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VAPOR INTRUSION

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Vapor Intrusion Forensic Analysis

presented by | Justin Knight, P.E.
Atlanta, GA

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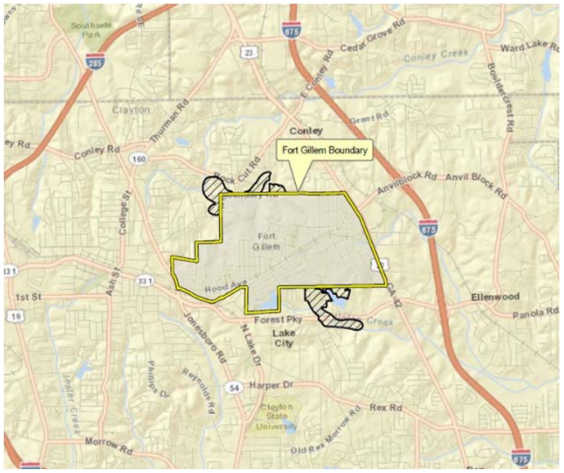
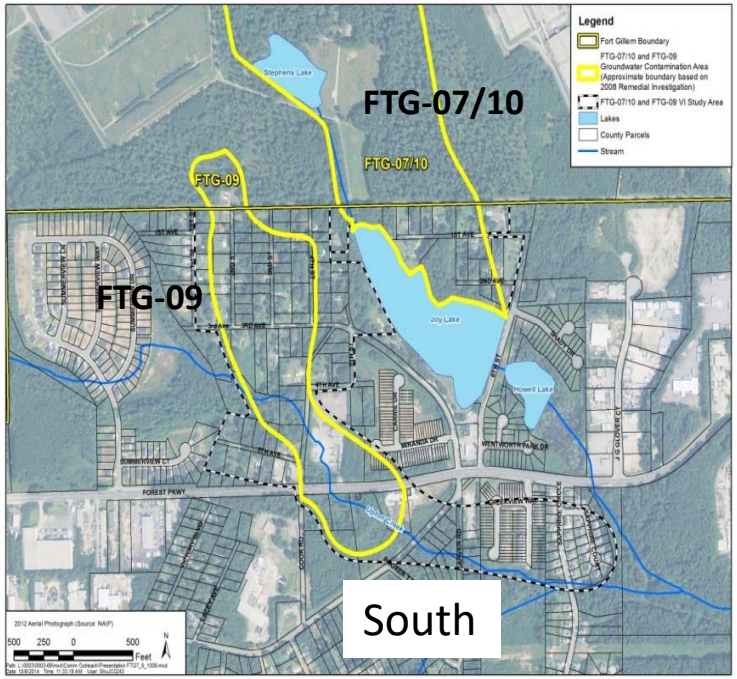
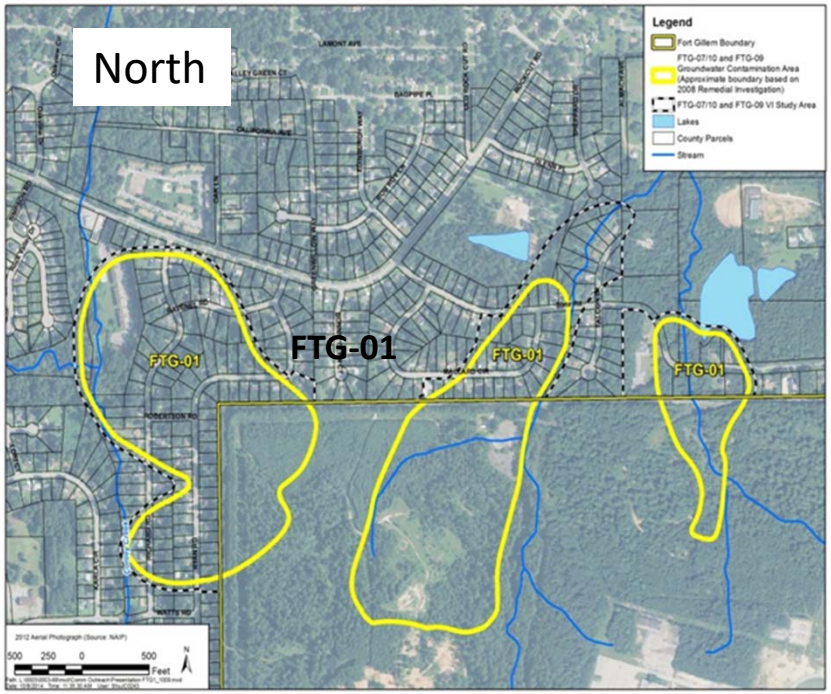
Large-Scale Residential Study

- Multiple GW plumes
- >300 buildings
- Building access challenges
- Regulatory pressures to sample IA







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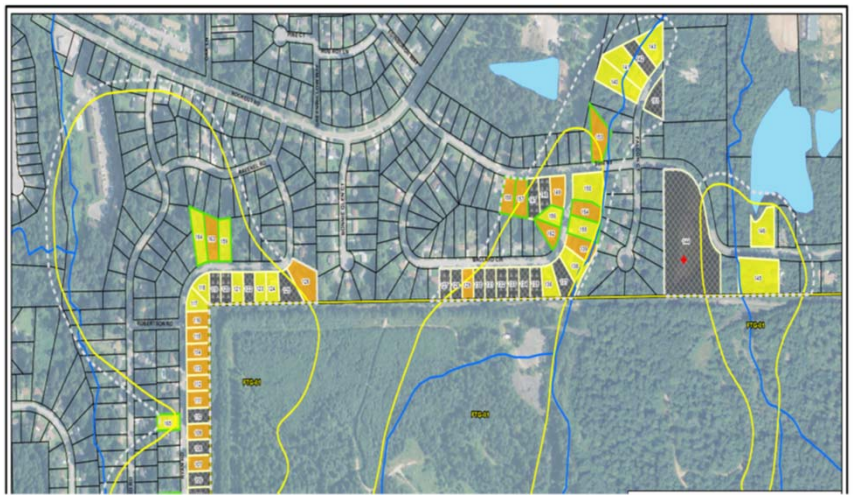
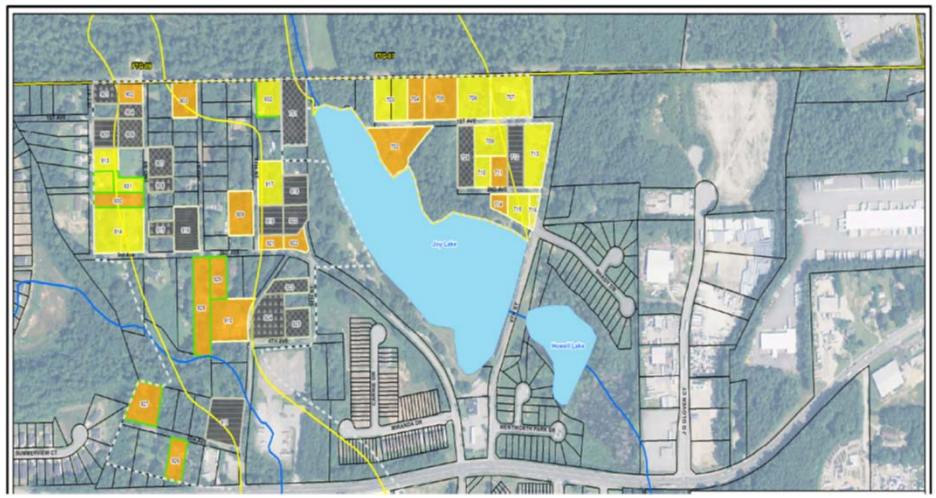
Sample Set 1 Results – VOCs Everywhere?!!

Media sampled: Indoor air, Sub-slab soil gas, Crawl Space air, Outdoor (Ambient) air

68 of 69 homes sampled had exceedances in indoor air

TCE, PCE, TMBs, 1,4-DCB, 1,1,2,2-TeCA, naphthalene, chloroform, benzene, carbon tetrachloride





In the News….

Toxic chemicals found in homes near Fort Gillem

NEWS By Shannon McCaffrey - The Atlanta Journal-Constitution

Fort Gillem: Toxic vapor

GEORGIA HEADLINES September 16, 2014 WABE 0 Comments

State environmental officials say the U.S. Army has not fulfilled a commitment to help residents of 26 homes that have tested positive for toxic vapor near Fort Gillem.

Georgia DNR: Army Has Yet to Address Toxic Vapor Found in Homes Near Fort Gillem

By MICHELLE WIRTH • SEP 15, 2014

First-ever RCRA "imminent and substantial endangerment" Order for Vapor Intrusion

Letter Health Consultation

Vapor Intrusion Investigation

FORT GILLEM SITE – PRIDE AND JOY DAYCARE

MORROW, CLAYTON COUNTY, GEORGIA

Off-Post Contamination a Serious Concern at Ft. Gillem, Georgia

By Lenny Siegel
February, 2015

CLAYTON COUNTY NAACP & OTHERS TO HOST VAPOR INTRUSION COMMUNITY FORUM FOR FORT GILLEM AREA RESIDENTS

Posted Tuesday, November 25, 2014

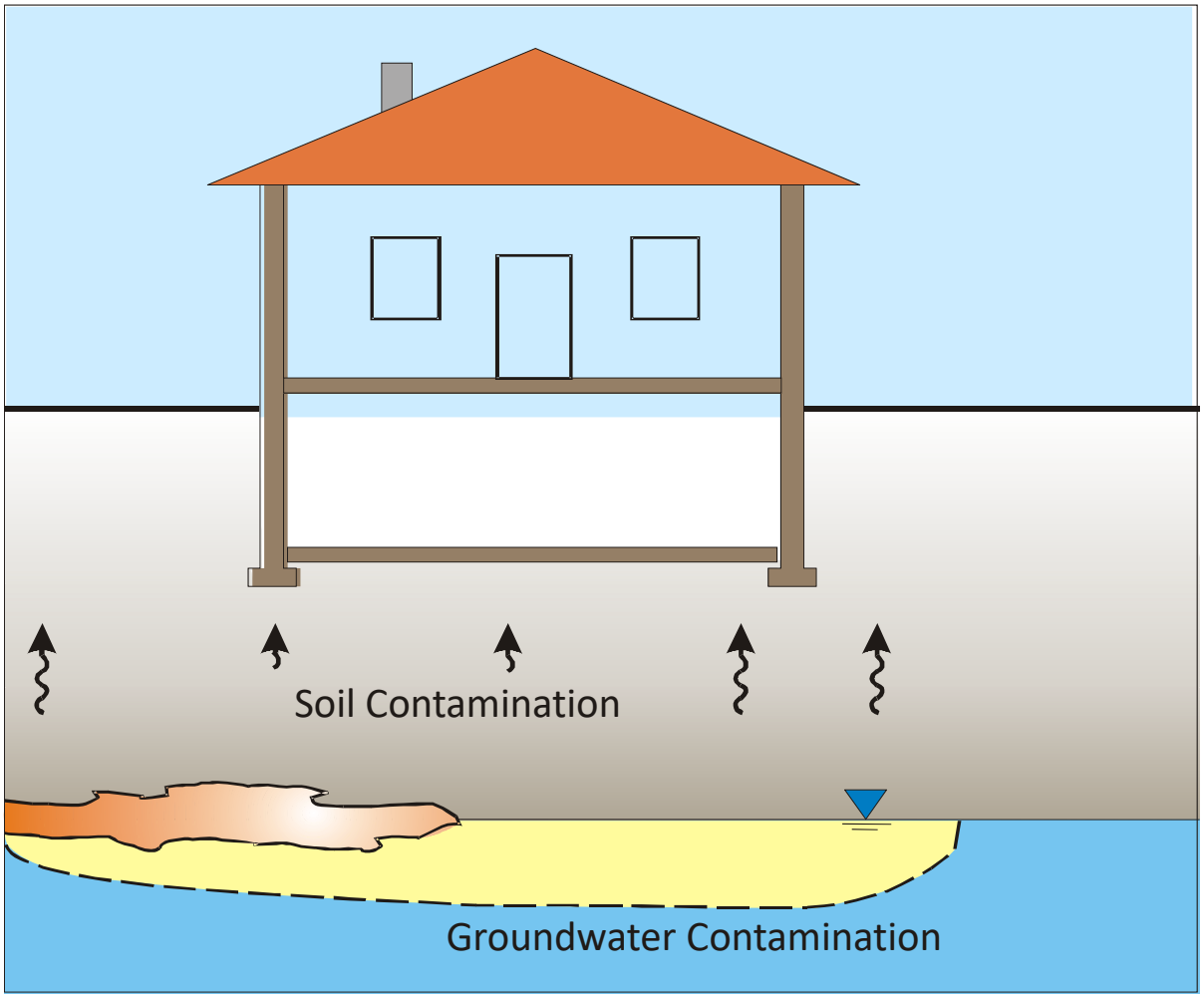
Political and Regulatory Pressure

- Secretary of the Army receives **letter from USEPA HQ** expressing "**data confirms the presence of VOCs in residential homes**" and concerns "that **the Army is endangering residents of Forest Park, Georgia**...."
- Secretary of Army receives **letter from Governor Nathan Deal** that directs the Army to expedite sampling
- **USEPA issues a RCRA Section 7003 Unilateral Administrative Order (UAO) to Fort Gillem** requiring specific actions related to VI.

Approach for VI Forensics

- VI-CSM
- Mitigation
- Building Inventories and Source Removal
- Desktop Forensic Study for Preliminary Evaluation
- Field Forensics for Secondary Evaluation

Importance of a Vapor Intrusion Conceptual Site Model


Soil Contamination
Groundwater Contamination

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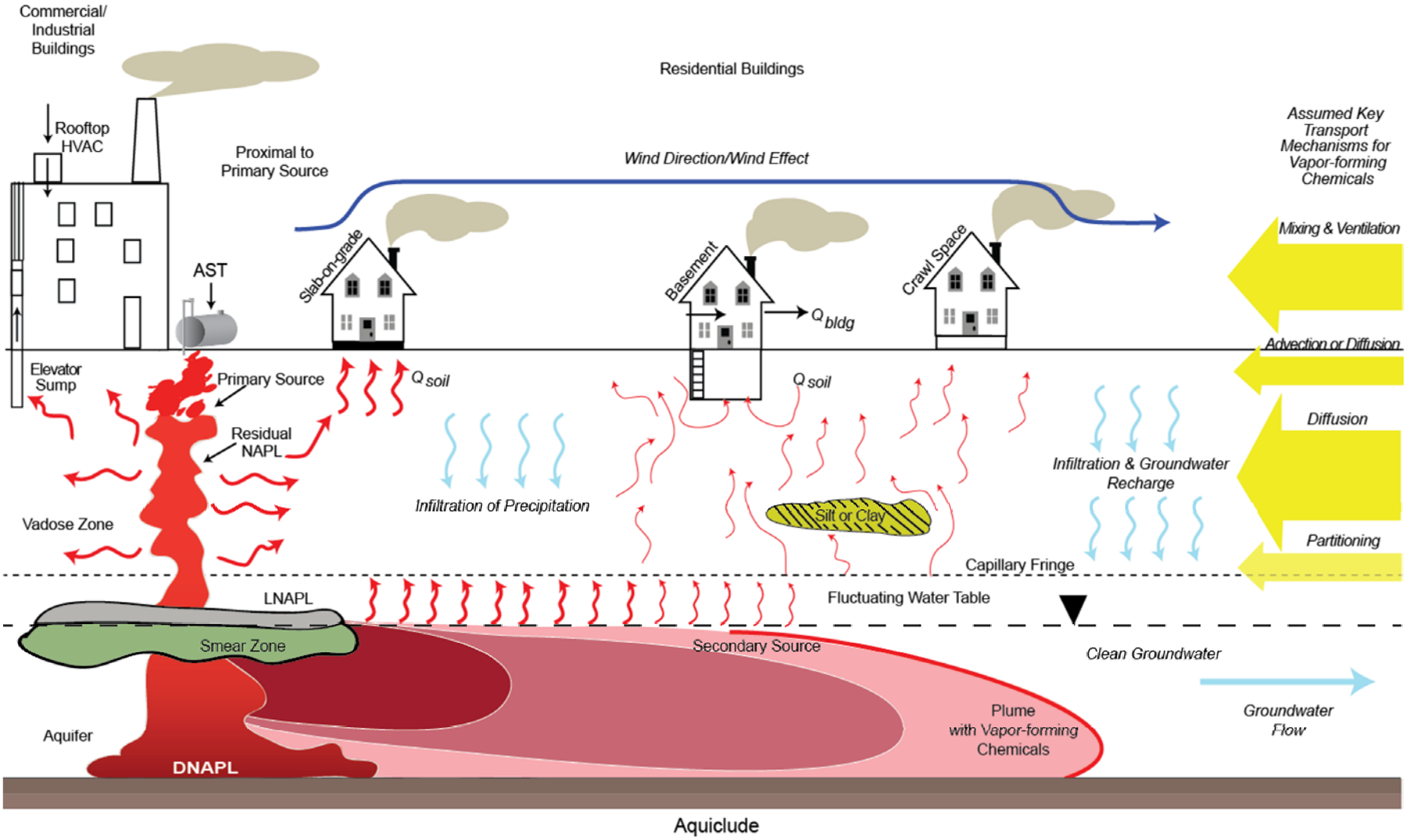

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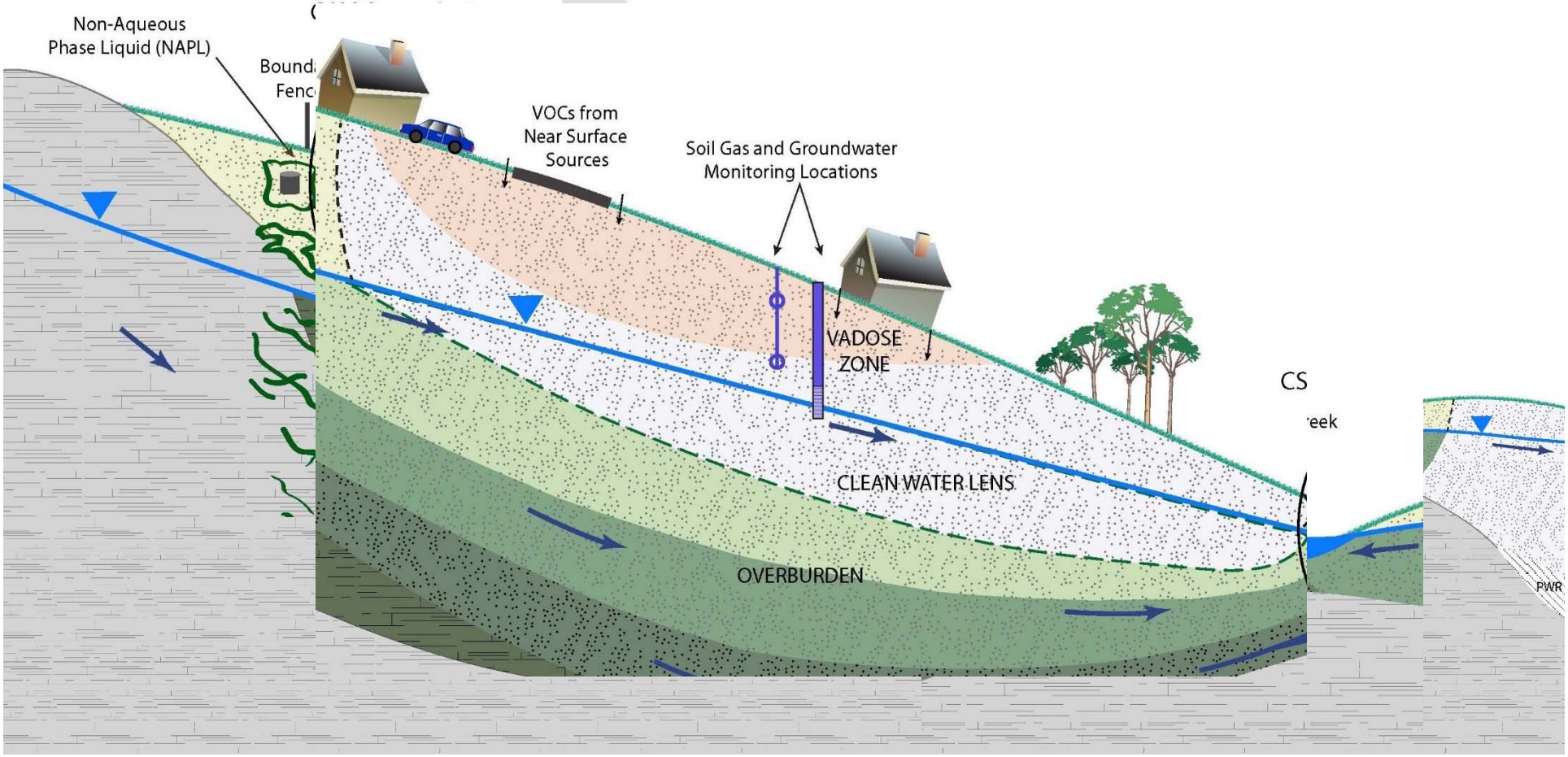

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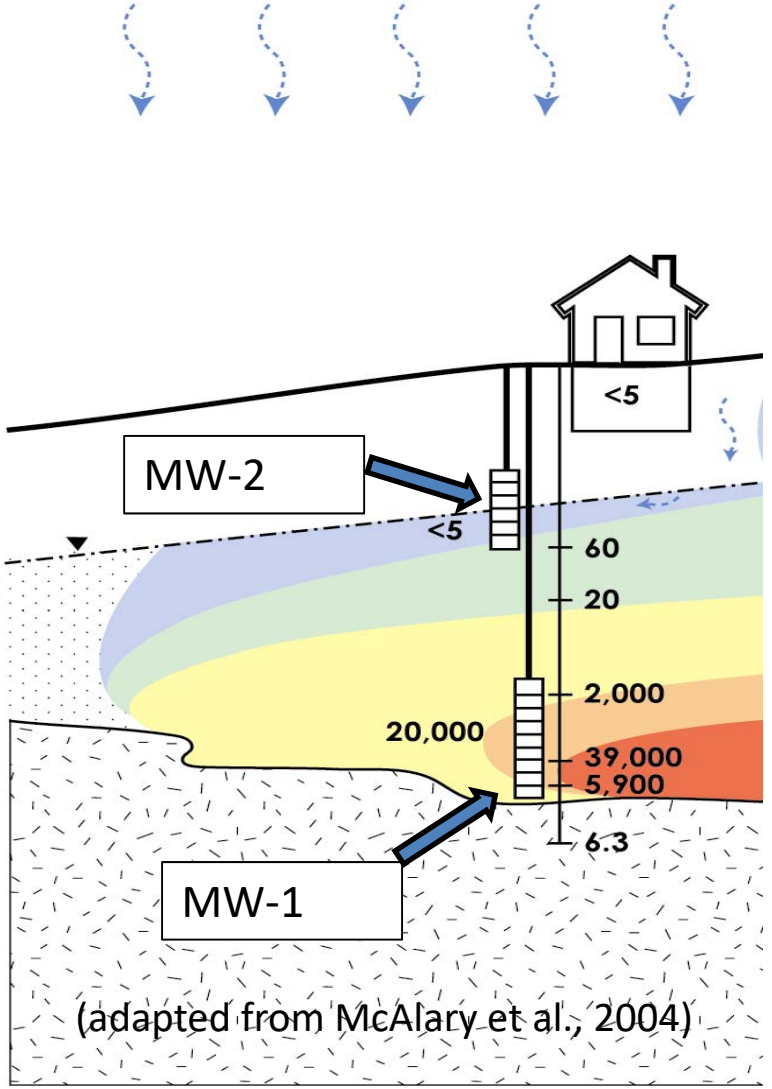
Why Shallow Groundwater Samples Matter

- Monitoring wells are installed to delineate plumes, not for VI
- What would you conclude from MW-1 data?
- Install a screen @WT MW-02



Distinguishing Background Contamination from Vapor Intrusion Contamination

(Mickunas, 2004)

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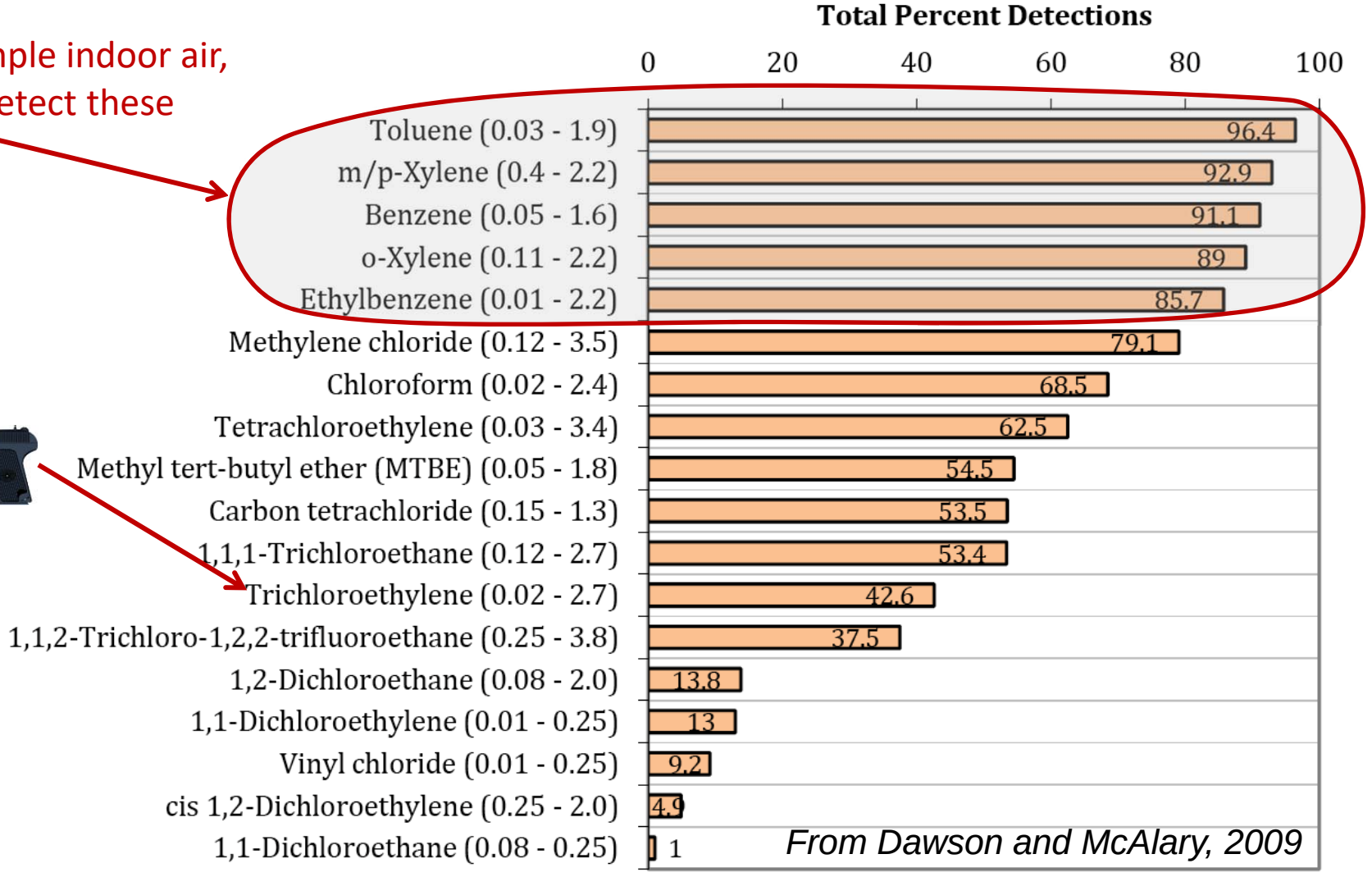
How Frequently do we Detect Background Sources?

If you sample indoor air, you will detect these



From Dawson and McAlary, 2009

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Household Products Database

householdproducts.nlm.nih.gov

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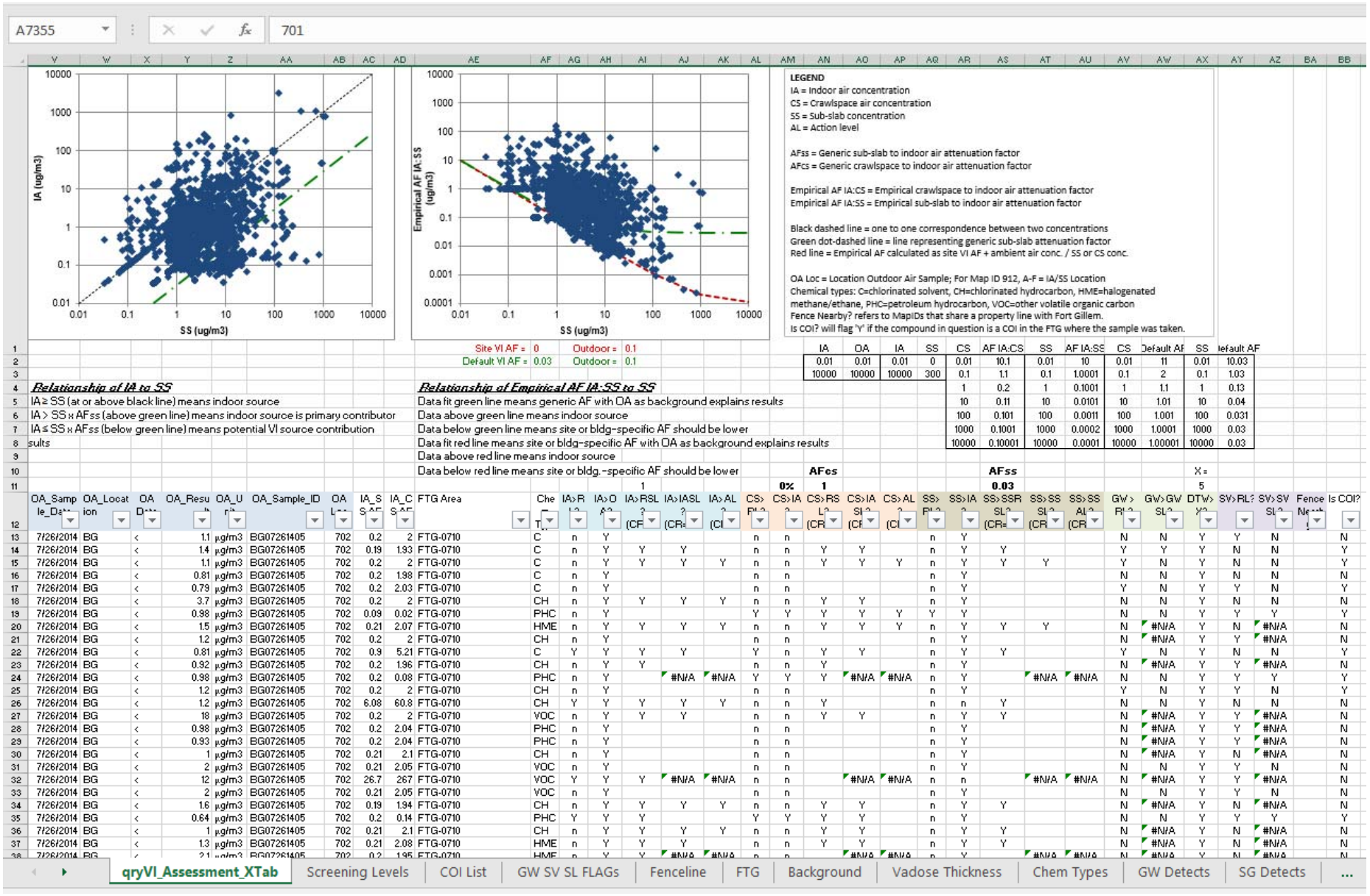
Example:

- Rental Property
- Crawl Space home
- Moved due to VI Concerns
- Media
- Used mothballs in planter beds
- Second event – empty house

Desktop Methods Used to Distinguish Background from VI

Desktop Methods to Distinguish Background from VI

- So how do you make sense of a large data set in a timely manner?
  - Built database (DB) modeled after EPA DB – (Helen Dawson, USEPA → Geosyntec)
  - Use Excel charts to examine ratios and building specific attenuation factors


A7355
701
IA (ug/m3)
SS (ug/m3)
Empirical AF IA:SS (ug/m3)
SS (ug/m3)
LEGEND
IA = Indoor air concentration
CS = Crawlspace air concentration
SS = Sub-slab concentration
AL = Action level
AFss = Generic sub-slab to indoor air attenuation factor
AFcs = Generic crawlspace to indoor air attenuation factor
Empirical AF IA:CS = Empirical crawlspace to indoor air attenuation factor
Empirical AF IA:SS = Empirical sub-slab to indoor air attenuation factor
Black dashed line = one to one correspondence between two concentrations
Green dot-dashed line = line representing generic sub-slab attenuation factor
Red line = Empirical AF calculated as site VI AF + ambient air conc. / SS or CS conc.
OA Loc = Location Outdoor Air Sample; For Map ID 912, A-F = IA/SS Location
Chemical types: C=chlorinated solvent, CH=chlorinated hydrocarbon, HME=halogenated methane/ethane, PHC=petroleum hydrocarbon, VOC=other volatile organic carbon
Fence Nearby? refers to MapIDs that share a property line with Fort Gillem.
Is COI? will flag 'Y' if the compound in question is a COI in the FTG where the sample was taken.
Site VI AF = 0 Outdoor = 0.1
Default VI AF = 0.03 Outdoor = 0.1
Relationship of IA to SS
IA ≥ SS (at or above black line) means indoor source
IA > SS x AFss (above green line) means indoor source is primary contributor
IA ≤ SS x AFss (below green line) means potential VI source contribution
sults
Relationship of Empirical AF IA:SS to SS
Data fit green line means generic AF with OA as background explains results
Data above green line means indoor source
Data below green line means site or bldg-specific AF should be lower
Data fit red line means site or bldg-specific AF with OA as background explains results
Data above red line means indoor source
Data below red line means site or bldg.-specific AF should be lower
IA OA IA SS CS AF IA:CS SS AF IA:SS CS Default AF SS Default AF
0.01 0.01 0.01 0 0.01 10.1 0.01 10 0.01 11 0.01 10.03
10000 10000 10000 300 0.1 1.1 0.1 1.0001 0.1 2 0.1 1.03
1 0.2 1 0.1001 1 1.1 1 0.13
10 0.11 10 0.0101 10 1.01 10 0.04
100 0.101 100 0.0011 100 1.001 100 0.031
1000 0.1001 1000 0.0002 1000 1.0001 1000 0.03
10000 0.10001 10000 0.0001 10000 1.00001 10000 0.03
AFcs 1
0% 1
AFss 0.03
X = 5
OA_Sample_Date OA_Location OA_Result OA_Sample_ID FTG Area Chemical Type
7/26/2014 BG < 1.1 µg/m3 BG07261405 702 0.2 2 FTG-0710 C n Y
7/26/2014 BG < 1.4 µg/m3 BG07261405 702 0.19 1.93 FTG-0710 C n Y Y Y Y n n Y Y n Y Y Y N N Y
7/26/2014 BG < 1.1 µg/m3 BG07261405 702 0.2 2 FTG-0710 C n Y Y Y Y n n Y Y Y n Y Y Y Y N N Y
7/26/2014 BG < 0.81 µg/m3 BG07261405 702 0.2 1.98 FTG-0710 C n Y n n n Y N N Y N N N
7/26/2014 BG < 0.79 µg/m3 BG07261405 702 0.2 2.03 FTG-0710 C n Y n n n Y Y N Y Y N Y
7/26/2014 BG < 3.7 µg/m3 BG07261405 702 0.2 2 FTG-0710 CH n Y Y Y Y n n Y Y n Y N N Y N N N
7/26/2014 BG < 0.98 µg/m3 BG07261405 702 0.09 0.02 FTG-0710 PHC n Y n n Y Y Y Y Y Y Y N N Y Y Y Y
7/26/2014 BG < 1.5 µg/m3 BG07261405 702 0.21 2.07 FTG-0710 HME n Y Y Y Y n n Y Y Y n Y Y Y N #N/A Y N #N/A N
7/26/2014 BG < 1.2 µg/m3 BG07261405 702 0.2 2 FTG-0710 CH n Y n n n Y N #N/A Y Y #N/A N
7/26/2014 BG < 0.81 µg/m3 BG07261405 702 0.9 5.21 FTG-0710 C Y Y Y Y Y n Y Y n Y Y Y N N Y
7/26/2014 BG < 0.92 µg/m3 BG07261405 702 0.2 1.96 FTG-0710 CH n Y Y n n Y n Y N #N/A Y Y #N/A N
7/26/2014 BG < 0.98 µg/m3 BG07261405 702 0.2 0.08 FTG-0710 PHC n Y #N/A #N/A Y Y #N/A #N/A n Y #N/A #N/A N N Y Y Y Y
7/26/2014 BG < 1.2 µg/m3 BG07261405 702 0.2 2 FTG-0710 CH n Y n n n Y Y N Y Y N Y
7/26/2014 BG < 1.2 µg/m3 BG07261405 702 6.08 60.8 FTG-0710 CH Y Y Y Y Y n n Y n n Y N N Y N N N
7/26/2014 BG < 18 µg/m3 BG07261405 702 0.2 2 FTG-0710 VOC n Y Y Y n n Y Y n Y Y N #N/A Y Y #N/A N
7/26/2014 BG < 0.98 µg/m3 BG07261405 702 0.2 2.04 FTG-0710 PHC n Y n n n Y N #N/A Y Y #N/A N
7/26/2014 BG < 0.93 µg/m3 BG07261405 702 0.2 2.04 FTG-0710 PHC n Y n n n Y N #N/A Y Y #N/A N
7/26/2014 BG < 1 µg/m3 BG07261405 702 0.21 2.1 FTG-0710 CH n Y n n n Y N #N/A Y N #N/A N
7/26/2014 BG < 2 µg/m3 BG07261405 702 0.21 2.05 FTG-0710 VOC n Y n n n Y N N Y Y N N
7/26/2014 BG < 12 µg/m3 BG07261405 702 26.7 267 FTG-0710 VOC Y Y Y #N/A #N/A n n #N/A #N/A n n #N/A #N/A N #N/A Y Y #N/A N
7/26/2014 BG < 2 µg/m3 BG07261405 702 0.21 2.05 FTG-0710 VOC n Y n n n Y N N Y Y N N
7/26/2014 BG < 1.6 µg/m3 BG07261405 702 0.19 1.94 FTG-0710 CH n Y Y Y Y n n Y Y n Y Y N #N/A Y N #N/A N
7/26/2014 BG < 0.64 µg/m3 BG07261405 702 0.2 0.14 FTG-0710 PHC Y Y Y Y Y n Y Y n Y N N Y Y Y
7/26/2014 BG < 1 µg/m3 BG07261405 702 0.21 2.1 FTG-0710 CH n Y Y Y Y n n Y Y n Y Y N #N/A Y N #N/A N
7/26/2014 BG < 1.3 µg/m3 BG07261405 702 0.21 2.08 FTG-0710 HME n Y Y Y n n Y Y n Y Y N #N/A Y N #N/A N
7/26/2014 BG < 2.1 µg/m3 BG07261405 702 0.2 1.95 FTG-0710 HME n Y Y #N/A #N/A n n #N/A #N/A n Y #N/A #N/A N #N/A Y N #N/A N
qryVI_Assessment_XTab
Screening Levels
COI List
GW SV SL FLAGS
Fenceline
FTG
Background
Vadose Thickness
Chem Types
GW Detects
SG Detects
...

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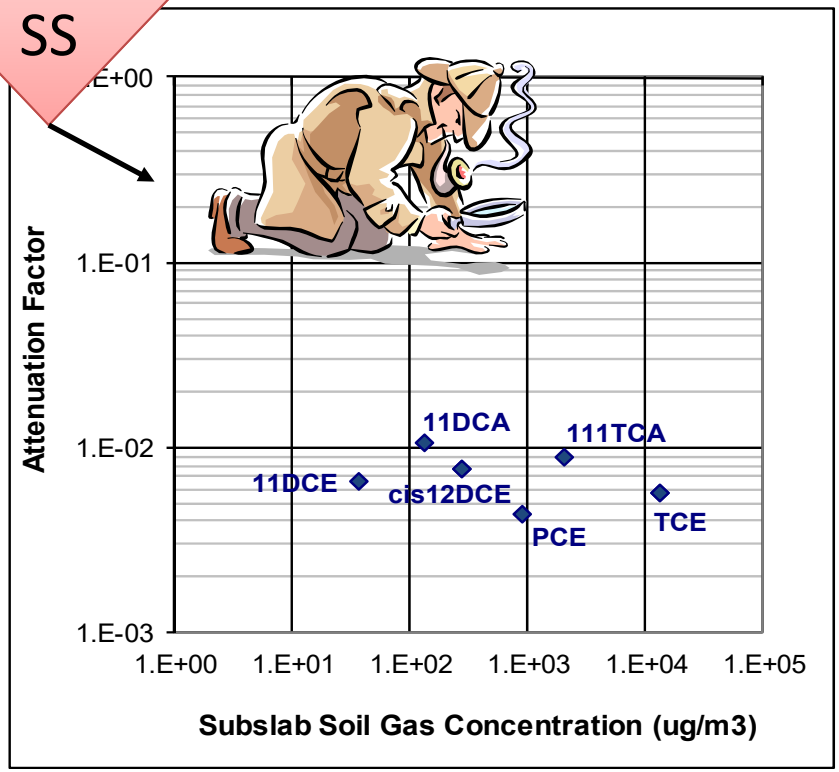
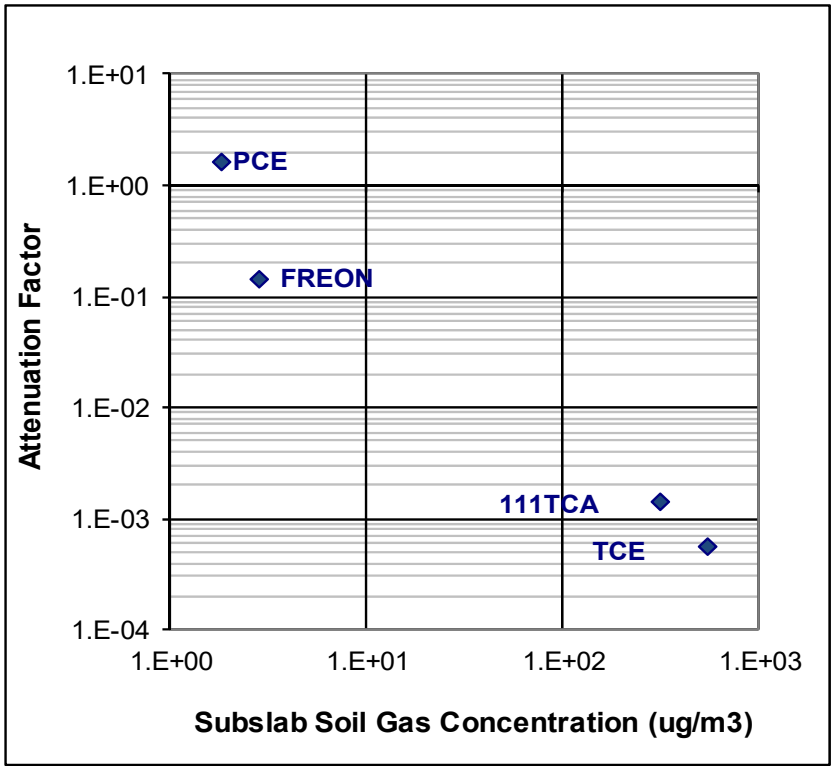
Attenuation Factors Shed Light on VOC Sources

IA/SS

Minimal Influence on IA from Consumer Sources



Substantial Influence on IA from Consumer Sources



Source: Dawson & Kapuscinski, 2012

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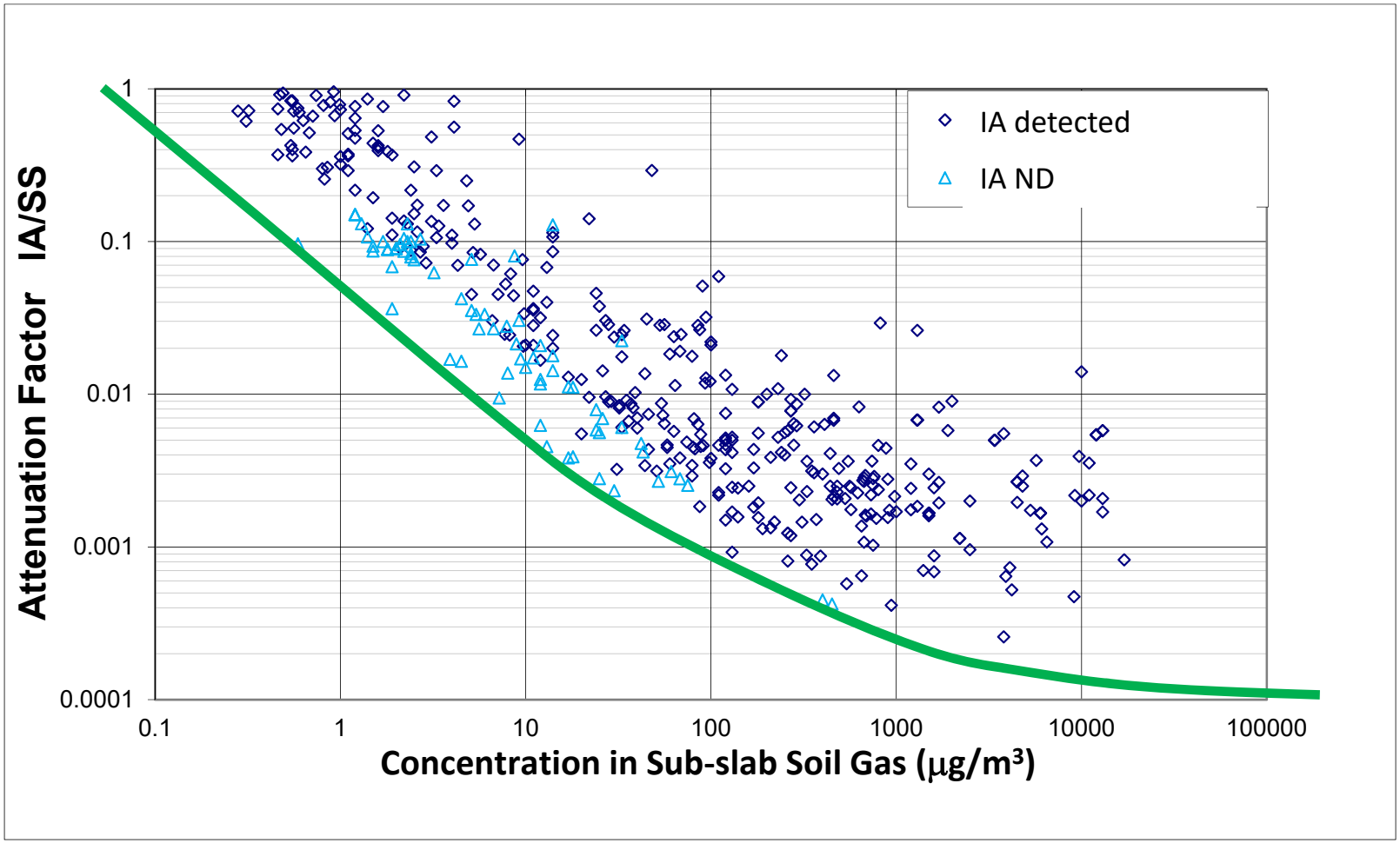
Measuring the "True" Attenuation Factor from a Large Empirical Dataset



Data from USEPA (Helen Dawson)

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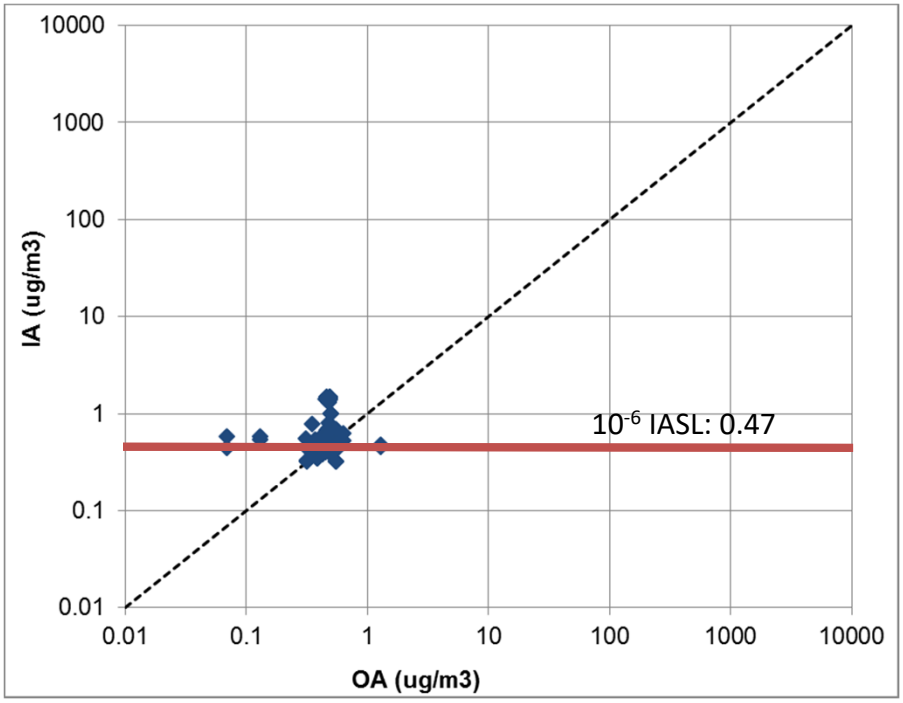
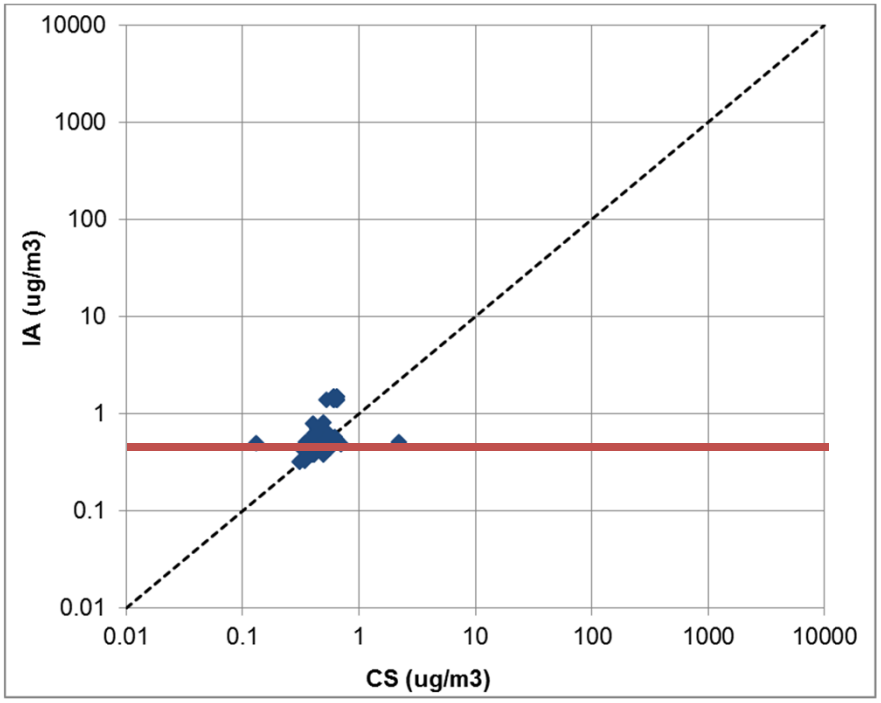
Carbon Tetrachloride – What's the CSM?

Plots include samples w/ detections in IA

Buildings: n=63
IA samples: n=156

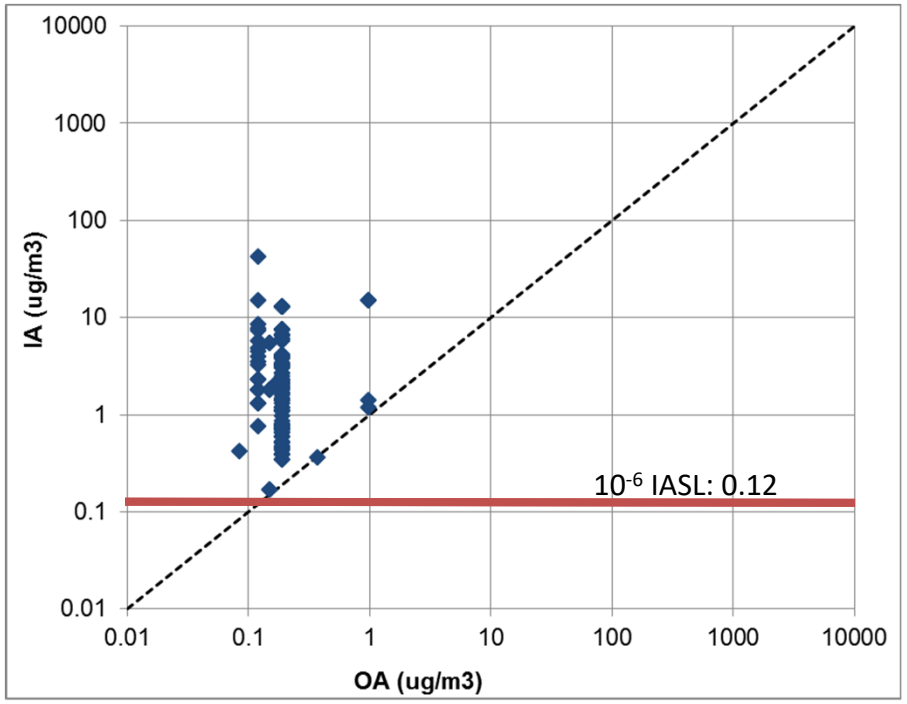


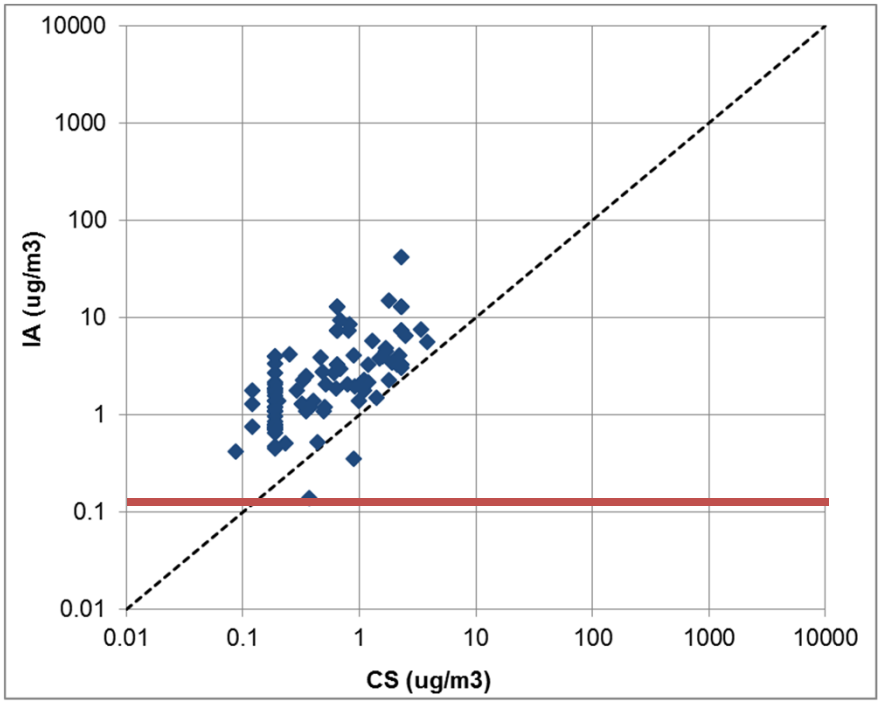


Chloroform – What's the CSM?

Plots include samples w/ detections in IA

Buildings: n=63
IA samples: n=156





Desktop Forensics Helped at Fort Gillem

Quote From Client: "The forensic screening spreadsheet tool developed by Geosyntec provided guidance and transparency to regulators to facilitate their review and approval of NFA recommendations."

- In a few clicks, make queries about specific areas or compounds

Field Methods Used to Distinguish Background from VI

Field Methods to Distinguish Background from VI

- Building inspections: remove suspected sources
- Field GC-MS like HAPSITE or mobile labs
- Building pressurization

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First Event vs. Second Event

Home Questionnaire
- No product removal
- Few photographs

Sampled 69 Buildings

Result – High VOC concentrations creating a difficult dataset to evaluate

Home questionnaire & product removal

Sampled 80 buildings (incl. 67 of 69)

Result – Cleaner dataset where forensic evaluation could be applied more easily

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HAPSITE Field GC-MS

- HAPSITE
  - Continuous run “sniff” mode available
  - Calibrate to 5-10 VOCs
  - PPB RLs achievable
  - Need trained technician
- Flux chambers can be used to enhance clarity of suspected sources
- Helped identify chloroform, 1,2-DCA, and xylene sources at Fort Gillem

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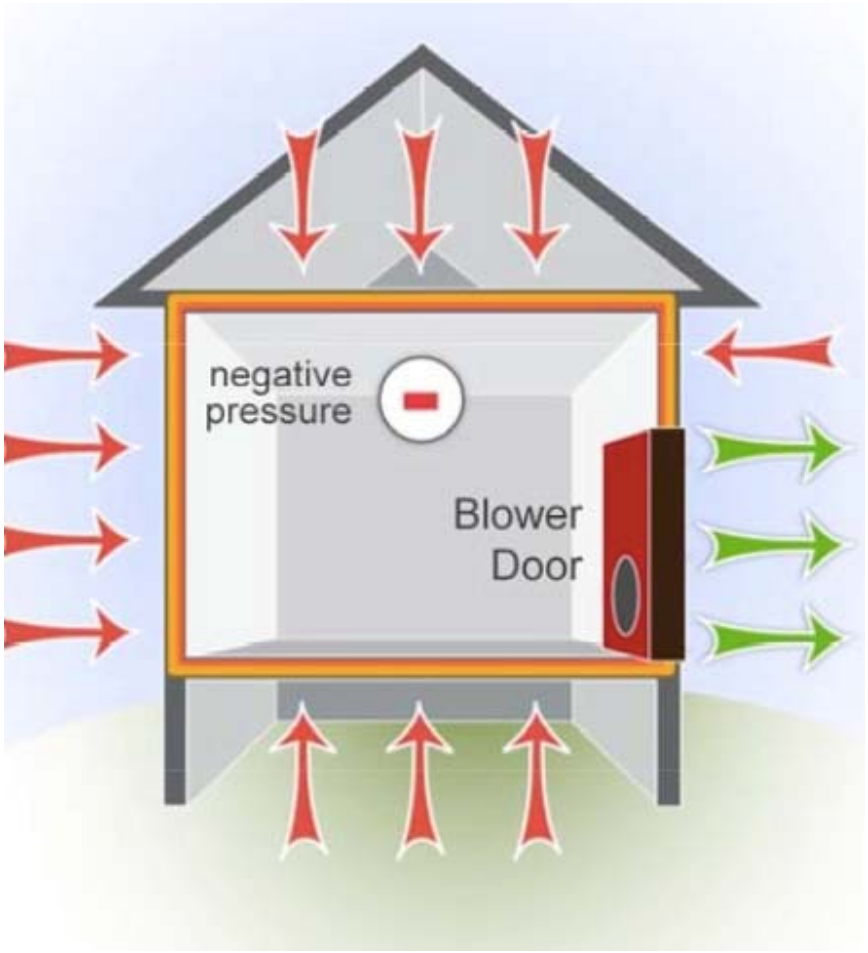
Building Pressure Cycling



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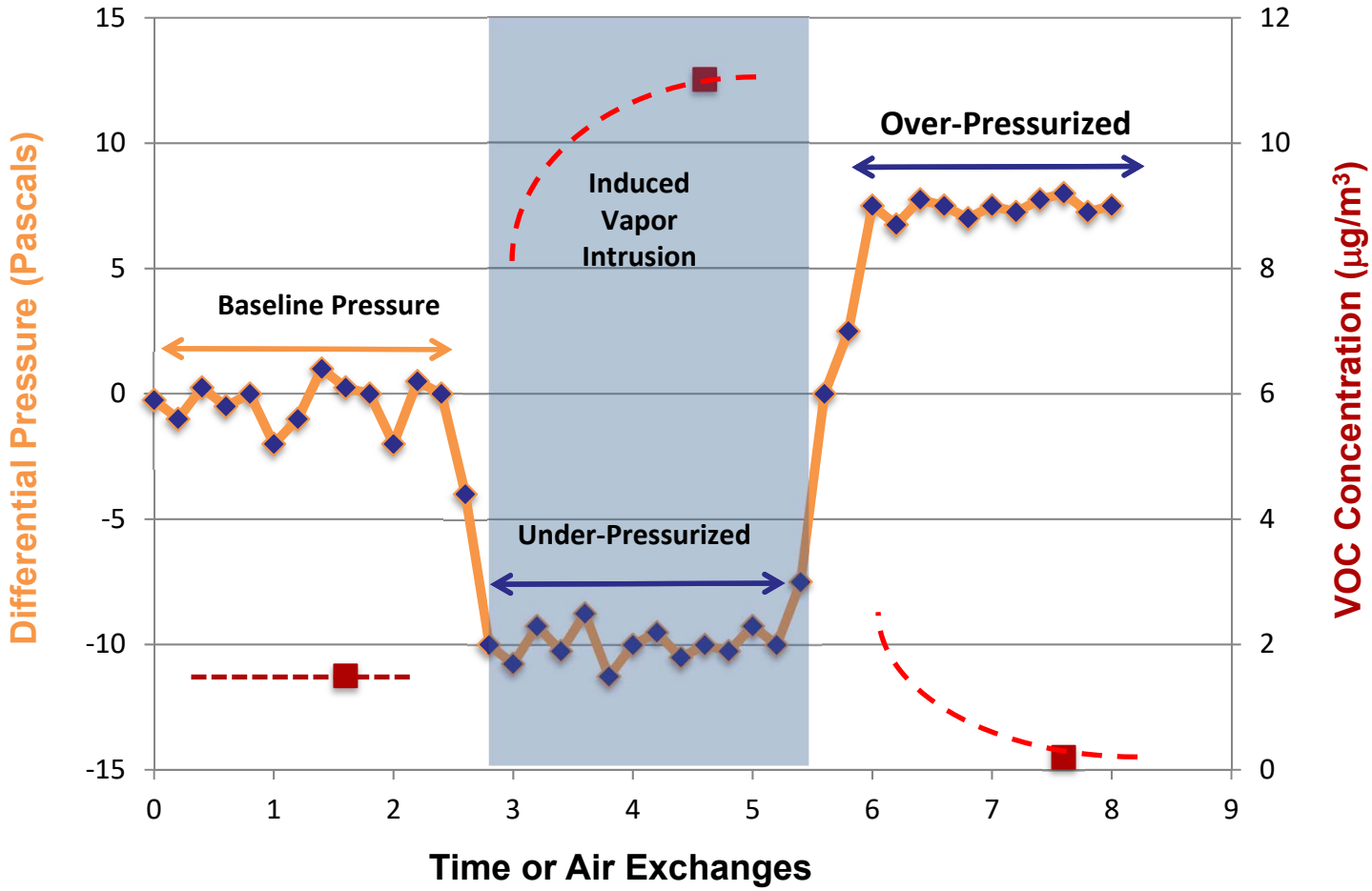
Building Pressure Cycling to Demonstrate VI Pathway Complete



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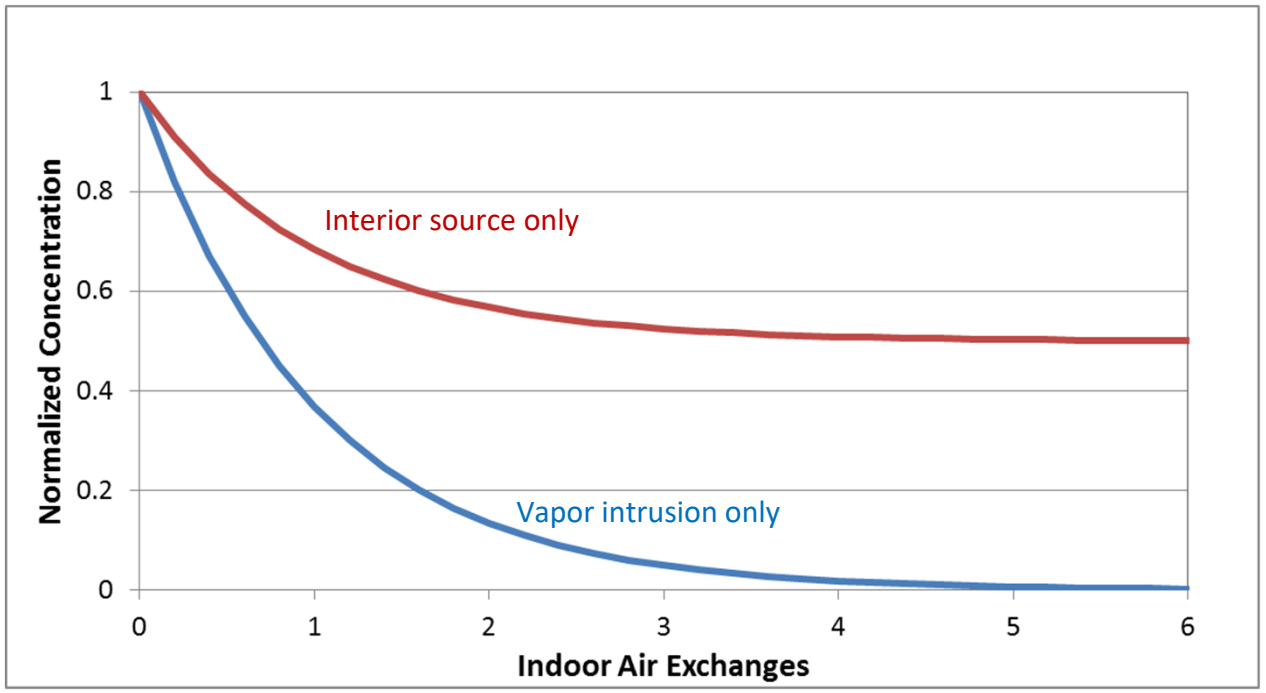
Building Pressure Control: VI or background?

Idealized results during building pressurization



At Fort Gillem, Building Pressure Control showed no VI

Summary

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from Ft. Gillem:

- Use a robust VI CSM
- Bottom up approach (hint: it's in EPA VI Guide)
- Lessons for a large data set

VI Problems → Many tools to address:

- Large buildings → High Volume Sampling
- Timeliness → Building Pressure Control
- Mitigation → many styles (active, passive)
- Temporal variability → quantitative passive samplers
- Big datasets → EPA forensic tool
- Low K soils → Low K soil gas protocol

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Thank you

Justin Knight, P.E.
Senior Engineer
jknight@geosyntec.com
678.202.9580

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