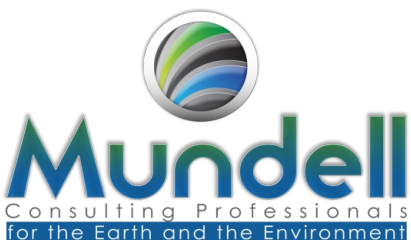
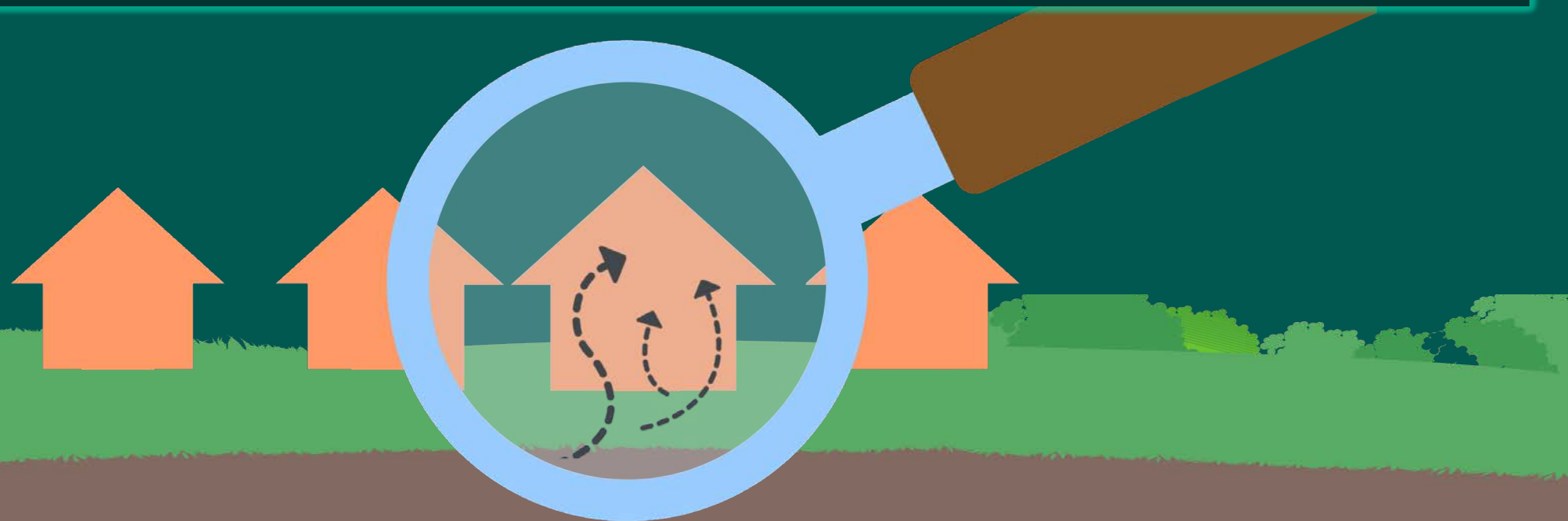


RE-EVALUATING VAPOR INTRUSION “COLD CASE” SITES USING RAPID, COMMUNITY-WIDE INDOOR AIR SCREENING



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Twelfth International Conference on
the Remediation of Chlorinated and
Recalcitrant Compounds
May 25, 2022

Talk Outline

- Why are VI issues at many sites unresolved for years or decades?
- Background of legacy site in Franklin, Indiana
- Traditional VI sampling approach and limitations
- Enhanced community-wide VI investigation:
 - ▶ Rapid screening of homes
 - ▶ Real-time, continuous monitoring at select homes
- Results
 - ▶ Comparison of three paired VI sampling methods



Types of “Cold Case” VI Sites

Human Exposures Missed Due to Inadequate Sampling

1. “Legacy” sites closed before VI was considered

- Communities unaware/led to believe all contamination issues associated with site are resolved
- Lack of regulatory urgency/consistency in re-opening investigations at sites where VI may be ongoing

2. “New” VI sites not assessed effectively with traditional methods

- Data typically 24-hour time-weighted averages
- Unable to see concentration patterns/short-term variability
- Repeated, randomly timed sampling events leave residents:
 - ▶ Exposed to indoor air toxics longer
 - ▶ Fatigued with length of sampling program (months-years)



Cancer Clusters in Franklin, Indiana



INDYSTAR.COM

New technology reveals how dangerous vapors may be entering Franklin homes
Another round of testing kicked off in Franklin last week, but this time with cutting-edge techn...



CANCER CONCERNS
WILL TRUMP POLICIES HURT CANCER-STRICKEN TOWN?



CANCER CONCERNS
INDIANA SUBURB SUFFERS RASH OF CHILDHOOD CANCERS

CNN.COM

Parents demand action from Trump's EPA, after rash of childhood cancers - CNN
Video



Franklin, Indiana “Cold Case”:

*38 Yrs. Post-Investigation; 20 Yrs. Post-Remediation,
VI Concerns Remained*

- Electrical component manufacturing, 1961-1983
 - cVOC releases to city sewer
- Early site investigations, 1984-1993
 - TCE/PCE plume mapped migrating south into residential area
- Pump-and-treat system constructed, 1995
- Chemical odors reported in basements, 1996
 - Groundwater/air modeling concludes “little risk to residents”
- Groundwater/Exposure “Under Control,” 2000

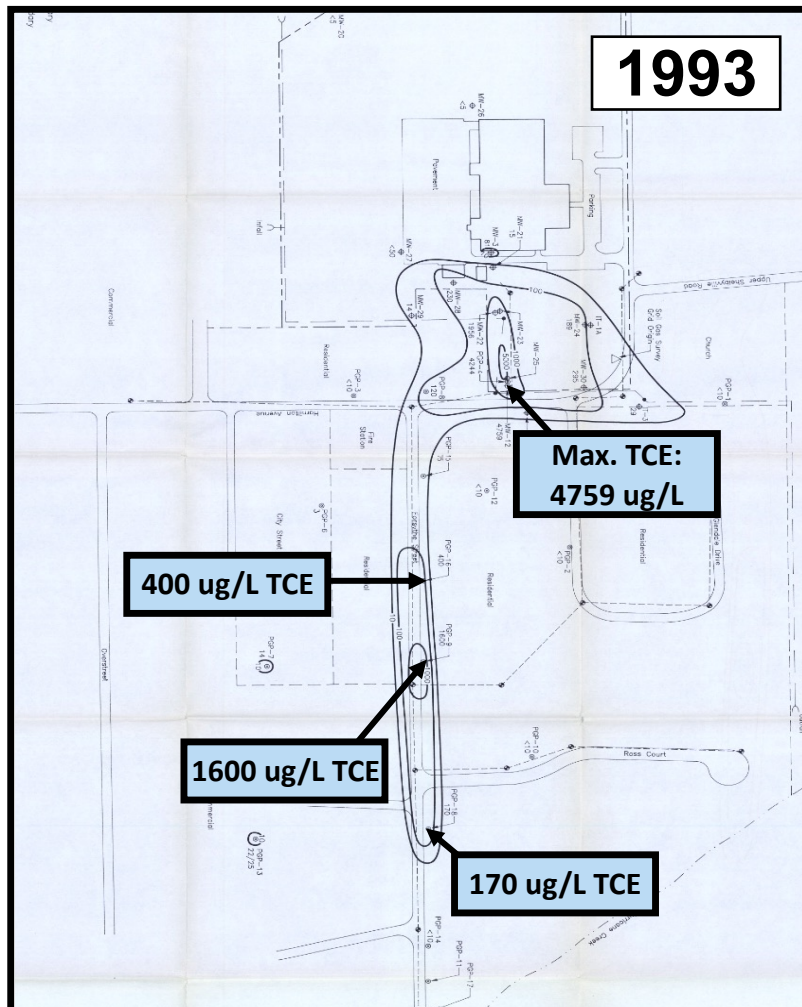
****No VI assessments completed in homes
despite evidence!****



U.S. Geological Survey, 1998



SHALLOW TCE PLUME OVER TIME

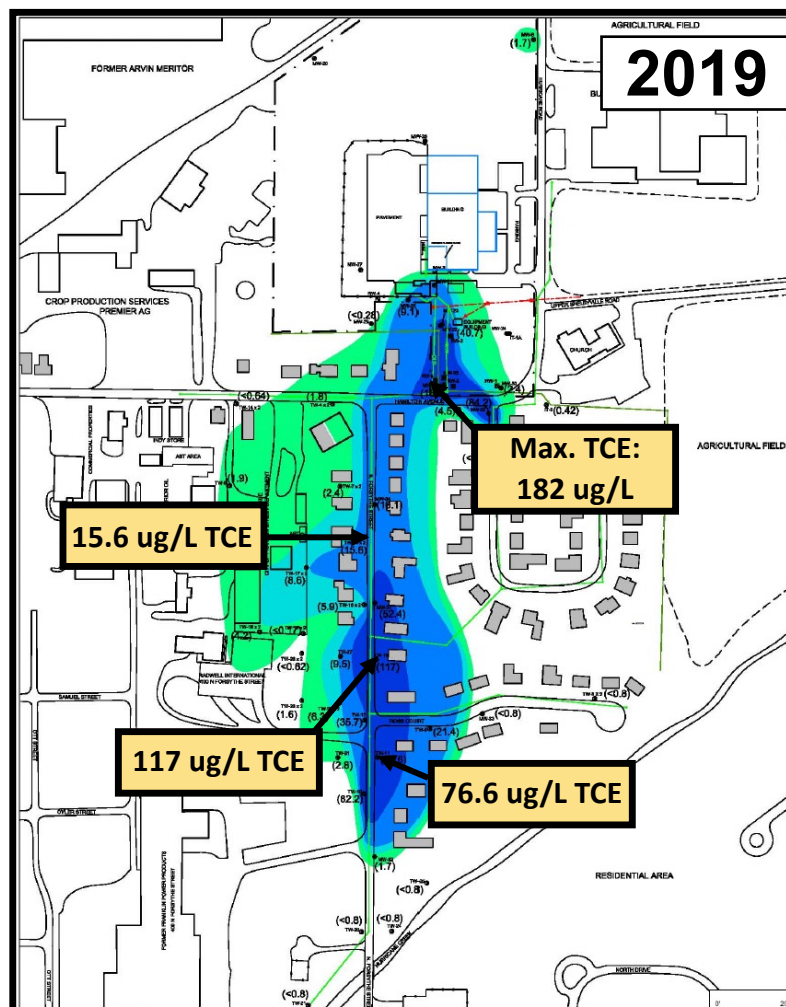


Original Investigation

- Pre-P&T system installation (1995)
- No residential vapor intrusion testing

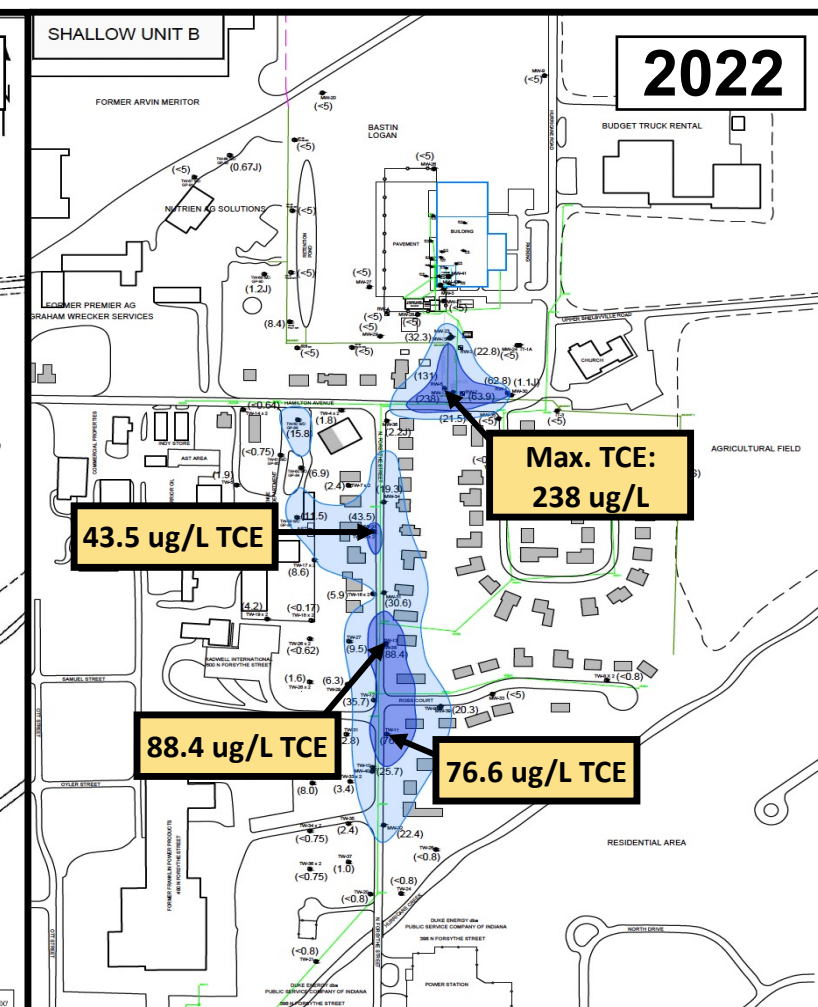


WW Engineering & Science, 1993



Re-opened Investigation After Residential VI Sampling

- 2018-19 MUNDELL indoor air results prompted new groundwater/sewer tests



- Current plume 2-yr. after interim sewer excavation/PRB pilot study

U.S. Environmental Protection Agency, 2019

IWM Consulting, 2022

Initial VI Sampling: Traditional Methods

- **Two 24-hour events:** June and October 2018
- **20 residences**
 - ▶ Potential indoor sources removed, building surveys conducted
- **Summa cans & passive samplers** to sample:
 - ▶ Sub-slab vapor, where possible
 - ▶ Crawl spaces
 - ▶ Soil gas
 - ▶ Indoor air in breathing zone
 - ▶ Outdoor (ambient) air



Outcome of Traditional VI Sampling

- Identified homes to the south of the site with likely VI concerns
- Alerted EPA to multiple indoor air exceedances of PCE/TCE

However:

- Number of homes sampled was limited by time and cost
- Unable to pinpoint *when* and *where* vapors could be entering homes
- Wide variation in laboratory results from same locations over 4-month time

Example: Inconsistency in Indoor Air Results in a Tested Home – June and October

VOC	June 2018	October 2018
PCE	126.63 µg/m ³	ND (<1.1 µg/m ³)
TCE	39.61 µg/m ³	ND (<0.86 µg/m ³)
1,1,1-TCA	7.48 µg/m ³	ND (<1.8 µg/m ³)



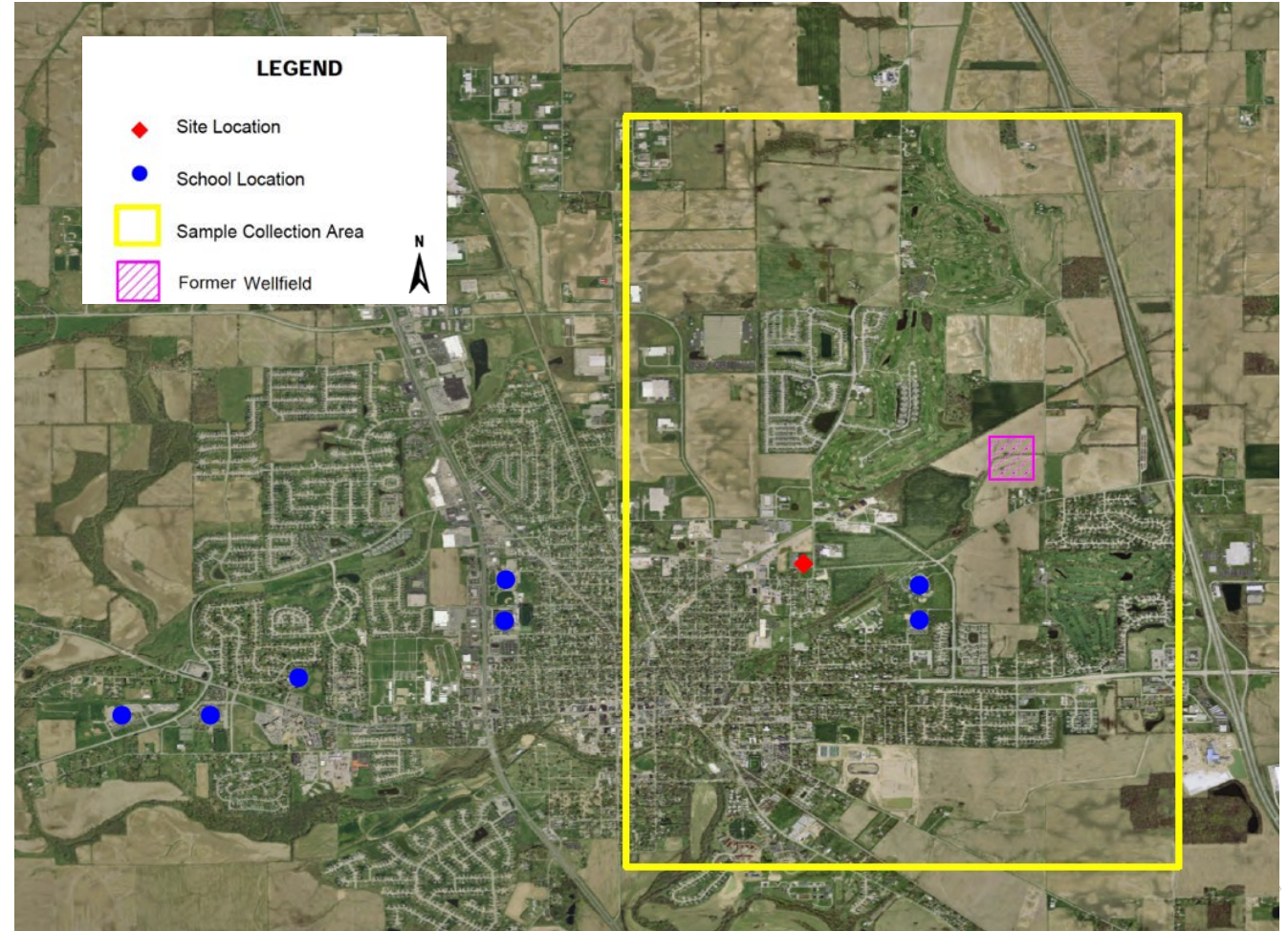
Enhanced Sampling Plan to Resolve Key Questions

Objectives:

- Expand sampling to more homes, including further downgradient and upgradient from Site
- Collect finer resolution data from more sampling points
- Identify patterns

Process:

- 1) Screen indoor air throughout the community in near real-time
- 2) Select homes for 24-hour continuous monitoring



STEP 1: Mobile Laboratory Prep



- February-March 2019
- Converted locally rented RV into “mobile laboratory” with ~2 hours of setup time
- Ran a real-time monitoring system (VaporSafe[®] GC unit) out of mobile lab and transported to each sampling location
- Efficient community-wide sampling
 - ▶ Prioritized homes based on proximity to known groundwater/sewer contamination and homes with previously suspected VI, then;
 - ▶ Expanded outward



STEP 2: Screen Homes – Rapid Grab Samples



- 30 residences of varying construction field screened
- Collected 40 mL air grab samples via glass syringe samplers
- 3 to 9 samples from each home
 - ▶ 131 total samples in 6 days
 - ▶ Indoor air, sub-slab soil gas, sewer cleanouts tested
- Analyzed in near-real time (results in 10 minutes) by injecting into sampling port of GC while set to discrete mode



STEP 3: 24-hr. Continuous Monitoring at Select Homes

- 5 residences
- GC operated in continuous mode
 - ▶ 1/8" Nylaflow tubing run from inlet selector of the GC to sample location inside home
 - ▶ Up to 16 locations analyzed in a cycle
 - ▶ Each sample analysis time: approx. 10 min
- Supplemented with Summa canisters and passive samplers at select locations as comparison tool
- Tracked barometric pressure and temperature alongside indoor air analysis



Co-located Summa can and tubing (run to continuous monitor) in child's room



Tubing affixed to selected sampling location with masking tape



Monitoring 2 Houses Simultaneously



RESULTS: Comparison of 24-hr. Sampling Methods

- EPA Methods TO-14, TO-15, and TO-17
- Unique: studies comparing technologies typically done in single, unoccupied building
- In several cases, results agreed closely across technologies, while not in other cases

Take a closer look at 2 examples in **BLUE**

Location ID	Location Address	Sample Collection Date	Sampling Location	Tetrachloroethylene (PCE)	Trichloroethylene (TCE)
				µg/m ³	µg/m ³
8	South	3/3/2019	Living Room (Air Can)	<1.7	<1.3
			Living Room (RAD-130)	<1.2	<1.1
			Living Room (VaporSafe)	3.4	2.4
			Bedroom (Air Can)	<1.7	<1.3
			Bedroom (VaporSafe)	3.1	2.3
			Bathroom (VaporSafe)	2.8	2.8
			Ambient Outdoor Air (shared with Location 15)	<1.7	<1.3
15	South	3/3/2019	Living Room (Air Can)	<1.7	<1.3
			Living Room (RAD-130)	<1.2	1.0
			Living Room (VaporSafe)	1.9	3.1
			Bathroom (Air Can)	<1.7	4.3
			Bathroom (VaporSafe)	3.5	4.0
			Bedroom (VaporSafe)	2.0	3.0
			Ambient Outdoor Air (shared with Location 8)	<1.7	<1.3
5	South	3/1/2019	Main Bedroom (Air Can)	46.3	40.6
			Main Bedroom (RAD-130)	<1.2	1.3
			Main Bedroom (VaporSafe)	1.9	5.4
			Upstairs Bedroom (Air Can)	<1.7	<1.3
			Upstairs Bedroom (VaporSafe)	1.3	3.1
			Upstairs Bathroom (VaporSafe)	1.3	2.9
			Living Room (VaporSafe)	0.7*	3.4
			Seating Area (VaporSafe)	2.5	3.1
			Office (VaporSafe)	0.8*	2.8
		4/4/2019	Main Bedroom (Air Can)	<1.7	5.9
			Upstairs Bedroom (Air Can)	<1.7	<1.3
			Seating Area (Air Can)	<1.7	<1.3
			Subslab 1 Bedroom (Air Can)	2.4	3.8
			Subslab 2 Living Room Closet (Air Can)	2.0	1.9
			Ambient Outdoor Air (Air Can)	<1.7	<1.3
			Sanitary Sewer Cleanout (Air Can)	<1.7	7.5
			7	Sewer	3/2/2019
Bathroom (VaporSafe)	2.1	1.1			
Child Bedroom (Air Can)	<1.7	<1.3			
Child Bedroom (RAD-130)	<1.2	<1.1			
Child Bedroom (VaporSafe)	0.8*	ND			
Main Bedroom (VaporSafe)	0.9*	ND			
Living Room (VaporSafe)	0.8*	ND			
Ambient Outdoor Air (Air Can)	<1.7	<1.3			
13	Sewer	2/27/2019			
			Bedroom (VaporSafe)	22.6	ND
			Basement Bathroom (VaporSafe)	15.9	ND
			Basement Floor Drain (VaporSafe)	29.8	ND
			2019 IDEM RCG Residential Indoor Air Screening Level		42
2019 IDEM RCG Residential Subslab Air Screening Level (0.03 attenuation factor)		1,400	70		
2019 IDEM RCG Residential Indoor Air Action Level (x10 IASL)		420	21		

Note: Table reports maximum VaporSafe concentration



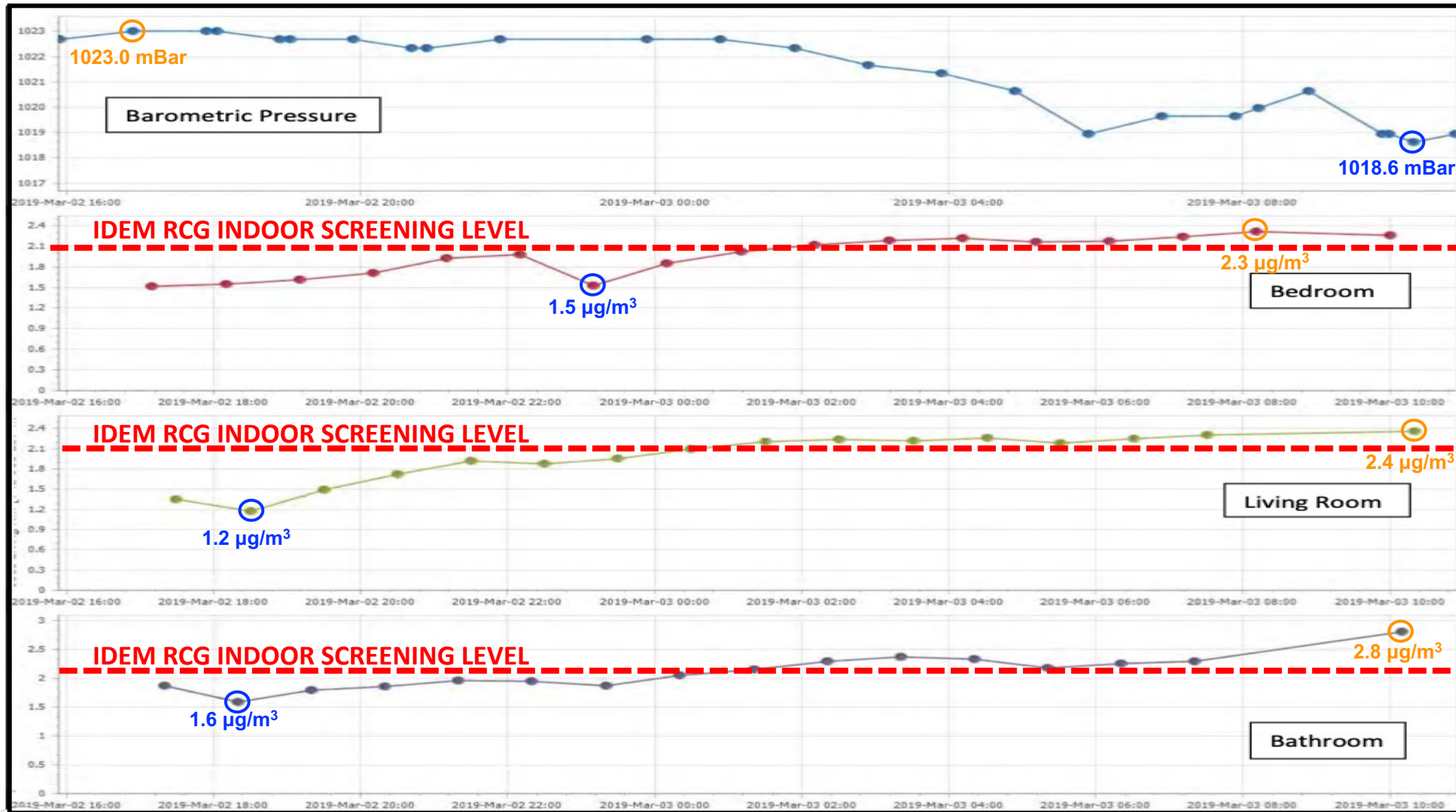
RESULTS: TCE Concentrations Across Methods

Sample Location	Air Can	Passive Sampler	Real-Time Continuous (max.)
HOME A: Living Room	ND (<1.3 µg/m ³)	ND (<1.1 µg/m ³)	2.4 µg/m ³
HOME A: Bedroom	ND (<1.3 µg/m ³)	Not tested	2.3 µg/m ³
HOME B: Living Room	ND (<1.3 µg/m ³)	1.0 µg/m ³	3.1 µg/m ³
HOME B: Bathroom	4.3 µg/m ³	Not tested	4.0 µg/m ³
Indiana TCE Residential Indoor Air Screening Level			2.1 µg/m ³

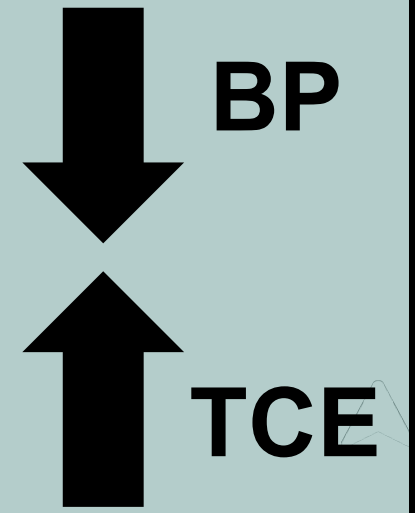
Key point: Dynamic concentrations presented as single, 24-hour averages can mask or entirely miss key exposure times and underestimate risk.



RESULTS: Barometric Pressure and Indoor TCE



Apparent relationship between BP & TCE observed at this home during approaching snowstorm:



--- = Indiana TCE Residential Indoor Air SL ($2.1 \mu\text{g}/\text{m}^3$)

■ = Min. observation

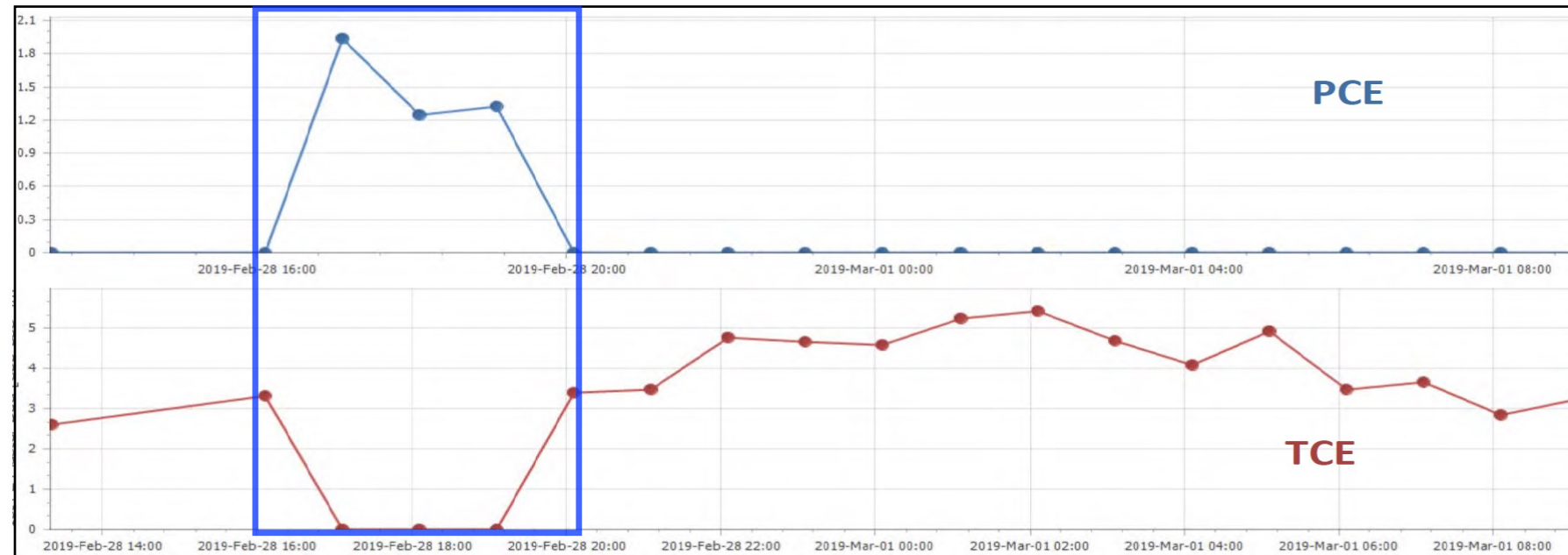
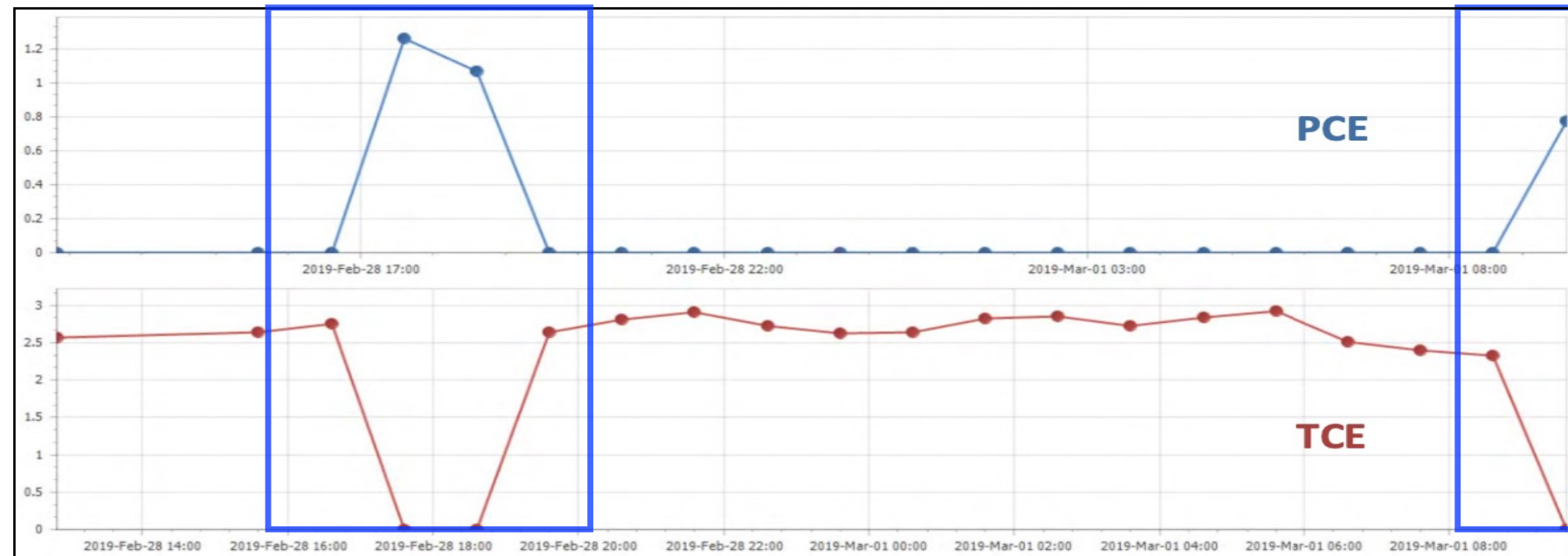
■ = Max. observation



RESULTS: Other Unexpected Observations

- All locations in this home experienced brief appearance of PCE and disappearance of TCE between 4:00 - 8:00 PM.
- Different sources of PCE/TCE?
- Influence of HVAC system?

Key point: short-term fluctuations like this are impossible to see with 24-hour average data. Indoor air concentrations can shift suddenly in response to environmental factors.



Solving the Decades-Old VI Mystery

EPA's re-opened investigation found the old, cracked sewer line continued to be a groundwater/indoor air source

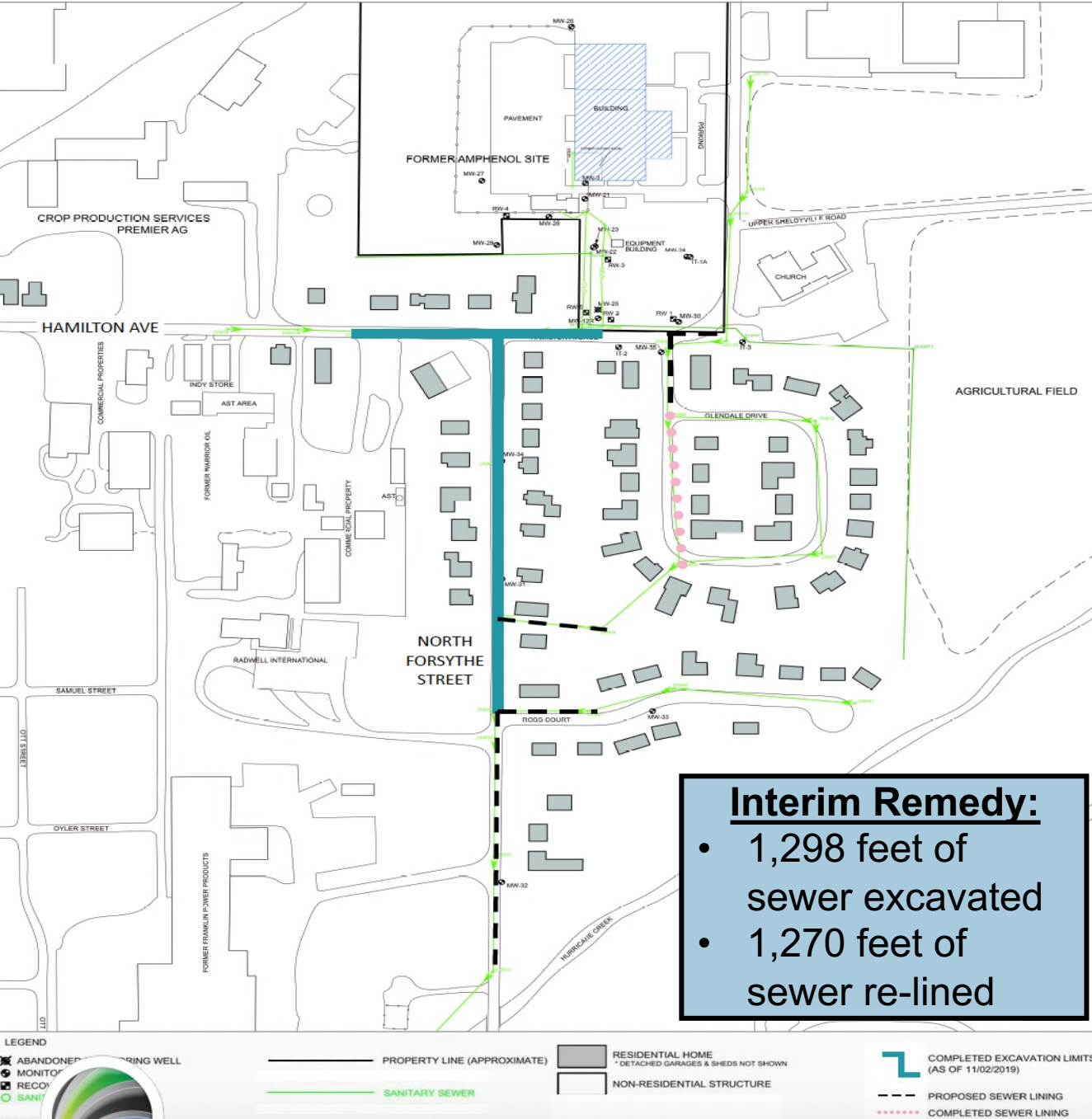
Homes with
vapor mitigation
systems installed

7

Homes with
plumbing vapor leaks
detected/repaired

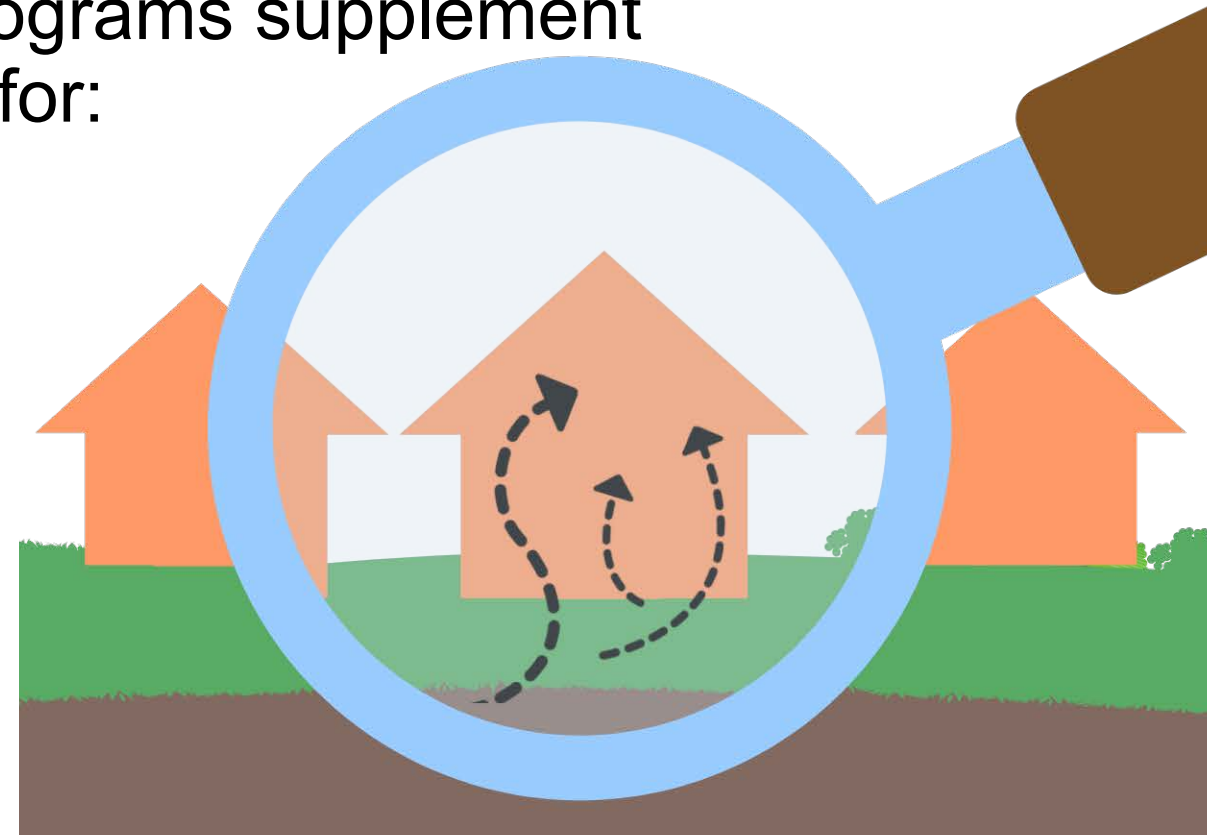
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EPA, 2022



Applying Franklin Experience to Other “Cold Case” VI Sites

- Homes that have VI and spikes above regulatory levels may be “missed” by TWA technologies alone
- Rapid community-wide screening programs supplement Conceptual Site Models by allowing for:
 - ▶ Expanded spatial coverage
 - ▶ Indoor-first approach: checking homes that would otherwise be overlooked
 - ▶ Selection of homes where continuous monitoring is needed



THANK YOU!



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