Innovation that provides sustainable solutions to complex challenges worldwide

Sewer Ventilation as a VI Mitigation Alternative- Case Studies

April 10, 2018

Keri Hallberg, PE, Jacobs
Loren Lund, PhD, Jacobs
Jessica High, PE, Jacobs
Quinten Bingham, Jacobs
David Cleland, PG, NAVFAC Mid-Atlantic
Mark Roginske, Air Force Civil Engineer Center

CH2M is now Jacobs

JACOBS®

www.jacobs.com | worldwide

Presentation Outline

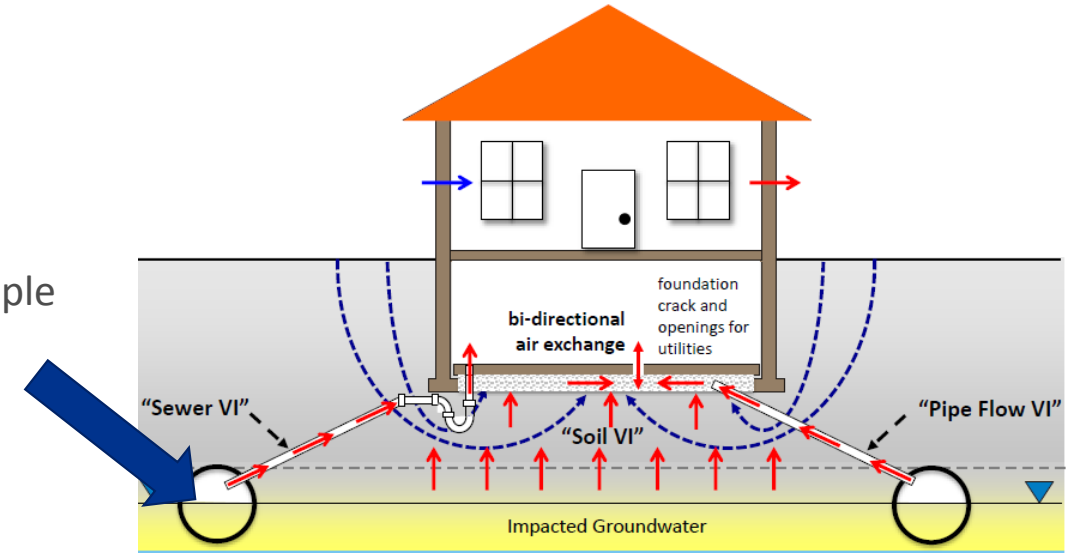
- Introduction
- Overview of the Sewer Preferential Pathway
- Ventilation Objectives
- Case Study – Site A
- Case Study – Site B
- Conclusions

JACOBS

Atypical Preferential Pathways (APPs)

Definition: A conduit into building (e.g., sewer line) that intercepts VOC source area and provides little resistance to vapor flow

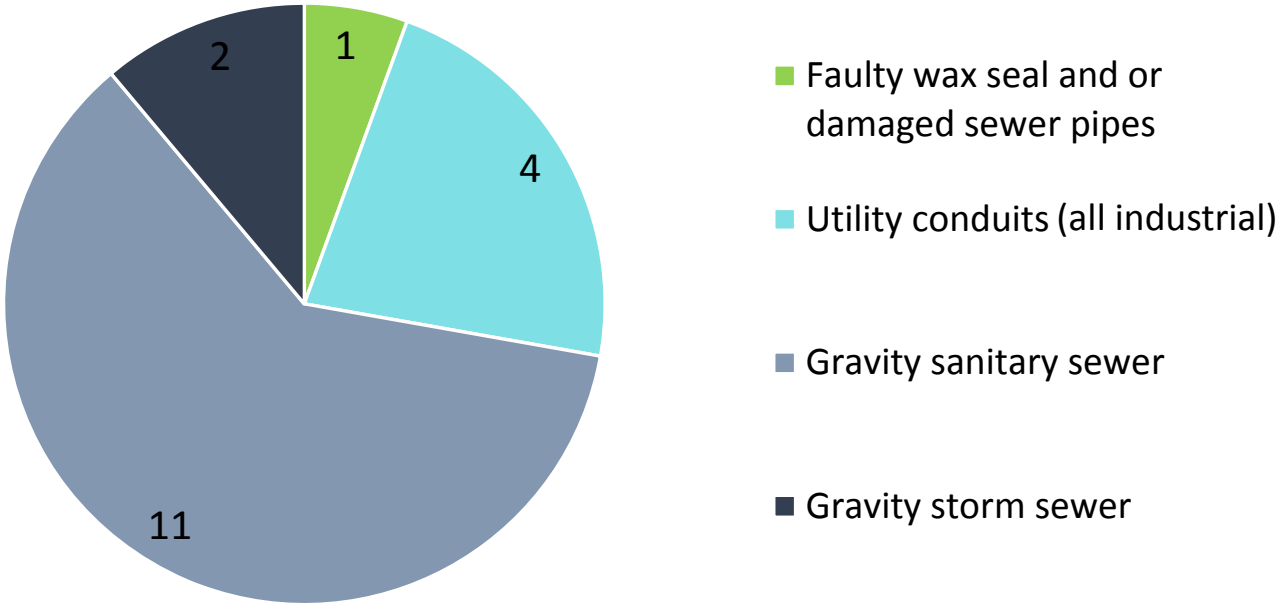
Example APP



Modified from Johnson 2015

JACOBS

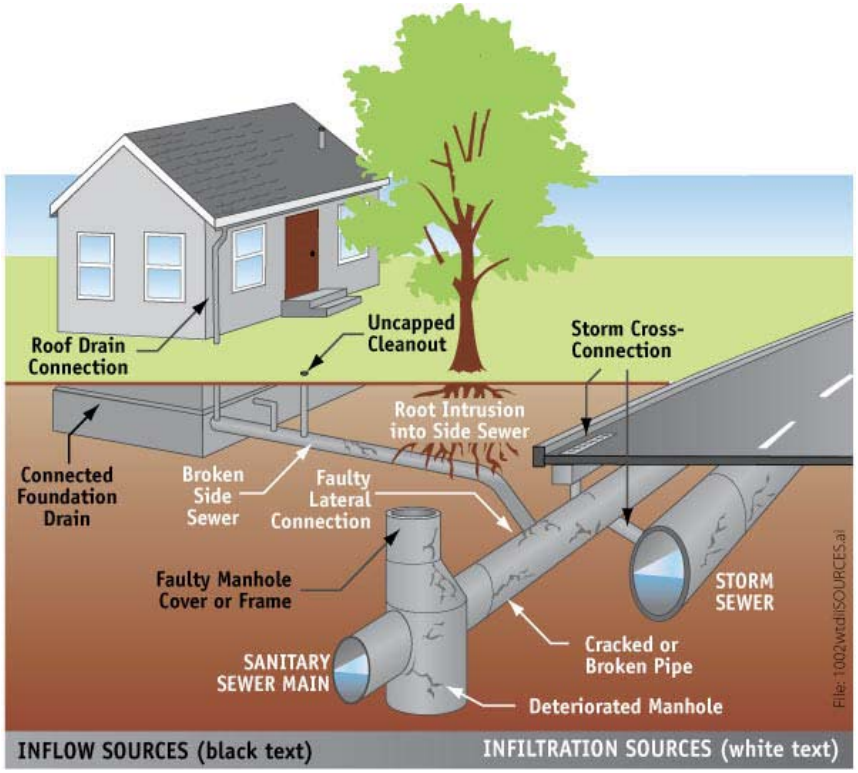
Frequency and Type of APPs (Literature Review*)



*Mix of residential and commercial

JACOBS

Sewer Atypical Preferential Pathways



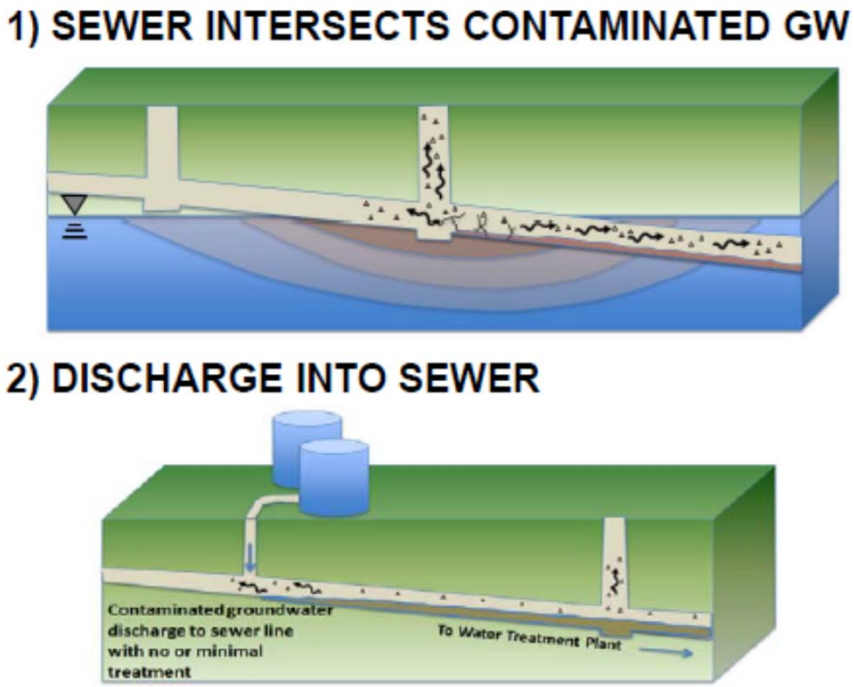
www.kingcounty.gov/services/environment/wastewater/ii/what.aspx)

- Gravity sewers – large headspaces (facilitates vapor flow)
- Most sewers leak both in and out
- Sewers receive flow from smaller pipe networks
- Larger receiving pipes can be over 20-ft below ground

JACOBS

VOCs in Sewer Gas

- VOCs enter sewer gas through 2 primary mechanisms
  - Contaminated groundwater (may include NAPL) and/or soil gas enters sewer
  - Direct discharge of water containing VOCs to sewer system



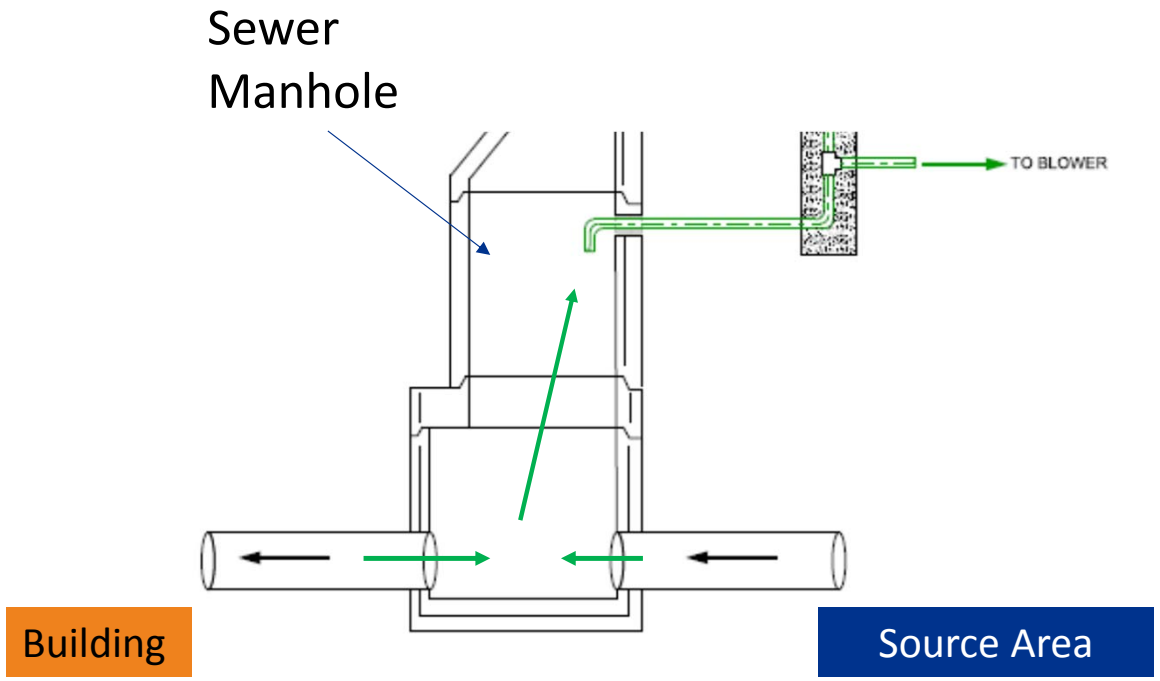
Adapted from McHugh and Beckley AEHS 2017

https://www.fvrobertson.com/sewer-video-inspection/

JACOBS

Ventilation Objectives

- Prevent VOCs in sewer gas from entering occupied space by:
  - Intercepting vapors between source area and target buildings
  - Preventing vapor build-up in sewer headspace
  - Reversing flow of vapors away from target buildings



JACOBS

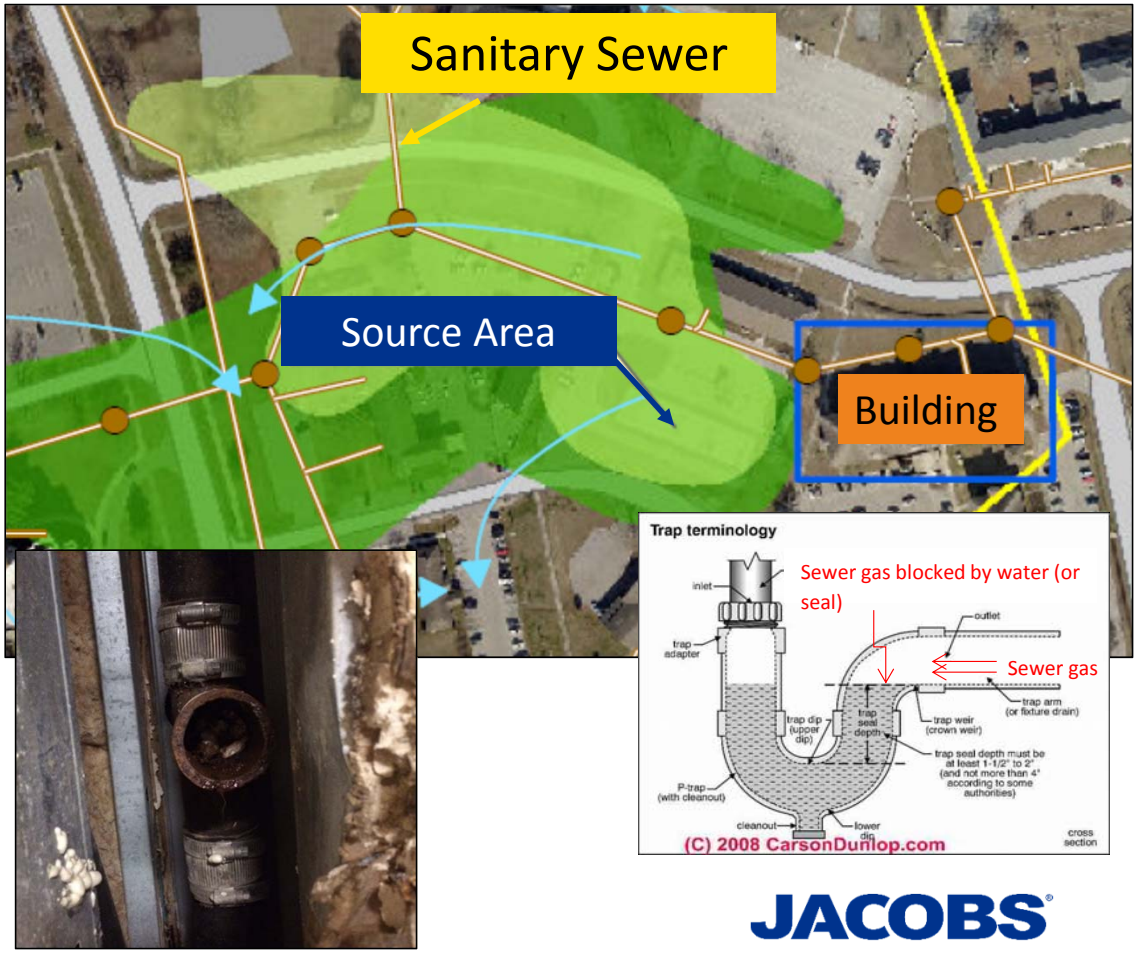
Innovation that provides sustainable solutions to complex challenges worldwide

Site A

JACOBS

Site A Background

- Upgradient of source area
- Source area
  - PCE ~600 µg/L and TCE ~300 µg/L
  - Residual soil NAPL
- Sewer connects source area to building
- TCE periodically detected in indoor air
  - Above regulatory targets
  - IA concentrations did not correlate with SG concentrations
- Additional investigation to determine source
  - Uncapped pipe in mechanical room
  - Dry or damaged p-traps
  - HAPSITE confirmed PCE and TCE inside plumbing



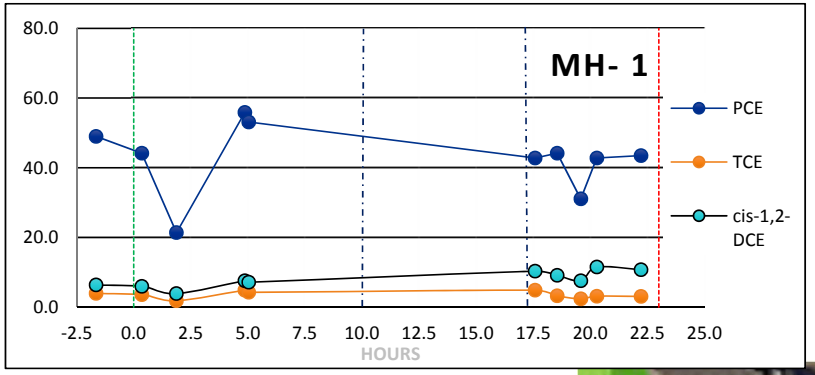
JACOBS

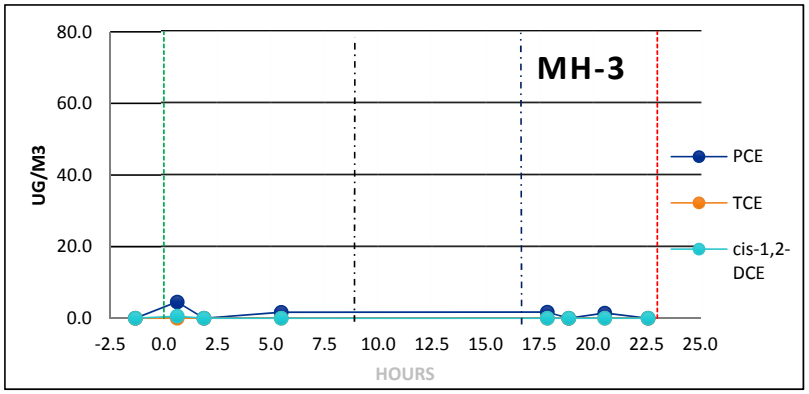
Phase I Sewer Ventilation Pilot Study

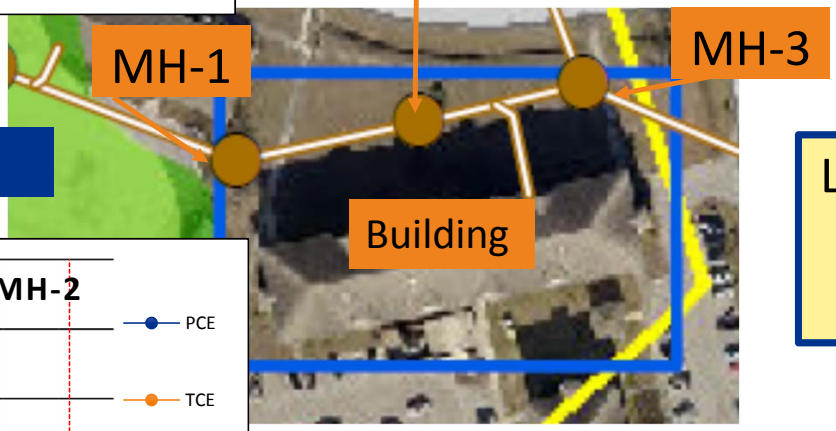
- Conducted to assess whether ventilation of the sewer line can:
  - Reduce PCE and TCE concentrations within manholes
  - Reverse the flow of vapor to potential entry points inside Building
- Test blower was selected to match the flow rate of the blower tentatively specified (240 cfm)
- Conduct confirmation sampling at manhole locations MH-1, MH-2, and MH-3, the mechanical room plumbing, and within sink plumbing

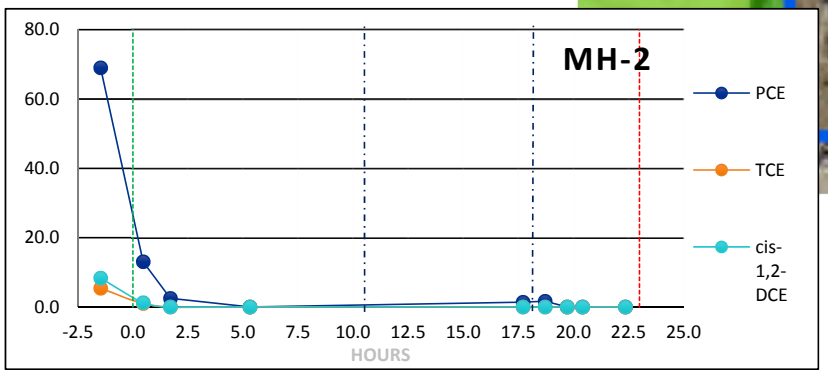
JACOBS

Phase 1 Results





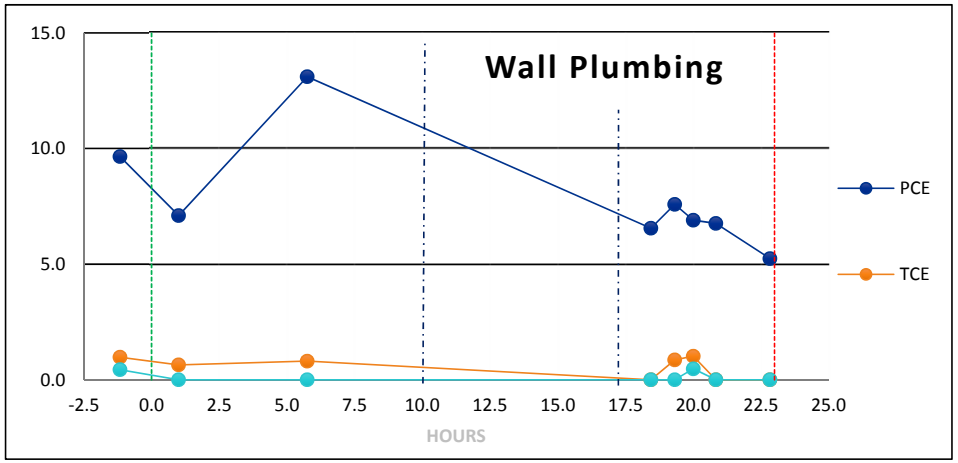




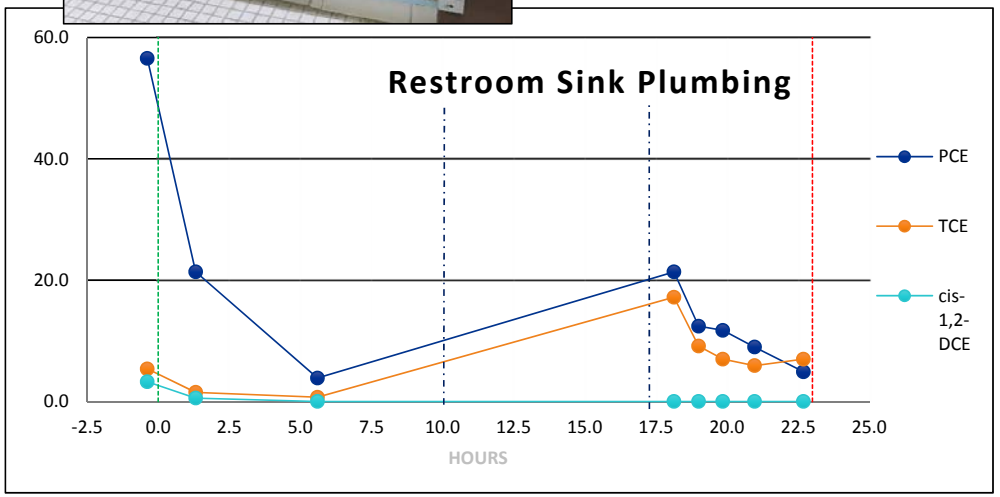
Little influence at MH-1, but significant reductions at MH-2 and MH-3

JACOBS

Phase 1 Results



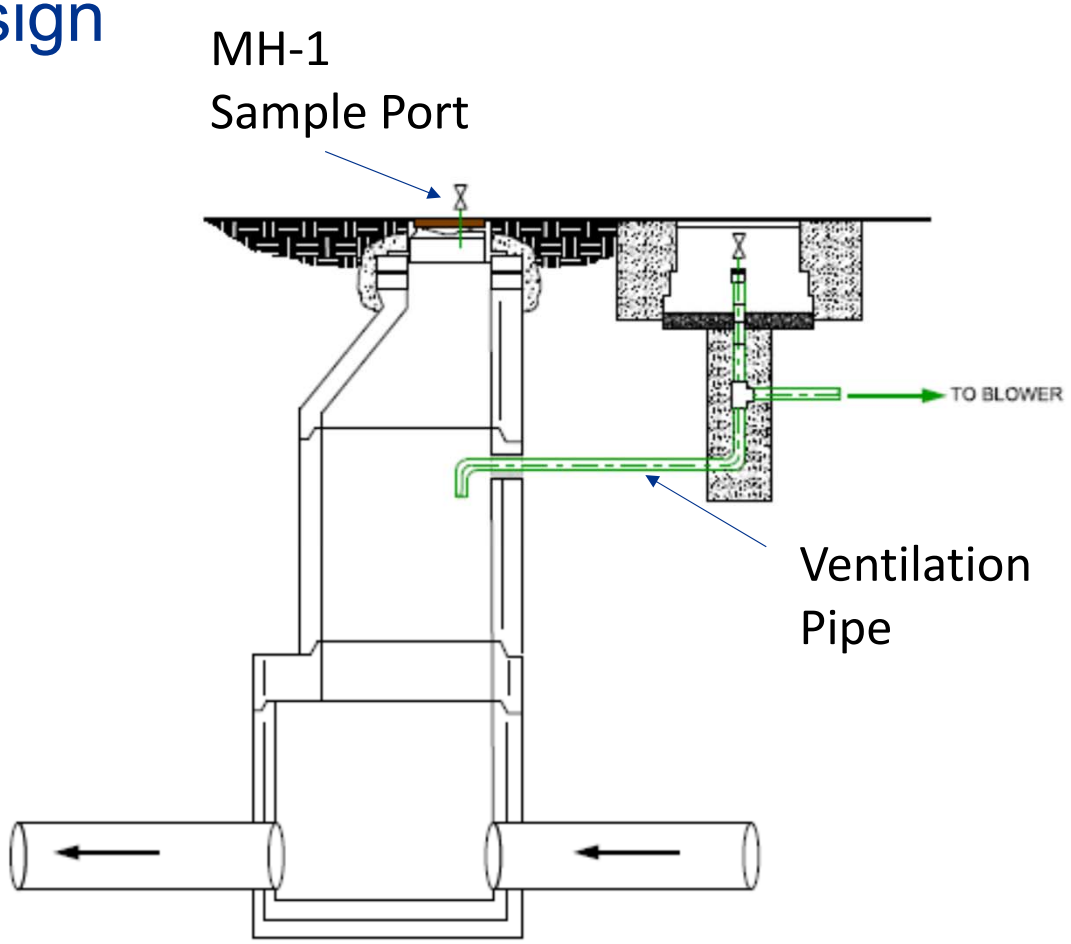
Significant reductions in building plumbing



JACOBS

Sewer Venting System Design

- 4” ventilation pipe from the sewer
- Connected to skid mounted blower
  - 240 cfm, 25” H_2O
- Blower exhaust vented above roofline
- Vapor monitoring port installed (MH-1)



JACOBS

Phase 2 Field Activities

- Ventilation system and sample port installation

Blower Enclosure and Stack

Blower System

Manhole Sample Port

Blower Connection to Manhole

System Connection

Piping into manhole

JACOBS

Phase 2 Field Activities

- Baseline sampling, startup, and post-startup performance monitoring
  - Highest sewer line concentrations observed at MH-1 (located closest to source area)
  - COCs not detected in indoor air above screening levels during baseline or after startup
  - Post-startup monitoring conducted 36 hours after startup

MH-1

IA Sampling

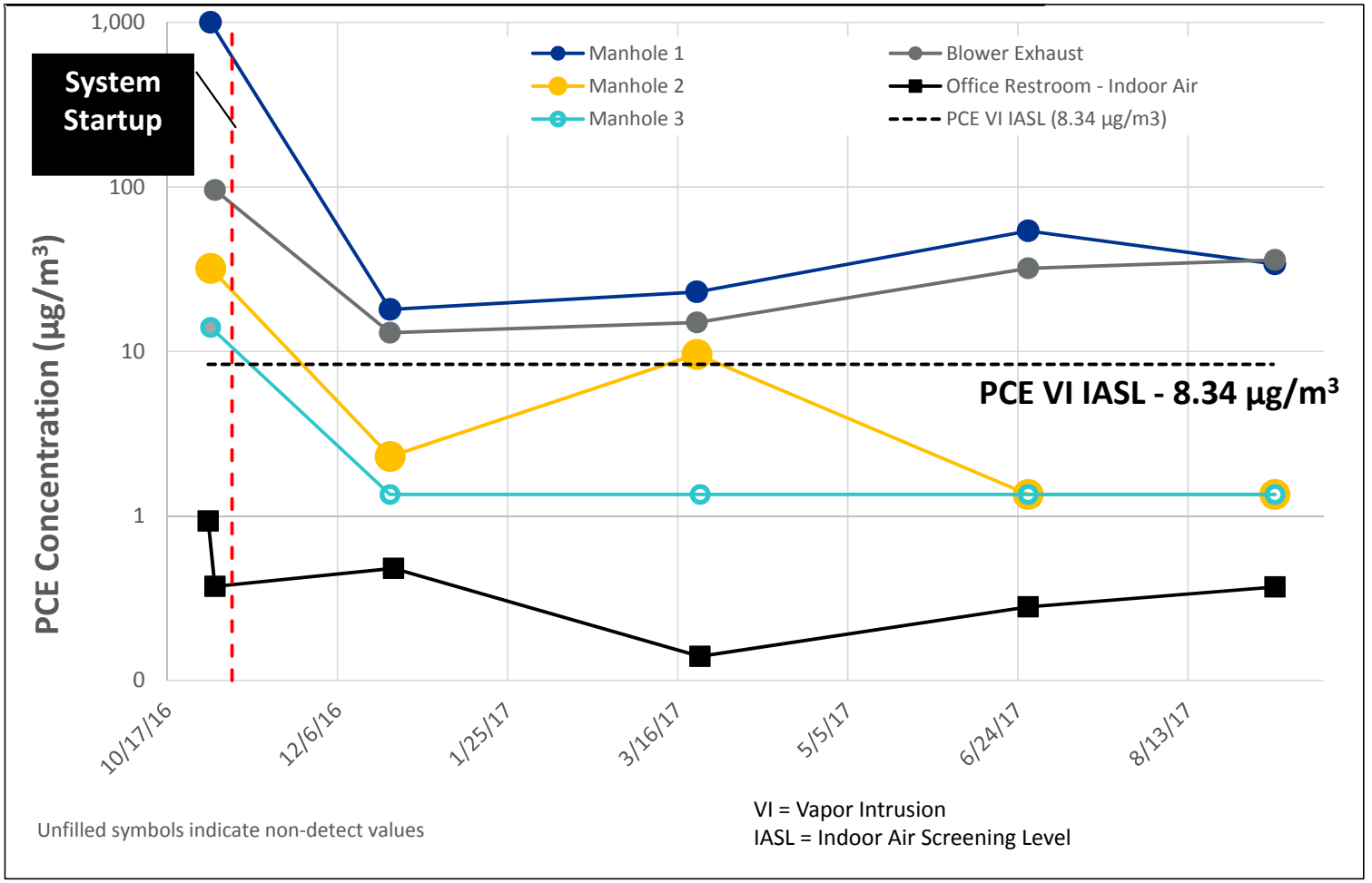
Wall Plumbing

Office Plumbing

Blower Exhaust

JACOBS

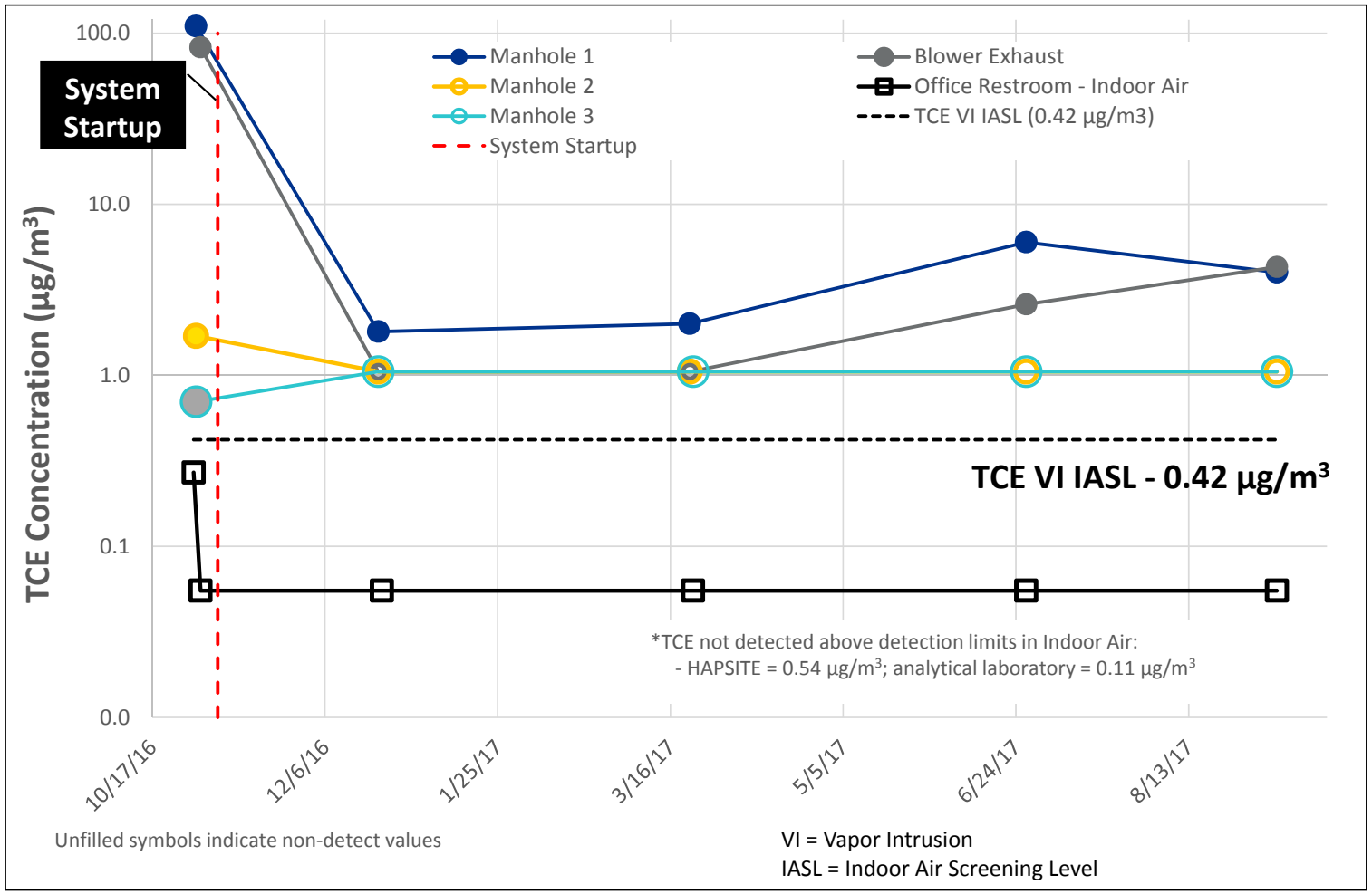
Phase 2 Performance Monitoring- PCE



PCE concentrations below IASL by MH-2

JACOBS

Phase 2 Performance Monitoring – TCE



TCE concentrations below detection limits by MH-2

JACOBS

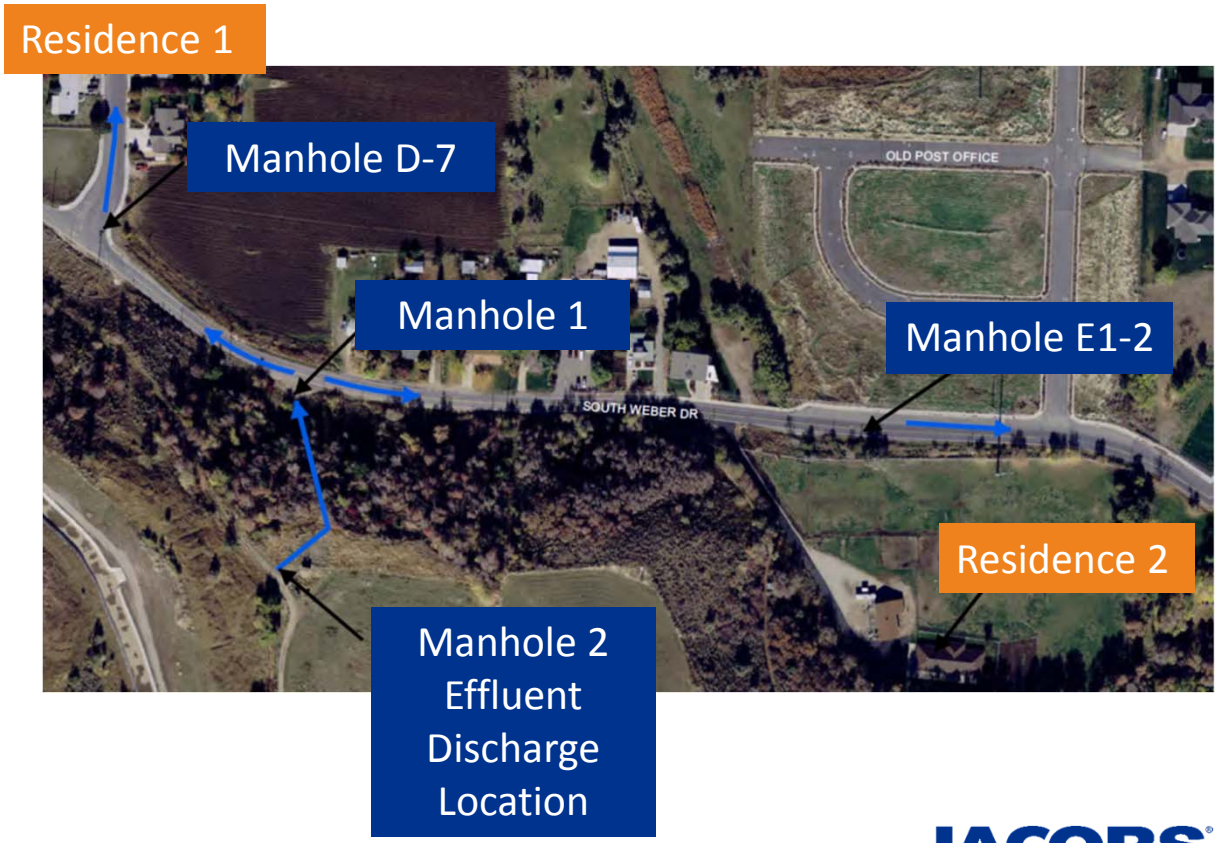
Innovation that provides sustainable solutions to complex challenges worldwide

Site B

JACOBS

Site B Background

- TCE in sewer gas related to remediation system effluents discharging to Manhole 2, and flowing toward Manhole 1
  - Effluent water concentrations 10-50 µg/L
- TCE detected in the indoor air of nearby residences above mitigation action level



JACOBS

Pre-Design Testing Activities

- Baseline sewer gas samples collected (3 manholes)
- FanTech® FKD 8XL inline-duct fan connected to existing manhole passive vent pipe
- Post-Startup Sampling
  - 25 to 55 minutes
  - 67 to 87 minutes
  - 98 to 122 minutes

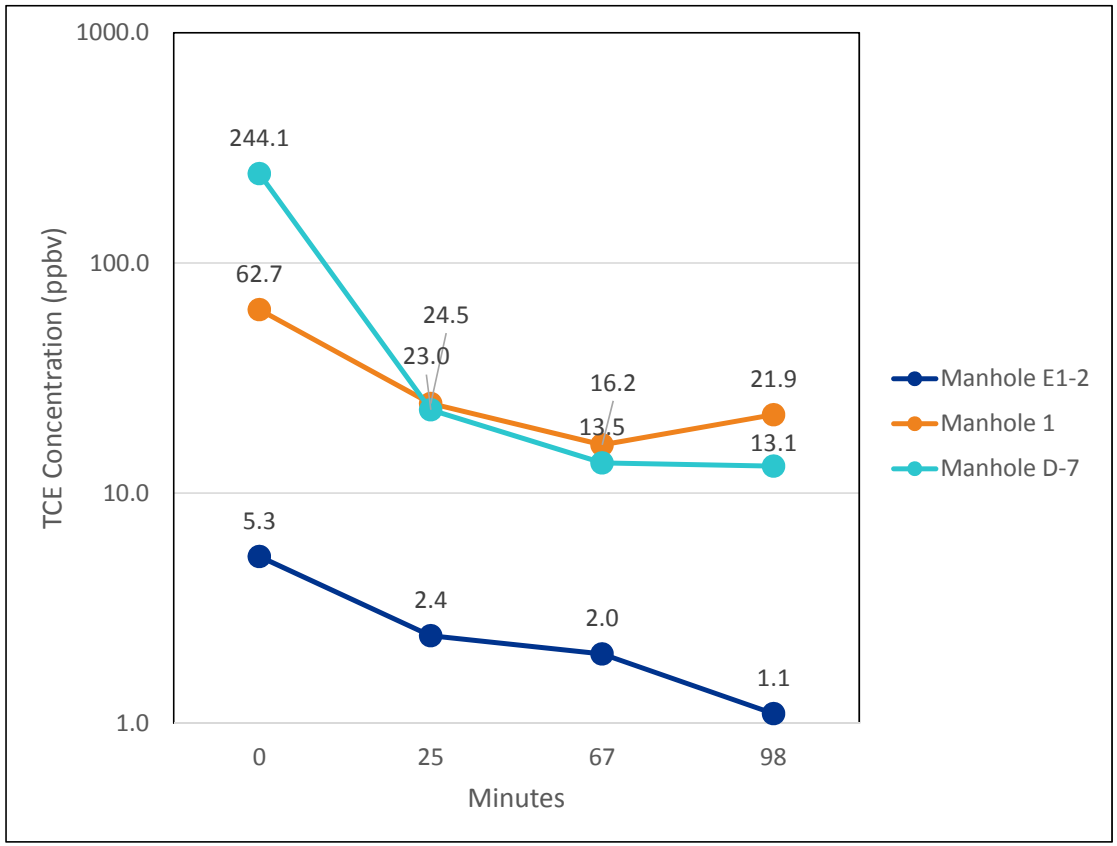
Manhole 1 Sampling

Inline – Duct Fan

JACOBS

Pre-Design Testing Results

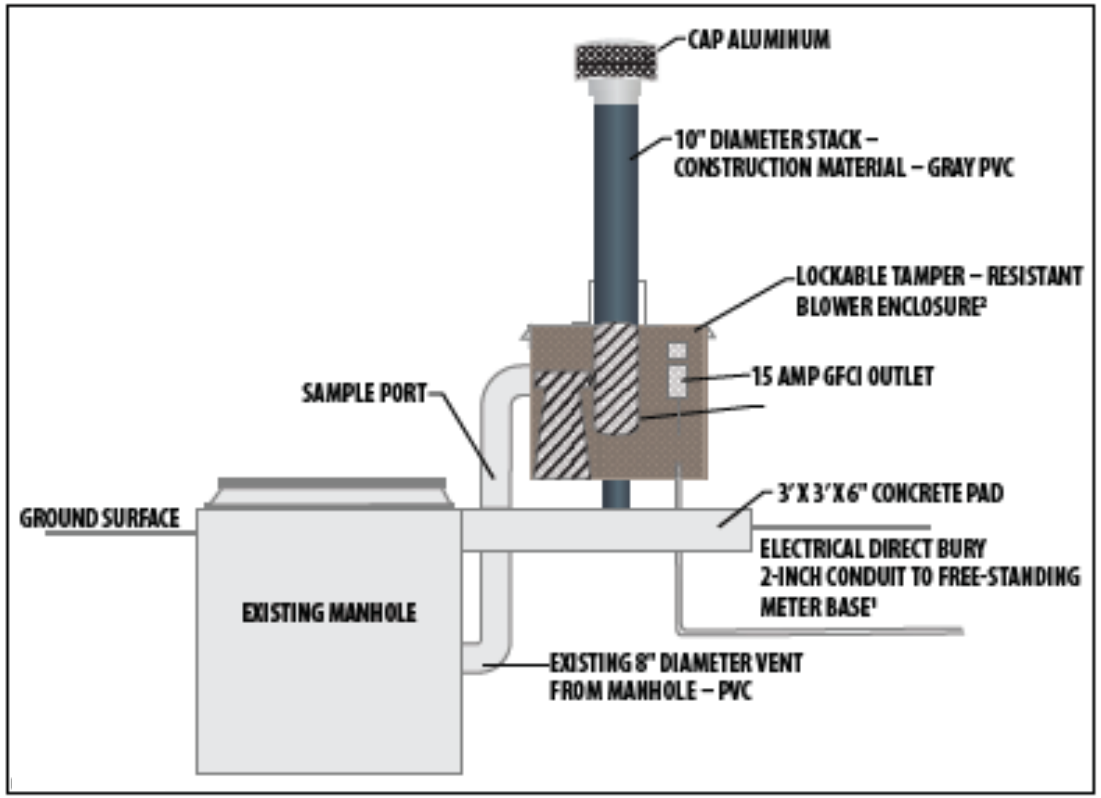
- 50% reduction in TCE concentration within 25 to 55 minutes
- Up to 95% reduction after 98 minutes at manholes nearer residences
- Reduction maintained over 2-hour period



JACOBS

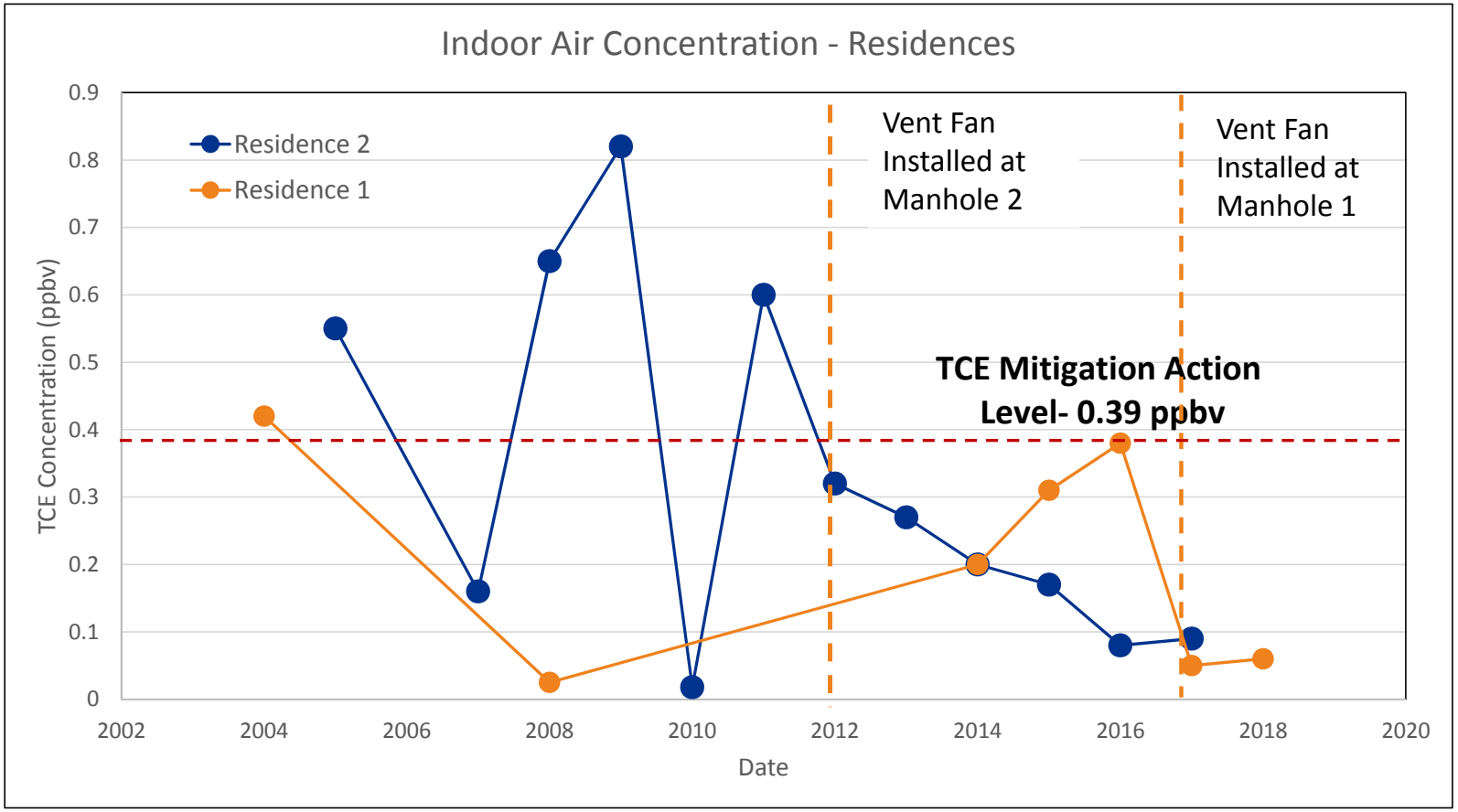
Ventilation System Design

- Vent fan installed on concrete pad within tamper-resistant enclosure
- Plastec PLAS25XS4P blower
  - Initial Flowrate 770 cfm



JACOBS

Performance Monitoring



JACOBS

Conclusions

- Sewer ventilation is effective in mitigating VI through sewers by:
  - Intercepting vapors between the source area and the building:
    - Site A: concentrations of PCE and TCE in sewer manholes and in building plumbing reduced up to 99-percent
    - IA concentrations < IASLs
  - Preventing accumulation of vapors:
    - Site B: TCE concentrations in the sewer line were reduced by 79-percent to 95-percent
    - IA concentrations reduced to concentrations < mitigation action level

JACOBS

Thank you!

Keri Hallberg
Keri.hallberg@ch2m.com

May 8, 2018

www.jacobs.com | worldwide