soil gas concentrations
  - Partitioning equations exist. Likely overestimate.

Modeling

- Pros:
  - Can Use GW, Soil (?), Soil Gas Data
  - Relatively Easy
- Cons:
  - Which Version to Use?
  - No Validation – Erroneous Conclusions
  - Often Too Restrictive
  - Can Tweek to Your Pleasure

How Well Does J-E Predict?
(From GW & Soil Data)

- Hydrocarbons
  - Calculated SG value too high by 10-1000x
  - No bioattenuation (10 to 1000x reduction)

  OVER PREDICTS IN ALMOST ALL CASES

- Chlorinated Solvents – Deep Source
  - Calculated SG value too high by 10-1000x

  OVER PREDICTS IN MOST CASES

- Chlorinated Solvents – Surface Source
  - Calculated SG value too low by 10-1000x

  UNDER PREDICTS IN MOST CASES

Direct Flux Measurement
(Flux Chambers)

- Pros:
  - Direct Measurement of Intrusion
- Cons:
  - Proper Location?
  - Protocols Debated
  - How to Use Data?
  - Unsophisticated Audience
  - Regulatory Acceptance Limited

Static Flux Chamber

Soil Gas Measurement

- Pros:
  - Representative of Subsurface Processes
  - Higher Fail Levels
  - Relatively Inexpensive
  - Can Give Real-time Results
- Cons:
  - Transfer Rate Unknown
  - Overly Restrictive Default Criteria
  - Protocols still debated

Currently Most Preferred Approach

Which Soil Gas Method?

- Active?
- Passive? (limited use)
- Flux Chambers? (limited use)

Active method most often employed for VI

VI Requires Much Lower DLs

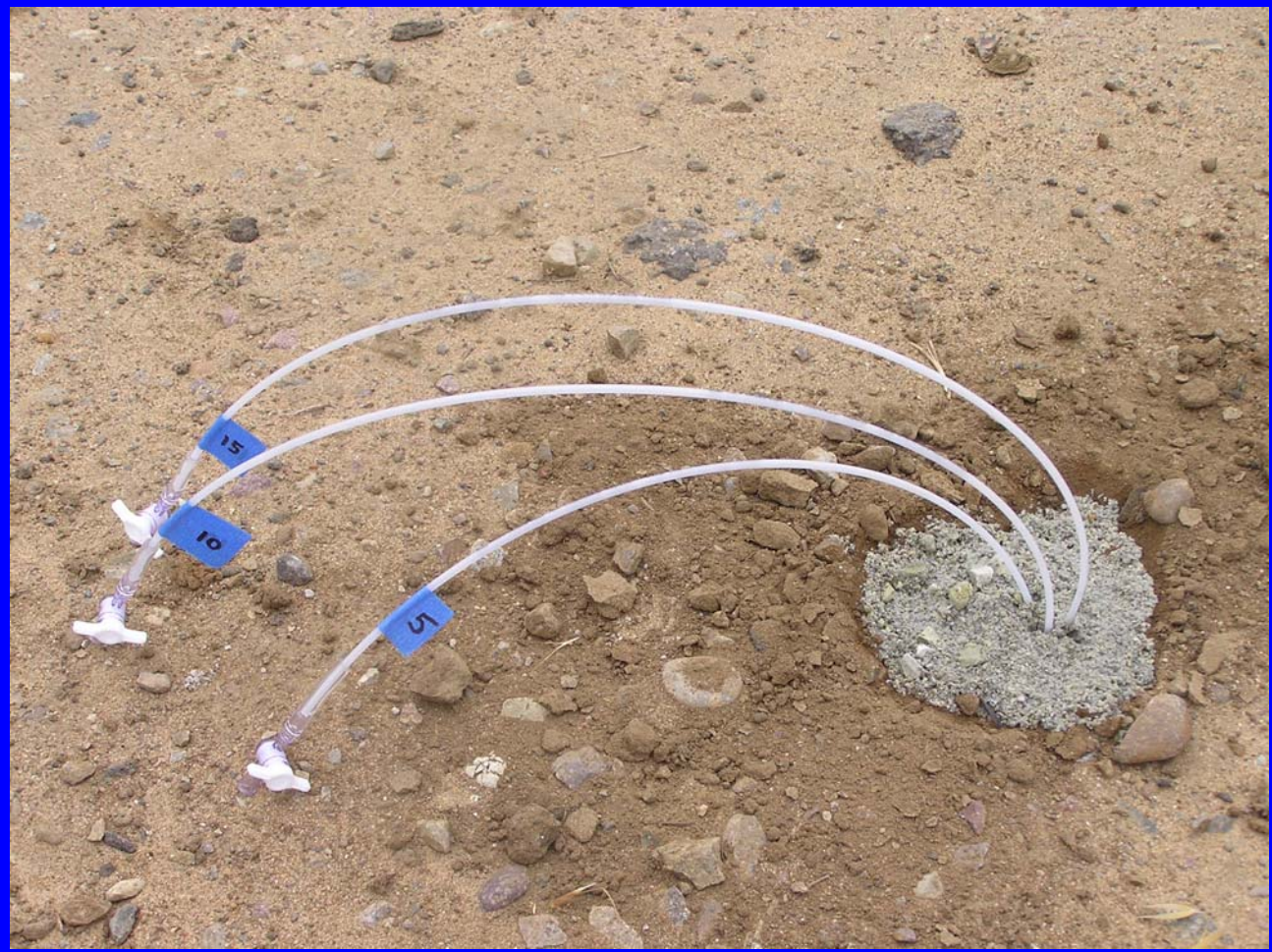
- Typical Soil Gas Concentrations
  - MTBE & Benzene near gasoline soil: >100 ug/L
  - PCE under dry cleaner: >100 ug/L
- Soil Gas Levels a Threat to GW:
  - MTBE: >10 ug/L
  - BTEX/PCE: >100 ug/L
- Soil Gas Levels "Failing" EPA VI Criteria
  - Subslab: Benzene: 0.003 ug/L, PCE: 0.008 ug/L
  - At 5': Benzene: 0.15 ug/L, PCE: 0.400 ug/L

Probe Installation Methods

- Driven Probe/Rod Methods
  - Hand Equipment, Direct-Push
  - Collect sample while probe in ground
- Vapor Mini-Wells/Implants
  - Inexpensive & easy to install/remove
  - Allow repeated sampling
  - Near surface & deep (down auger flights)
  - Can “nest” in same bore hole

Sampling Through Rod

Soil Vapor Implants



Probe Considerations

- Tubing Type
  - Rigid wall tubing ok (nylon, teflon, SS)
  - Flexible tubing not (tygon, hardware store)
  - Small diameter best (1/8” or ¼”)
- Probe Tip
  - Beware metal tips (may have cutting oils)
- Equilibration Time
  - Effects by air knife, rotary, air percussion, sonic
- Equipment Blanks
  - Need to collect blank through collection system

Soil Gas Sampling Issues

- Sample Size
  - Greater the volume, greater the uncertainty
  - Smaller volumes faster & easier to collect
- Containers
  - Canisters: More blank potential. Higher cost
  - Tedlars: Good for ~2 days. Easier to collect
- Flow Rate
  - Really not imp. But most agencies < 200 ml/min
- Tracer/Leak Compound
  - Crucial for sub-slab & larger sample volumes
  - Gases (He, SF6, Propane) & Liquids (IPA)

Sample Volumes

Sample Collection

Sample Collection

Sample Transfer

Soil Gas Analysis Issues
(TO-14/15 or 8260 or 8021)

- All Methods Give Reliable Results
- Some States Require TO-15
- Detection Level Discriminator:
  - TO Methods: <1 to 1 ug/m^3
  - 8021: 2-5 ug/m^3
  - 8260: 10-100 ug/m^3
- On-Site Analysis:
  - Extremely Helpful for VI
  - Minimizes False Positives

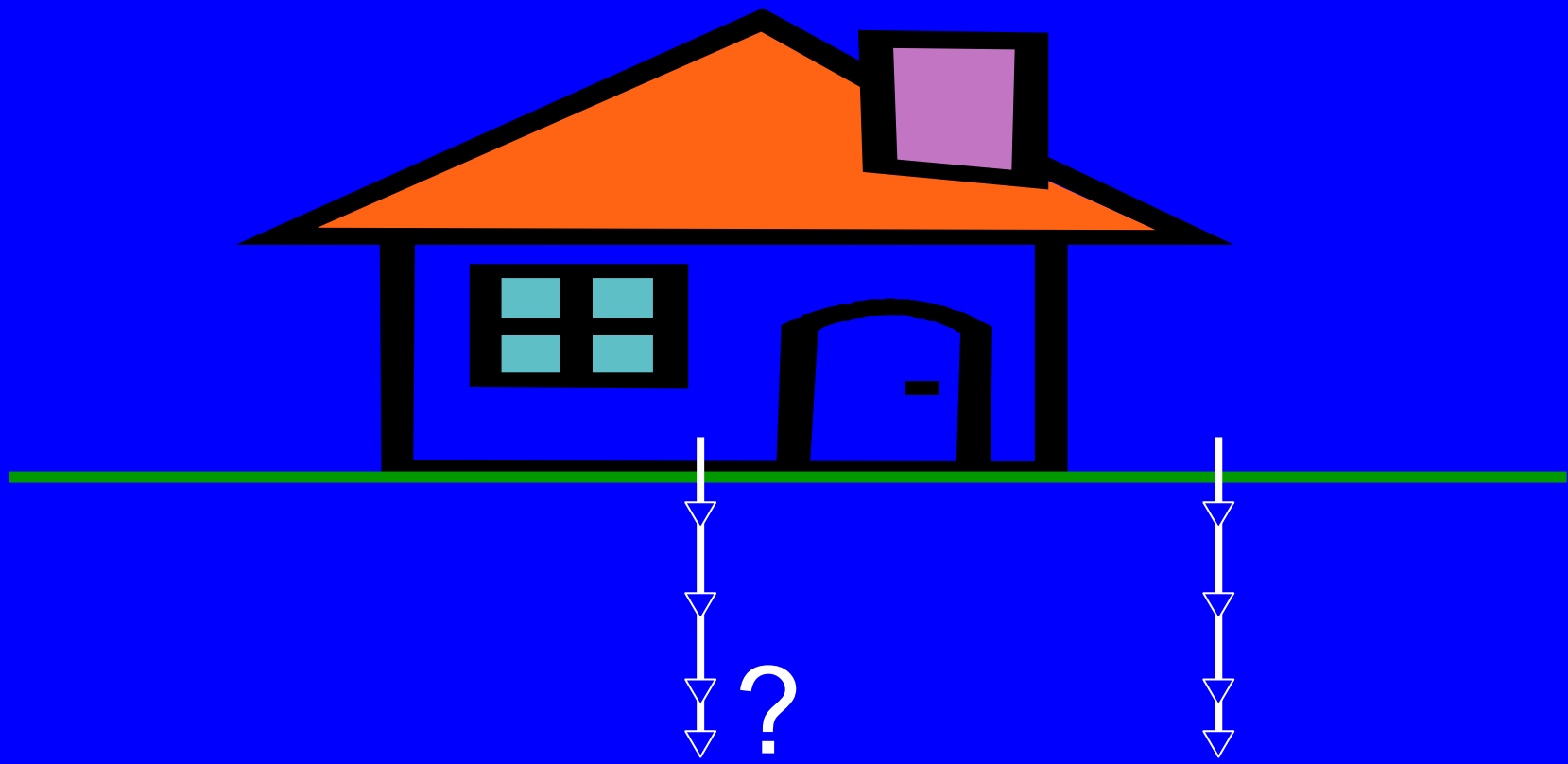
New Advance for Indoor Air On-site TO-15 Scan/SIM

- Simultaneous Scan/SIM mode enables

  <10 ug/m3 for All VOCs &

  < 2 ug/m3 for subset of compounds.
- Only 2cc of Sample. Eliminates Hardware
- Real-time Analysis in Structures: Control!
- Already in CA

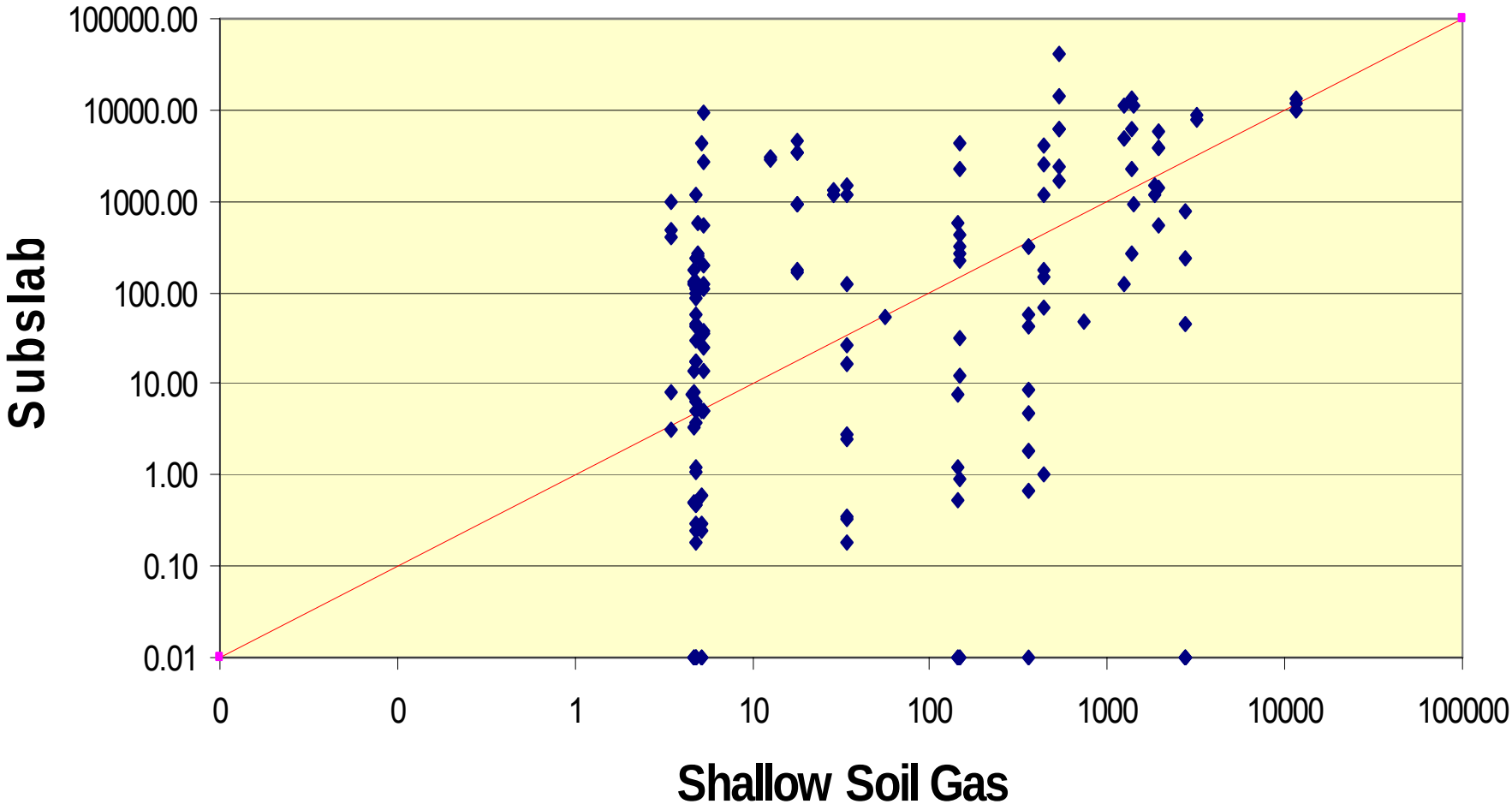
Sub-Slab vs. Near-Slab Samples



Sub-Slab vs. Near-Slab

- EPA & Some States Prefer Sub-slab
  - "Ponding" effect under slab?
  - Balls don't run uphill
- Good Comparison Database Lacking
- Very Intrusive. Attorney Time.
- If O_2 High Around Slab, Near-slab OK
- For Cl-HCs, at GW or mid-way to GW

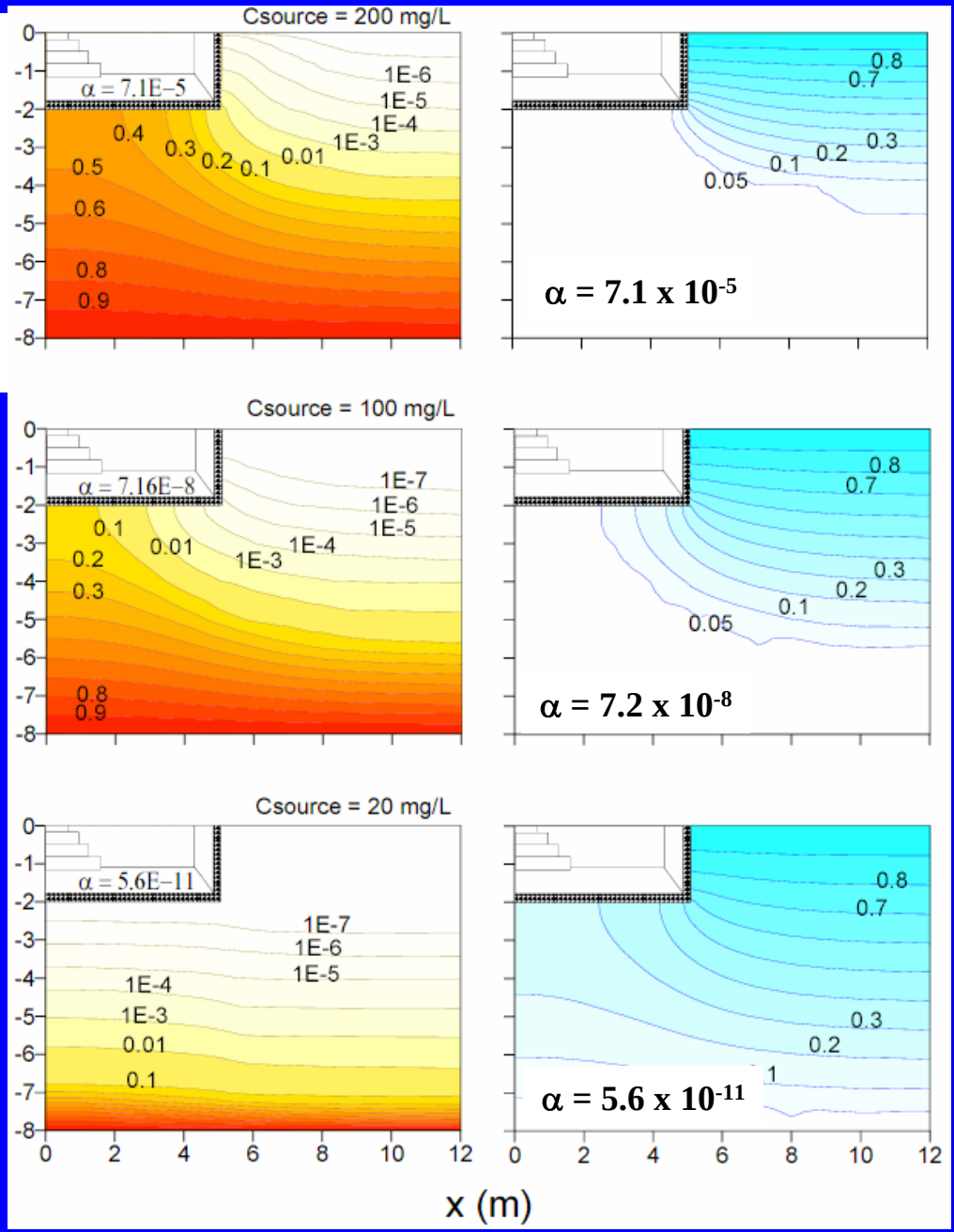
Shallow Soil Gas vs Subslab
TCE ug/m3



Effect of Source Concentration

[$\lambda = 0.18\ h^{-1}$]

Results suggest that there may be source vapor concentrations that are of little concern if soil gas beneath the foundation is well-oxygenated (e.g., groundwater plume sources)

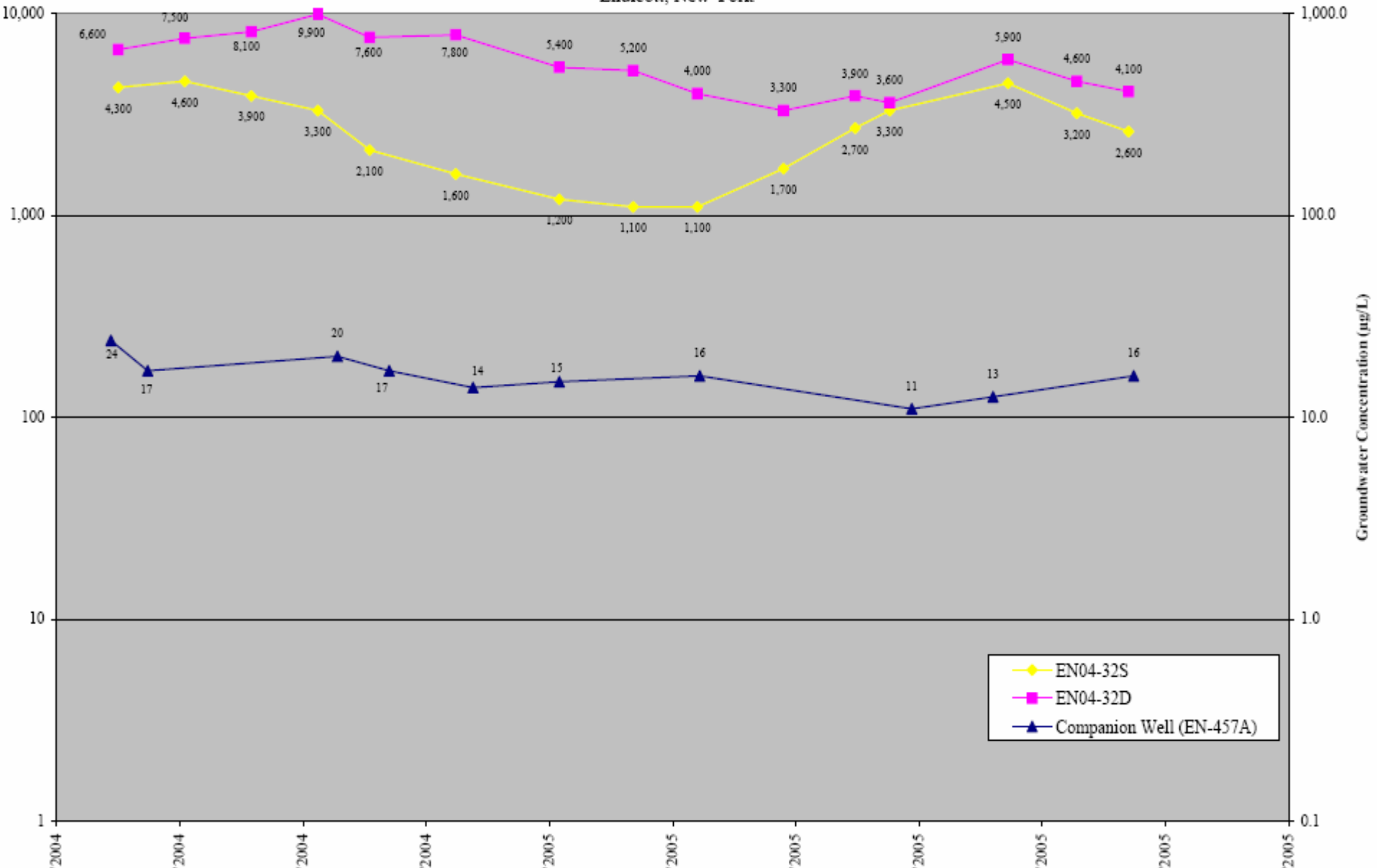


How Often to Sample?

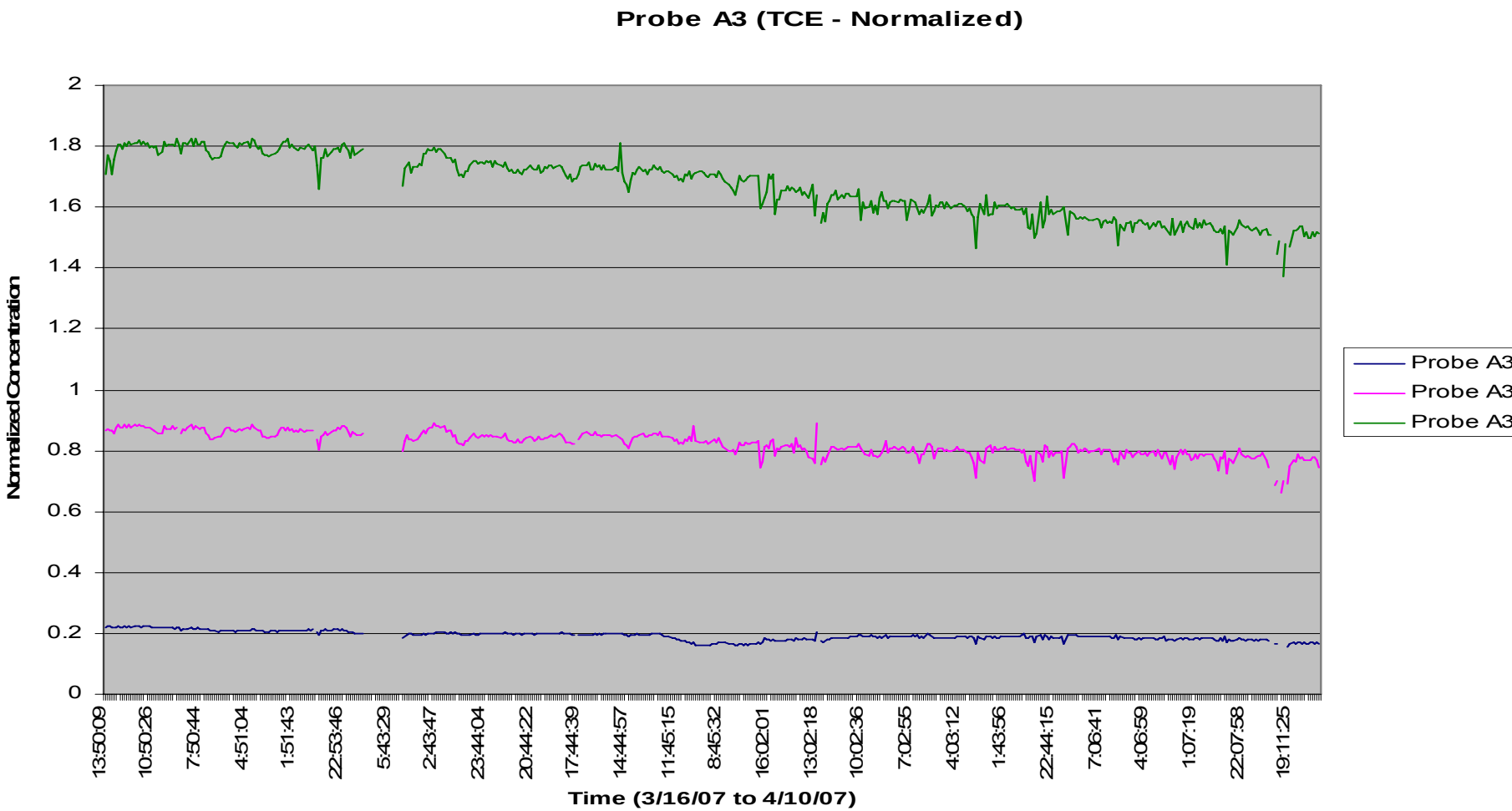
- Depth Below Surface
  - 3’ to 5’ bgs generally considered stable
  - Temporal Studies Ongoing
- Seasonal Effects – How Important?
  - Most studies show less than 5x
- Extreme Conditions?
  - Heavy rain
  - Extreme heating/cooling

Why Spend the $?

Figure B.32
TCE in Soil Vapor and Groundwater
Quarterly Report - Soil Vapor Monitoring
Comprehensive Operations, Maintenance, & Monitoring Program
Endicott, New York



Soil Gas Temporal Study



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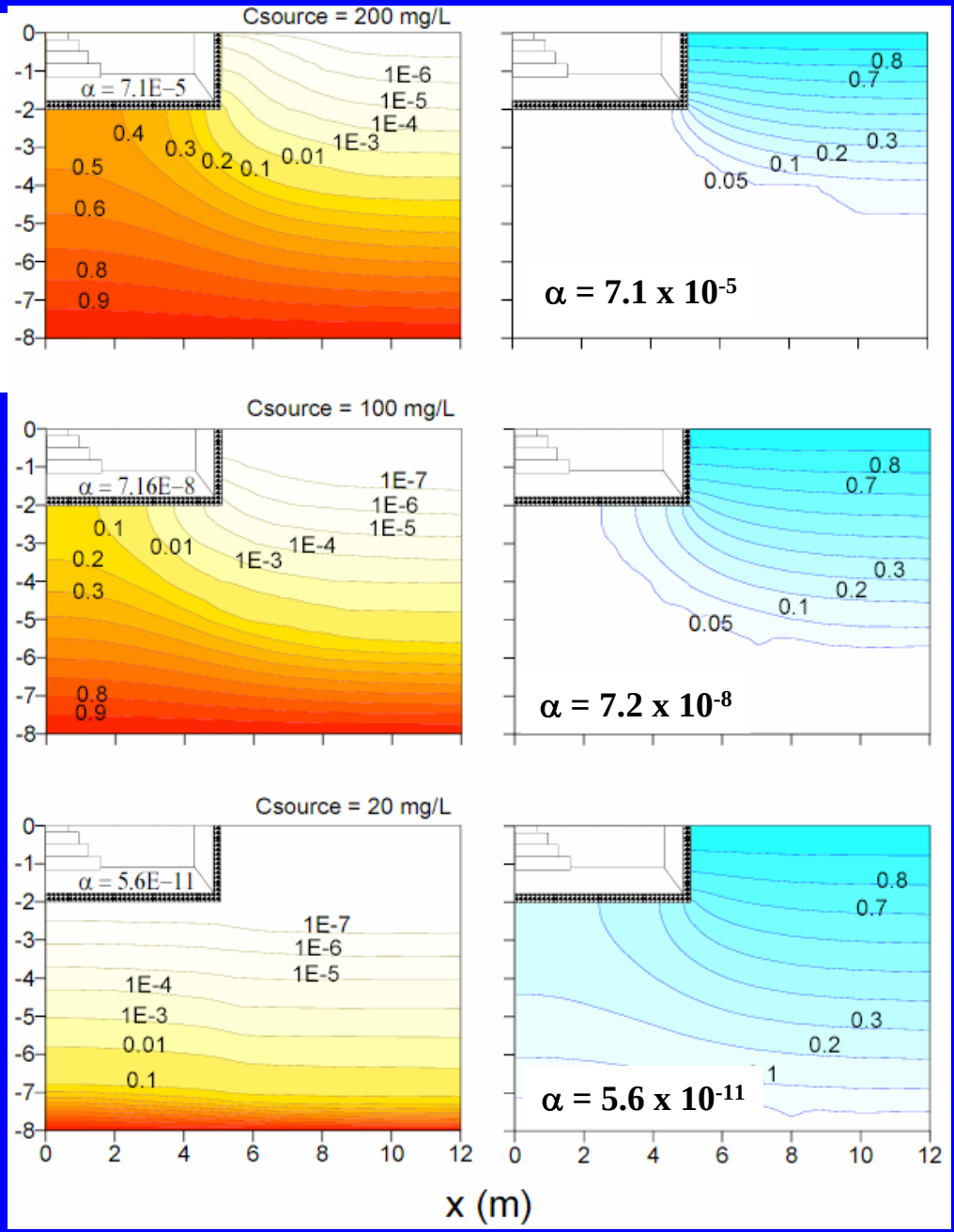
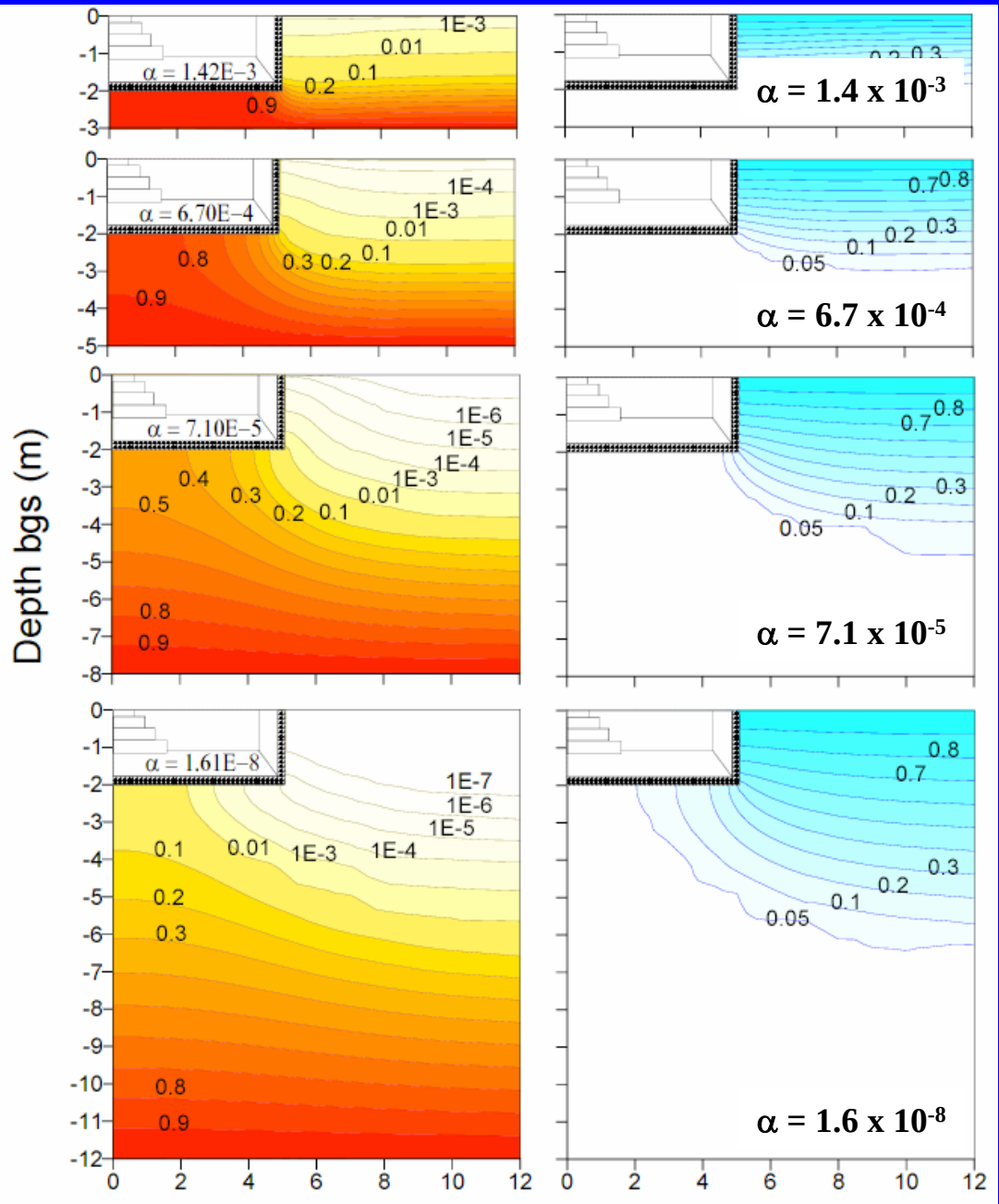


Effect of Depth on α

[λ = 0.18 h^{-1}]

Results suggest that, for a given source vapor concentration, there may be a critical depth beyond which vapor migration is of little concern



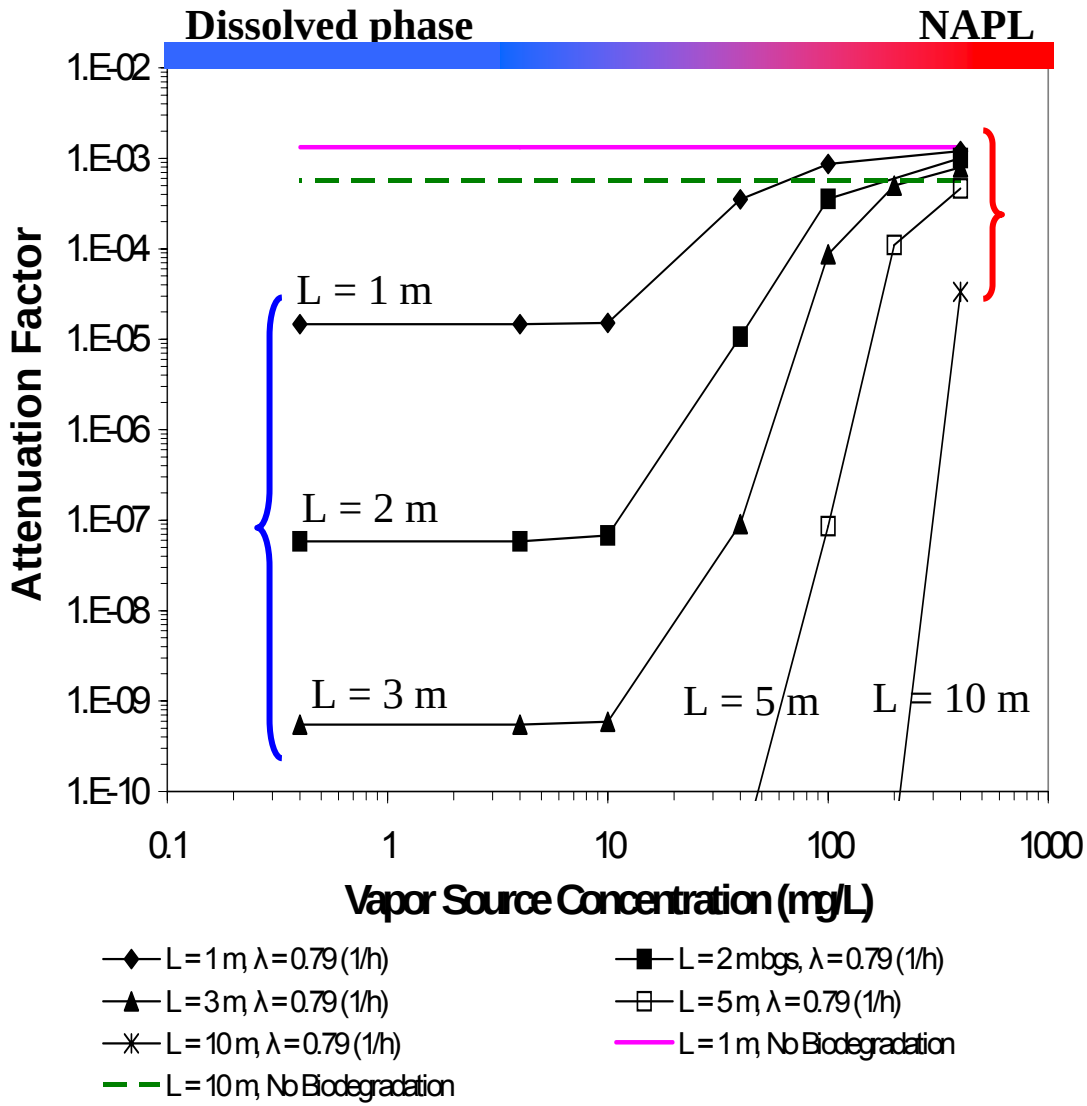
Modeling Assumptions:

- **Benzene source**
- **Sand soil**
- **Basement scenario**
- **$\lambda = 0.79\ h^{-1}$**

Biodegradation is likely to have a significant effect on α for non-NAPL sources

For NAPL sources, effect of biodegradation on α may be minimal due to oxygen depletion

L: source-foundation distance



Supplemental Tools/Data

- Site Specific Alpha Using Radon
  - Factor of 10 to 100. $100/sample
- Indoor Air Ventilation Rate
  - Factor of 2 to 10. <$1,000 per determination.
- Real-Time, Continuous Analyzers
  - Can sort out noise/scatter
- Pressure Measurements
  - Can help interpret indoor air results

Practical Strategies
(Things to Do)

- Use Reasonable RBSLs
- Have Reasonable Distance Criteria
- Get Enough Data
- Allow Less Expensive Methods (8021, 8260)
- HCs: Vertical Profiles Around Structure
- Use Radon for Slab-Specific Alpha
- Measure Ventilation Rate
- Have Competent Consultants & Subs
- Check Your Units!!!!!!!!!!!

VI Documents

- Overview of SV Methods (www.handpmg.com)
  - LustLine Part 1 - Active Soil Gas Method, 2002
  - LustLine Part 2 - Flux Chamber Method, 2003
  - LustLine Part 3 - FAQs October, 2004
  - LustLine Part 4 – Soil Gas Updates, Sept 2006
- Other
  - ITRC VI Guidance (www.itrcweb.org)
  - Robin Davis Lustline Article on Bioattenuation (Lustline March 2006, www.neiwpcc.org)

Existing Documents & Training

- Soil Gas Sampling SOPs
  - Soil Gas Sampling, Sub-slab Sampling, Vapor Monitoring Wells/Implants, Flux Chambers (www.handpmg.com)
  - EPA-ORD Sub-slab SOP–Draft, Dr. Dom DiGuilio (www.iavi.rti.org/resources)
- Other
  - API Soil Gas Document (www.api.org/bulletins)
  - Robin Davis Lustline Article on Bioattenuation (Lustline June 2006, www.neiwpcc.org)

VI Websites & Links

- www.handpmg.com
  - Soil Gas Information
  - Other Site Assessment Methods
  - Articles & Presentations
- www.itrcweb.org
- www.api.org
- http:iavi.rti.org

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