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Optimizing Long-Term Vapor Intrusion Monitoring During Site Management

Battelle Chlorinated Conference, Denver, Colorado
June 2-6, 2024

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Agenda

- Introduction and Objective
- Site Background
  - VI LTM Program
- Lines of Evidence Considered
- Data Evaluation
- Data Evaluation Summary
- VI LTM Optimization Summary
- Questions and Answers

Introduction and Objective

- Long-term monitoring (LTM) for vapor intrusion (VI) can be expensive, intrusive, and potentially unnecessary

Objective

Summarize an effective VI LTM optimization strategy using a case study site with chlorinated volatile organic compound (cVOC) data collected from 2009 to 2021

Site Background

- Coastal industrial site
- Small and large occupied and unoccupied buildings
- Historical machine, vehicle, locomotive, and electrical maintenance, and munitions loading
- Documented trichloroethene (TCE) use and ground-surface disposal
- Current use: Storage and maintenance
- Future anticipated use: Industrial

Site Background (continued)

- Site-related chemicals of concern (COCs):
  - TCE
  - Cis-1,2-dichloroethane (DCE)
  - 1,1-DCE
  - Vinyl chloride (VC)

- Site remedy:
  - *In situ* chemical reduction (ISCR) through zero-valent iron injections where TCE > 1,000 µg/L
  - Enhanced reductive dechlorination (ERD) through emulsified vegetable oil injections where TCE < 1,000 µg/L
  - Land use controls (LUCs)

VI LTM Program

- 2009 VI investigation indicated no current or future risk
- **But wait!** GW remedial action (RA) could increase concentrations of COC degradation products or explosive hazards
- VI LTM used to monitor building use/condition and changes in concentrations of constituents of interest (COIs)

Inhalation risk COIs:

- *TCE, VC, cis-1,2-DCE*
- *Degradation products: 1,1-DCE, trans-1,2-DCE, 1,2-dichloroethane (DCA)*

Explosive hazard COIs:

- *Hydrogen sulfide*, methane*

*ERD by-product

VI LTM Program (continued)

- Semi-annual
- Types of VI data collected were determined by review of LTM GW data
- Updated building surveys
- If warranted: Collected indoor air (IA), outdoor air (OA), and subslab soil gas (SG) at occupied buildings
- Post-injection: Monitored SG and IA explosive hazards at all buildings for at least 3 rounds

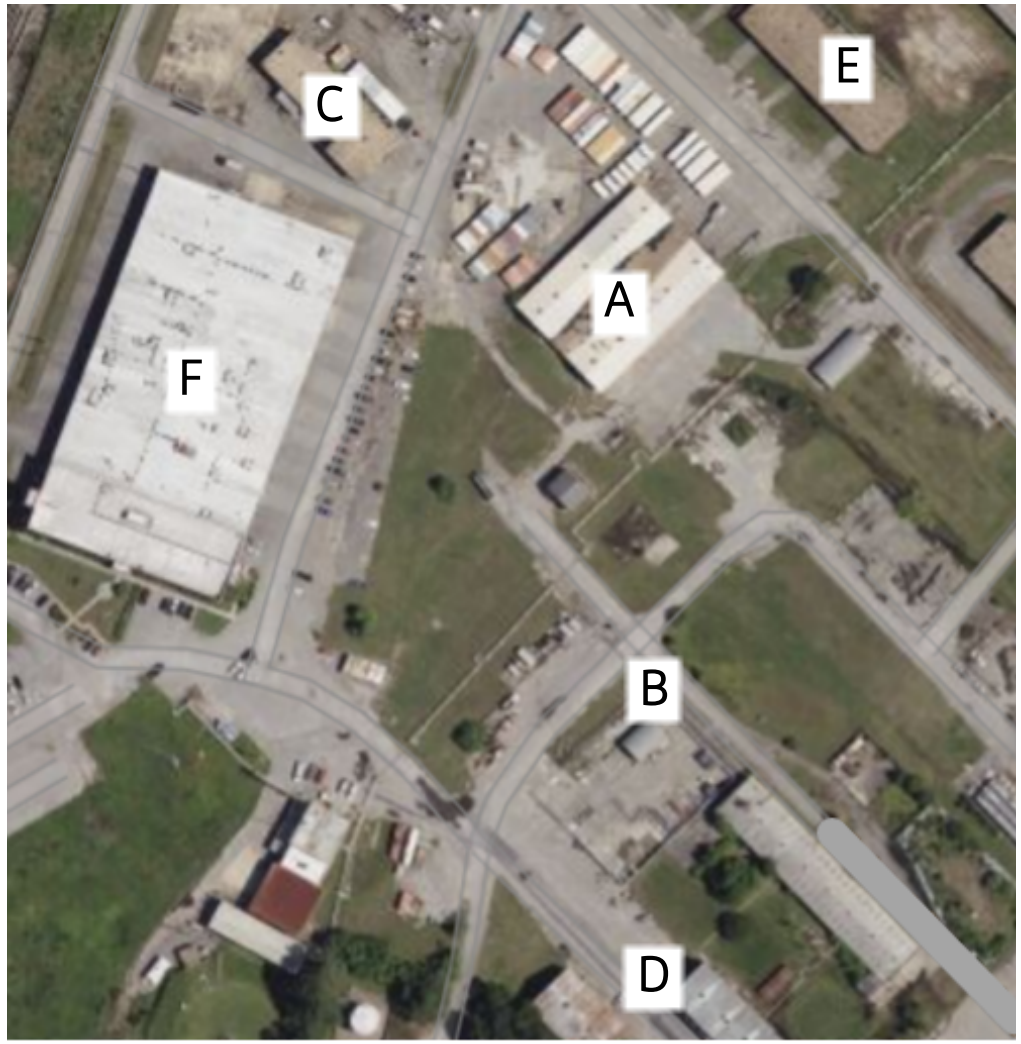
Lines of Evidence Considered

Data available from 2009 to 2021

Data continually reviewed for optimization opportunities

- Remedial Action-Construction Phase
  - Initial ISCR and ERD injections site-wide
- Remedial Action-Operation (RA-O) Phase
  - Site/LUC inspections
  - Five-Year Reviews (FYR)
  - Groundwater and stormwater monitoring (16 events)
  - Additional targeted ERD injections (2 events)
  - Building surveys and inhalation/explosive risk COI monitoring (16 events)
  - Follow-on VI investigations triggered at two buildings proposed for occupancy

Data Evaluation – Surveys

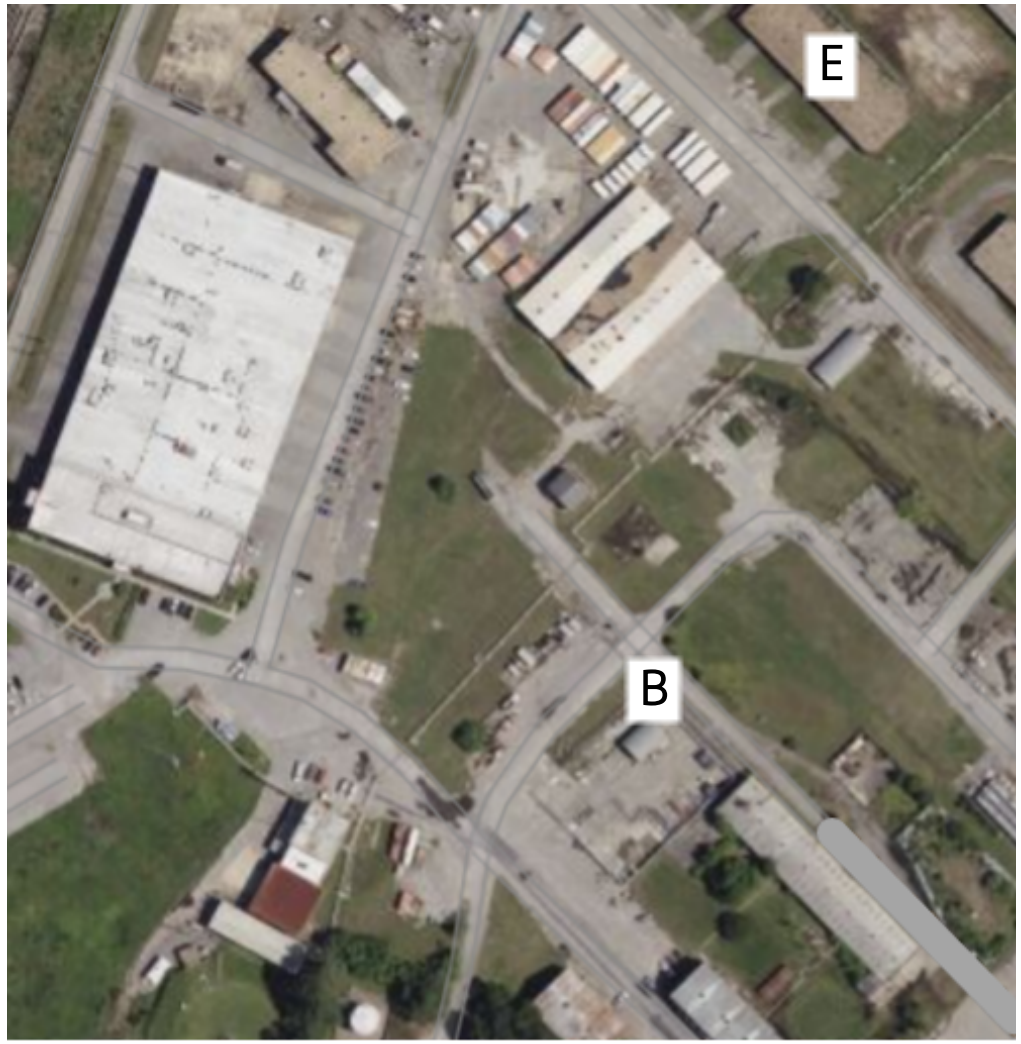


- **B, C, E, and F** (2012-2020) – B and E proposed for occupancy, resulting in follow-on VI risk investigations
- **A** (2012-2014) – Structure fell into disrepair and became unoccupiable
- **D** (2012) – VI LUC boundary redefined based on GW data

Optimization Opportunities!

- ✓ Building A VI LTM discontinued after building vacated
- ✓ Building D removed from VI LTM since it was no longer within VI LUC boundary

Data Evaluation – Follow-On VI Risk Investigations



- **Building B**:
  - IA and SG COI concentrations < screening criteria
  - No current risk, but potential future risk from ongoing RA monitored
- **Building E**:
  - IA and SG COI concentrations < screening criteria
  - Building located upgraded of GW plume
  - Occupants moved out
  - No current or future risk

Optimization opportunity!

✓ Building E VI LTM discontinued after building vacated and since no VI risk

Data Evaluation – Explosive Hazard Monitoring

- Collected baseline SG and IA explosive COI data from all buildings
- Post-injection (when short-term SG increases expected):
  - Collected at least 3 rounds of data
  - Compared to project action limits (PALs)
    - If > PAL, continued monitoring until 3 consecutive rounds < PAL
    - If < PAL, discontinued monitoring until next treatment (as necessary)

Explosive Hazard PAL	
Hydrogen Sulfide	0.4 percent
Methane	0.5 percent

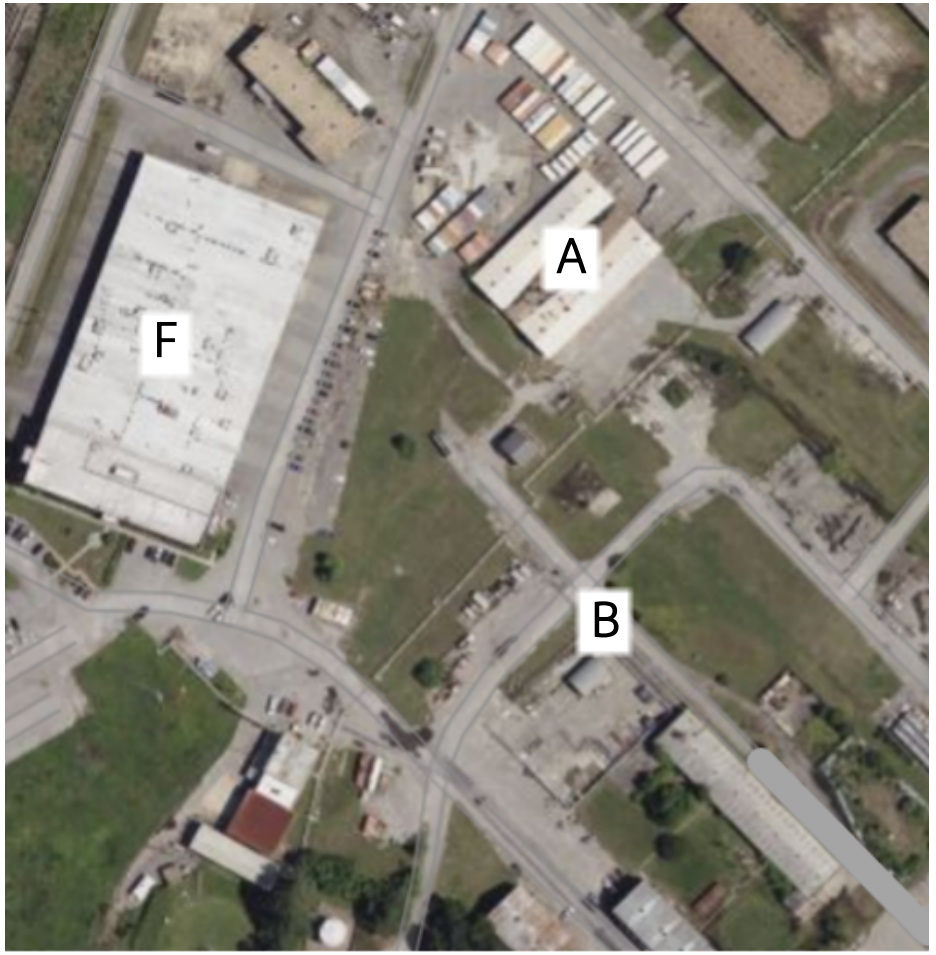
PAL conservatively established as 1/10th the lower explosive limit (LEL)

<u>Overall finding:</u>
No explosive hazards during RA. Monitor again if additional treatment implemented.

LEL = Minimum concentration below which propagation of a flame does not occur in the presence of an ignition source (www.osha.gov)

Data Evaluation – Trend Analyses

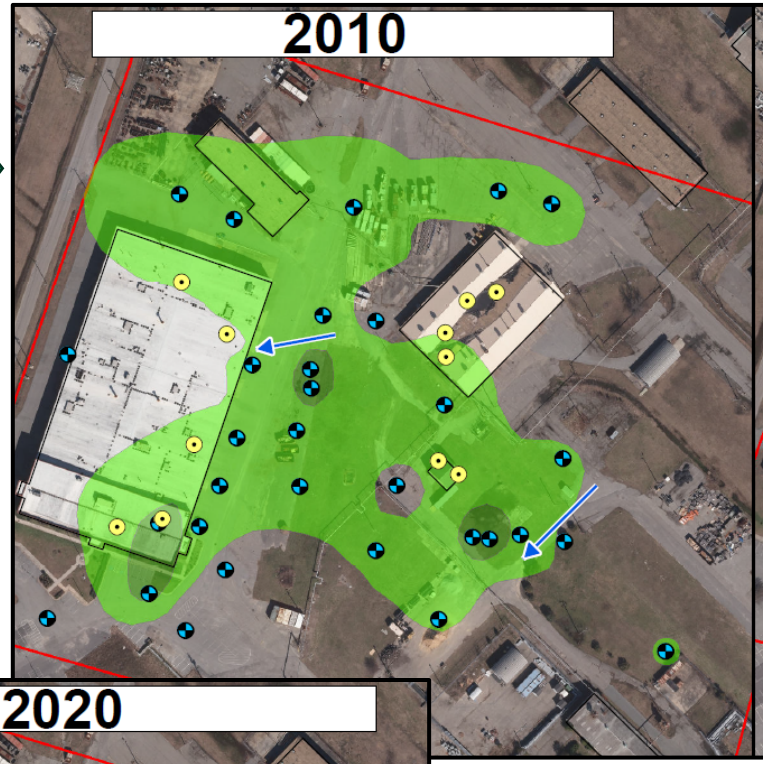
- Reviewed SG data to determine COIs for trend analysis (excluded non-detects)
- TCE and VC trends evaluated for Bldgs A, B, and F
- Plotted available GW data (within 100 feet of bldg) and IA data
  - *Trend analysis results for Building A used in subsequent slides as being representative*

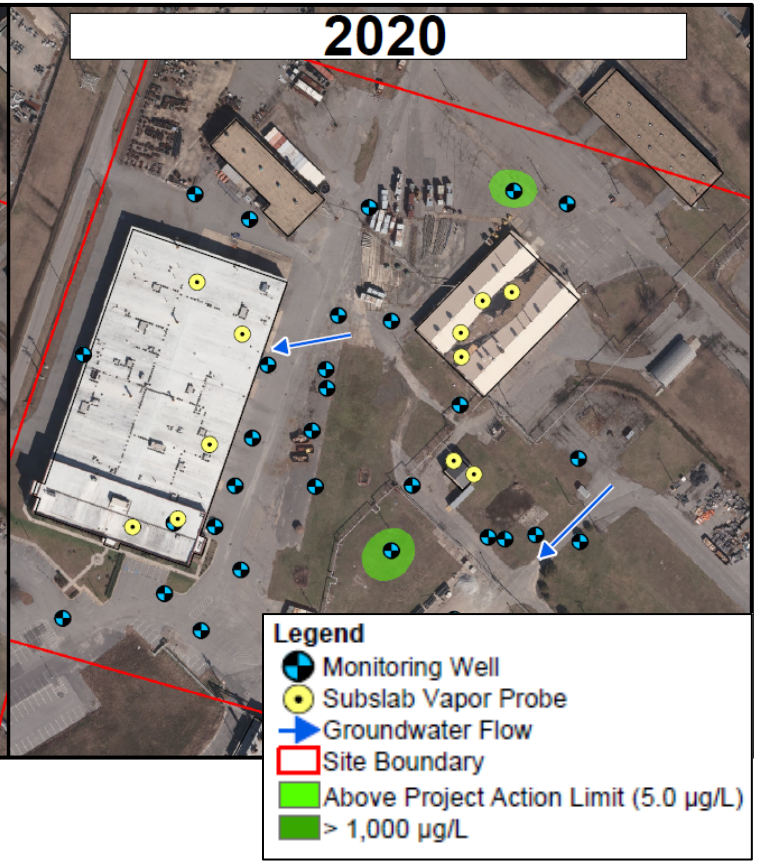


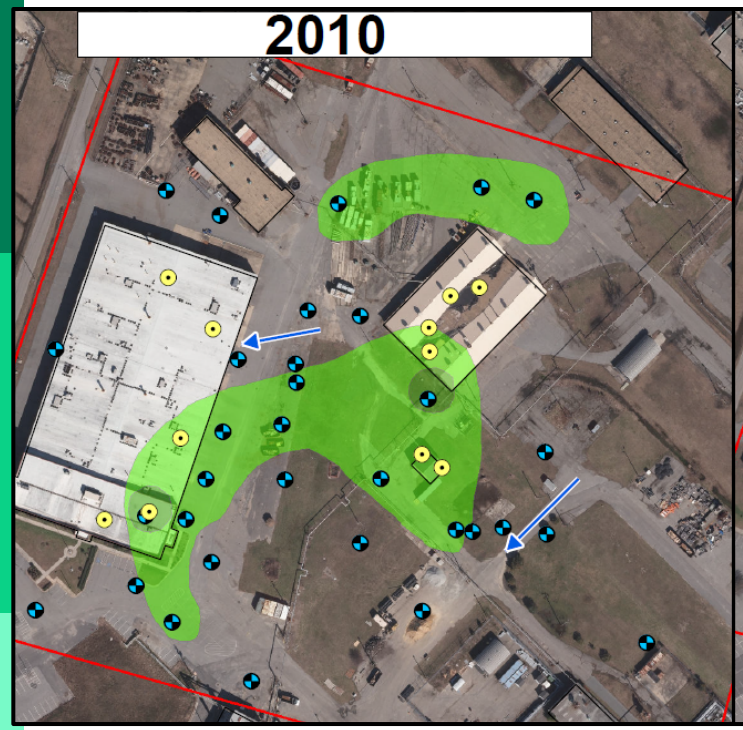
Data Evaluation – GW Trends

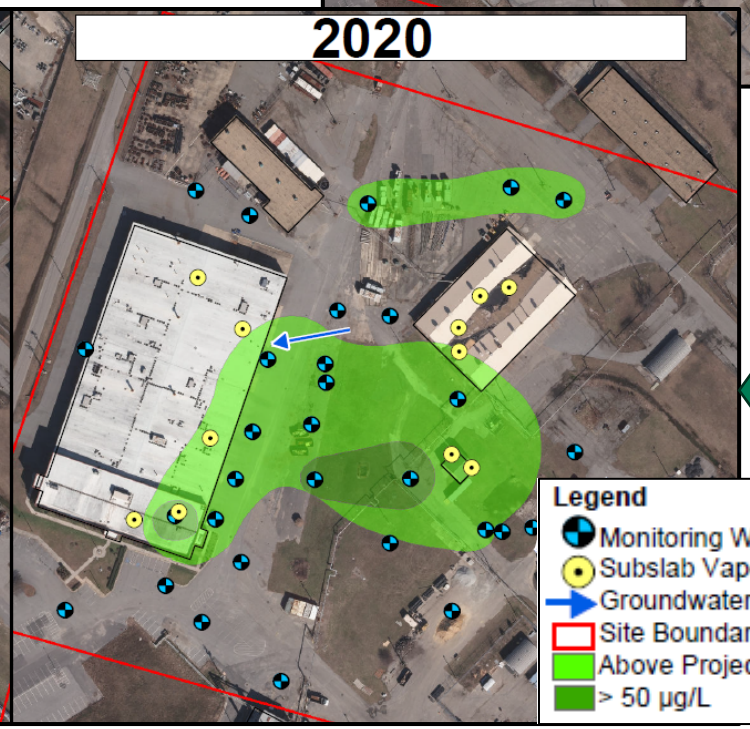
TCE Highlights:

- ✓ Concentration and spatial distribution significantly reduced through RA
- ✓ Plumes flowing away from bldgs
- ✓ Future concentrations not expected to result in VI risk





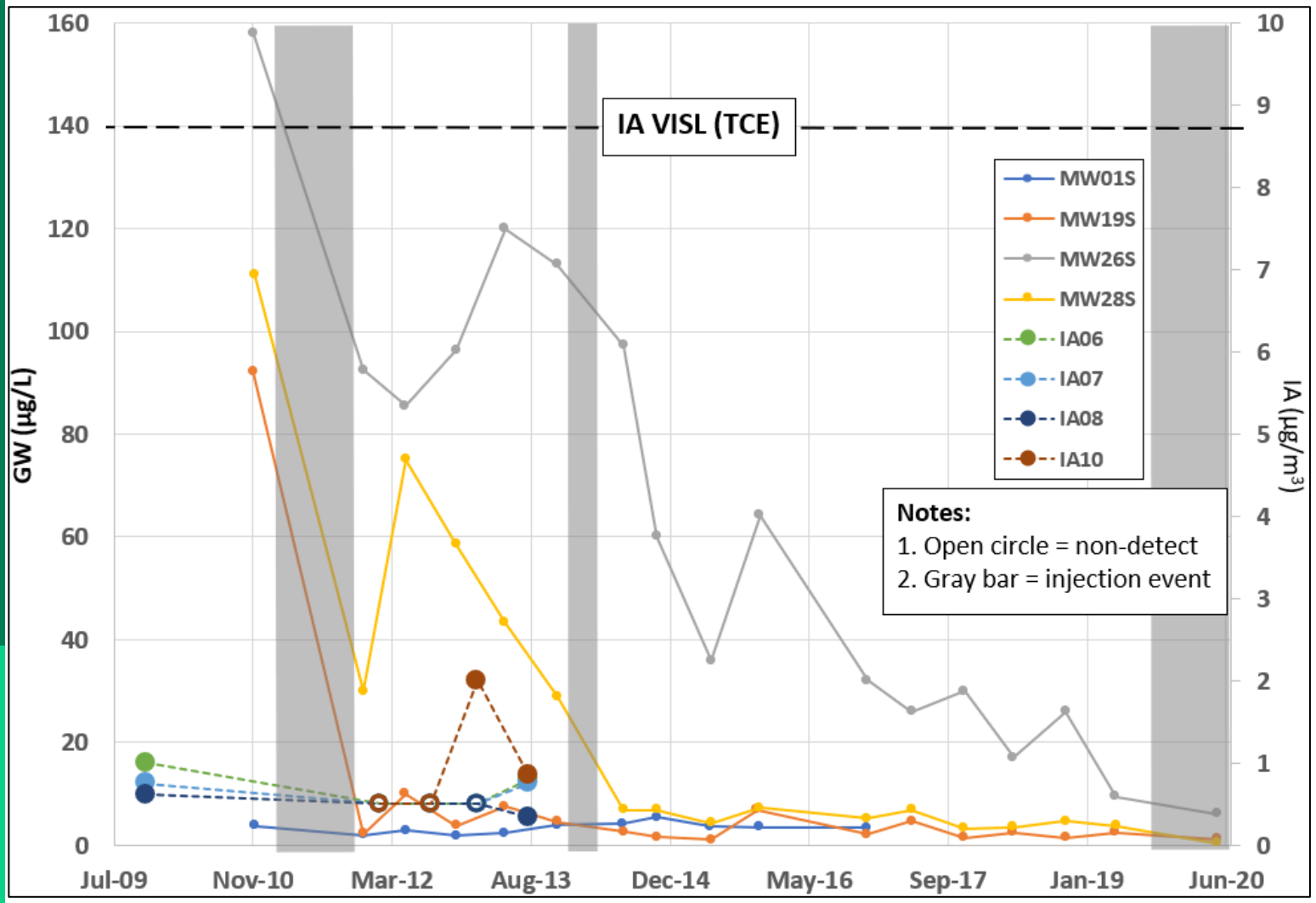




VC Highlights:

- ✓ Similar/fluctuating spatial & temporal distribution post-injections
- ✓ Trends related to TCE degradation

Data Evaluation – Building A GW and IA Trend (TCE)



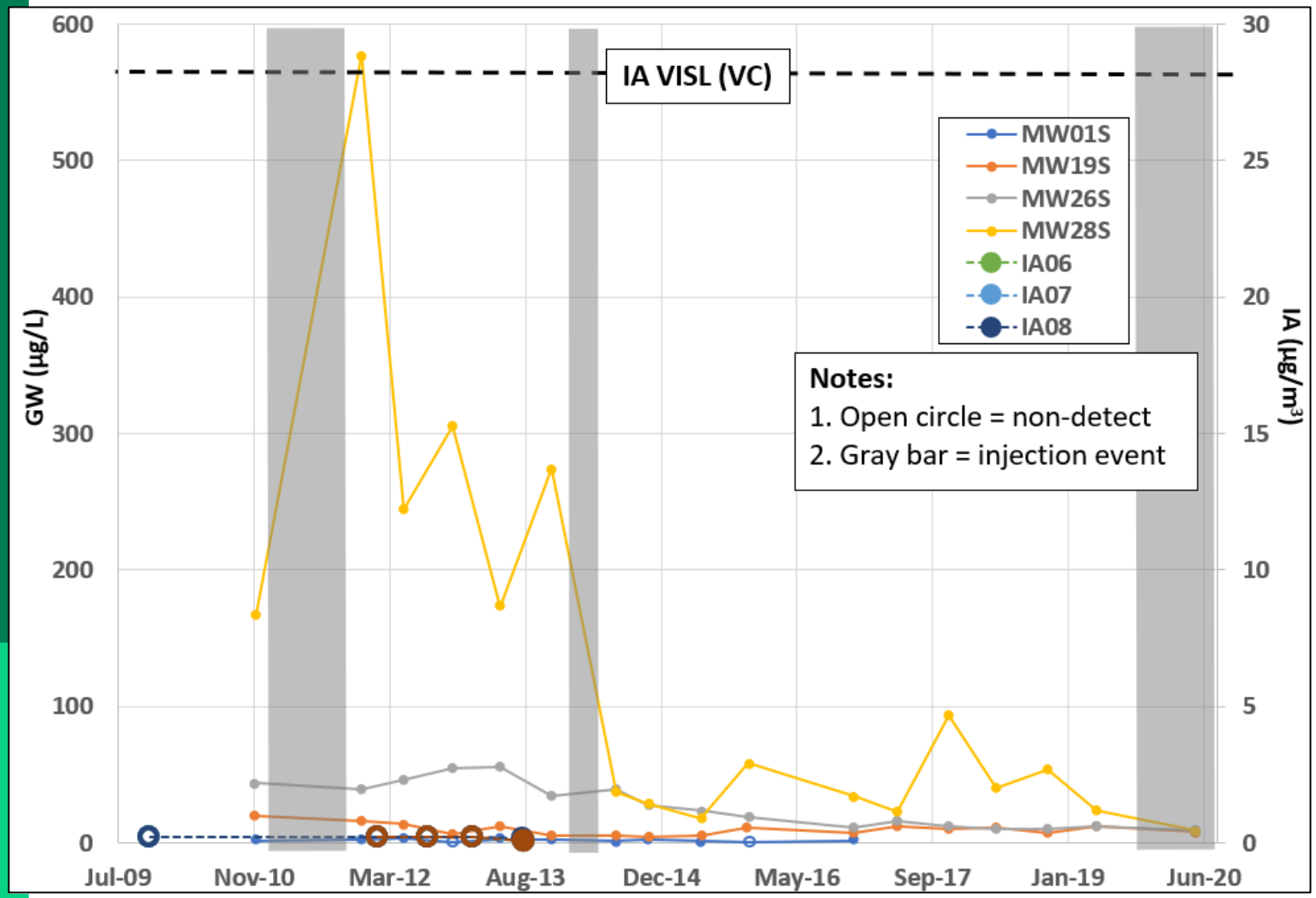
Highlights:

- ✓ IA < VISL
- ✓ No VI (at max or any GW TCE level)
- ✓ Significant TCE GW decline
- ✓ GW unlikely to increase > maximum

Optimization Opportunities!

- Sample IA only if GW > maximum
- Notify using cumulative rather than individual COI risk exceedance
- Recommended discontinuing all VI monitoring

Data Evaluation – Building A GW and IA Trend (VC)



Highlights:

- ✓ IA < VISL
- ✓ No VI (at max or any GW VC level)
- ✓ Transient GW increases post-injection
- ✓ Future TCE degradation not expected to increase VC

Optimization Opportunities!

- Sample IA only if GW > maximum
- Notify using cumulative rather than individual COI risk exceedances
- Recommended discontinuing all VI monitoring

Data Evaluation Summary

- No VI (IA < VISLs), even after RA injections (12 yrs of LTM)
- RA injections significantly reduced GW concentrations
  - Remaining low-level TCE flowing away from occupied buildings
- Transient VC increases due to injections
  - Future TCE degradation not expected to further increase VC
- No future VI expected
- No explosive hazards from RA

VI LTM Optimization Summary

- ✓ Leveraged ongoing LTM data review to reduce sampling/number of buildings
  - Optimized GW triggers (e.g., compared with max) for VI sampling (IA/OA/SG)
  - Discontinued VI sampling if building became unoccupied
  - Removed building as GW VI LUC boundary changed
- ✓ Changed notification trigger from individual COI to cumulative risk targets
- ✓ Recommended discontinuing VI LTM since no VI risks based on 12 yrs LTM data

<u>Benefits</u>

- ✓ Minimizes data collection/costs
- ✓ Provides data-driven exit strategy to discontinue VI LTM

Thank you!

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