# A BREATH OF "FRESH AIR"

# EVALUATING THE ROLE OF SEWER PATHWAYS IN VAPOR INTRUSION

**Preliminary Results from ESTCP Project ER-201505**

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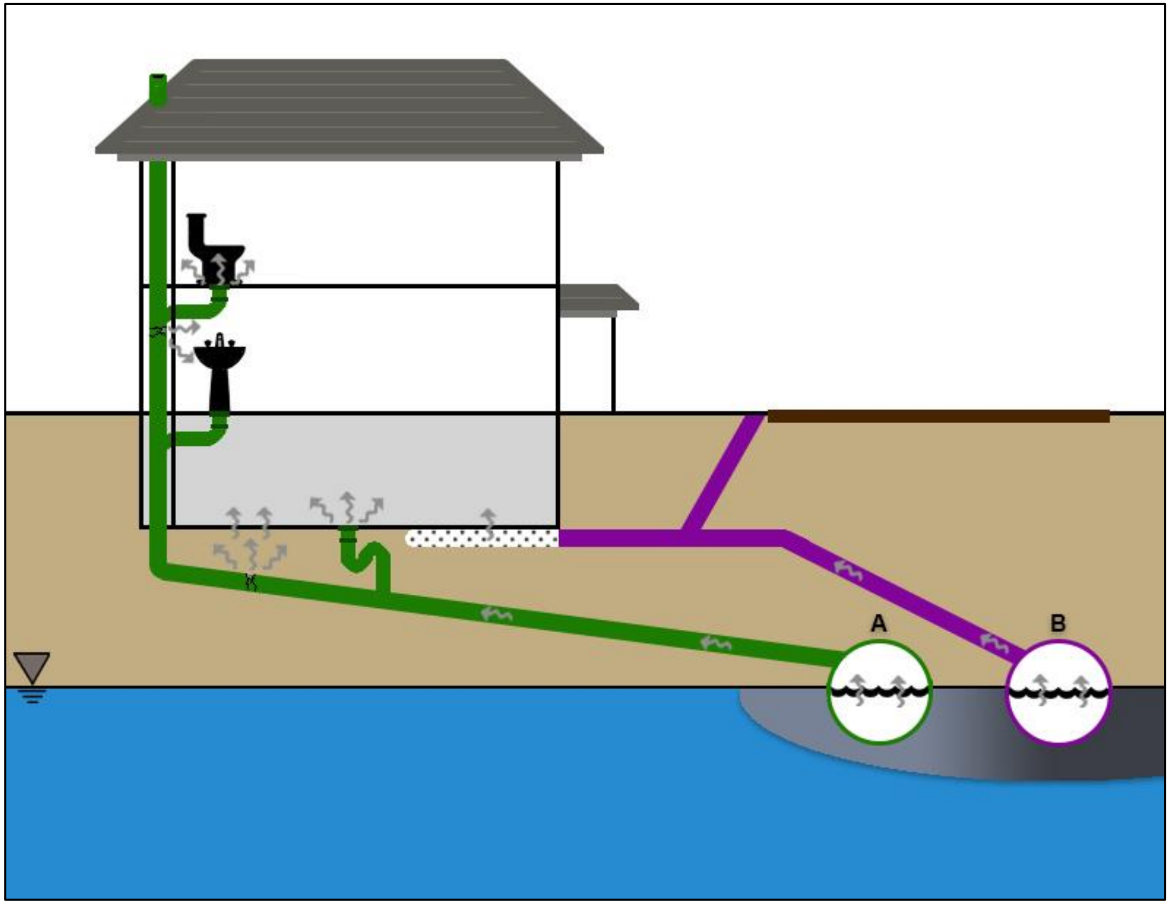
**Lila Beckley, P.G.**
**GSI Environmental**

*Battelle Bioremediation Symposium May 2017*

# Why Sewer VI?




**Many examples of sewer VI. No good investigation protocol.**

# ESTCP Project Technical Objectives

**Improve our current understanding of the role of preferential pathways at vapor intrusion sites.**

1. **Determine how commonly preferential pathways contribute to vapor intrusion.**
2. **Develop improved conceptual model with key risk factors for sewer/utility tunnel vapor intrusion.**
3. **Develop and validate an investigation protocol: initial site screening, field testing, delineation.**


***THIS TALK:*** **Present preliminary findings.**

# Understanding the Role of Sewers:

- Groundwater to Sewer Attenuation: **What are VOC Concentrations in Sewer Manholes?**
- Sewer to Building Attenuation: **Do VOCs Move from Sewers into Buildings?**
- Updated Conceptual Model: **How Common Are Sewer Preferential Pathways?**

SOUTH HAVEN

City unsure why the sewer smells

By KRISTIN HAY
H-P Correspondent

SOUTH HAVEN — The tests have been inconclusive in trying to locate the source of a mysterious odor that has been detected in several downtown South Haven businesses.

Bob Stickland, the director of

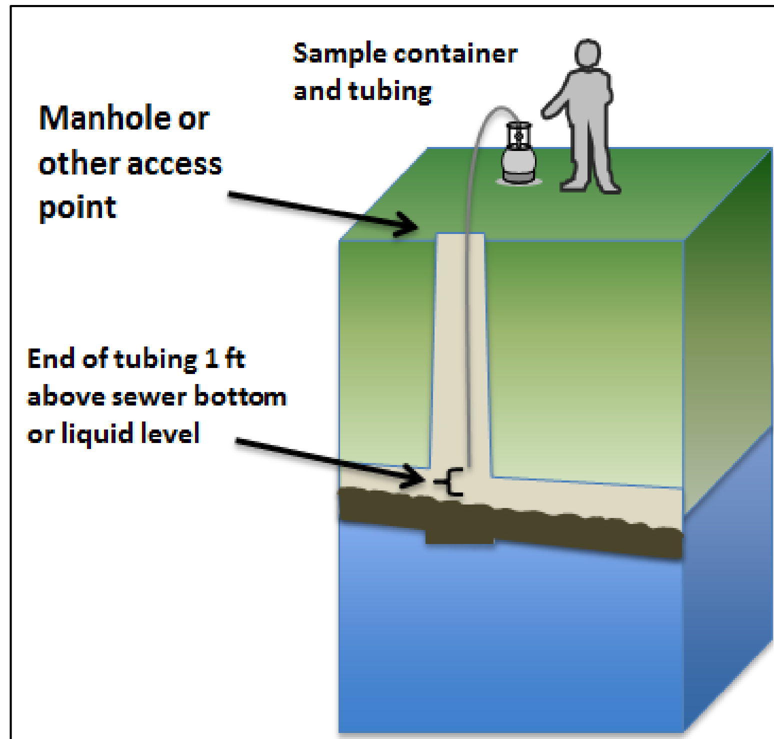
Stickland said he will discuss the strategy of putting a non-toxic smoke into the sewer to detect the path of the offensive gas emanating from basement drains.

"Somebody is putting something into the sewer that is creating the odor," Stickland said in an interview after the council meeting. "We are trying to find out

# What Are VOC Concentrations in Sewer Manholes?

<u>WHERE</u>: MANHOLES WITHIN FOOTPRINT OF GW PLUME (OR IMMEDIATELY DOWNSTREAM)

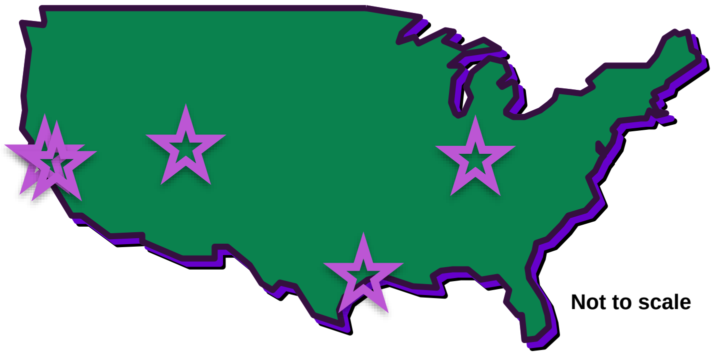

<u>HOW</u>: COLLECT VAPOR SAMPLE FROM BOTTOM OF MANHOLE



# What Are VOC Concentrations in Sewer Manholes?

**Sites Tested:**

1) Near USEPA Research House, IN
2) Moffett Field, CA
3) Houston, TX Dry Cleaner Sites
4) Near ASU Research House, UT
5) Bay Area, CA TCE Plumes

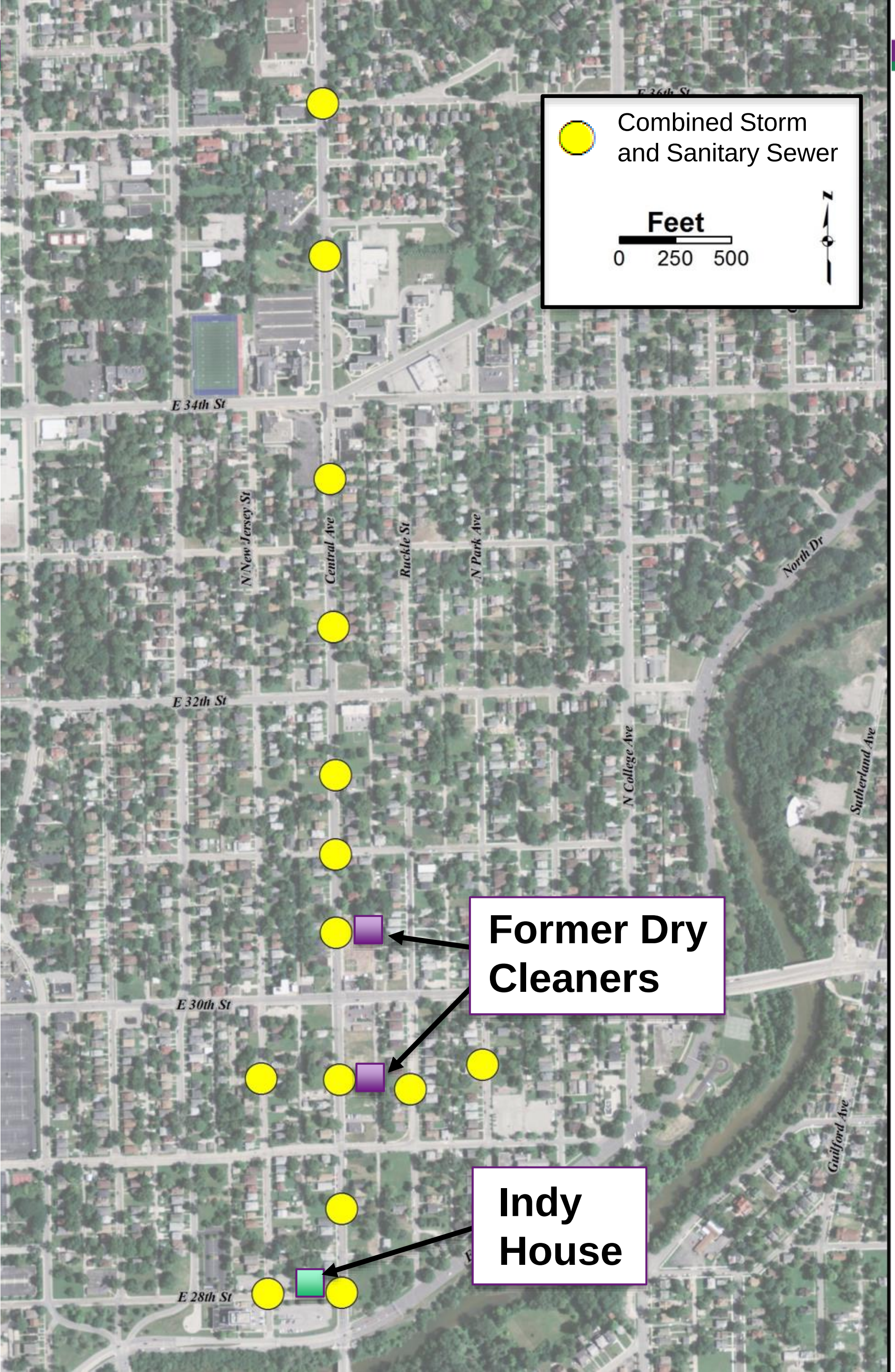


# What Are VOC Concentrations in Sewer Manholes?

## 1) Near USEPA Research House

# What Are VOC Concentrations in Sewer Manholes?

## 1) Near Indianapolis House




# What Are VOC Concentrations in Sewer Manholes?

1) Near Indianapolis House

# What Are VOC Concentrations in Sewer Manholes?

## 1) Near Indianapolis House (Duplex)


**PCE Concentrations:**

**Median: 36 µg/m$^3$**

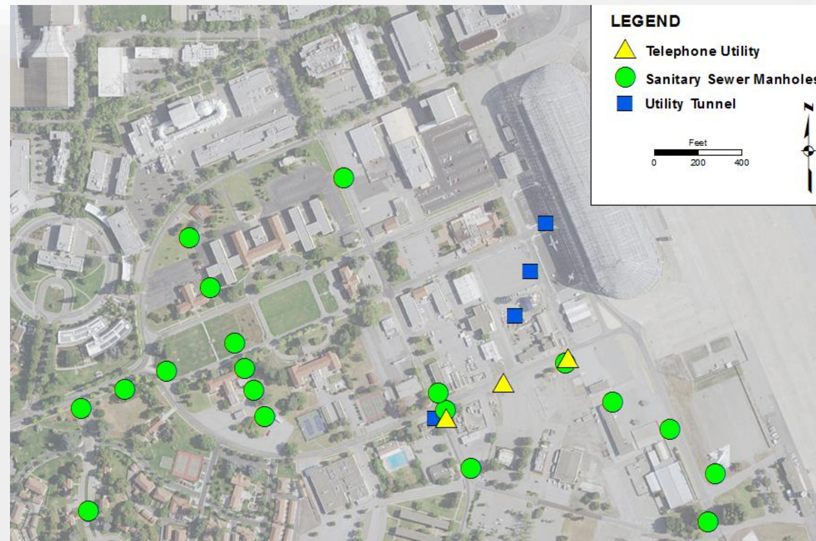
**Max: 353 µg/m$^3$ (32x Indoor Air SL)**

***32% were > 10x Indoor Air SL***

Assumed PCE indoor air screening level = 11 µg/m$^3$ (USEPA May 2016 RSL Tables (Residential))

# What Are VOC Concentrations in Sewer Manholes?

## 2) Moffett Field




**<u>TCE Concentrations</u>:**

**Median: 97 µg/m$^3$**

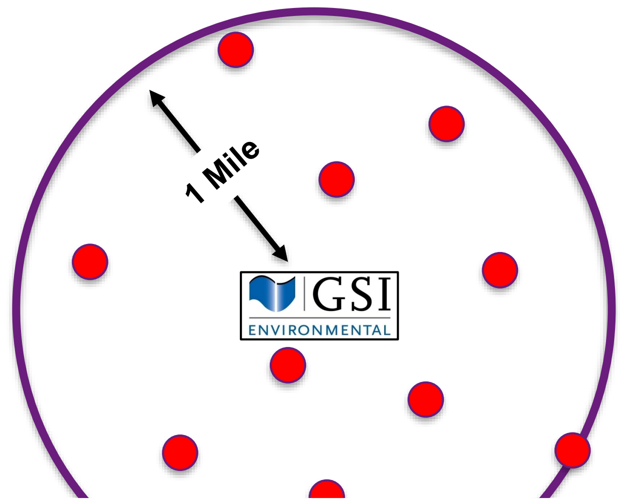
**Max: 1,494 µg/m$^3$ (500x Indoor Air SL)**

***65% were > 10x Indoor Air SL***

Assumed TCE indoor air screening level = 3 µg/m$^3$ (USEPA May 2016 RSL Tables (Commercial))

# What Are VOC Concentrations in Sewer Manholes?

## 3) 9 Dry Cleaner Sites, Houston, Texas - PCE




**<u>PCE Concentrations</u>:**

**Median: 34 µg/m$^3$**

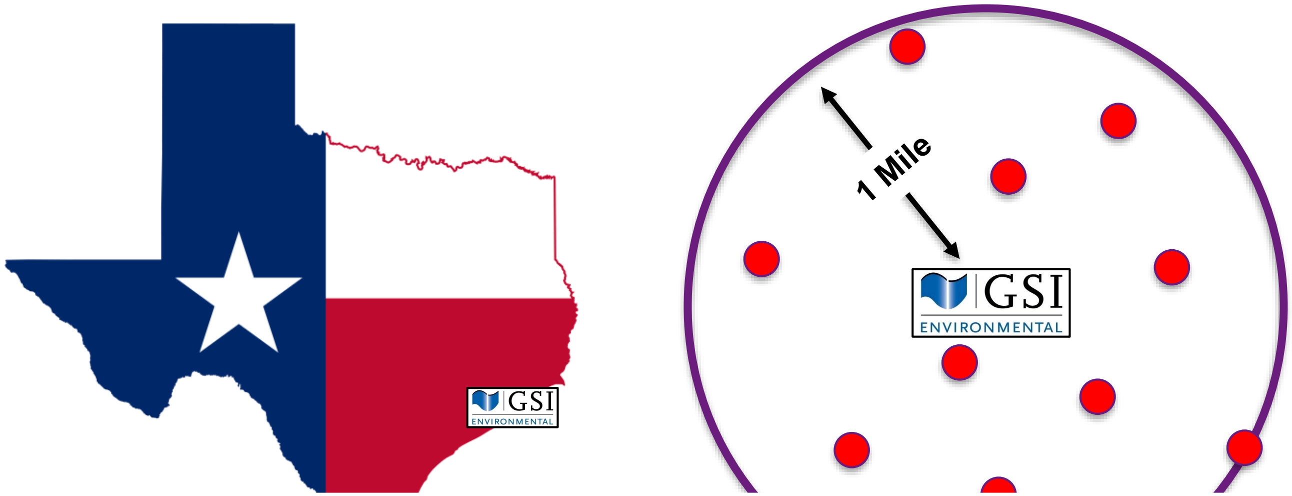
**Max: 1,500 µg/m$^3$ (140x Indoor Air SL)**

***43% were > 10x Indoor Air SL***

Assumed PCE indoor air screening level = 11 µg/m$^3$ (USEPA May 2016 RSL Tables (Residential))

# What Are VOC Concentrations in Sewer Manholes?

## 3) 9 Dry Cleaner Sites, Houston, Texas - TCE




**TCE Concentrations:**

**Median: 31 µg/m³**

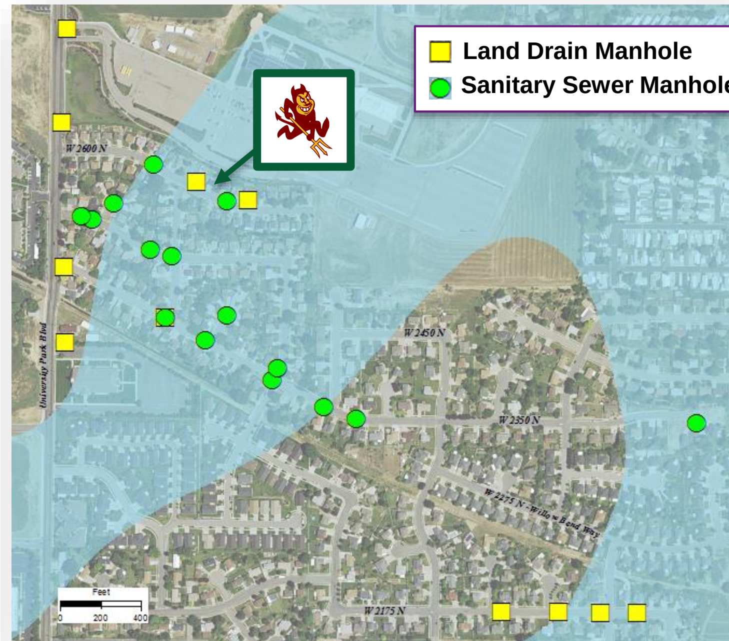
**Max: 180 µg/m³ (375x Indoor Air SL)**

***86% were > 10x Indoor Air SL***

Assumed TCE indoor air screening level = 0.48 µg/m³ (USEPA May 2016 RSL Tables (Residential))

# What Are VOC Concentrations in Sewer Manholes?

## 4) Near ASU Research House




GSI ENVIRONMENTAL

**<u>TCE Concentrations (May 2016)</u>:**

**Median: 40 µg/m³**

**Max: 1,100 µg/m³ (93x Indoor Air MAL)**

***41% were > 10x Indoor Air MAL***

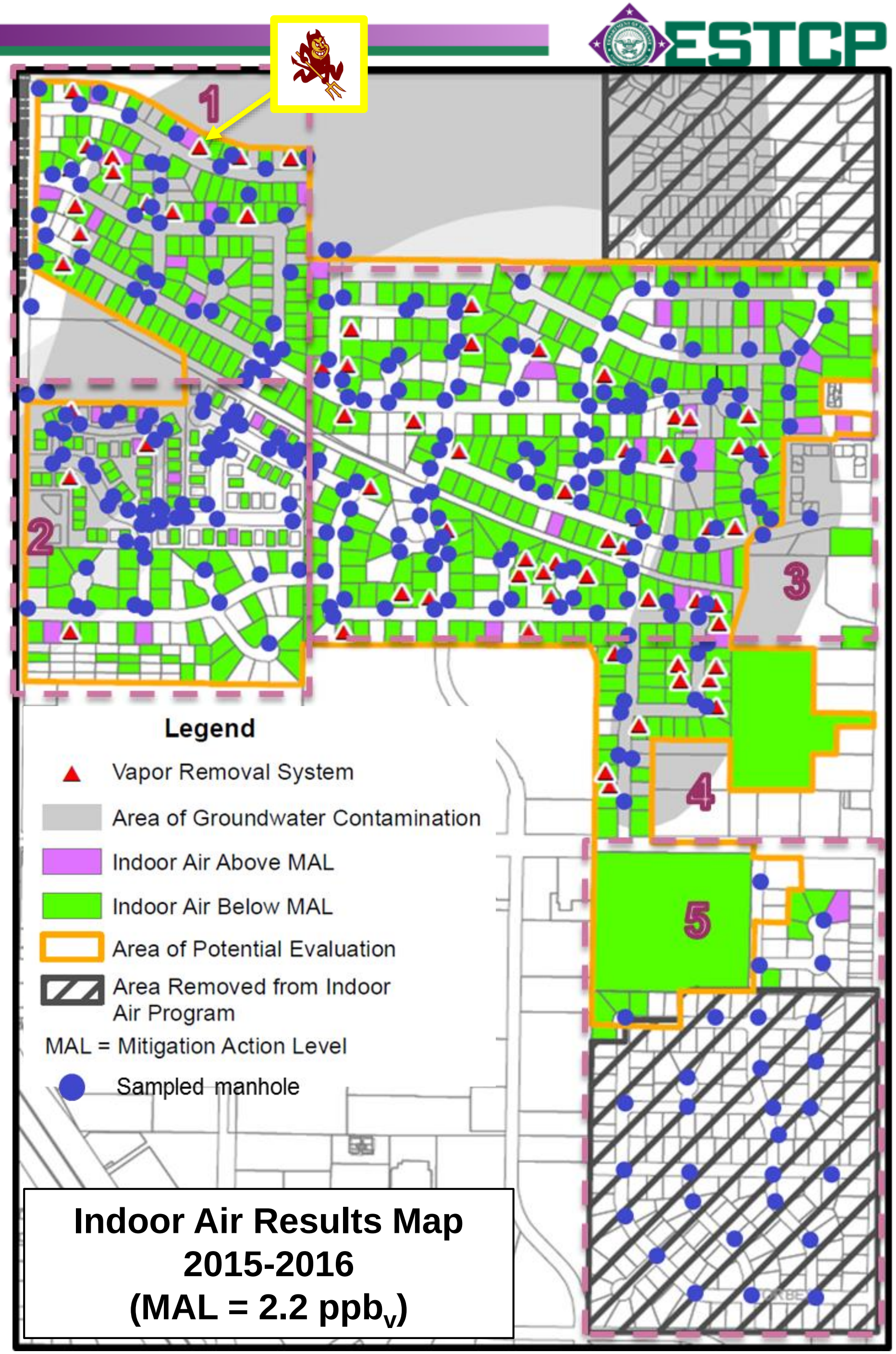
Hill AFB TCE mitigation action level for indoor air 11.8 ug/m³ (2.2 ppbV)

Results from ESTCP Project ER-201501, <u>The VI Diagnosis Toolkit for Assessing Vapor Intrusion Pathways</u>. Thanks to Yuanming Guo, Paul Dahlen, and Paul Johnson. Contact Dr. Yuanming Guo at Yuanming.Guo@asu.edu

# 4) Near ASU Research House

**More!**

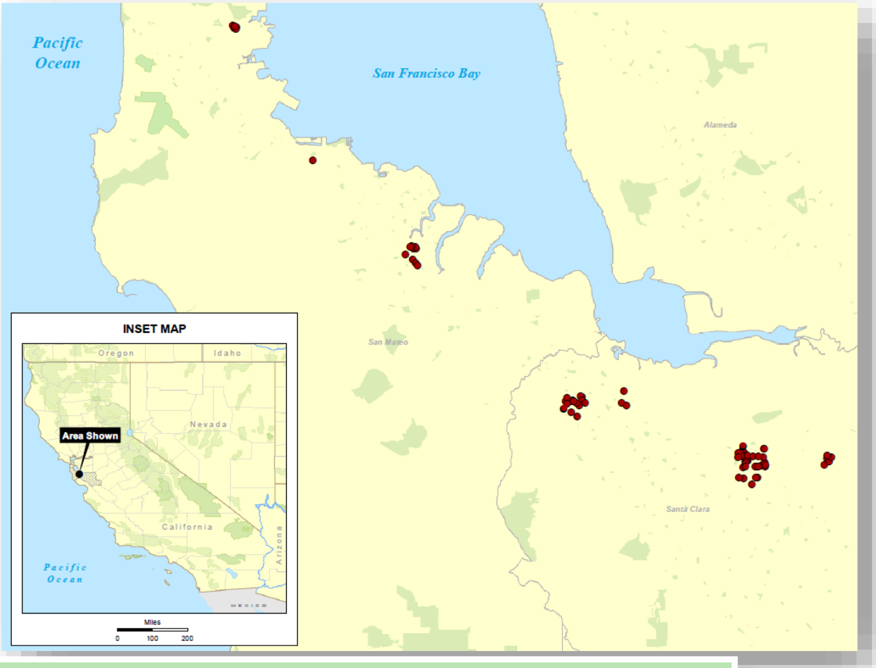
- Multiple rounds of testing (up to 277 manholes per round)
- TCE distributed sporadically in utility systems
- Conc range ND to 2,700 µg/m$^3$
- > 50% of results greater than 10x Indoor MAL




**Indoor Air Results Map 2015-2016 (MAL = 2.2 ppb$_v$)**

# What Are VOC Concentrations in Sewer Manholes?

## 5) Bay Area, CA TCE Plumes




entanglement TECHNOLOGIES, INC.

Results from Entanglement Technologies, Inc. using their AROMA instrument. Contact Bruce Richman at 650-204-7875.

**TCE Concentrations:**

**Median: 4.5 µg/m$^3$**

**Max: 1,315 µg/m$^3$ (2,740x Indoor Air SL)**

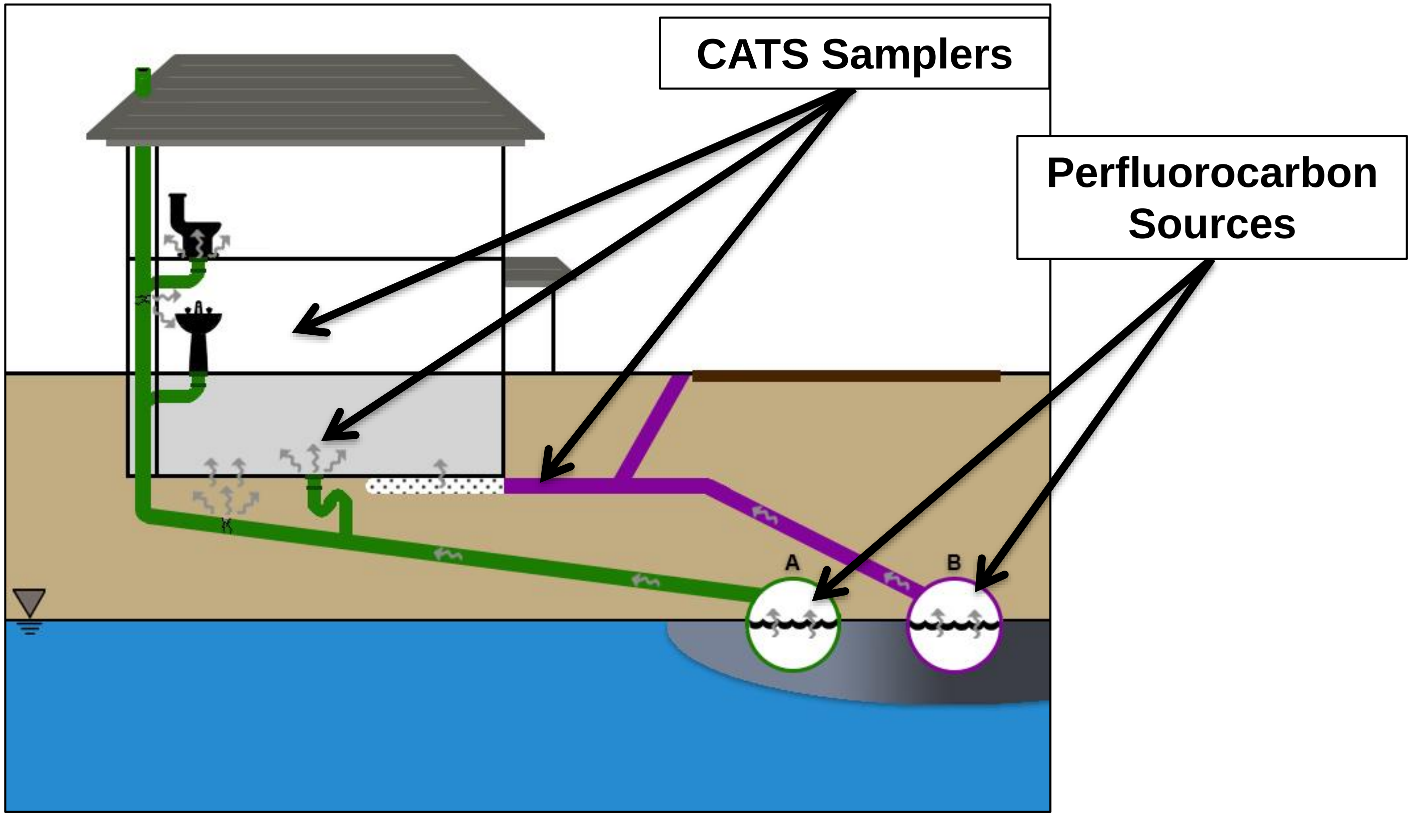
***49% were > 10x Indoor Air SL***

Assumed TCE indoor air screening level = 0.48 µg/m$^3$ (USEPA May 2016 RSL Tables (Residential))

# Understanding the Role of Sewers:

- Groundwater to Sewer Attenuation: **What are VOC Concentrations in Sewer Manholes?**
- Sewer to Building Attenuation: **Do VOCs Move from Sewers into Buildings?**
- Updated Conceptual Model: **How Common Are Sewer Preferential Pathways?**


# Do VOCs Move From Sewers Into Buildings?



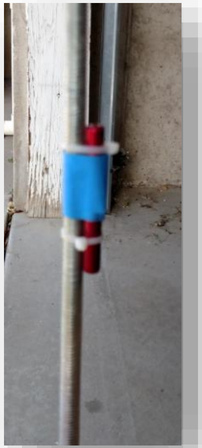

**<u>KEY QUESTIONS</u>:**

**Gas flow from sewer line into building?**
**Attenuation factor?**

# Do VOCs Move From Sewers Into Buildings?

**Sites Tested:**

1) **ASU Research House, UT**
2) **Indianapolis Duplex, IN**
3) **Office Building, Moffett Field, CA**



# Do VOCs Move From Sewers Into Buildings?

## 1) ASU Research House

| Sewer/Building Combination Tested: | Land Drain Manhole to House | Sanitary Sewer Manhole to House |
|---|---|---|
| **Attenuation** | **20x – 40x** | **60x – 80x** |

# Do VOCs Move From Sewers Into Buildings?

## 2) Indianapolis Duplex



| Combined Storm/Sanitary Sewer Connection Tested: | Upstream Manhole to House | Downstream Manhole to House |
|---|---|---|
| **Attenuation** | **160x – more than 1000x** | **50x – 100x** |

# Do VOCs Move From Sewers Into Buildings?

## 3) Moffett Field Office Building

PFT Sources in Separate Manholes


| Sewer/Building Combination Tested: | Sanitary Sewer Manhole to Bldg | Telephone Utility Manhole to Bldg |
|---|---|---|
| **Attenuation** | **1300x – more than 2500x** | **45x – 50x** |

# Do VOCs Move From Sewers Into Buildings?

**YES - detected tracer in all buildings tested**

## Range of Sewer to Building Attenuation?

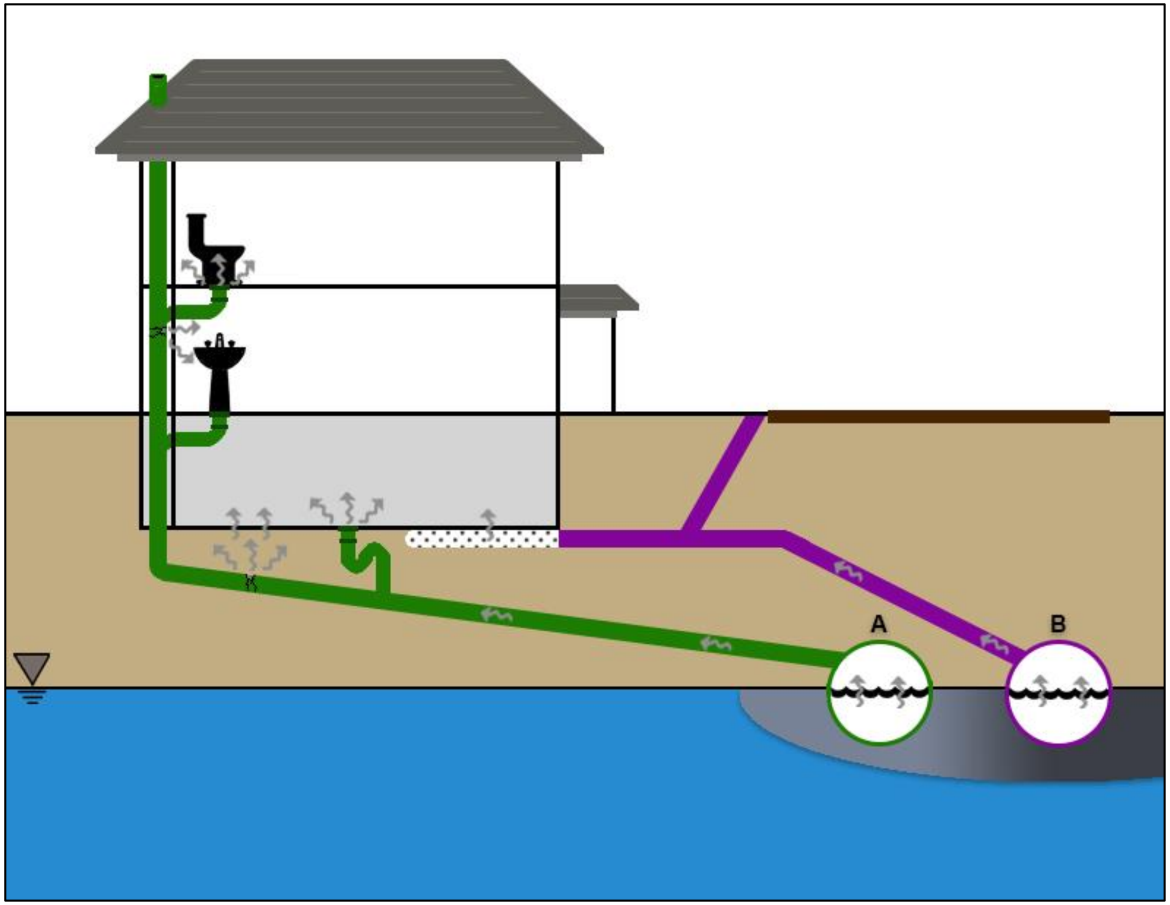
| | | |
|---|---|---|
| **ASU House:** | **Land Drain System**<br>**20x – 40x** | **Sanitary Sewer System**<br>**60x – 80x** |
| **Indy Duplex:** | **Upstream Manhole**<br>**160x - >1000x** | **Downstream Manhole**<br>**50x – 100x** |
| **Moffett:** | **Sanitary Manhole**<br>**1300x - >2500x** | **Telephone Manhole**<br>**45x – 50x** |

# Understanding the Role of Sewers:

- Groundwater to Sewer Attenuation: **What are VOC Concentrations in Sewer Manholes?**
- Sewer to Building Attenuation: **Do VOCs Move from Sewers into Buildings?**
- Updated Conceptual Model: **How Common Are Sewer Preferential Pathways?**

**Conceptual Model**

# Sewer/Utility Pathway: Conceptual Model



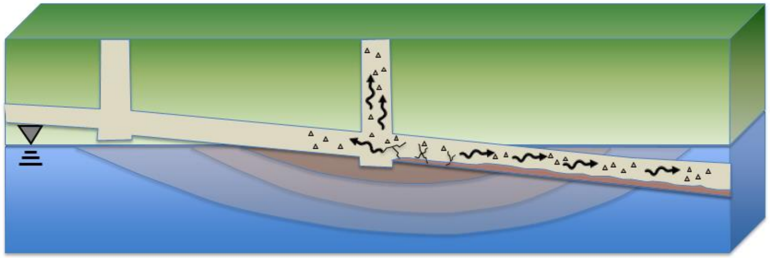

1) VOCs often detectable in sewers/utility tunnels close to VOC plumes in groundwater.

2) VOCs can move from sewers into buildings
(50x to 1000x attenuation???)

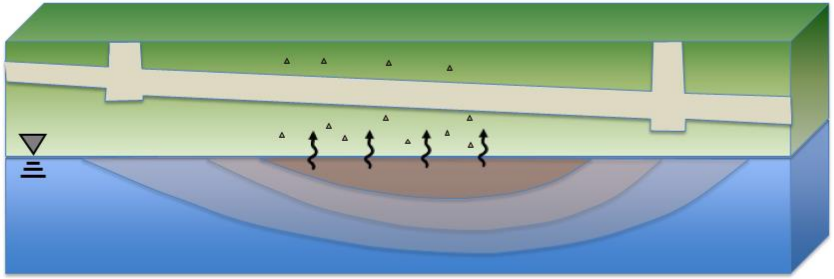
***KEY POINT:*** **Sewer/Utility Tunnel pathway should be considered during VI investigations.**

# What Are VOC Concentrations in Sewer Manholes?


**1) SEWER INTERSECTS CONTAMINATED GW**



**2) SEWER IN VADOSE ZONE ABOVE CONTAMINATED GROUNDWATER**

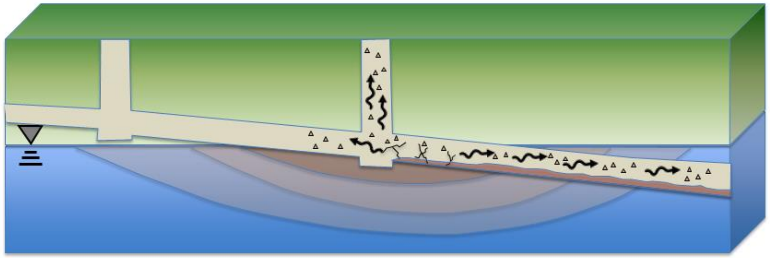


**<u>KEY QUESTION</u>:**

**How important is depth of sewer line relative to groundwater?**

# What Are VOC Concentrations in Sewer Manholes?


1) SEWER INTERSECTS CONTAMINATED GW



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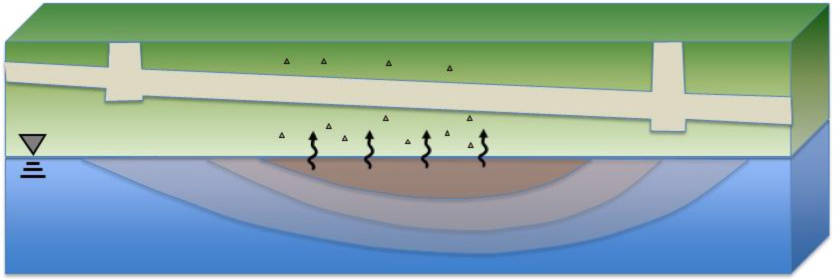


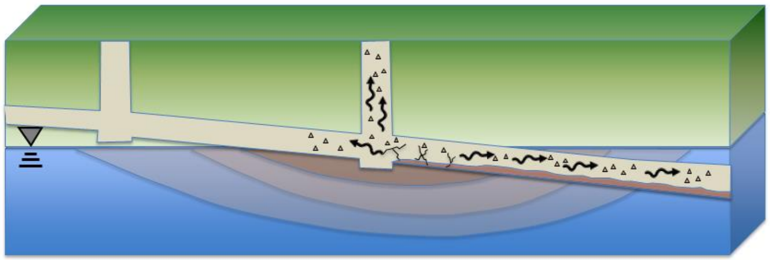
**PRELIMINARY ANSWER:**

**VOCs can be detected in sewer manholes in vadose zone above groundwater plumes.**

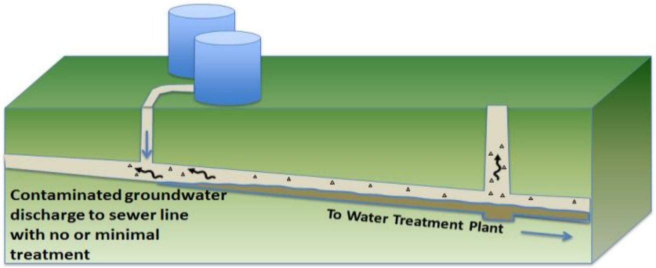
# Sewer/Utility Pathway: Conceptual Model

| Screen In Conditions | Possible Concern |
|---|---|

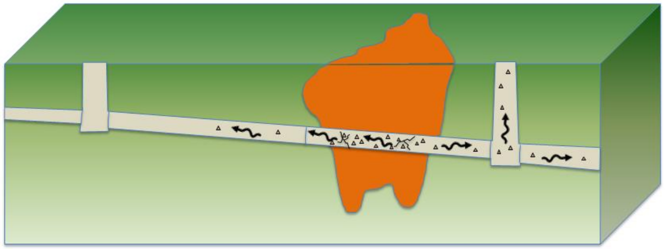
**1) SEWER INTERSECTS CONTAMINATED GW**



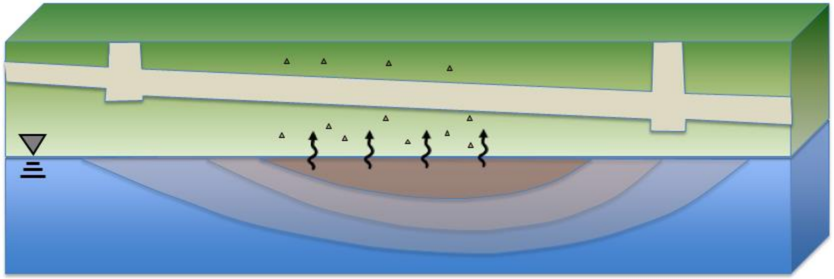
**2) DISCHARGE INTO SEWER**




**3) SEWER INTERSECTS NAPL**



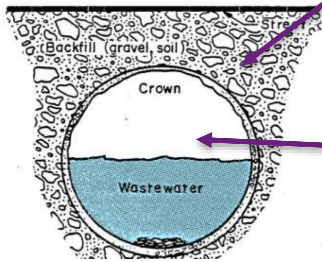
**SEWER IN VADOSE ZONE ABOVE CONTAMINATED GROUNDWATER**



# Sewer/Utility Pathway: Conceptual Model

**<u>Problems we have never seen:</u>**

- **VOC migration through sewer backfill**




**VOCs <u>OUTSIDE</u> Sewer:**

**Who cares?**

**VOCs <u>INSIDE</u> Sewer:**

**Potential concern.**

- **Buried utility lines (i.e., lines are NOT inside utility tunnel)**

***KEY POINT:*** **Overly broad definition of “preferential pathway” creates confusion; makes it harder to find the real problems.**

# Sewer/Utility Tunnel Preferential Pathway

## *Next Challenges*

- **Screen in/screen out logic:** **When should we test the sewers for VOCs?**

- **Spatial/temporal variability:** **How many locations?  How many times?**

- **Sewer screening levels:** **What VOC concentration inside a sewer manhole is a potential concern?**

# ESTCP ER-201505 Project Team

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