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### **Quantifiable Lines of Evidence for Chemical Vapor Intrusion**

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\*Personal Perspective & Presentation – Does not represent policy

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### Agenda

- Vapor Intrusion (VI) Assessment Challenges
  - Sampling upper percentile of concentration distribution (e.g., 95<sup>th</sup>%) under natural conditions
- Indicators, Tracers, and Surrogates (ITS) for VI Assessment
  - Definitions of ITS metrics
  - Evaluation of Data Rich VI Studies: Sun Devil Manor (SDM) and Indy
  - Temperature as an Indicator (SDM)
  - Radon as a Tracer/Surrogate (SDM)
- Summary and Looking Forward



## Vapor Intrusion – Assessment Challenges

- Indoor air sampling results subject to high variability
  - Difficult to capture upper percentile of concentration distribution with conventional sampling schemes
  - May result in false negative decisions
- Background sources can impact indoor air sampling results
  - Sometimes difficult to identify through conventional surveys
  - May result in false positive decisions
- Preferential vapor pathways are more common than we used to think
  - May result in inadequate or unnecessary mitigation







### Indicators, Tracers, and Surrogates for VI Assessment

- Indicators, Tracers, and Surrogates (ITS) metrics and tools that can make VI assessment more informative, efficient, and cost-effective
  - <u>Indicators</u> to narrow the assessment period (e.g., when are higher concentrations most likely to occur?)
  - <u>Tracers</u> to enhance understanding of the CSM and/or prioritize sampling locations (e.g., how are VOCs entering the building?)
  - **Surrogates** to support or substitute for VOC results and improve the odds of a higher concentration sample.
- Select ITS are already included in VI guidance (e.g., seasonality, rainfall)



### **Definition: Indicator**

- **Indicators** are metrics that indicate the state or level of something, for example...
  - In biology, an indicator can be a species that can be used to infer habitat conditions, as amphibian population declines may indicate environmental stress
- For VI, indicators are metrics that indicate an elevated potential for CVOC exposure (e.g., temperature, pressure)





### **Definition: Tracer**

- Tracers are easily observable substances that move physically along with the targets of interest, for example...
  - In hydrology, dyes can be followed through the course of a physical process (water flow)
- For VI, radon is a naturally occurring tracer of the subslab soil gas to indoor air pathway and can be used to identify buildings more susceptible to VI.





### **Definition:** Surrogate

- Surrogates are metrics with a quantitative relationship to the target of interest that is sufficiently accurate to be a substitute, for example...
  - Total coliform as surrogate for the pathogenic organisms associated with sewage contamination
- For VI, total VOCs may be used in place of speciated VOC data to make decisions in the field



Problems of microbial drinking water assessment

Image source: https://www.crcpress.com/The-Coliform-Index-and-Waterborne-Disease-Problems-of-microbial-drinking/Gleeson-Gray/p/book/9780419218708







Reference: Kurtz et al., 2018, AEHS **JACOBS**°

### Evaluation of Data Rich VI Studies: SDM and Indy

- Sun Devil Manor (SDM) (Layton, UT)
  - Studied by Arizona State University
  - 2.5+ year indoor air data set, also monitored weather and building dynamics
  - Known preferential pathway (land drain)
- Indy Duplex (Indianapolis, IN)
  - Studied by USEPA/NERL
  - 1+ year indoor air data set, also monitored weather and building dynamics
  - Suspected preferential pathway (sewer)









### SDM: Instrumentation and Monitoring Network













# SDM: What did we learn from early look at temperature data?

"Differential temperature monitoring may help narrow the assessment period – does not guarantee detection of higher concentrations"

"Diurnal changes in VI signal may be related to daily variation in differential temperature during periods of colder temperature"

Reference: Holton et al., 2013, AEHS (<u>https://iavi.rti.org/index.cfm</u>) JACOBS



Reference: Kurtz et al., 2018, AEHS **JACOBS**\*



Average Daily TCE and Radon in Indoor Air

### Radon as an Indicator of Preferential VI Pathways?

#### Observations: Winter 2011 – Fall 2011

TCE varies by 100X - 1000X; Radon signal about 2X – 3X of baseline signal

Radon and TCE attenuation factors (*a=indoor air/soil gas at some depth*) are different by 10X or more (especially at sub-slab depth)

		ТСЕ						Radon					
		<c></c>	<c></c>	<c></c>	α	α		<c></c>	<c></c>	<c></c>	α	α	
		sub-slab	(6 ft BS)	(indoor)	(sub-slab)	(soil gas)		sub-slab	(6 ft BS)	(indoor)	(sub-slab)	(soil gas)	
Year S	Season	[ <i>ppb</i> <sub>v</sub> ]	[ppb <sub>v</sub> ]	[ppb <sub>v</sub> ]	[unitless]	[unitless]		[pCi/L]	[pCi/L]	[pCi/L]	[unitless]	[unitless]	
2011	Winter	0.81	122	0.33	0.41	0.0027		290	1600	0.50	< 0.0017	< 0.00031	
2011	Spring	1.2	91	0.06	0.05	0.0007		310	1600	0.35	< 0.0011	< 0.00021	
2011 \$	Summer	0.36	93	0.0072	0.02	0.0001		370	1800	0.38	< 0.001	< 0.00021	
2011 I	Fall	0.31	104	0.067	0.22	0.0006							
2011	Overall	0.67	103	0.11	0.16	0.0011		323	1667	0.41	< 0.0012	< 0.00024	
					1							1	

*"May need to think more about use of radon as a surrogate or VI tracer"* Johnson et al., 2012

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### Discovery of Land Drain VI Pathway

 Land drain VI pathway discovery initiated by odd soil gas profiles observed during long-term controlled depressurization testing





## Summary and Looking Forward

- Summary:
  - Indicators, tracers, and surrogates related to VI-driving forces provide low cost data to guide sampling and support VI assessment; some are already in guidance!
  - Differential temperature is an inexpensive indicator of when VI is more likely to occur at SDM
  - Differences in TCE and radon attenuation factors a potential indicator of land drain preferential pathway at SDM
- Looking forward:
  - Seeking inputs (more sites, more data, experience with ITS) from VI community
  - Working toward multiple USEPA-supported publications and potentially a toolbox
    - Part 1 of ITS review and evaluation submitted to *Remediation Journal* for publication; Part 2 currently being written



### **Questions? Comments?**

- Any experience using indicators, tracers, and/or surrogates in support of vapor intrusion assessment?
  - How was the data collected (methods, frequency, duration)?



### Thank you!

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