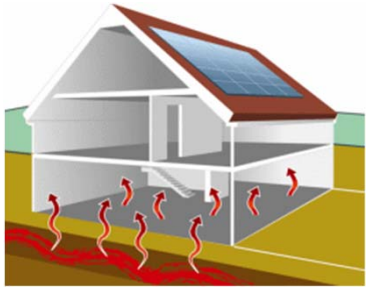
Automated Continuous VI Monitoring and Response for Evaluating Mitigation and Remediation Effectiveness



Mark Kram, Ph.D. (Groundswell)

Blayne Hartman, Ph.D. (HEG)

Cliff Frescura (Groundswell)

April 9th, 2018

Battelle Session G2

GROUNDSWELL
EARTH MONITORING SOFTWARE

HARTMAN
ENVIRONMENTAL GEOSCIENCE

Presentation Summary

- Why Continuous Monitoring?
- Technology Description
- Data from Real Sites
- Lessons Learned

Background/Motive

- Short Term TCE Risk Driver
  - 24 hours? A few days? 21 days? Shorter?
  - Rapid Response Requirements
- CA Supplemental Guidance
  - Acknowledge Dynamics, De-Emphasize Models
  - Default AF of 0.03 (Conservative)
  - More Indoor Sampling/Monitoring
- Mitigation/Remediation
  - Need for Confirmation/Optimization
  - Ensure Immediate Response to Acute Risks

CM Confirm/Optimize Applications

- Mitigation
  - HVAC Controls
  - Fans On/Off
  - Air Filtration Units
  - Sealing Sumps & Cracks
  - Sub-Slab Depressurization Systems
  - Building Manipulations
- Remediation
  - In-Situ GW/Soil Remediation
  - Thermal/SVE

Short-Term TCE Assessment Options

- Long Term Passive/Canister Sample
  - One number over sampling period
  - Can't see the pattern
  - No real-time feedback, acute TCE risks
  - False negative/positive possible
  - Costly if multiple rooms, multiple events
- Continuous Analyzers
  - Can determine duration: Hours? Days?
  - Can see the pattern! Day vs. Night? HVAC? Breakthrough?
  - Immediate response – Occupant H&S, liability

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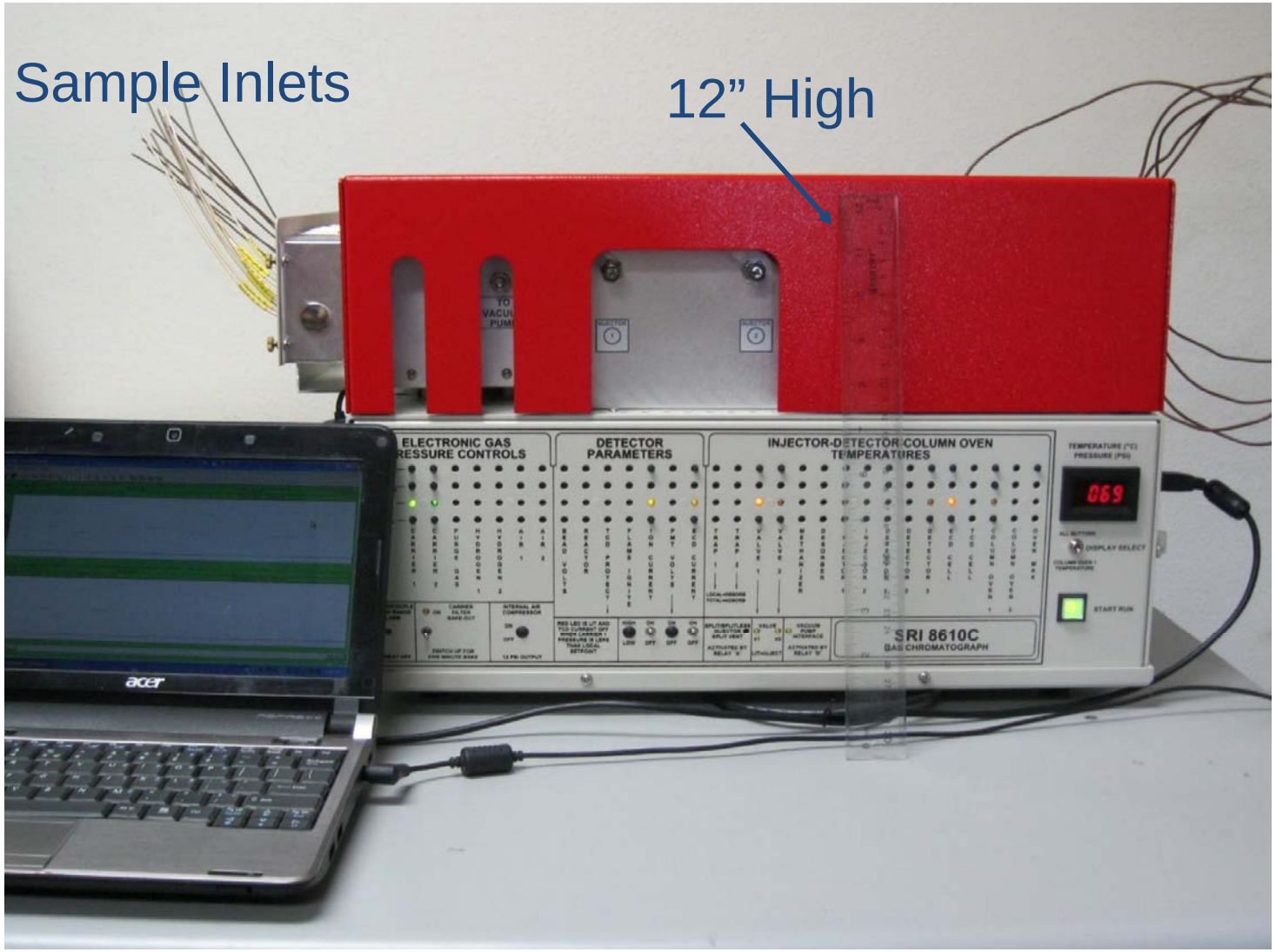
Continuous Monitoring System



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System Capability

- Fully Quantitative!
- Can Reach Ultra-Low Levels (<1 µg/m^3) for TCE, PCE, VC & others
- <10 min Analysis Time
- Multiple Sample Locations (16 to 30)
- Modified EPA Method TO-14A
- Stable - holds calibration for months
- Remote Control
- Real-Time Data/Response
- Discrete Mode

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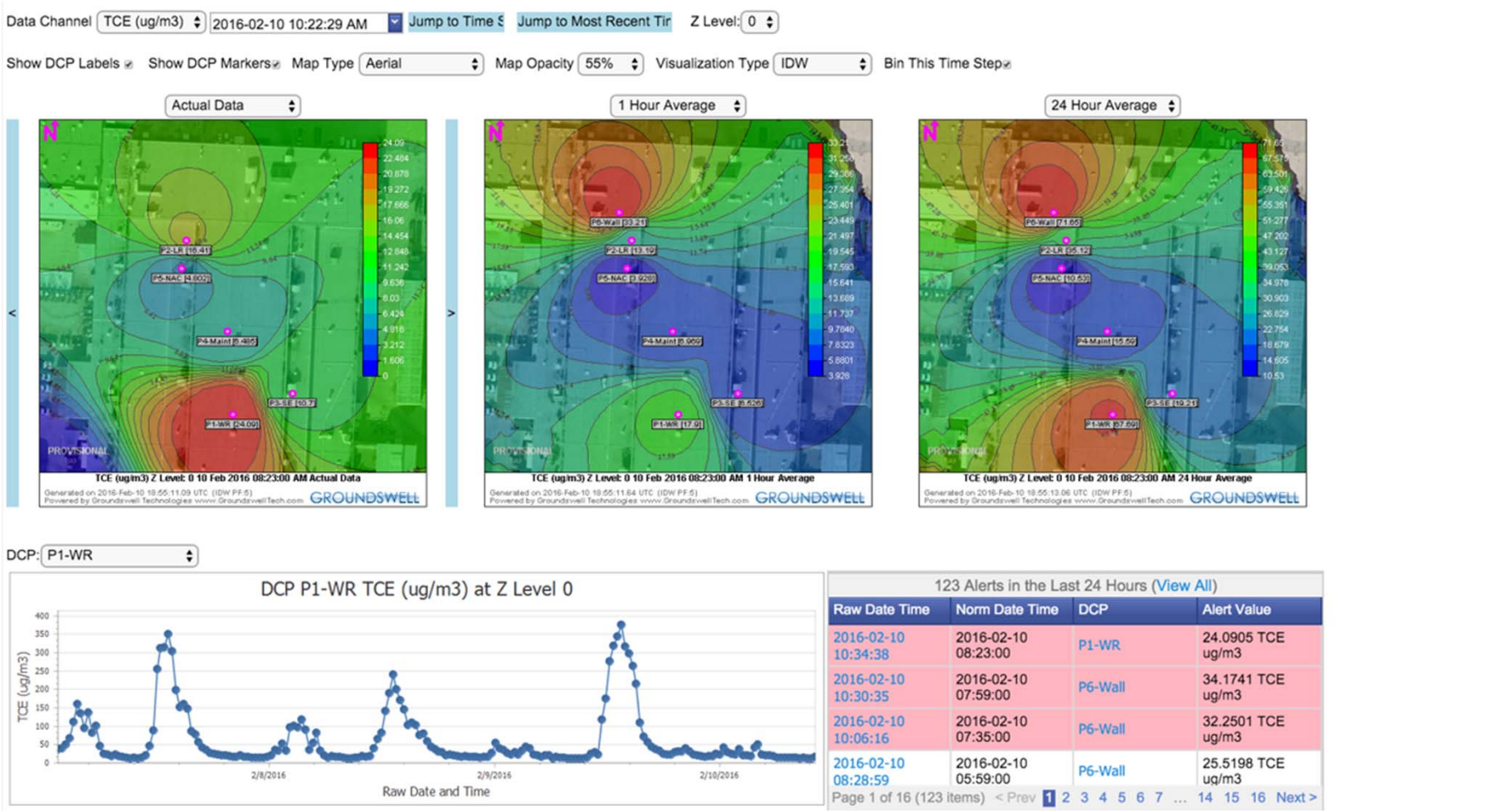
Data

- Concentrations
- Pressure Differential
- Barometric, Temp., Wind Speed, etc.
- Dashboard
  - Time Series
  - Stacked Time Series
  - Contour Images
  - Moving Averages
  - Alerting
- Trigger Relays
- All Web Based, Daily Reports

Monitoring/Response Dashboard



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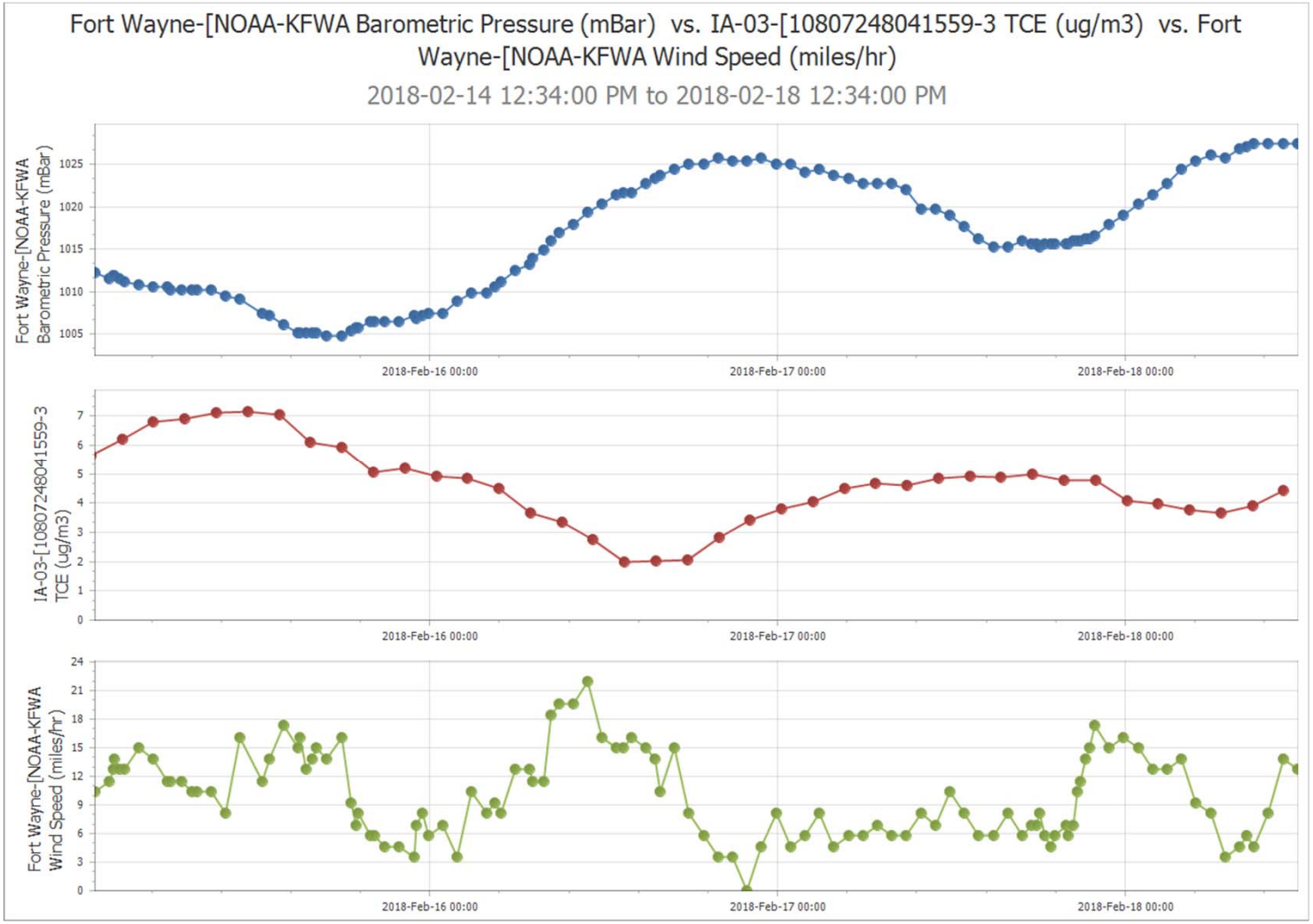
Stacked Time Series

Baro

TCE

Wind



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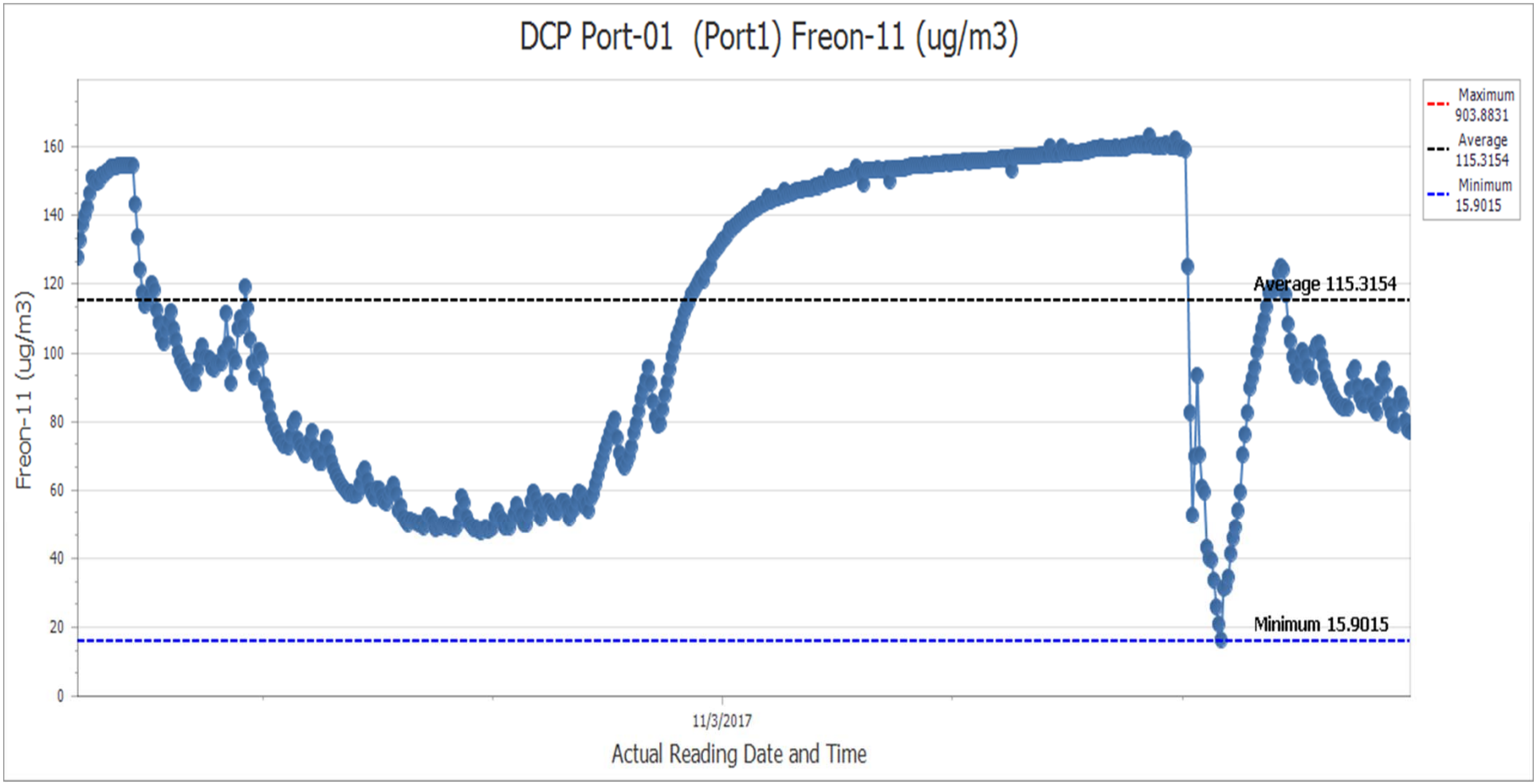
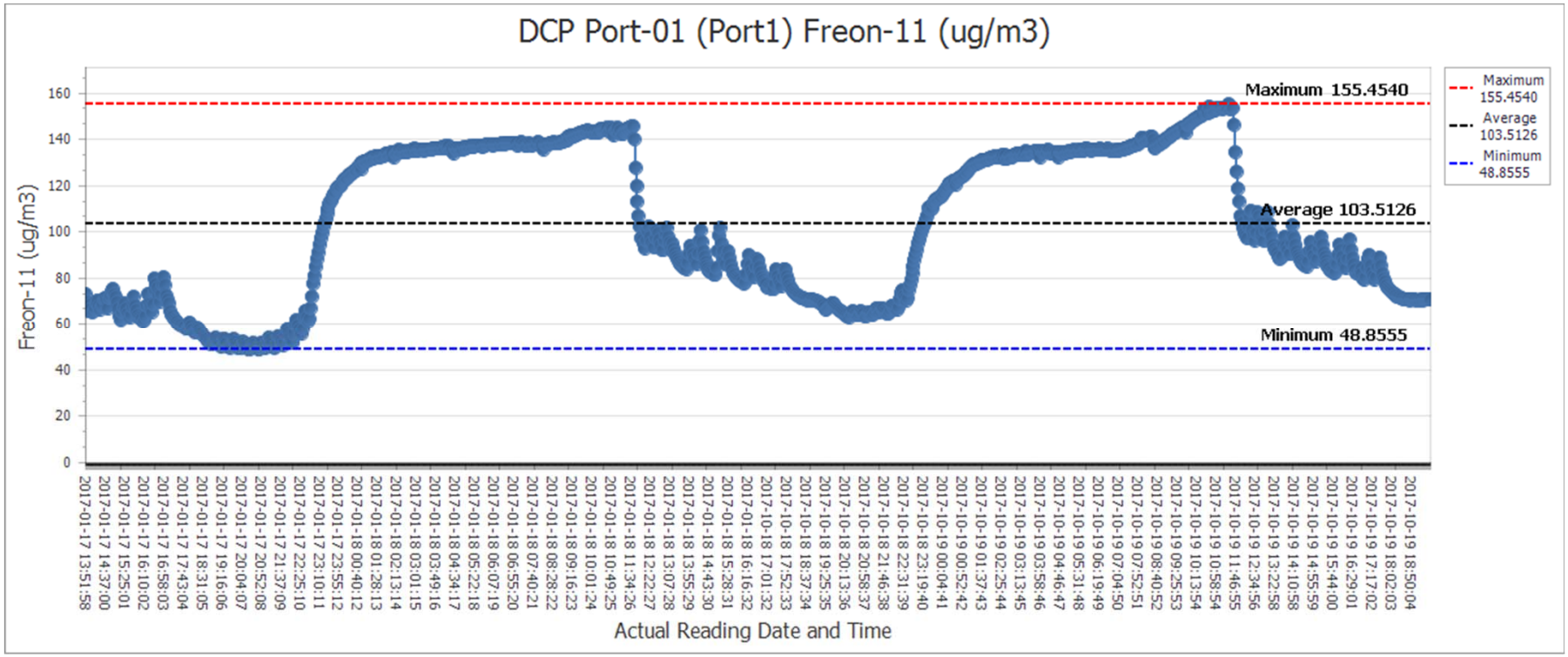
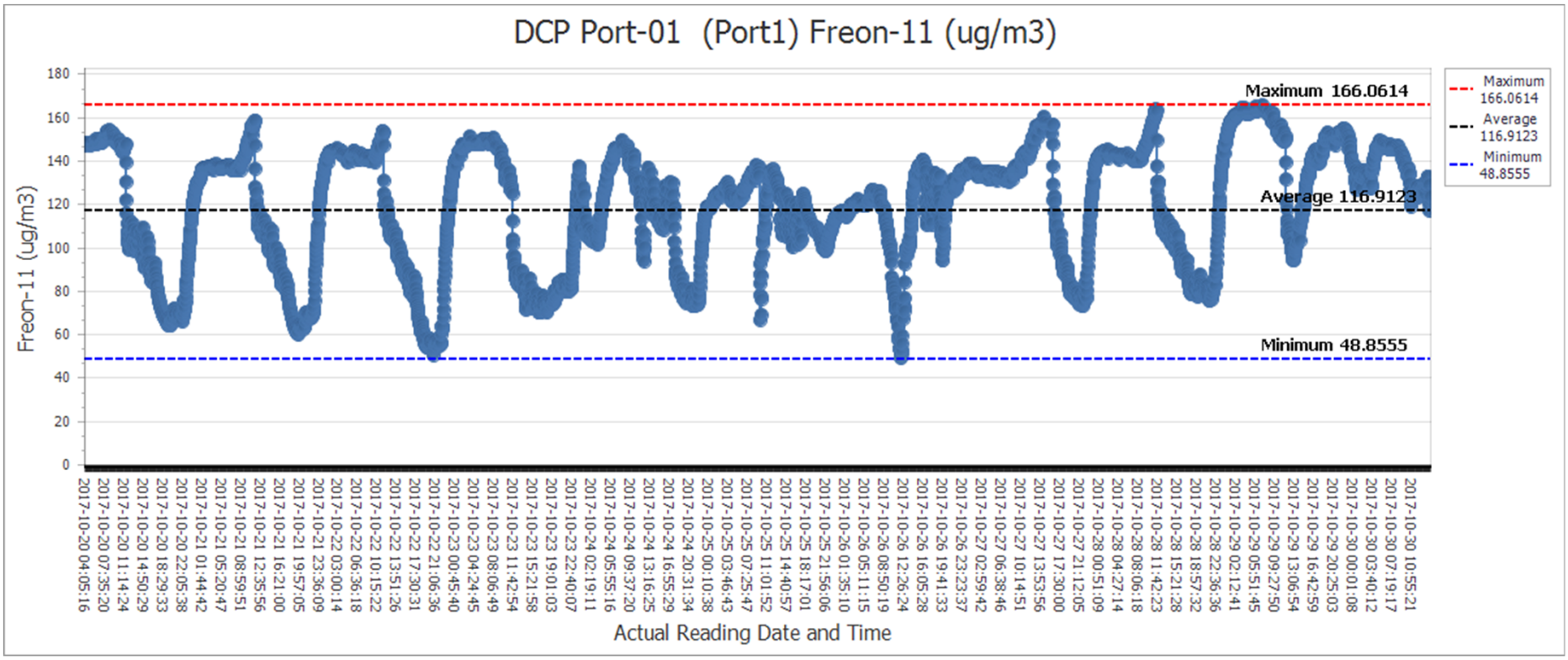
Data Pattern = Opportunity
Freon 11 - Office Bldg – 1 Day



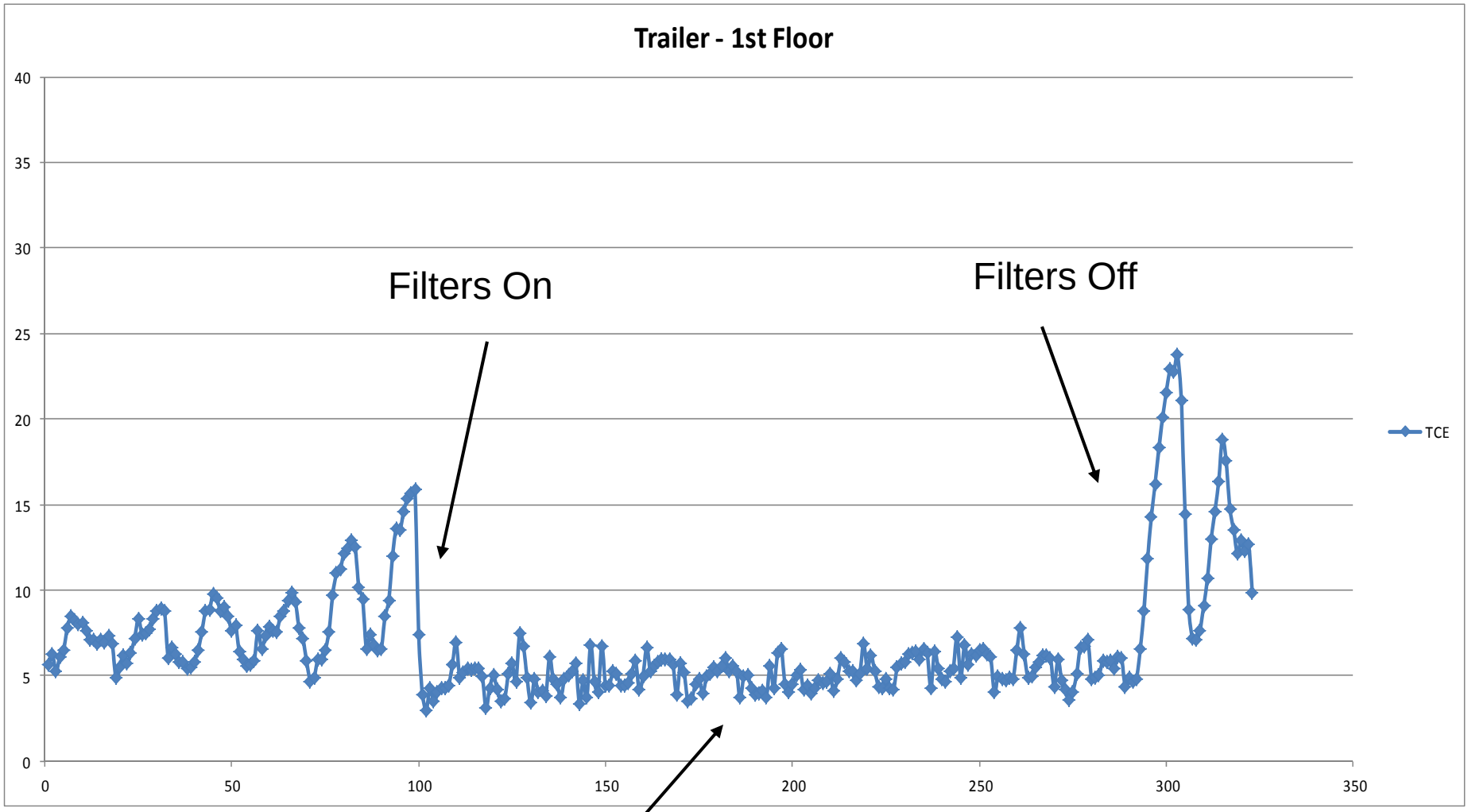
Freon 11 - Office Bldg – 2 Days



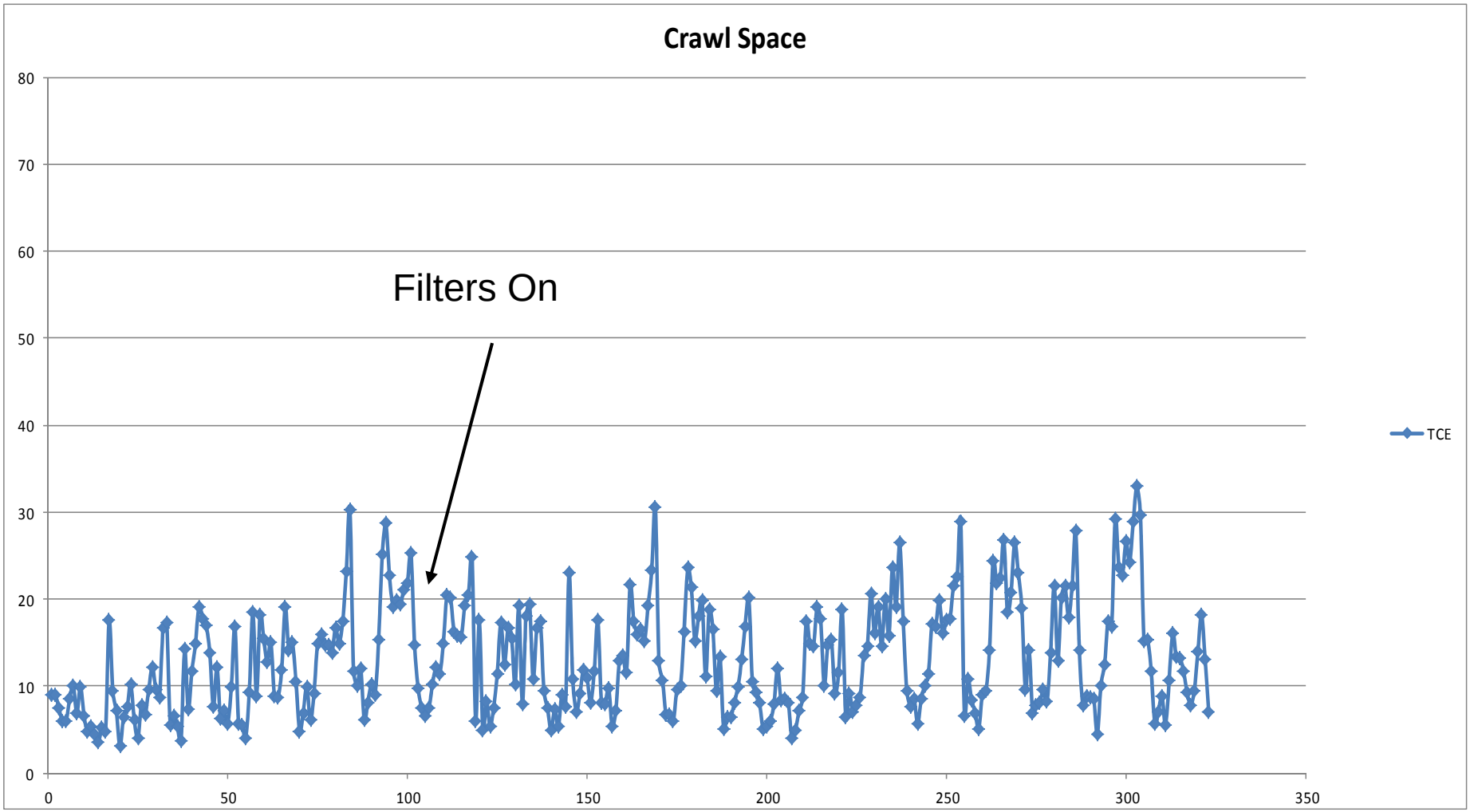
Freon 11 - Office Bldg – 10 Days



TCE – Trailer 1st Floor
Air Filtration



TCE – Trailer Shroud



Lessons Learned
Filter

- Pattern is Key
- 3x to 6x Concentration Range, Sinusoidal
- Filter Reduced, but Did Not Resolve Risk
- Trailer Shroud Not Impacted by Filter

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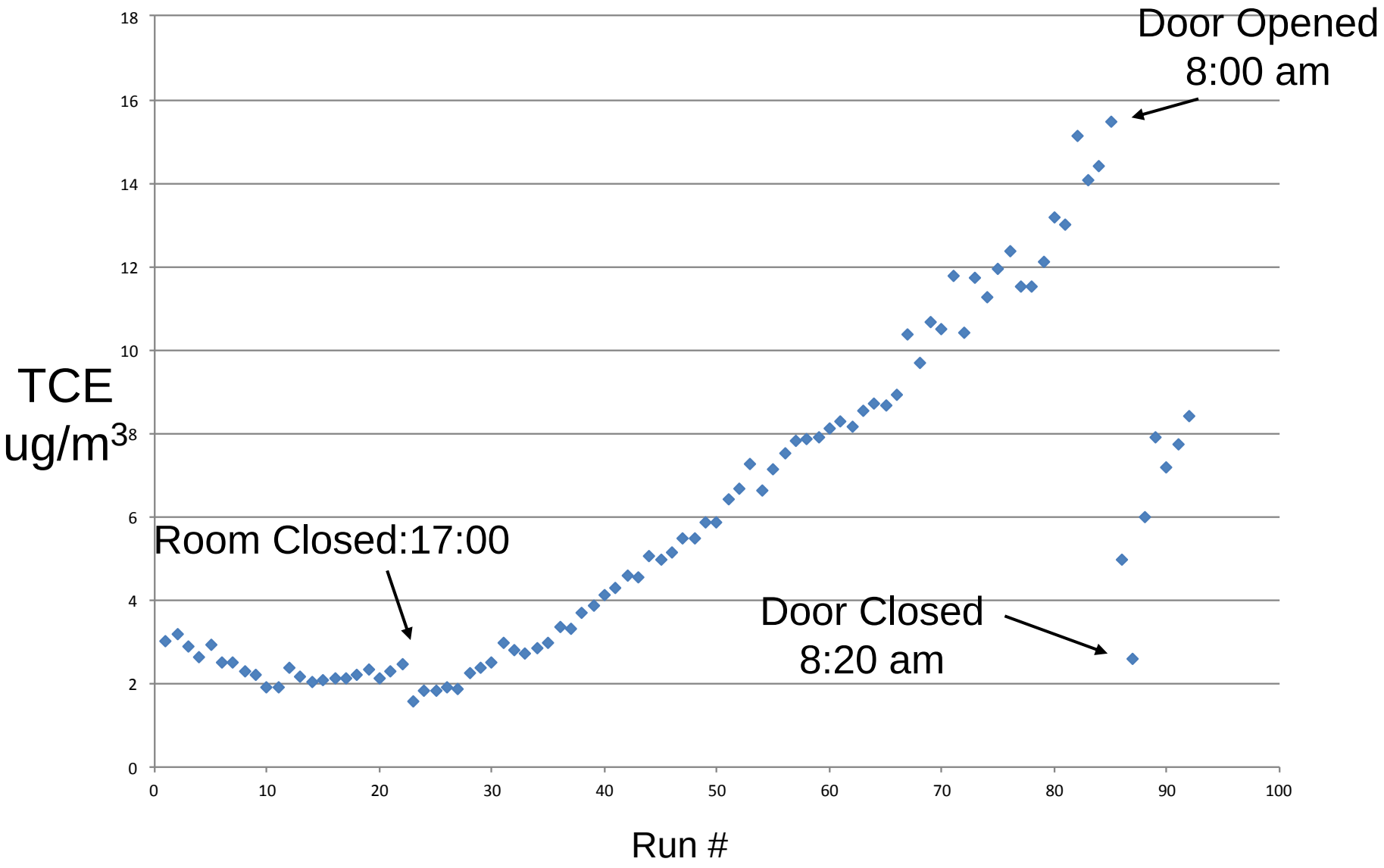
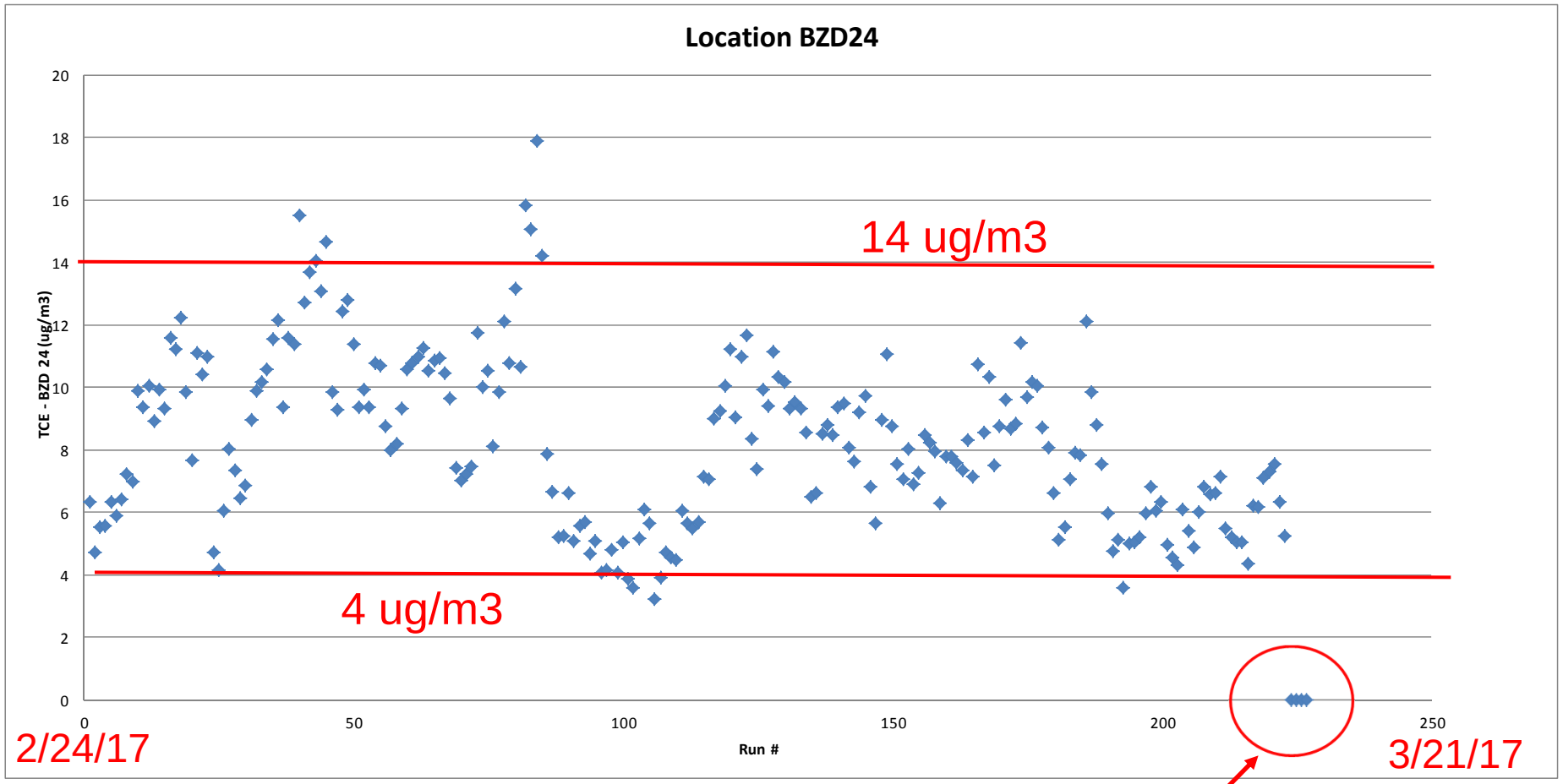
Close Door


Door Opened
8:00 am
Room Closed:17:00
Door Closed
8:20 am
TCE
ug/m3
Run #
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
80
90
100

Lessons Learned
Close Door

- Pattern is Key
- Determine VOC Entry Points within 12 Hours
- Can Estimate Mass Flux
- Instant Recognition of Bldg Manipulation
- Remedy Obvious: Seal Drain and Extract

Seal Sumps



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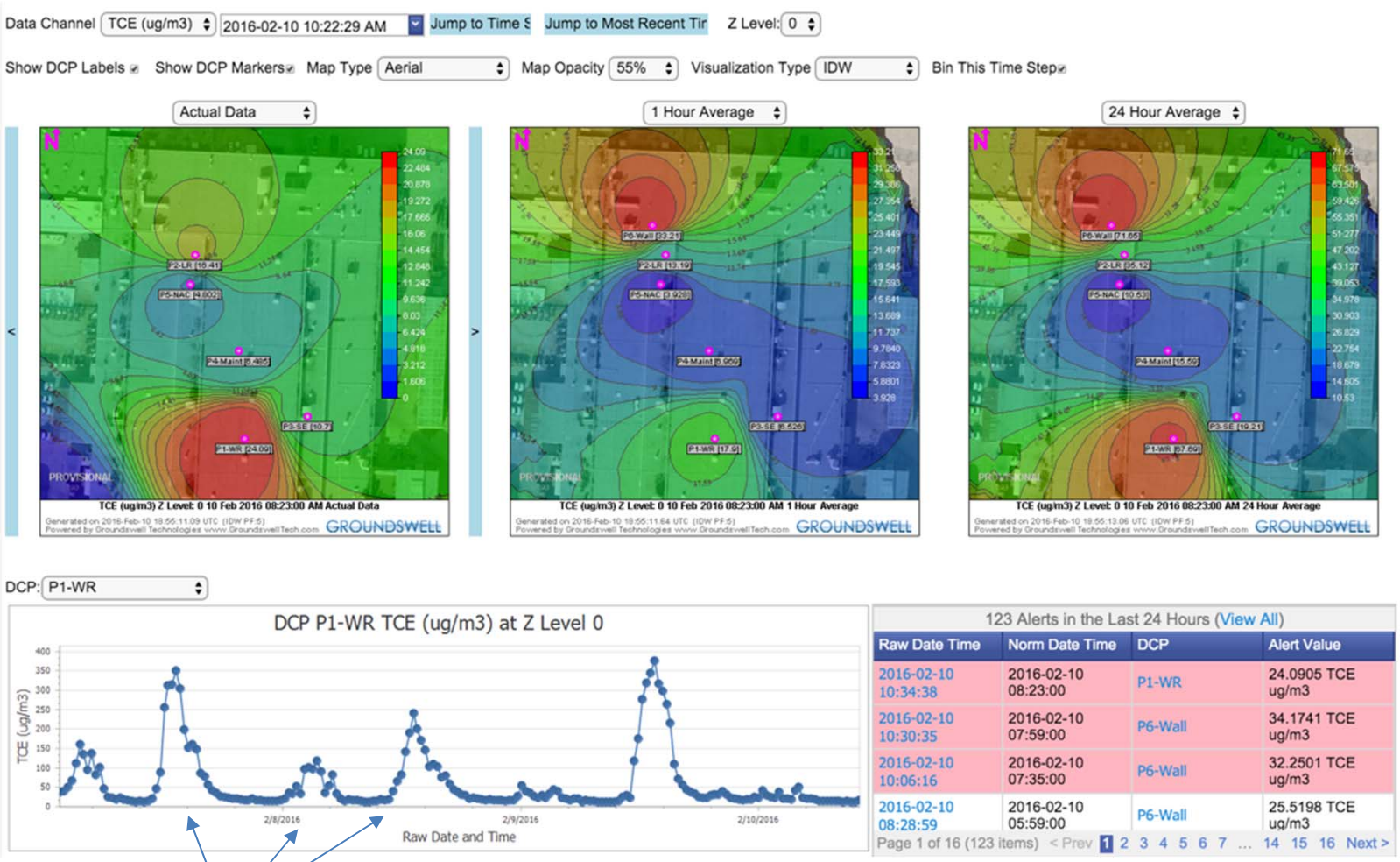
Lessons Learned
Seal Sumps

- Pattern is Key
- Temporal Variation ~ 3.5x
- Highest Conc Areas Known Within 12 Hours
- Instant Recognition of Bldg Manipulation
- Remedy Obvious: Seal Sumps & Extract
- Set to Return for Confirmation

Large Industrial Facility



Mid Morning, Late Eve Peaks

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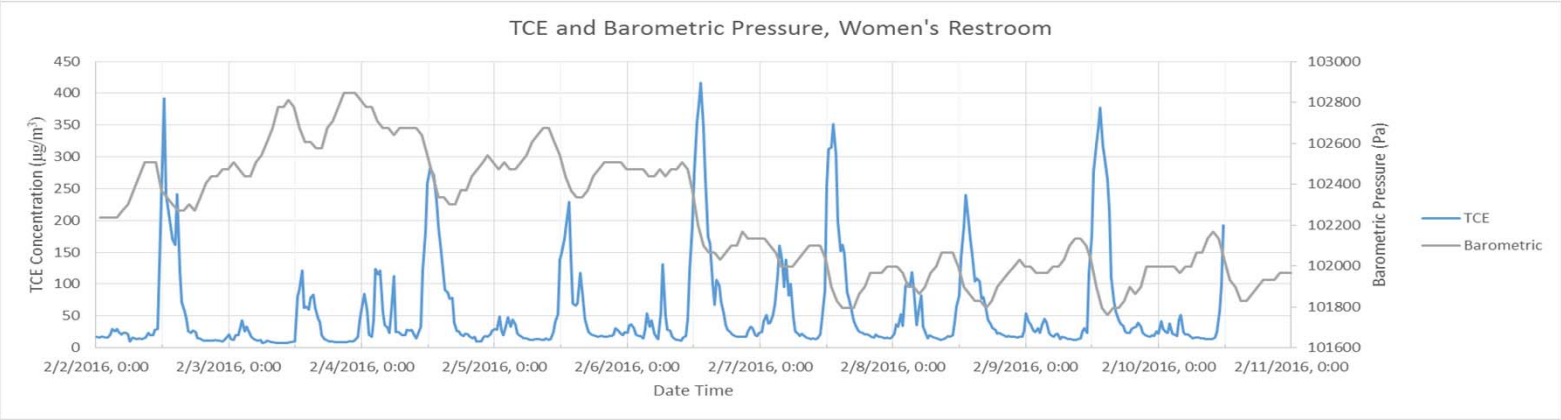
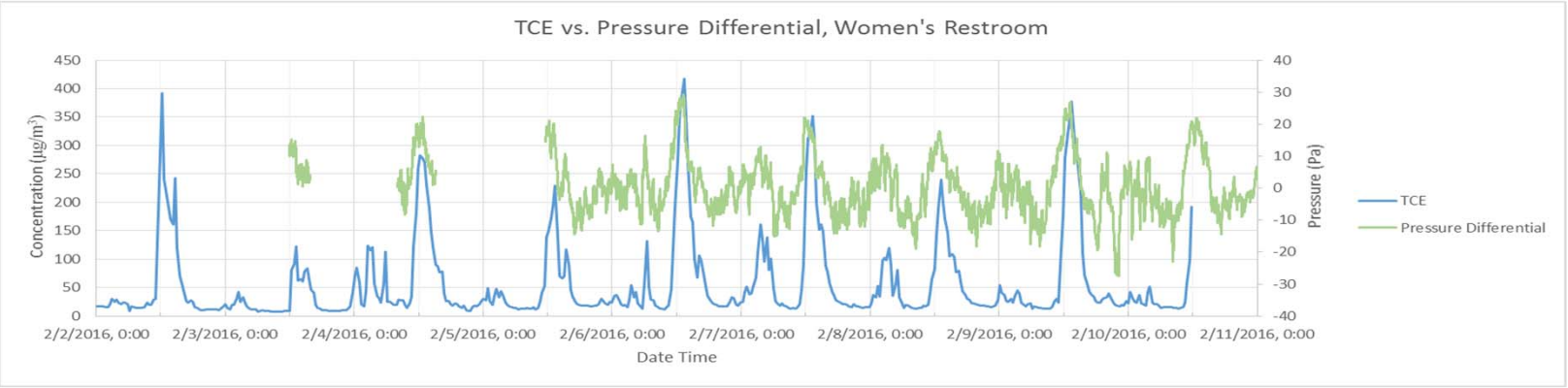
Large Industrial Facility





Daily BP Change ☛ Slight Pressure Diff ☛ VI

Hosangadi *et al*., 2017, *High Frequency Continuous Monitoring To Track Vapor Intrusion Resulting From Naturally Occurring Pressure Dynamics*, Journal of Remediation, Spring, v.27, no.2, p.9-25.

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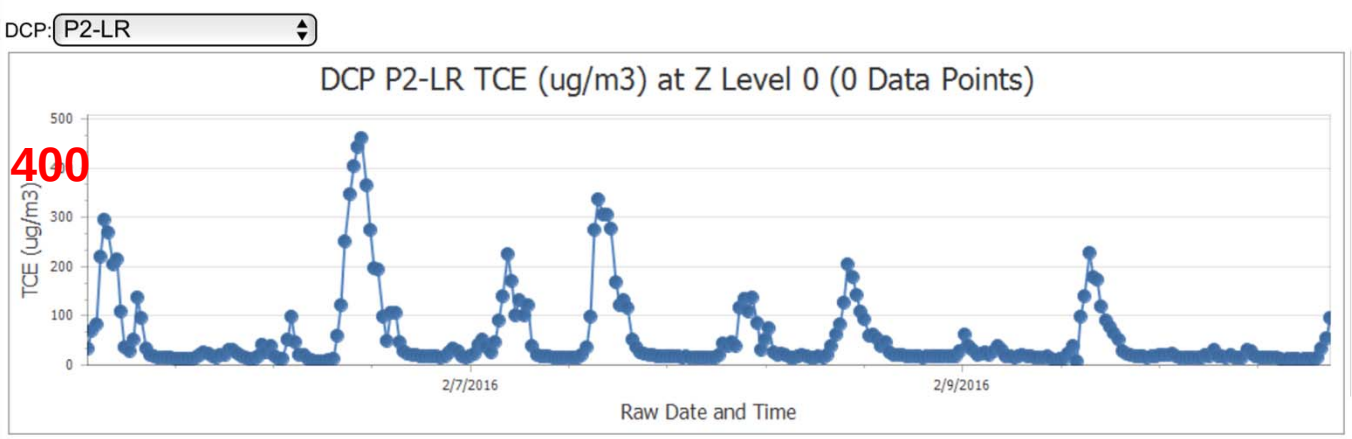
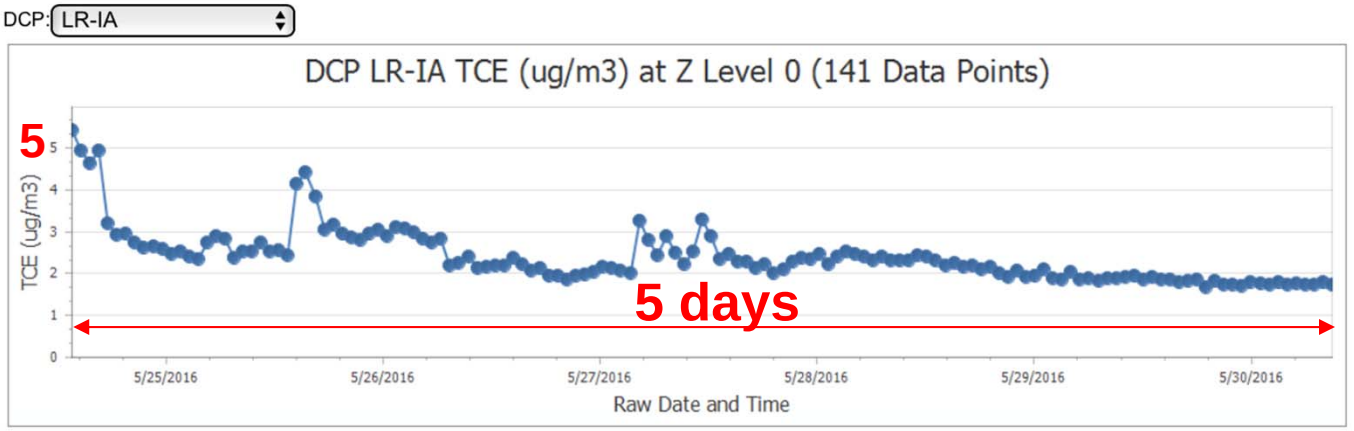
Large Industrial Facility

SVE Remedial Confirmation

Pre-SVE



Active-SVE



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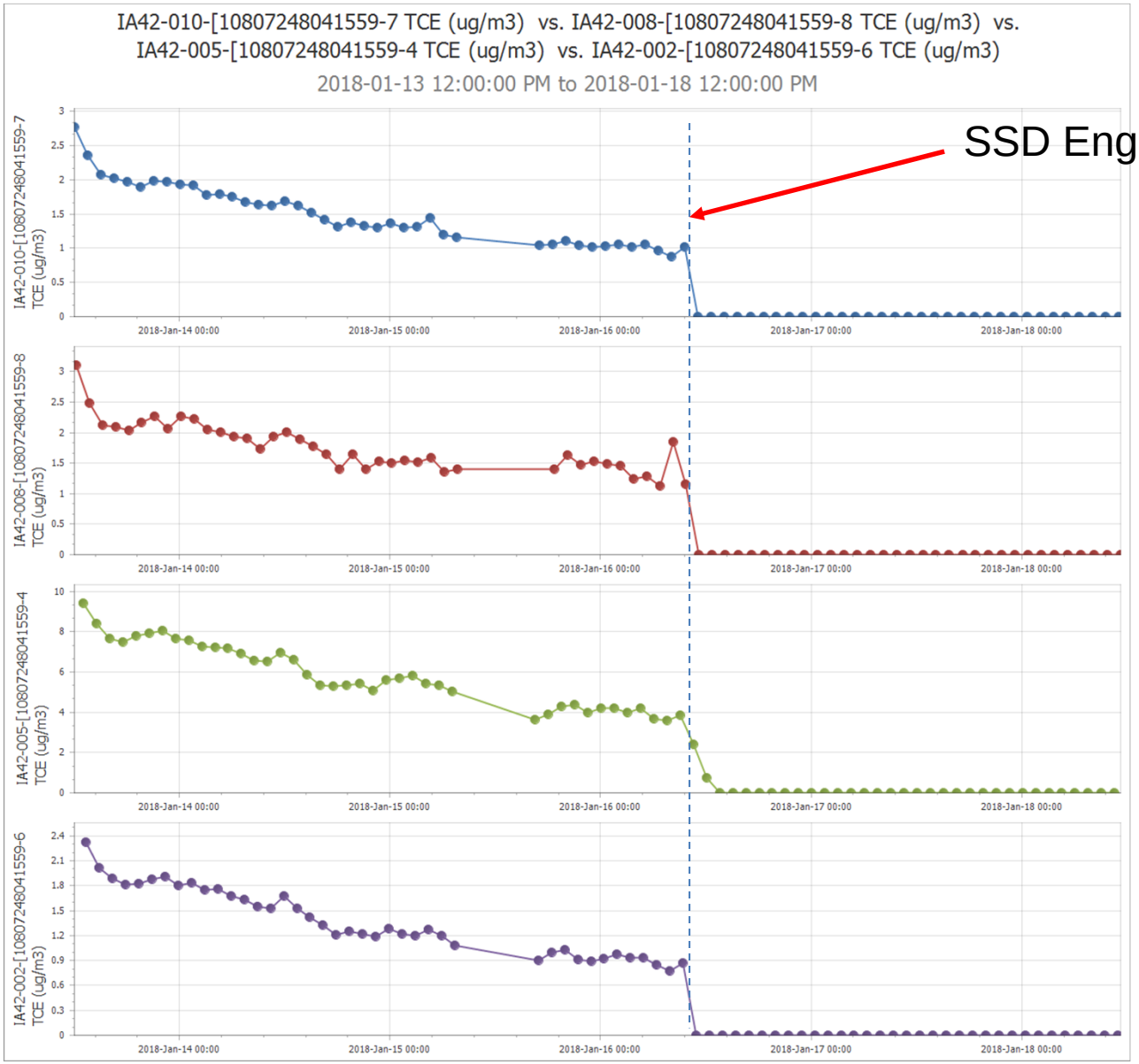
Lessons Learned
Industrial Facility

- Pattern is Key!!
- TCE Temporal Variation of 50x
- Elevated Values for 6 to 12 hour periods
- Highs Correlated with Sub-Slab Pressure
- BP trend & PD >> BP
- Confirmed SVE Working!

Proving SSD Remedy Effectiveness



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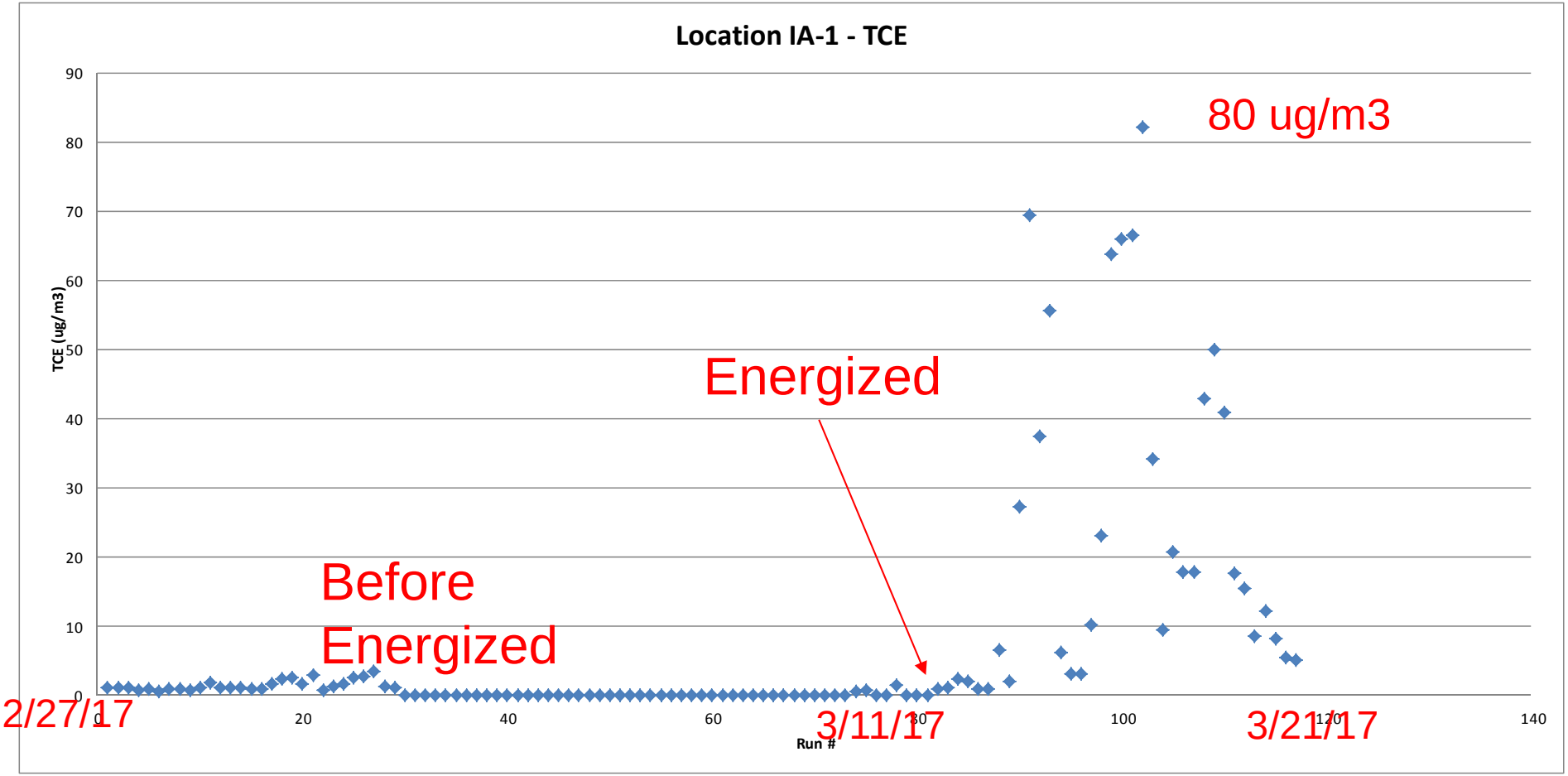
TCE – Warehouse Air

ERH System Start-Up



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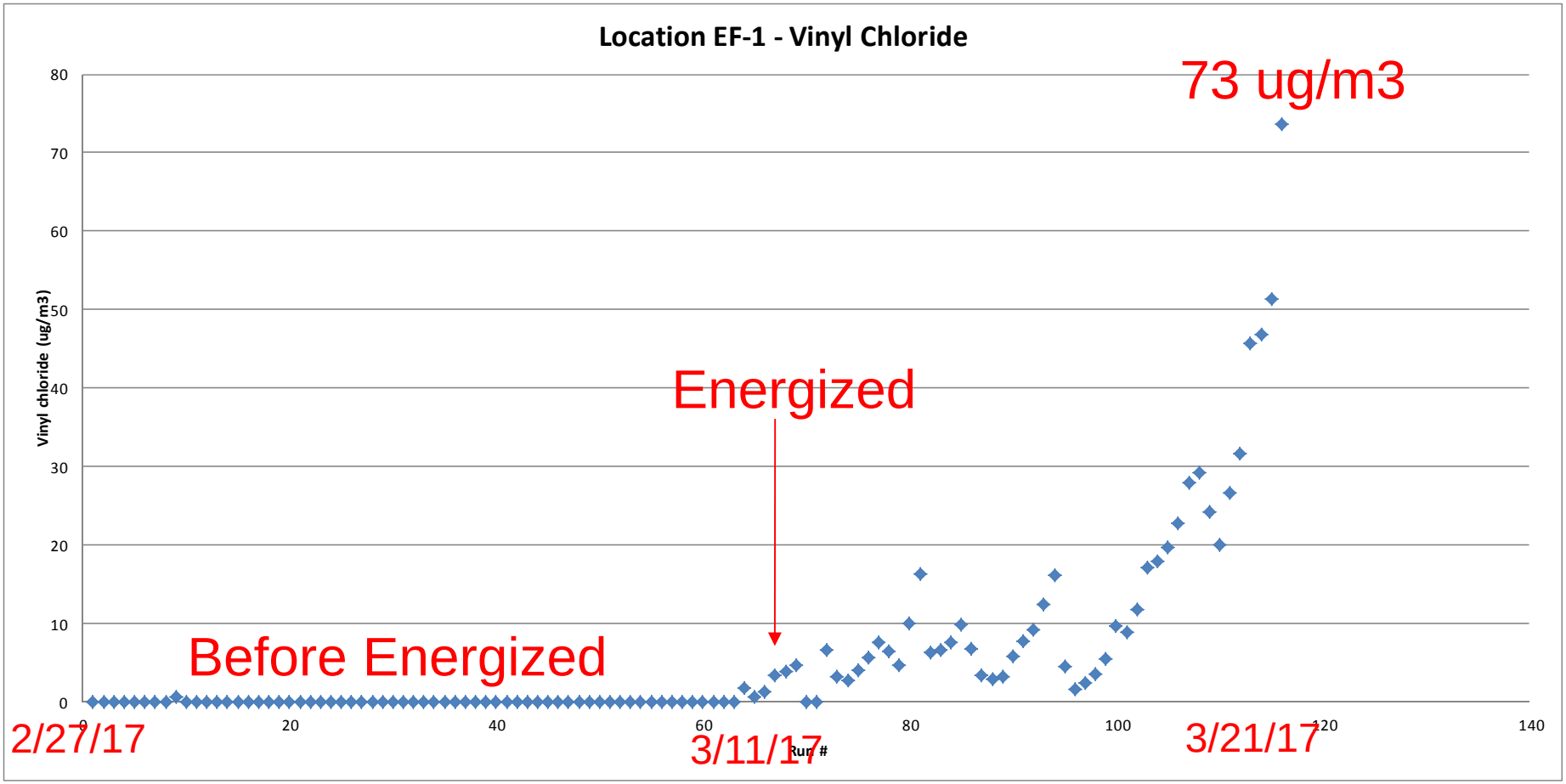
Vinyl Chloride – Effluent



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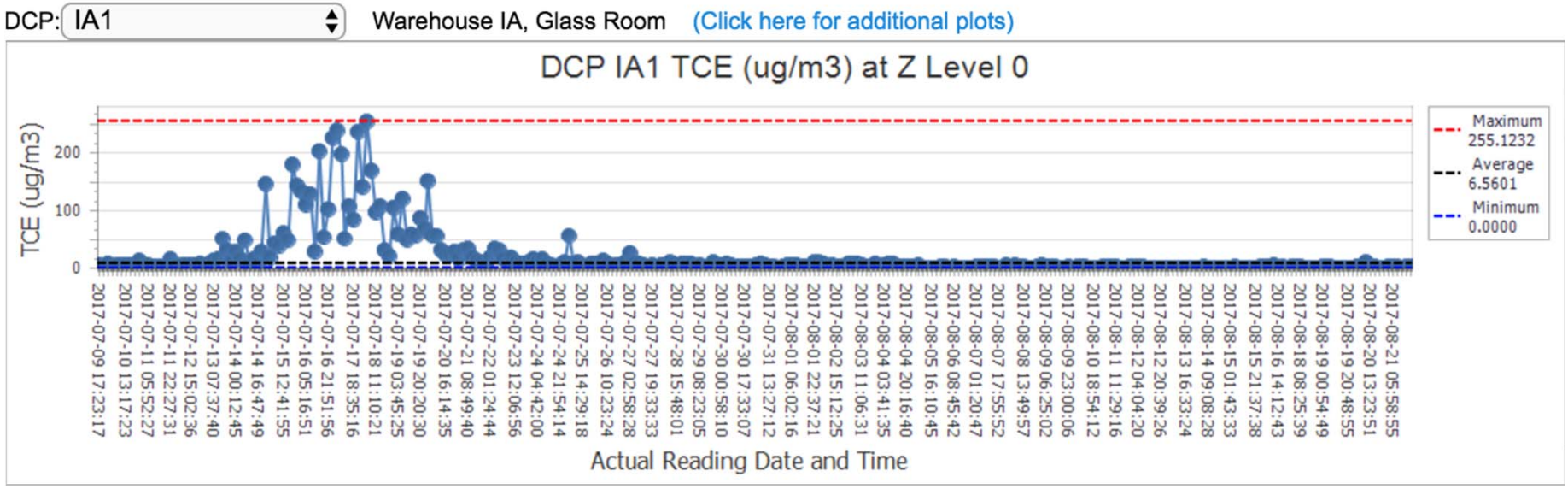
TCE – Warehouse Air
Adaptive Response



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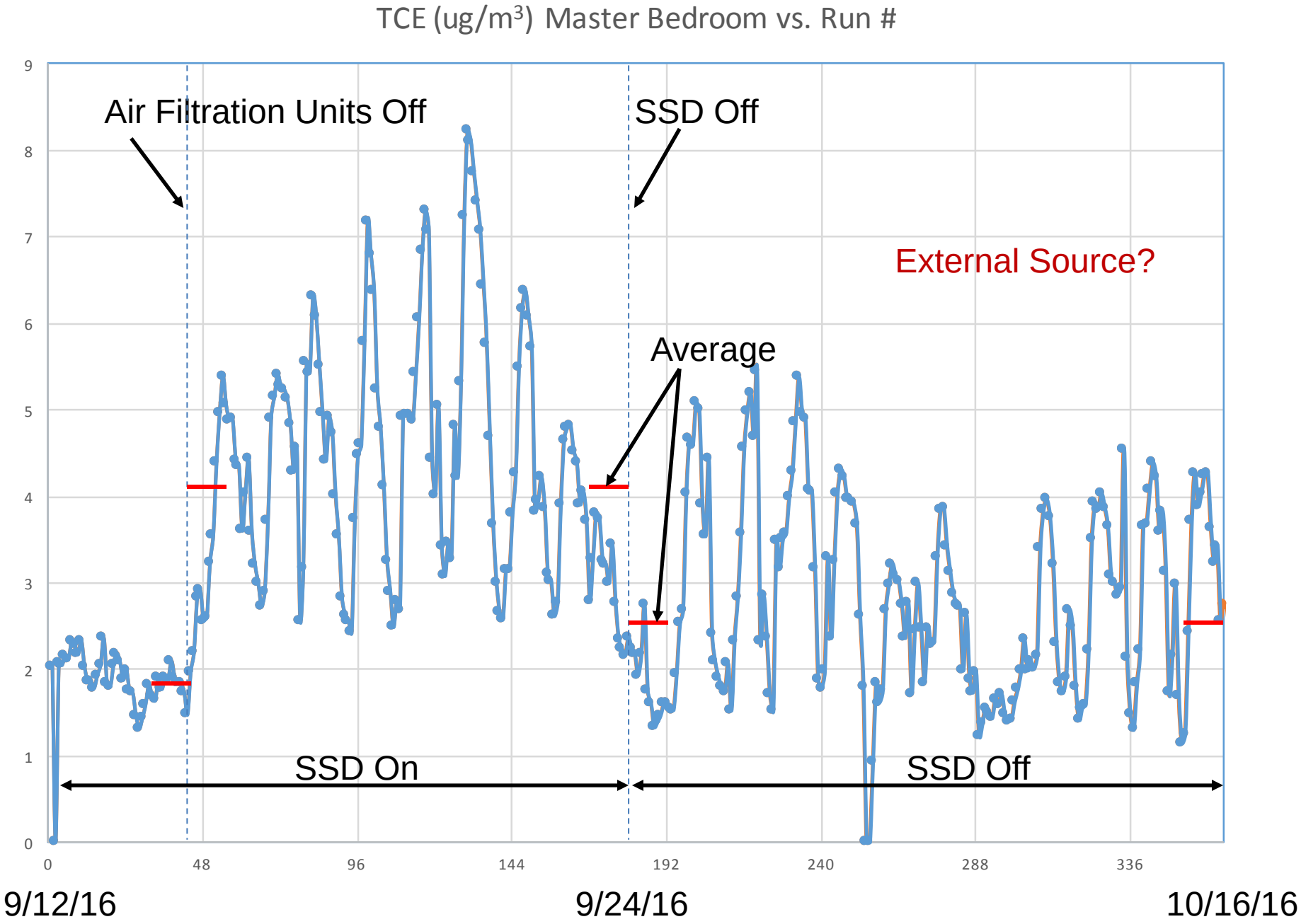
Lessons Learned
Thermal Remediation

- TCE & VC Increases Seen Within Days of Energizing
- Instant Recognition of “Leaks”
- Vapor Recovery Adjustment/Optimization
- 13 Locations Monitored: Multiple Buildings, Effluent, etc.
  - Cal Runs Every Cycle
- Automated Alerting, Response Triggers
- Cost Effectively Met Adaptive Objectives
- First Time Ever VC Monitored Continuously
- Integrated with EPA VIPER
- Only Continuous Monitoring Allows for Immediate Response


TCE (ug/m3) Master Bedroom vs. Run #
Air Filtration Units Off
SSD Off
External Source?
Average
SSD On
SSD Off
0
1
2
3
4
5
6
7
8
9
0
48
96
144
192
240
288
336
9/12/16
9/24/16
10/16/16

Lessons Learned
Residence

- Spatial Variation within House ~ 3x
- Temporal Variation Each Day ~ 3x
- Highest Conc Rooms Known Within 12 Hrs
- Air Filters Decreased But Did *Not* Eliminate
- Values Decreased when SSD Turned Off!
  - Pressure/Fan Monitoring Not Enough
  - External Source Capture by SSD?
  - Challenge for Large SS Samples
- Need to Confirm SSD!

Summary

- Monitoring/Response/Confirm Technology Exists
- TCE, PCE, VC and other VOCs
- Pattern = Opportunity!
- Rapidly Address:
  - No risk situations
  - TCE accelerated/urgent exceedances
  - VOC entry locations, preferential pathways
  - Effectiveness of mitigation systems
  - Effectiveness/optimization of remediation systems
  - Brownfield concerns (rapid resolution)
- Prevent Acute TCE Exposures!

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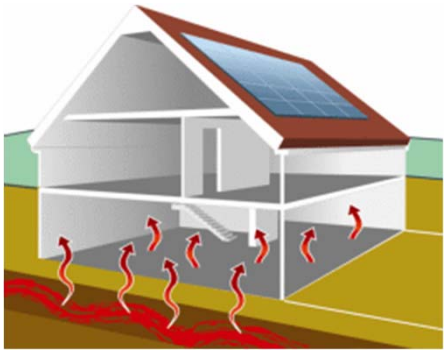

Questions?

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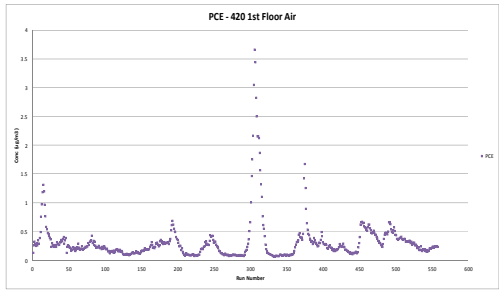

Booth: #104
Poster: Today, #277
Learning Lab: 0800 on 4/12/18

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