

# Combined ISTR Technologies at Four Recent Fund Lead Superfund Sites



Erin Hauber, PE

*Panel 3: Thermal Remediation RD/RA Case Studies*



**TERRATHERM**  
a Cascade Company

**EA**® EA Engineering,  
Science, and  
Technology, Inc., PBC



Design and Construction Issues at Hazardous Waste Sites

March 4 – March 6, 2026

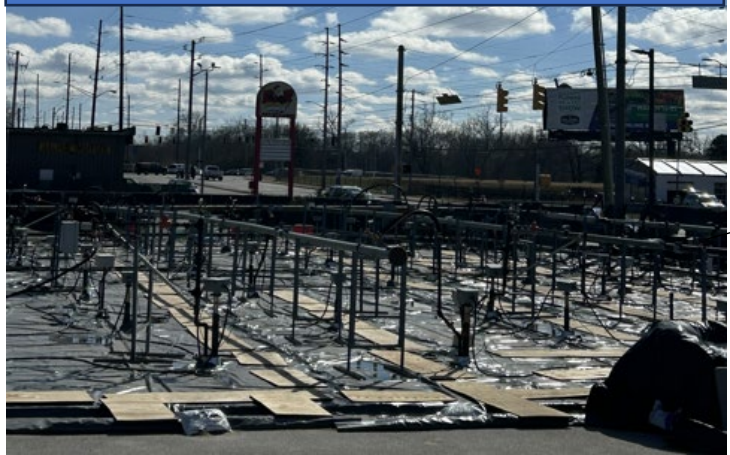
#4: Hastings, NE: TCH + SEE\*

20-140 ft, 71,623 cy, 300°C/100°C,  
MGP Waste



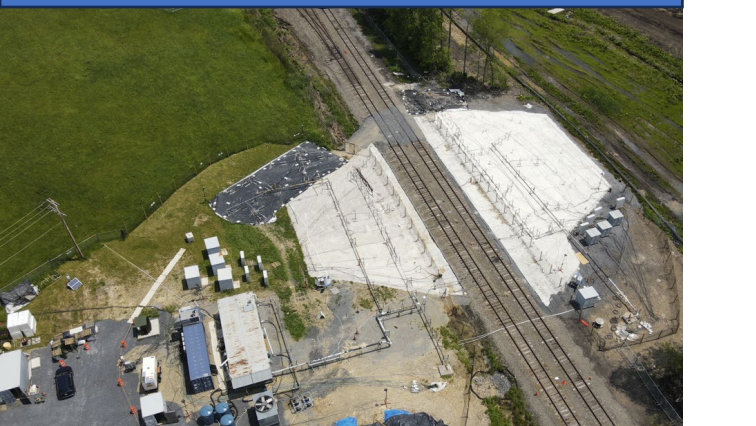
#3: Indianapolis, IN: TCH + SEE

5-45 ft, 13,810 cy, 100°C, CVOCs + TPH



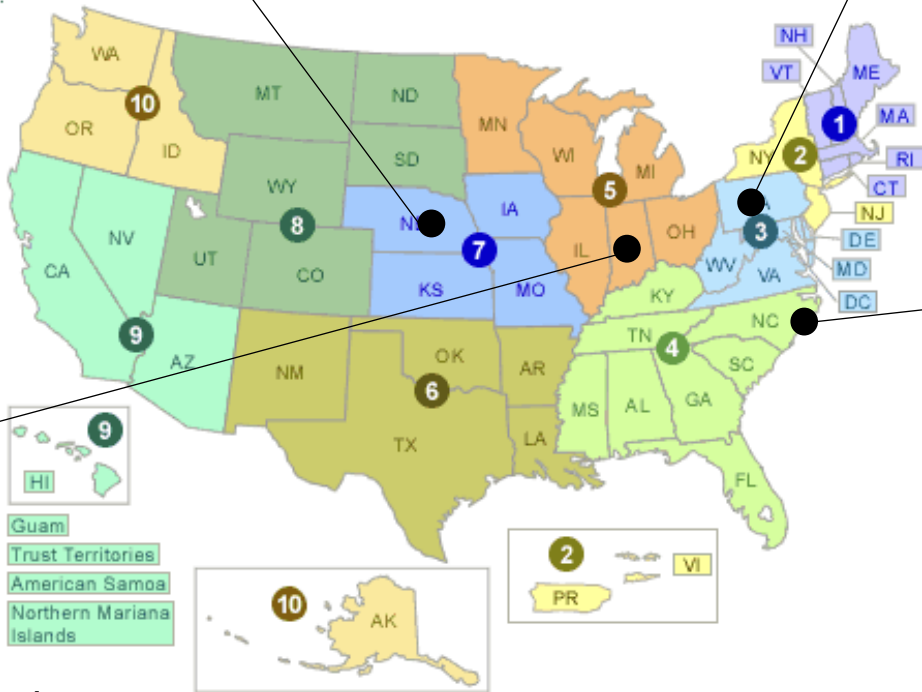
#1: Falls Creek, PA: ERH + TCH

5-22 ft, 13,720 cy, 100°C, CVOCs



#2: Jacksonville, NC: TCH + SEE

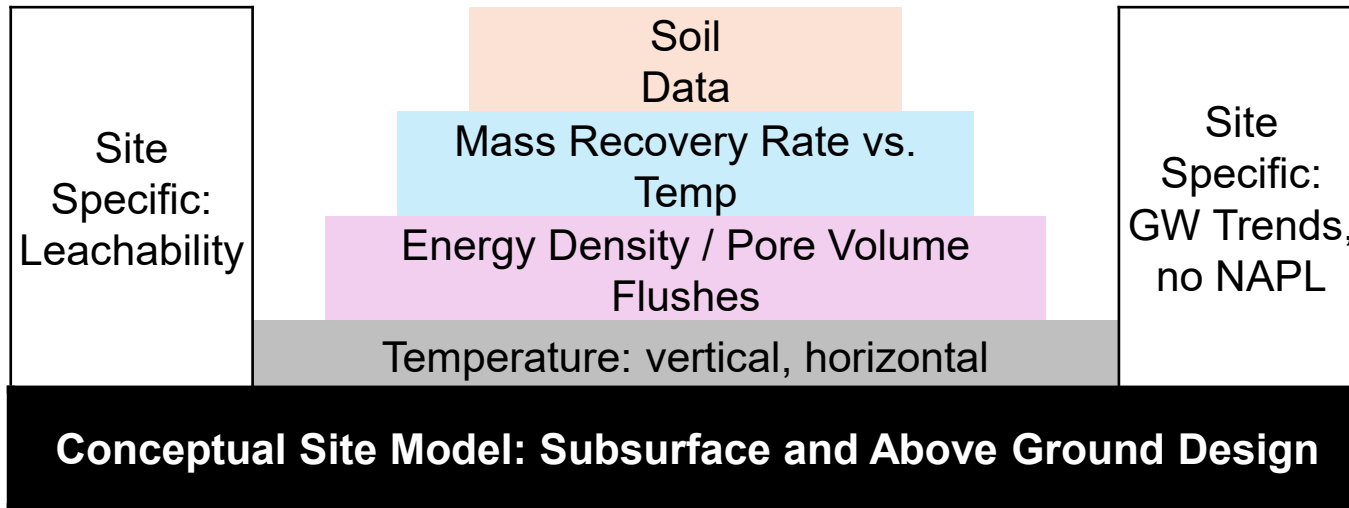
0-66 ft, 11,688 cy, 100°C, CVOCs



\*slides included for panel discussion only

# Performance Objectives Summary (Quick Recap)

## Primary Objectives



## Other Requirements

|                                     |                   |                   |                                      |
|-------------------------------------|-------------------|-------------------|--------------------------------------|
| Meeting Air, Liquid Discharge Rqmts | Pneumatic Control | Hydraulic Control | Protecting Utilities, Infrastructure |
|-------------------------------------|-------------------|-------------------|--------------------------------------|

# Mindset for Change Management

Thermal Provider Design

Wellfield Construction

Operation



*One of These Things is Not Like the Others...*

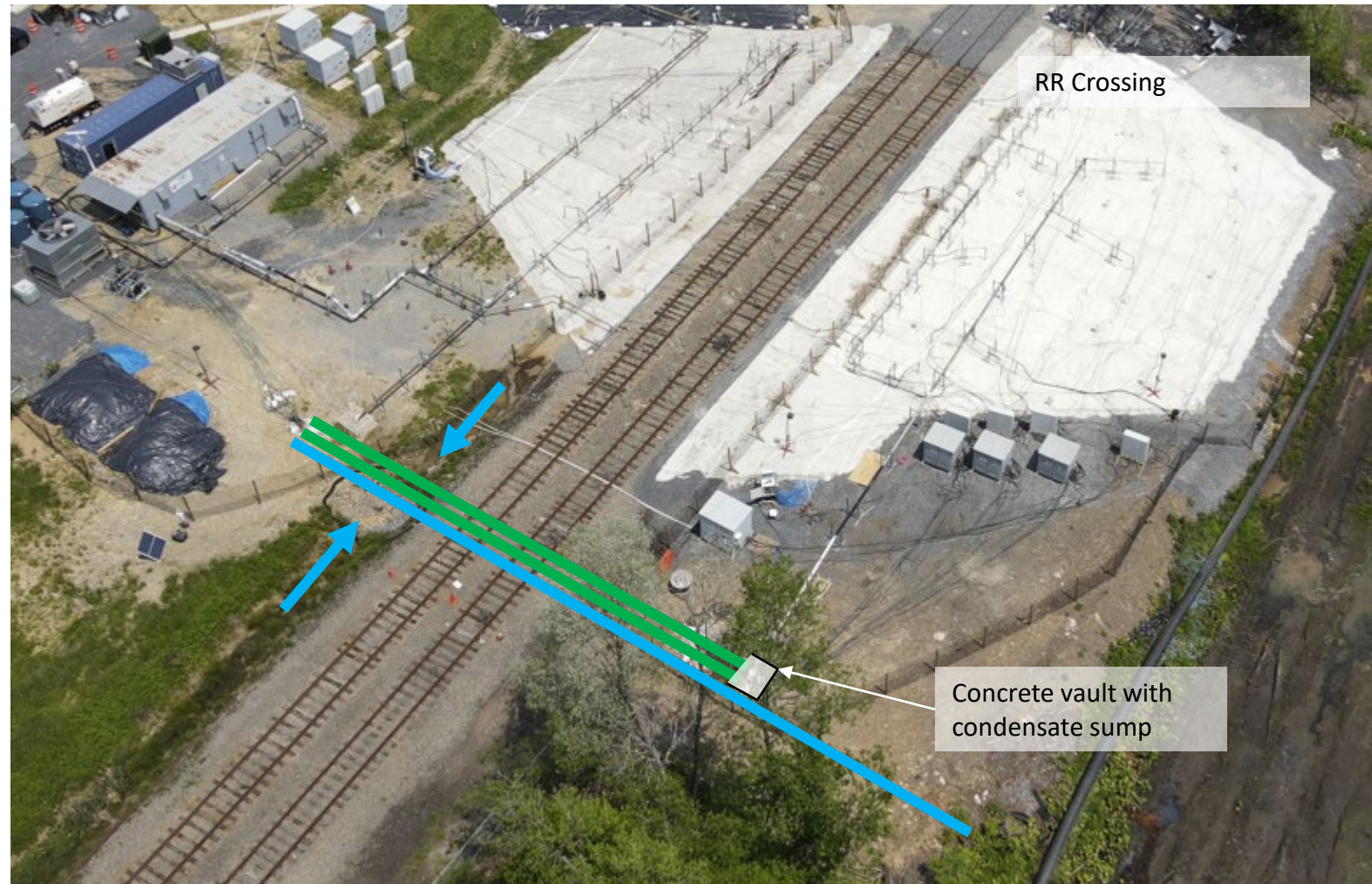
# #1: Known Design Challenges

- Shallow water table
- RR Tracks
- Surface Water Management
- Civil Work



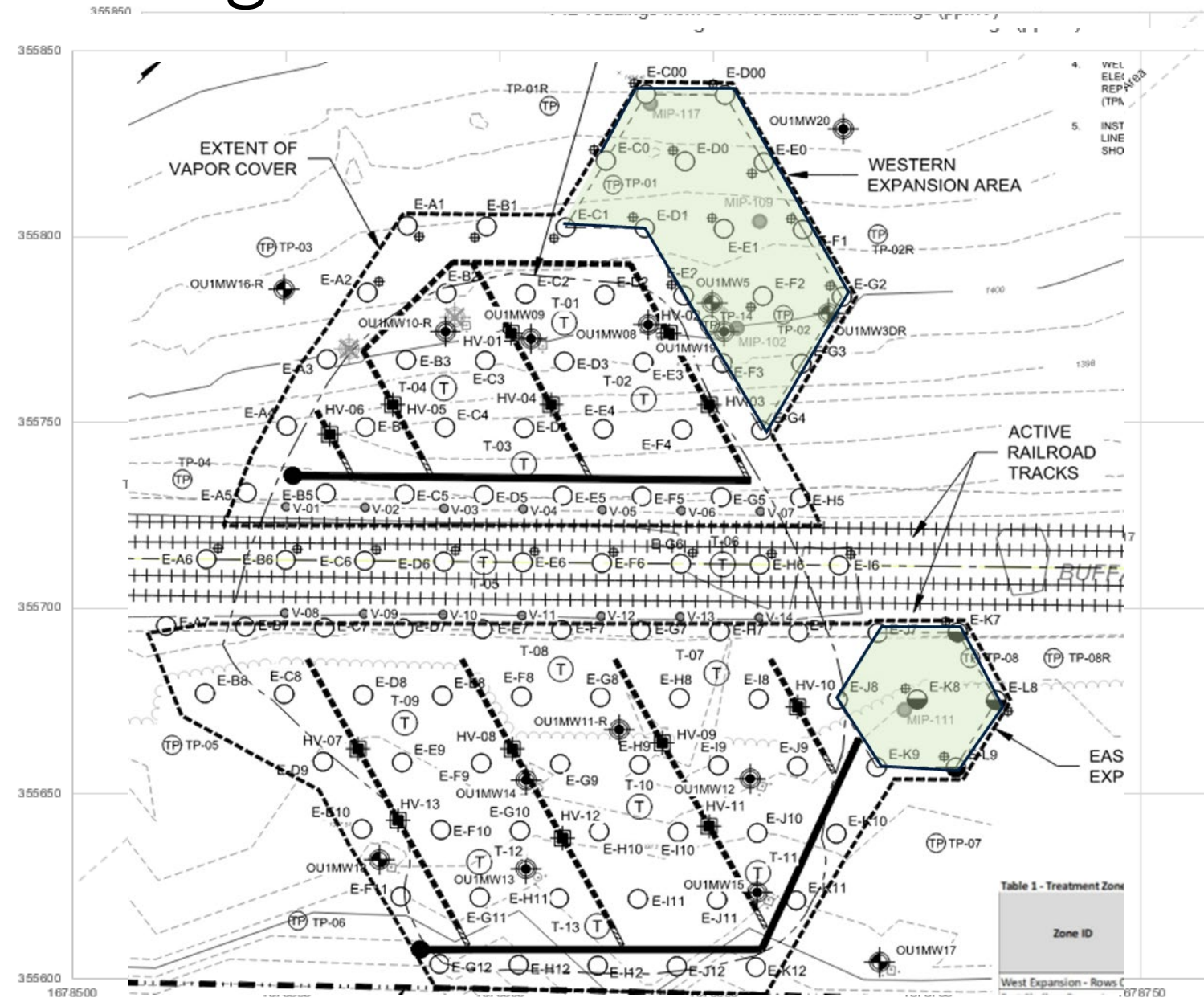
TTZ: 5-22 ft bgs, 13,720 cy, 100°C, CVOCs

Approach: ERH + horizontal extraction,  
passive groundwater collection + TCH



# #1: Pre-Remediation Investigation

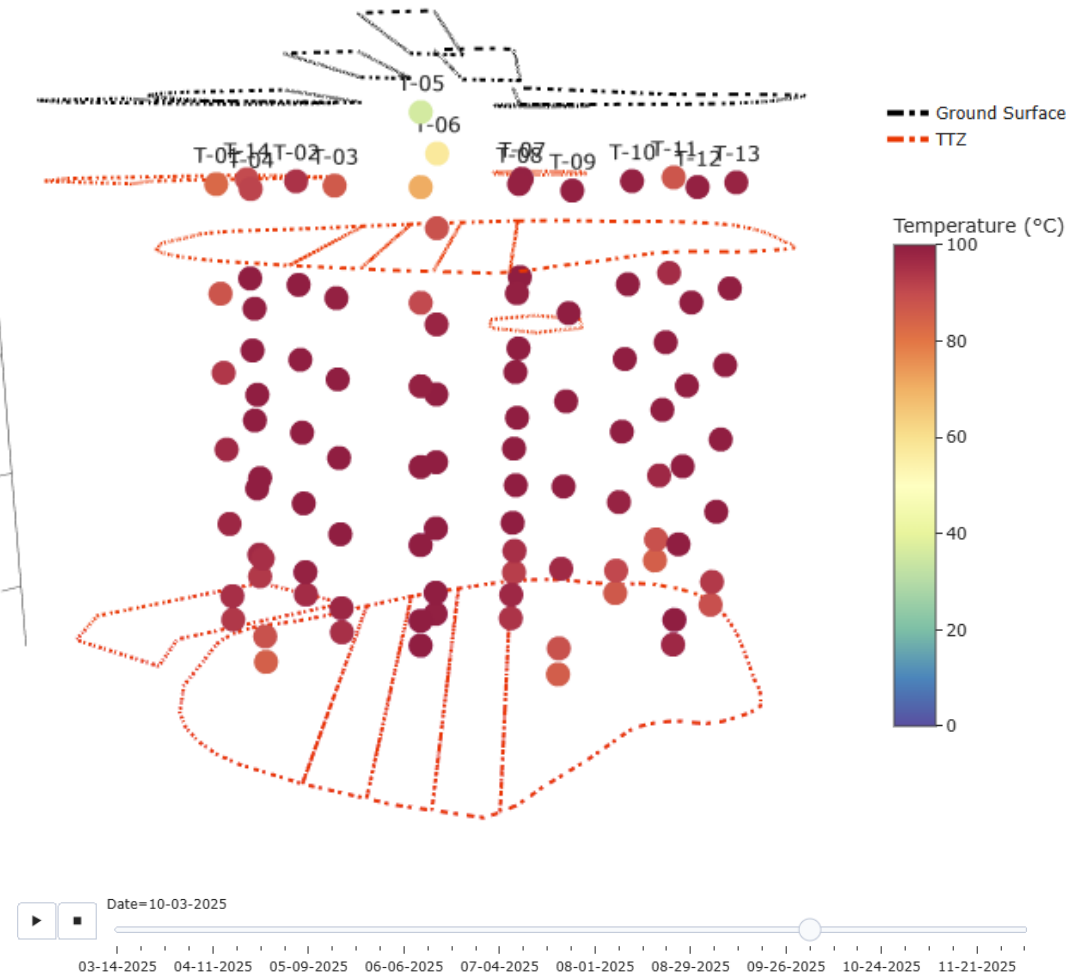
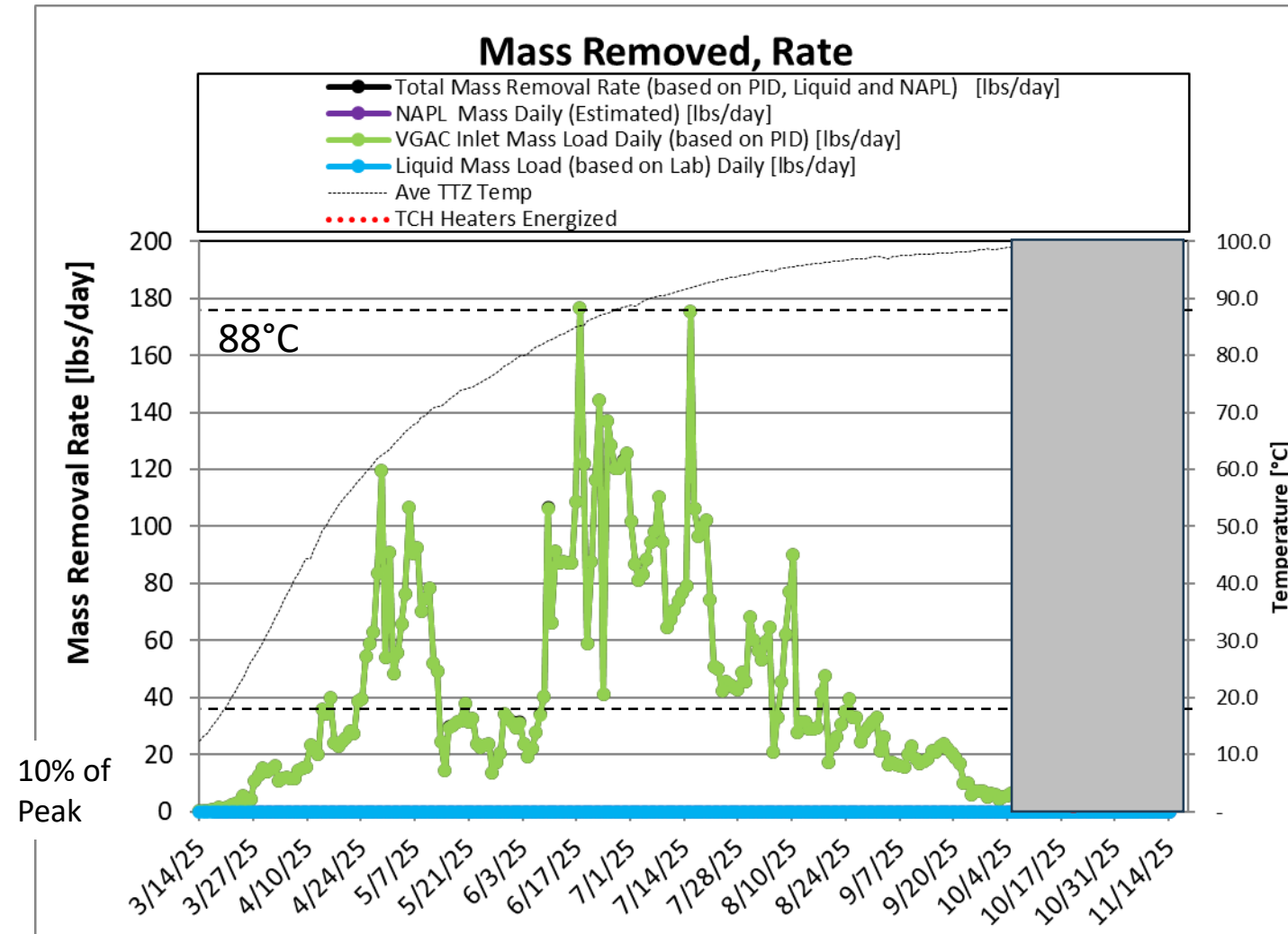
- Baseline GW Monitoring Data
- Reviewed CSM
- PRI
  - HPT/MIP w/ Soil
  - Field Effort: 5 Days
- Expanded Wellfield:
  - 19% increase area / 17% volume
  - 9 days of Drilling



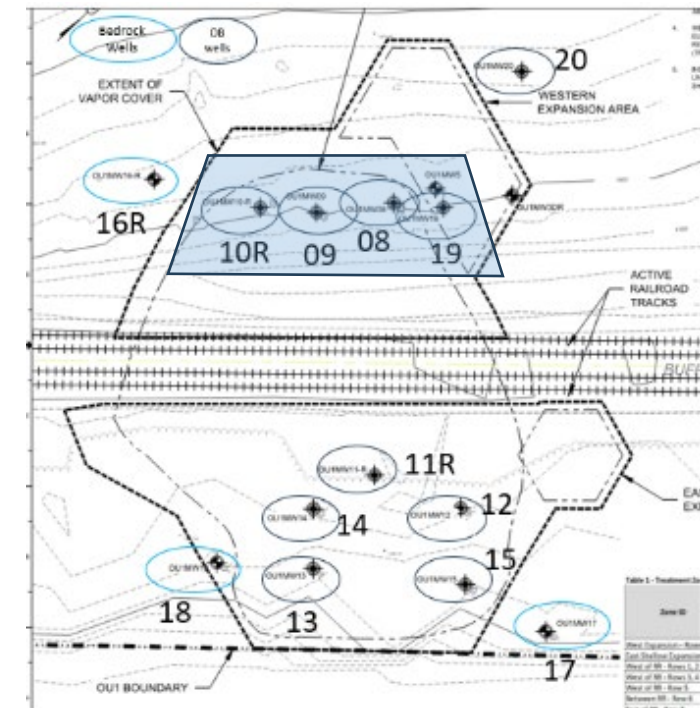
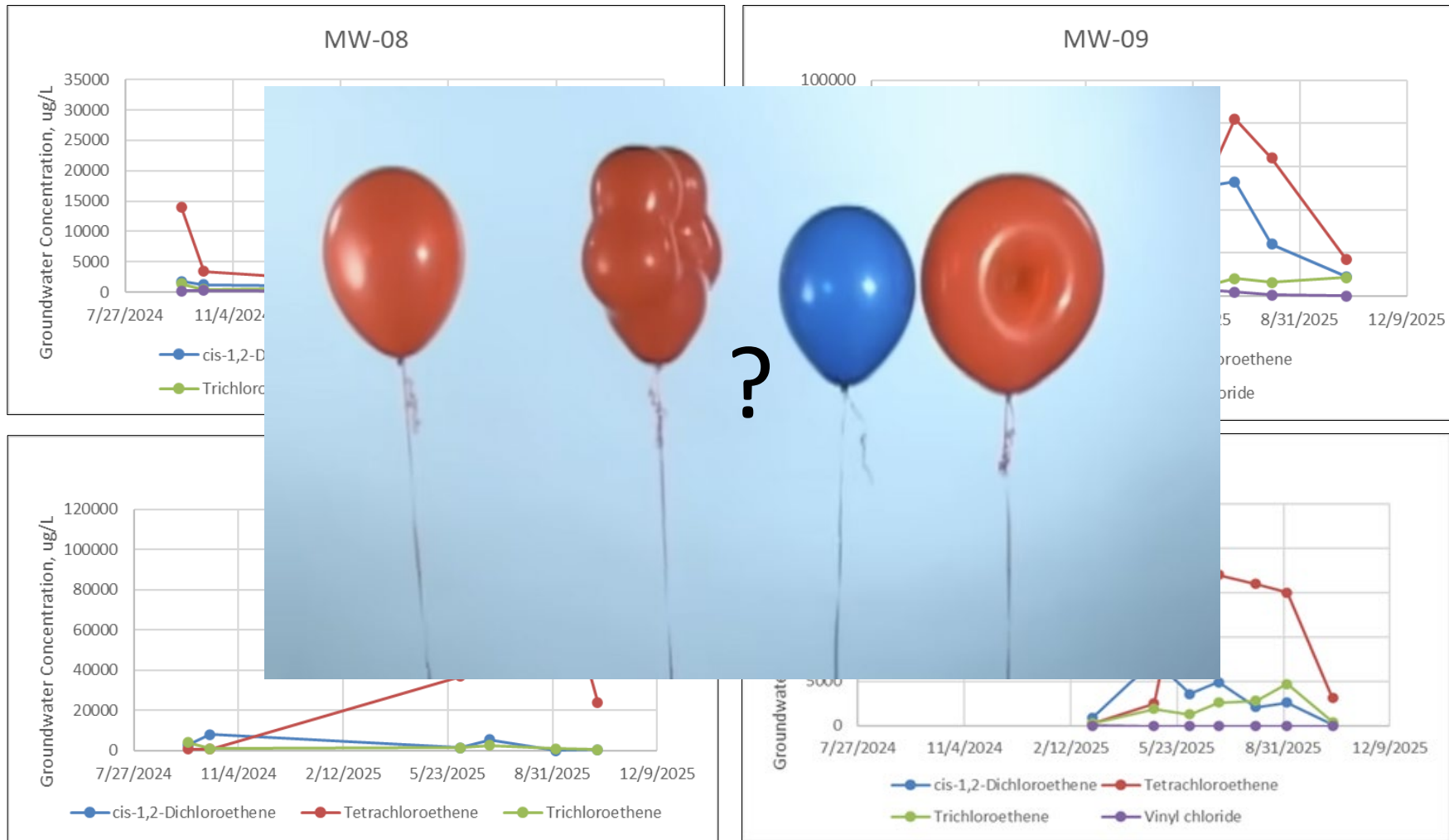
# #1: Are We Done Yet??



12-5-2025.html



# #1: Groundwater Trends: West Side – August thru October 2025



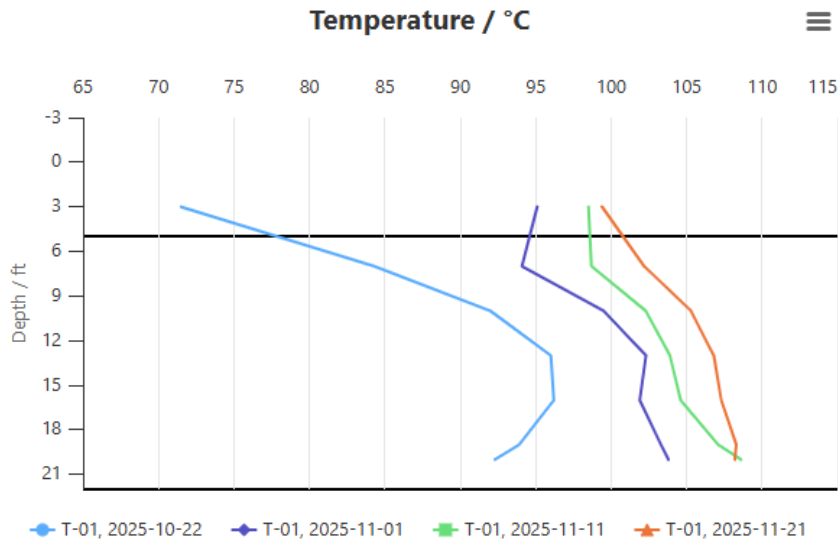
# #1: Let's Figure This Out...

- Collected Soil & GW Samples -> define hot spot
- Installed 21 Thermal Conduction Heaters, extending below 7 ft below TTZ
- Operated ERH & TCH for ~30 days

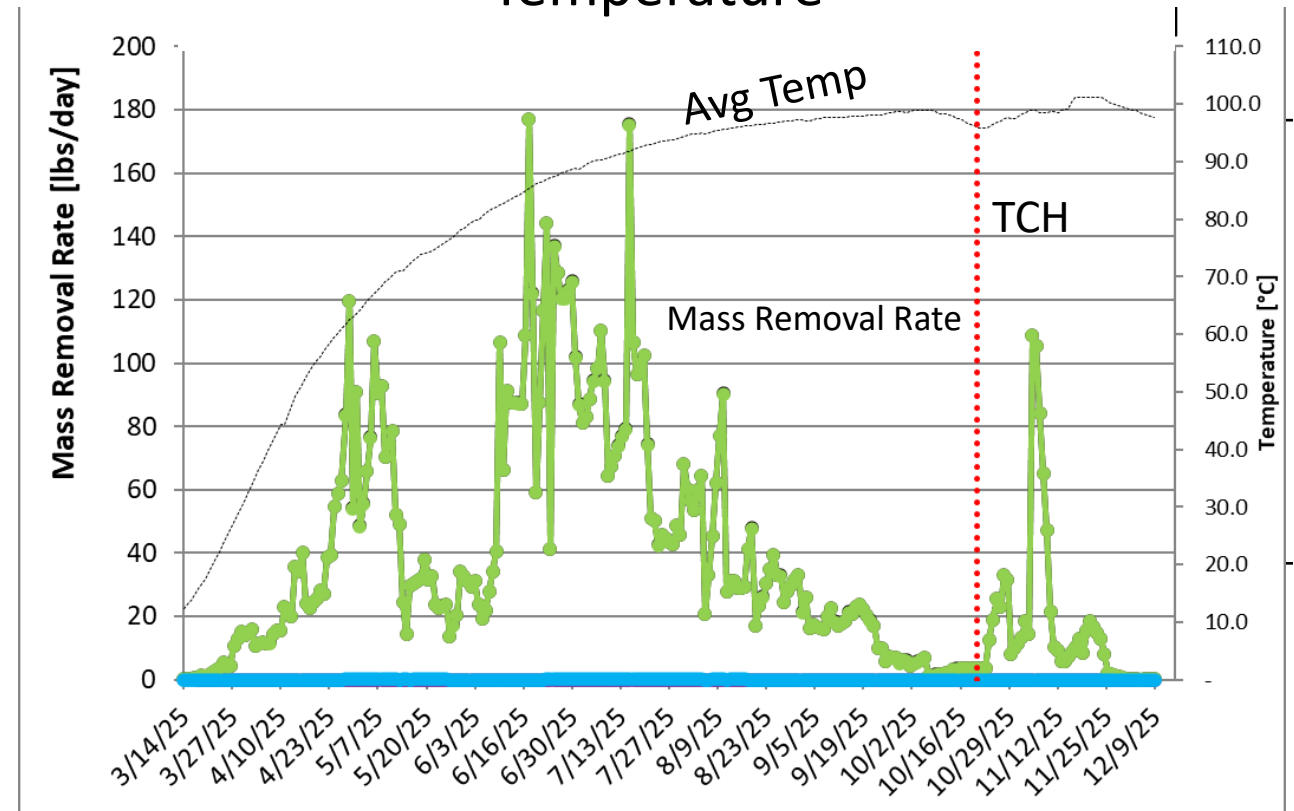
| C2.2 (1)                   |        |                   |                                |                                   |          |             | MW-10R |                             |           |
|----------------------------|--------|-------------------|--------------------------------|-----------------------------------|----------|-------------|--------|-----------------------------|-----------|
| Elevation<br>n [ft<br>msl] | ft bgs | PID<br>[ppm<br>V] | Soil Data<br>- CVOC<br>(mg/kg) | Soil Data<br>- Ketones<br>(mg/kg) | Moisture | Lithology   | ft bgs | GW Data<br>- CVOC<br>(mg/L) | Lithology |
|                            |        |                   |                                |                                   |          |             |        | 13-Oct                      |           |
| 1401                       | 0      |                   |                                |                                   |          |             | 0      |                             |           |
| 1400                       | 1      |                   |                                |                                   |          |             | 1      |                             |           |
| 1399                       | 2      |                   |                                |                                   |          |             | 2      |                             |           |
| 1398                       | 3      |                   |                                |                                   |          |             | 3      |                             |           |
| 1397                       | 4      |                   |                                |                                   |          |             | 4      |                             |           |
| 1396                       | 5      | 41.8              |                                |                                   | Moist    | Silty Clay  | 5      |                             |           |
| 1395                       | 6      | 77.9              | 0.0779                         | 0.0835                            | Moist    | Silty Clay  | 6      |                             |           |
| 1394                       | 7      | 19.9              |                                |                                   | Moist    | Silty Clay  | 7      |                             |           |
| 1393                       | 8      | 20.2              |                                |                                   | Moist    | Silty Clay  | 8      |                             |           |
| 1392                       | 9      | 21.8              |                                |                                   | Moist    | Silty Clay  | 9      |                             |           |
| 1391                       | 10     | 2.9               |                                |                                   | Moist    | Silty Clay  | 10     |                             |           |
| 1390                       | 11     | 2.9               |                                |                                   | Satur    | Clay        | 11     |                             |           |
| 1389                       | 12     | 44.7              | 0.241                          | 1.71                              | Moist    | Silty Clay  | 12     |                             |           |
| 1388                       | 13     | 2.4               |                                |                                   | Moist    | Silty Clay  | 13     |                             |           |
| 1387                       | 14     | 6.8               |                                |                                   | Moist    | Silty Clay  | 14     |                             |           |
| 1386                       | 15     | 6.4               |                                |                                   | Moist    | Silty Clay  | 15     |                             |           |
| 1385                       | 16     | 7.8               | 0.00519                        | 0.373                             | Moist    | Silty Clay  | 16     |                             |           |
| 1384                       | 17     | 2                 |                                |                                   | Moist    | Clayey Silt | 17     |                             |           |
| 1383                       | 18     | 2.3               |                                |                                   | Moist    | Clayey Silt | 18     |                             |           |
| 1382                       | 19     | 2.8               |                                |                                   | Moist    | Clayey Silt | 19     |                             |           |
| 1381                       | 20     | 9.8               |                                |                                   | Dry      | Clayey Silt | 20     | 24.97                       | ~20       |
| 1380                       | 21     | 36.3              |                                |                                   | Dry      | Clayey Silt | 21     |                             |           |
| 1379                       | 22     | 58.7              | 0.093                          | 0.103                             | Dry      | Clayey Silt | 22     |                             |           |
| 1378                       | 23     | 210               |                                |                                   | Dry      | Clayey Silt | 23     |                             |           |
| 1377                       | 24     | 223               |                                |                                   | Dry      | W. Bdrk     | 24     |                             |           |
| 1376                       | 25     | 331               | 13.054                         | 0                                 | Dry      | W. Bdrk     | 25     |                             |           |
| 1375                       | 26     | 15.8              |                                |                                   | Dry      | W. Bdrk     | 26     |                             |           |
| 1374                       | 27     | 43.3              |                                |                                   | Dry      | W. Bdrk     | 27     |                             |           |
| 1373                       | 28     | 21.8              |                                |                                   | Dry      | W. Bdrk     | 28     |                             |           |
| 1372                       | 29     | 9                 |                                |                                   | Dry      | W. Bdrk     | 29     |                             |           |
| 1371                       | 30     | 4                 | 0.0062                         | 0.026                             | Dry      | W. Bdrk     | 30     |                             |           |

March 4 – March 6, 2026

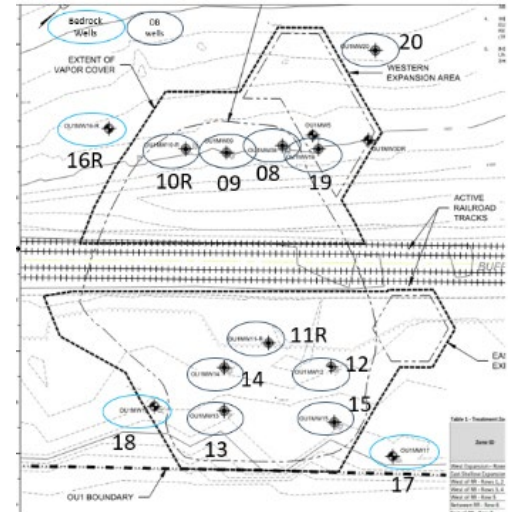
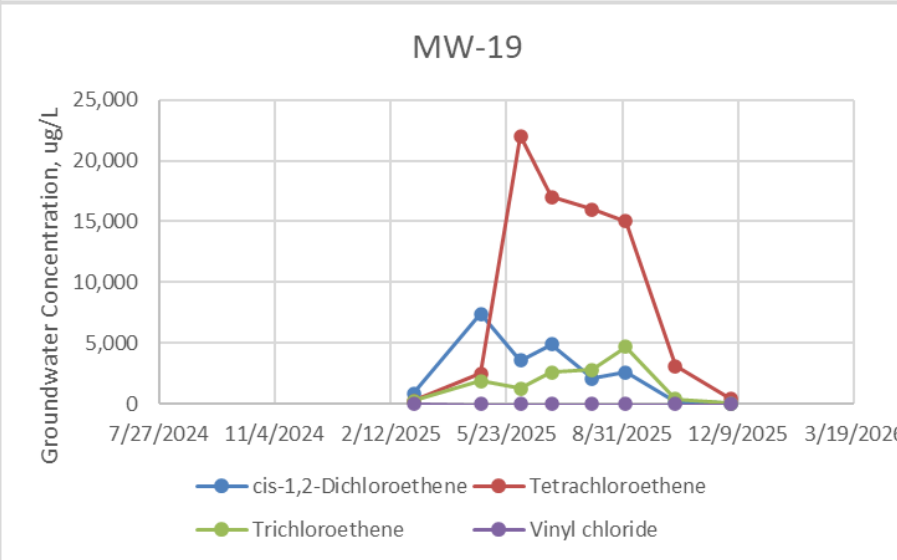
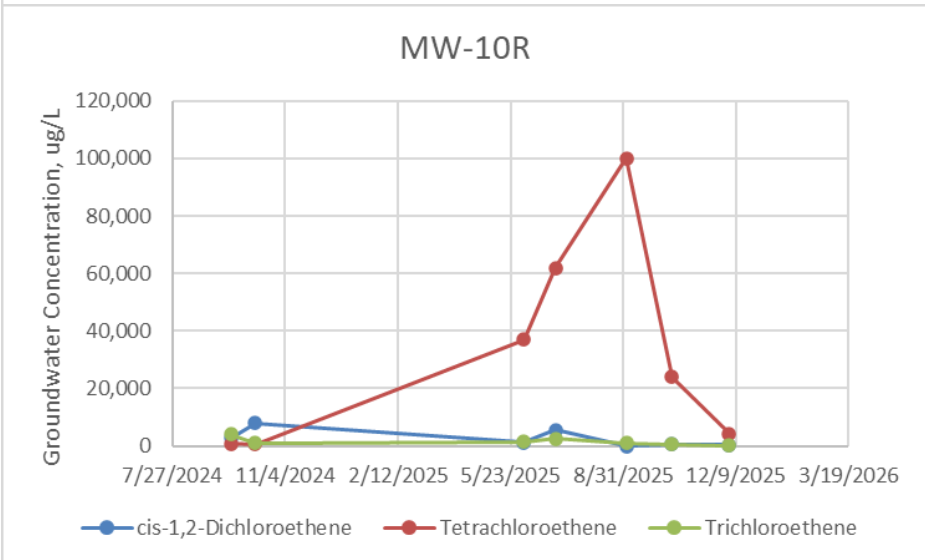
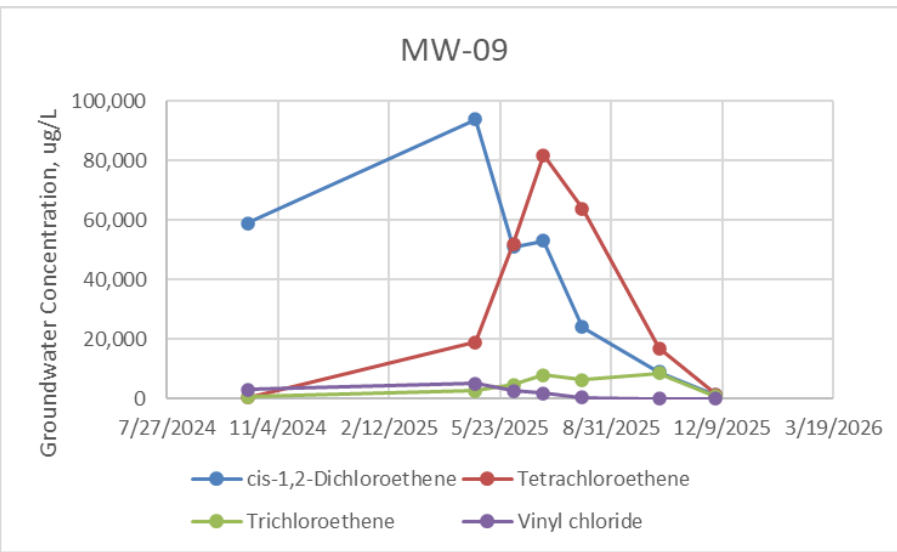
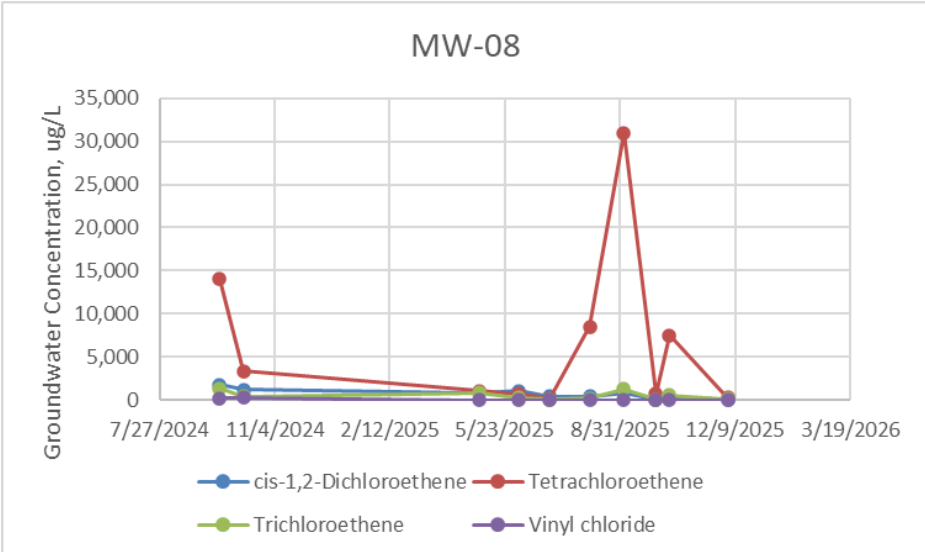
# #1: Back to the Lines of Evidence



## Mass Removal Rate and Average Temperature



# #1: Groundwater Trends, West Side – December 2025



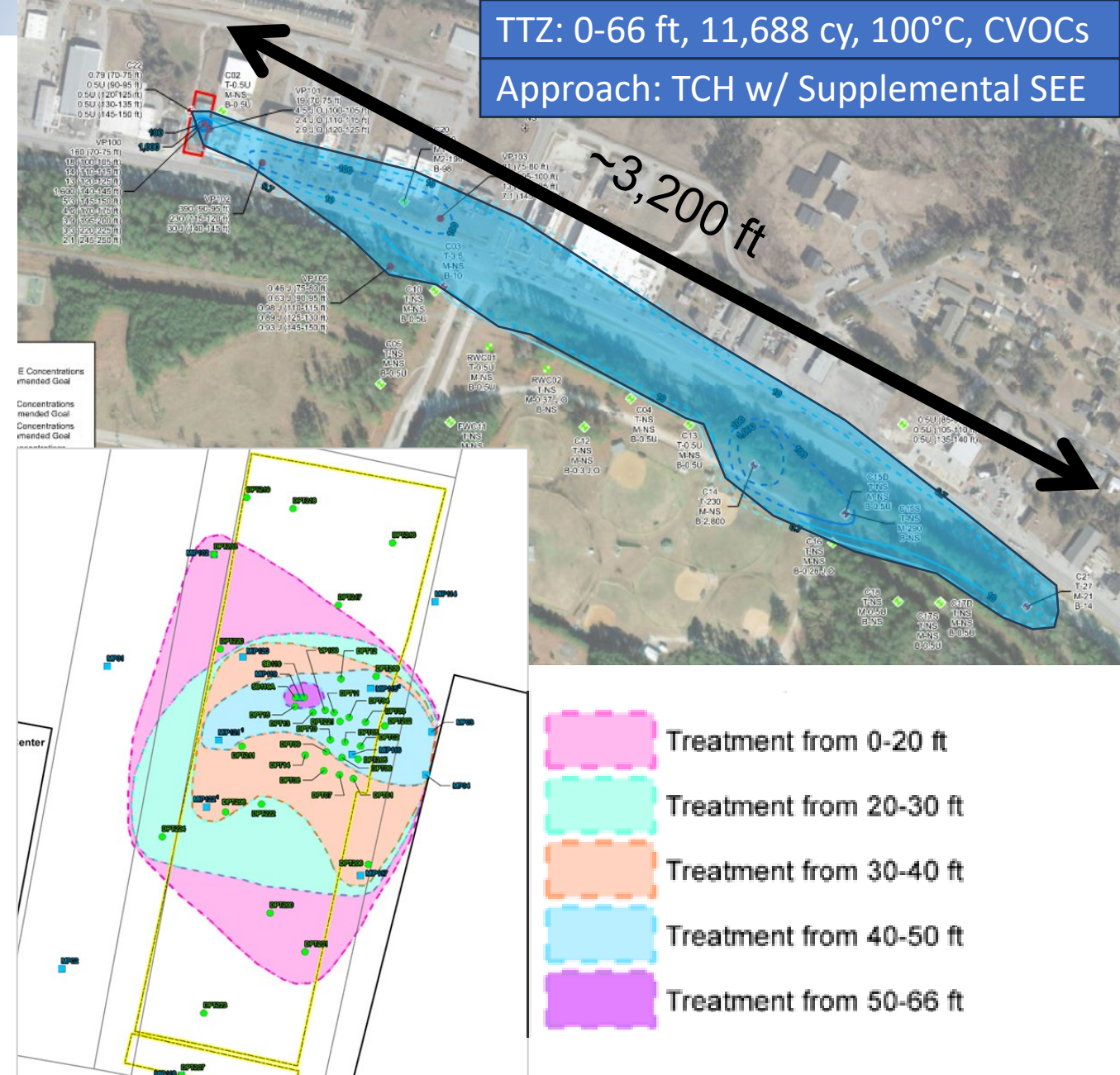
Shutdown: December 2025

~10,000 lbs mass removed  
+/- 4% of design energy

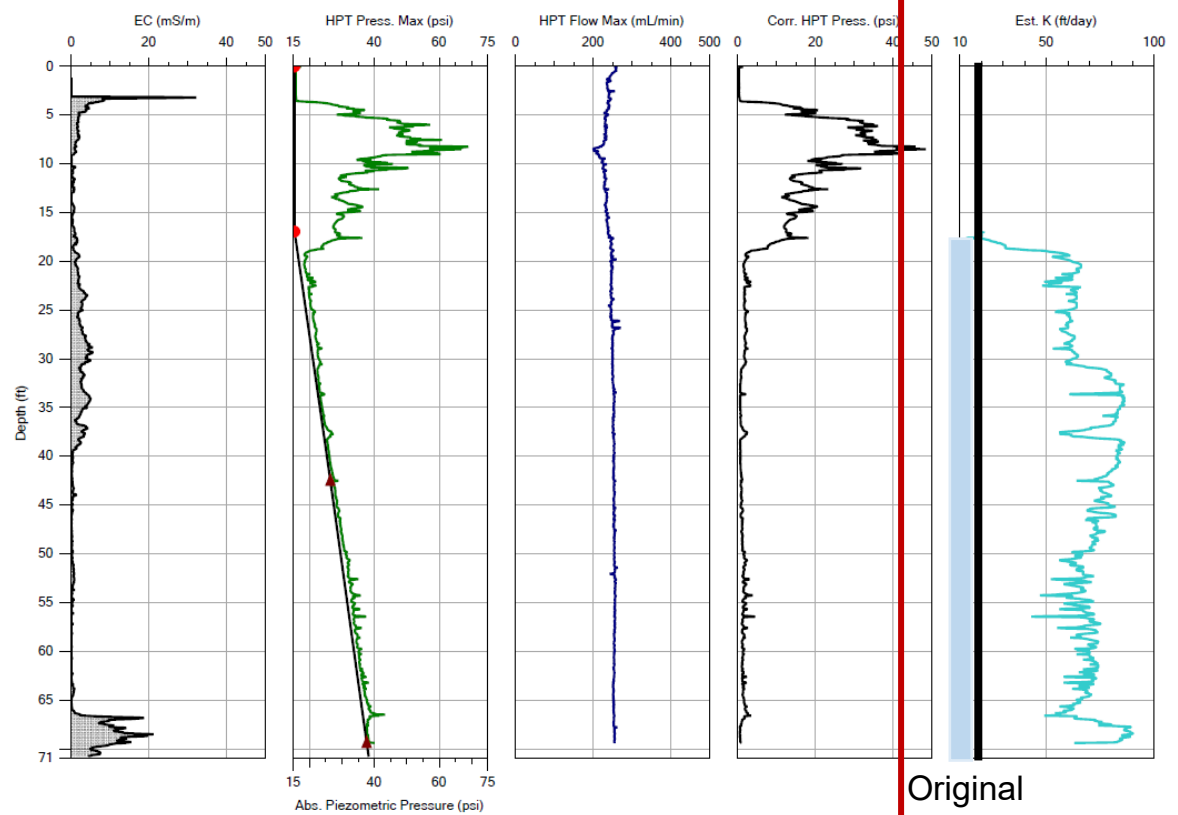
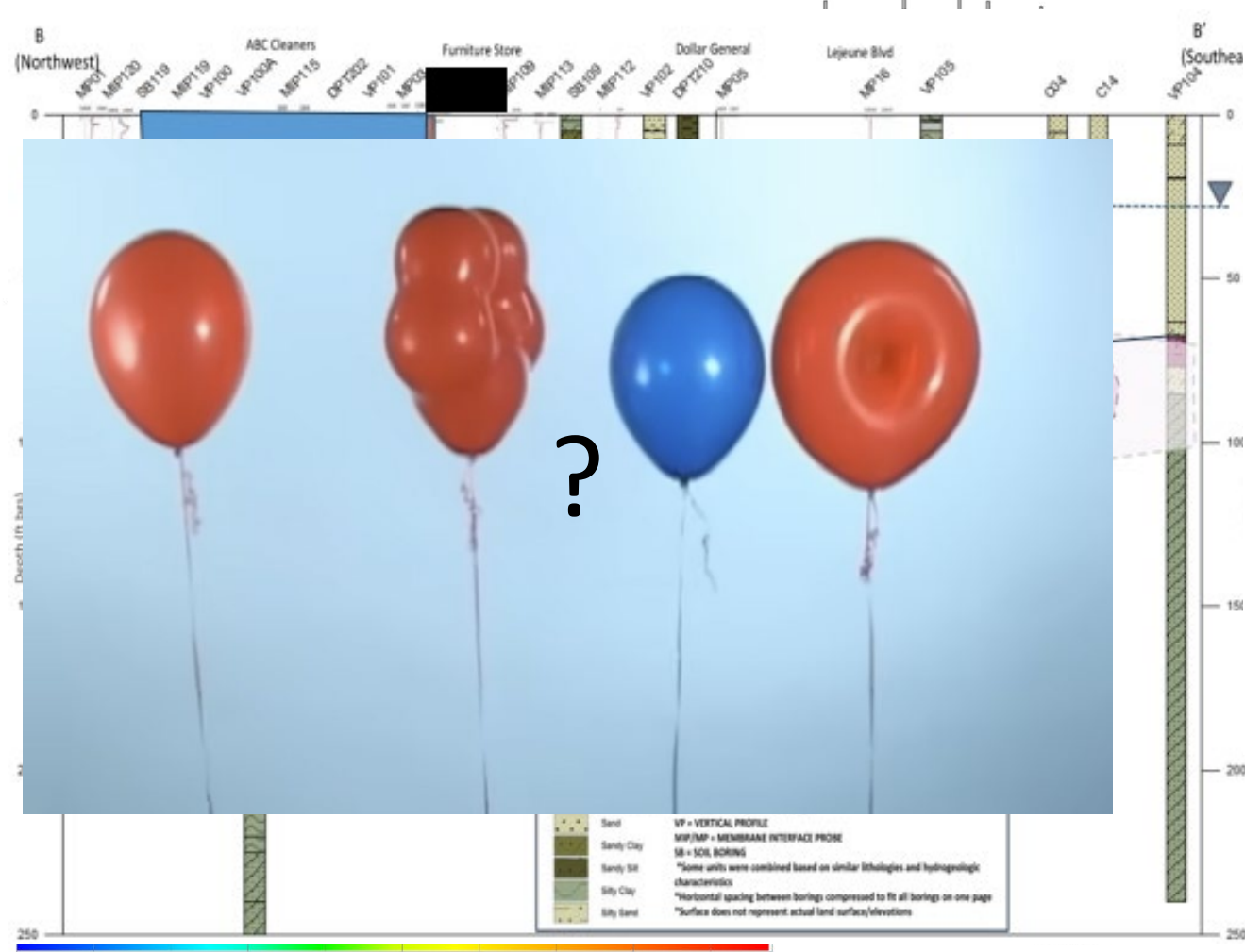
Note different y-axes

# #2: Jacksonville, NC

- Former Dry Cleaner 1964-2005
- COCs: PCE, DNAPL
- Thermal Design:
  - TCH
  - 6,500 sq ft / 7,900 cy
  - K: 9-19 ft/day
  - V: 0.3 ft/day
  - All vertical, full access



# #2: CSM Review -> PRI



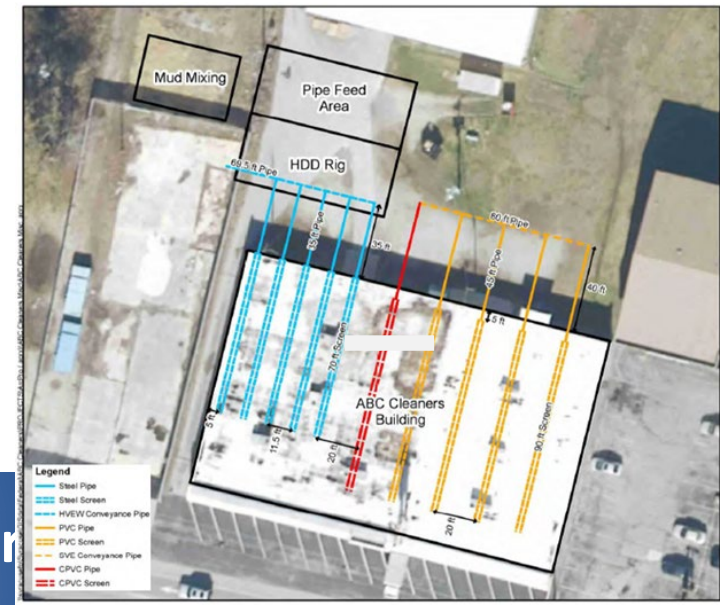
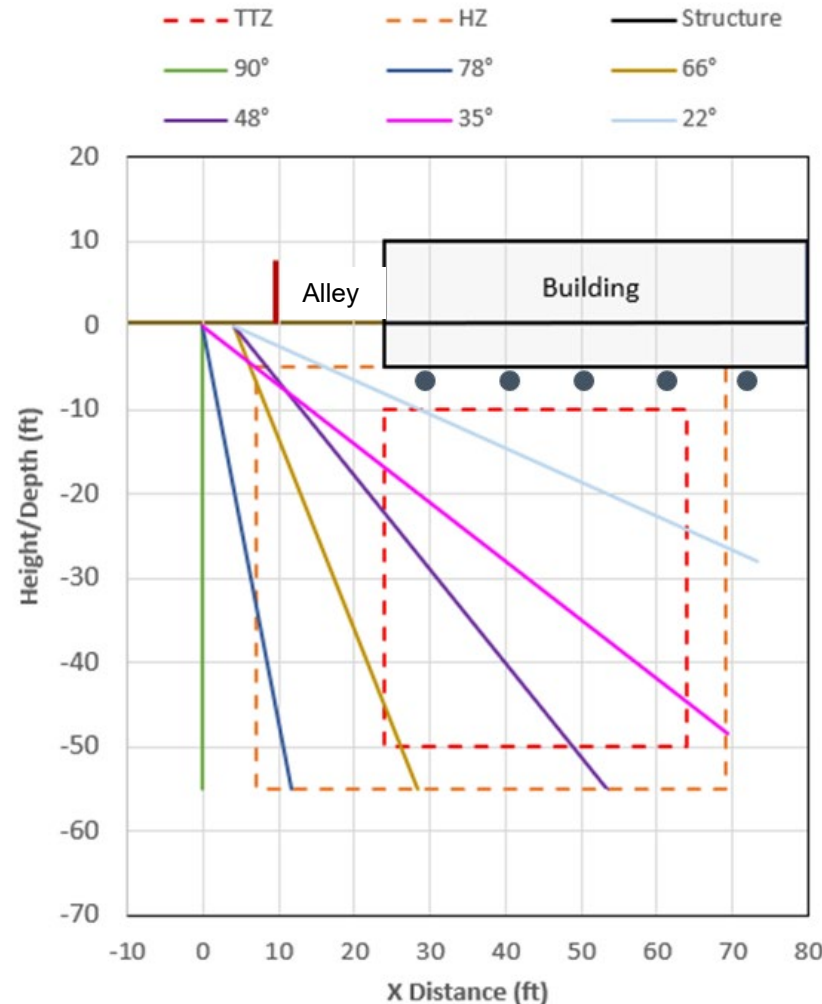
**CASCADE**  
DRILLING | TECHNICAL SERVICES

|             |                       |           |                |           |                  |
|-------------|-----------------------|-----------|----------------|-----------|------------------|
| Company:    | Cascade               | Operator: | Kochnev        | File:     | HPT1002.MHP      |
| Project ID: | ABC One-Hour Cleaners | Client:   | EA Engineering | Date:     | 01/18/23         |
|             |                       |           |                | Location: | Jacksonville, NC |

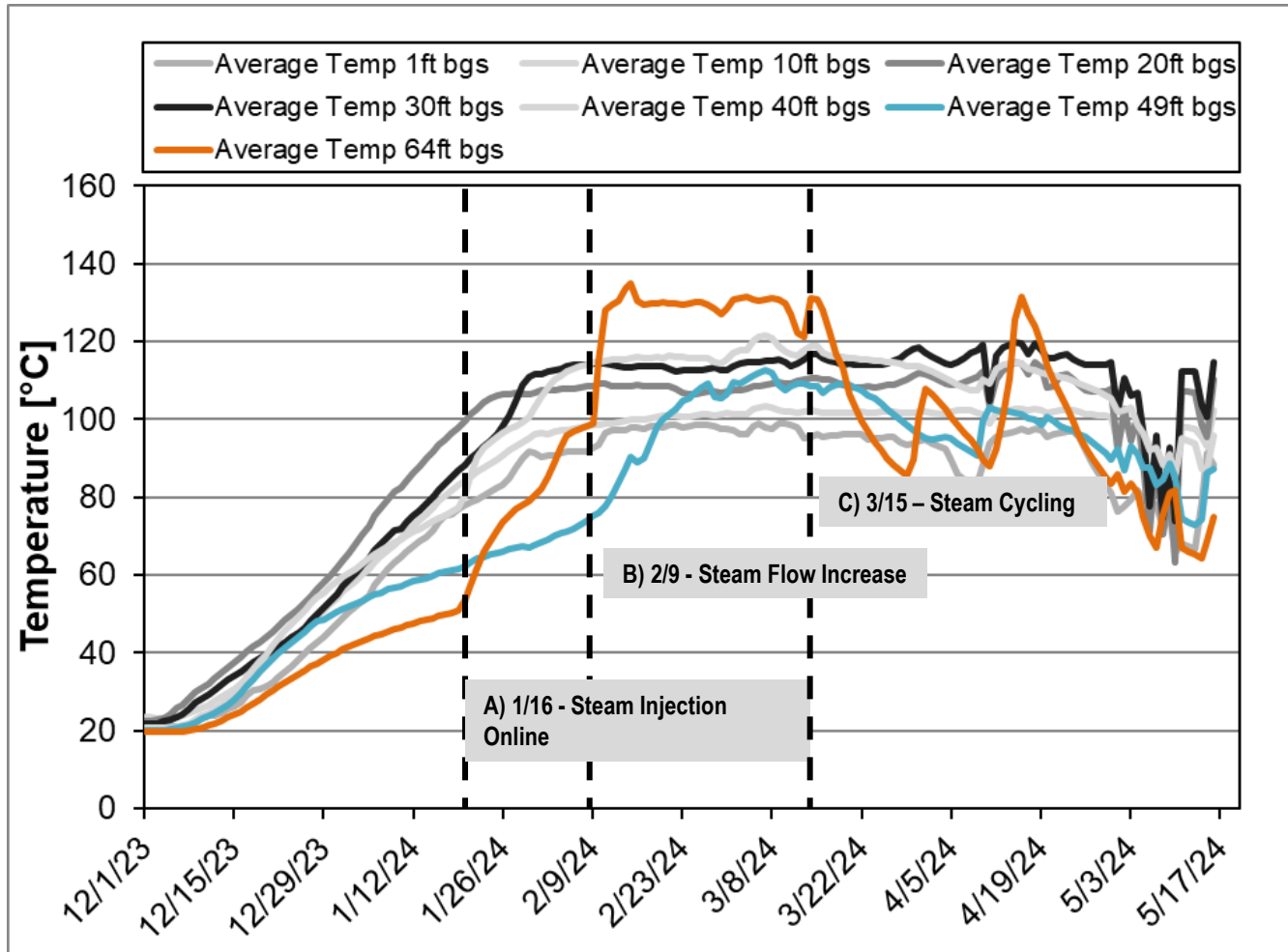
- > Source Mass Below Building
- > Groundwater Seepage Velocity 4-8 x design
- > No Access to Alley or Building

# #2: Revised Thermal Design

- Add Zone 6, Below Bldg
  - 6 Angled Heater Clusters
  - HVEW system via HDD
- No alley access
- TCH + SEE
  - 12 co-located SIWs
  - Extend 5 TCH
  - Boiler
  - 8,692 sq ft / 11,156 cy



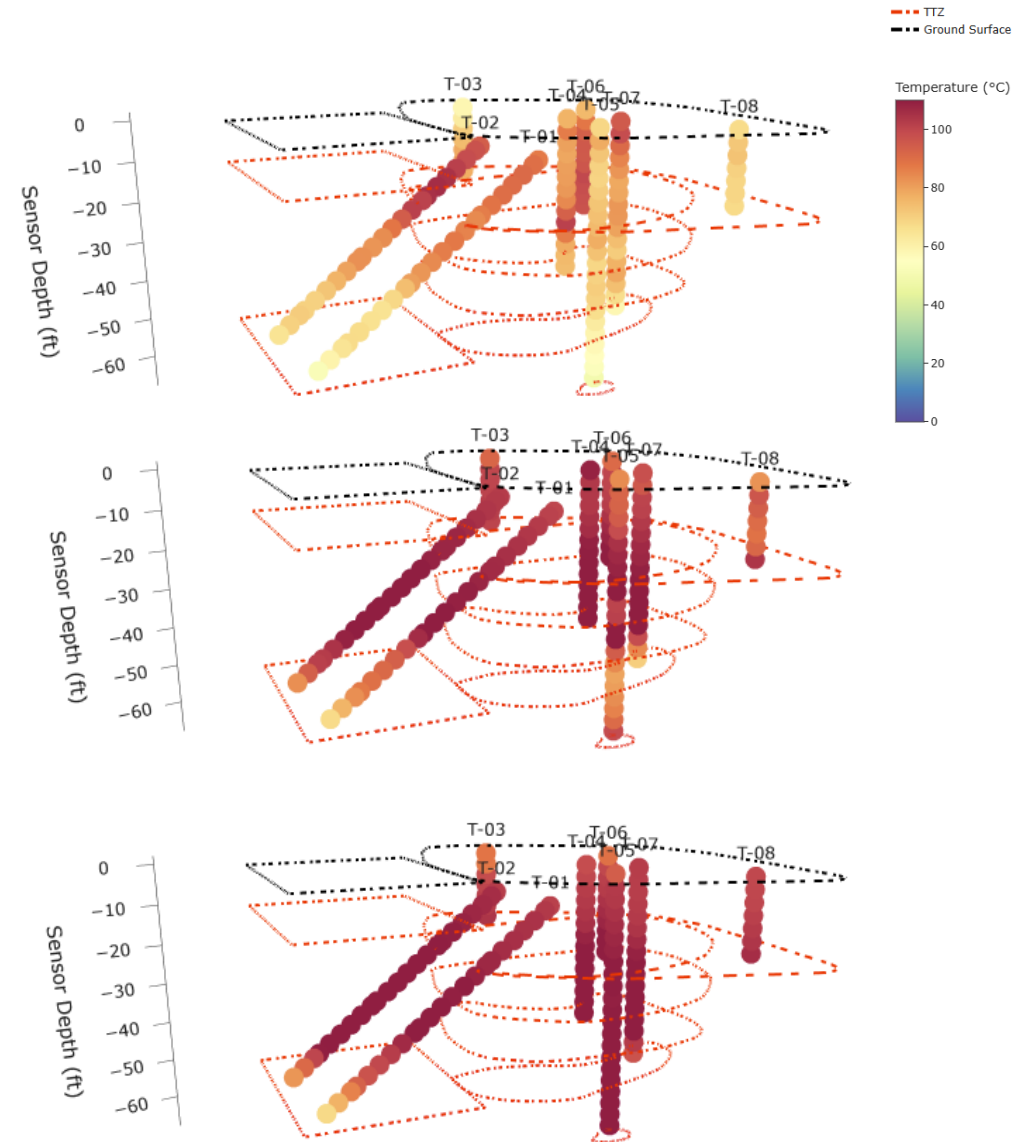
# #2: Steam Injection Impact



A

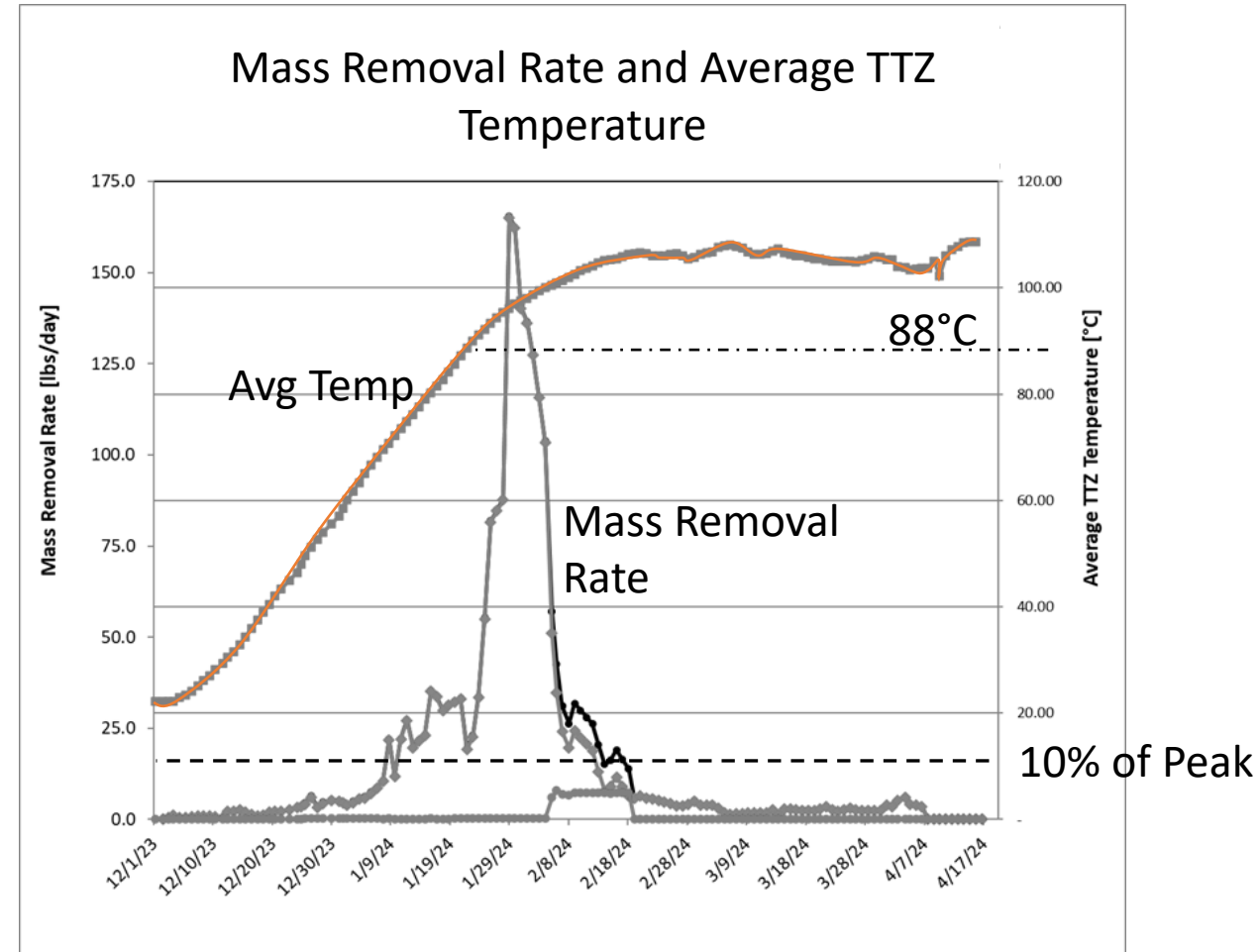
B

C



## #2: Results

- Temperature
- Mass Removal
- Energy Density
- Steam Cycling
- Soil Data

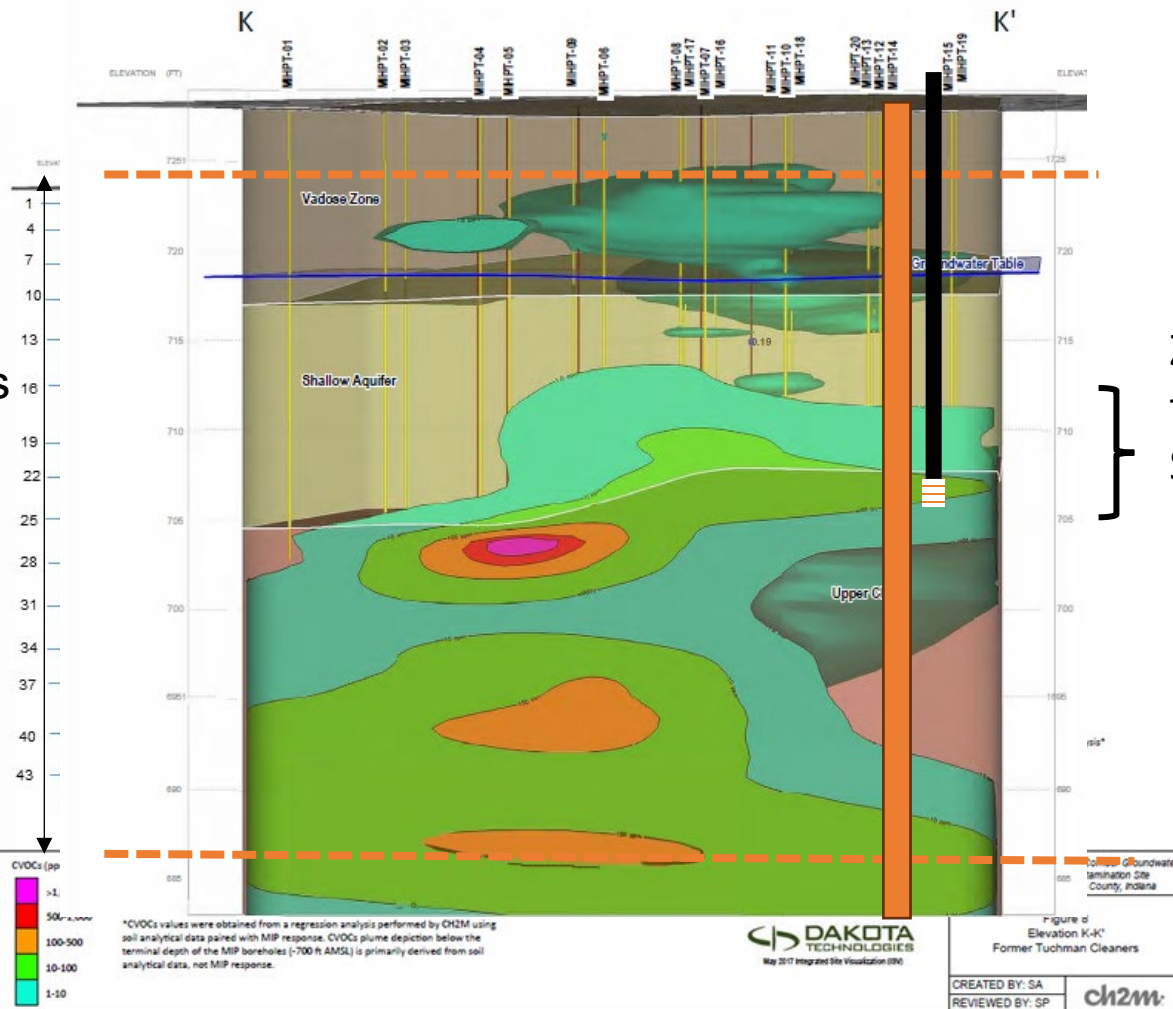


# #3: Indianapolis, IN

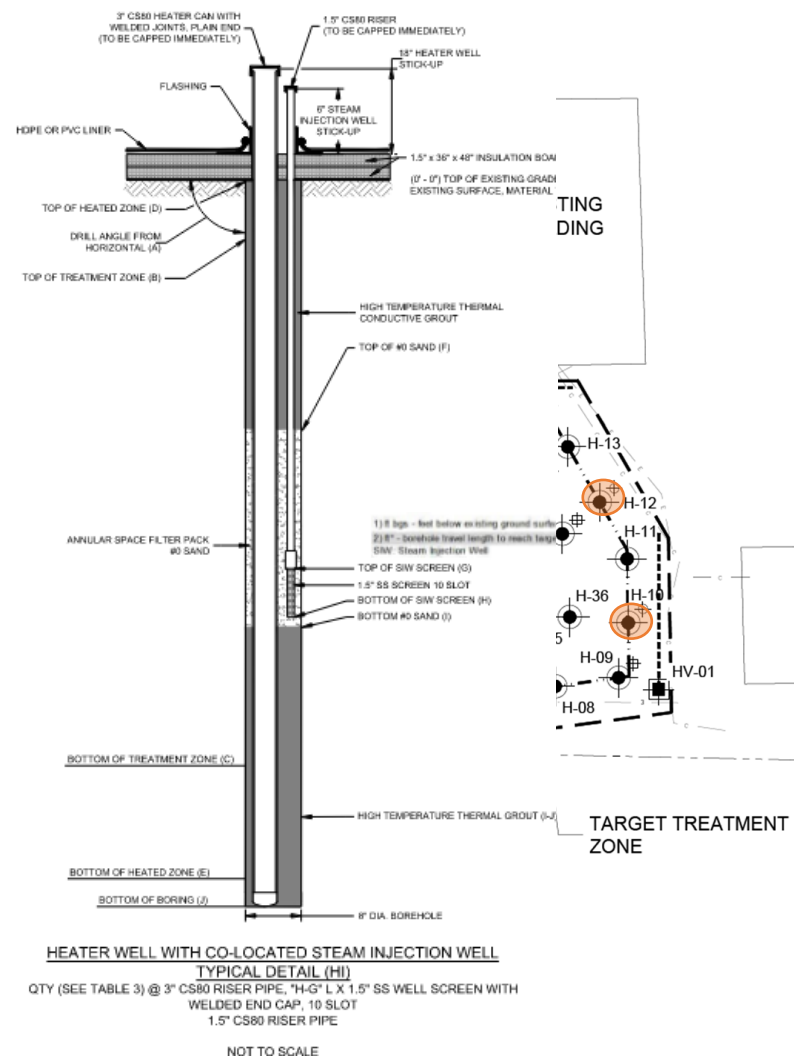
TTZ: 5-45 ft, 13,810 cy, 100°C, CVOCs + TPH

Approach: TCH + Supplemental Steam

TTZ: 5-45 ft bgs

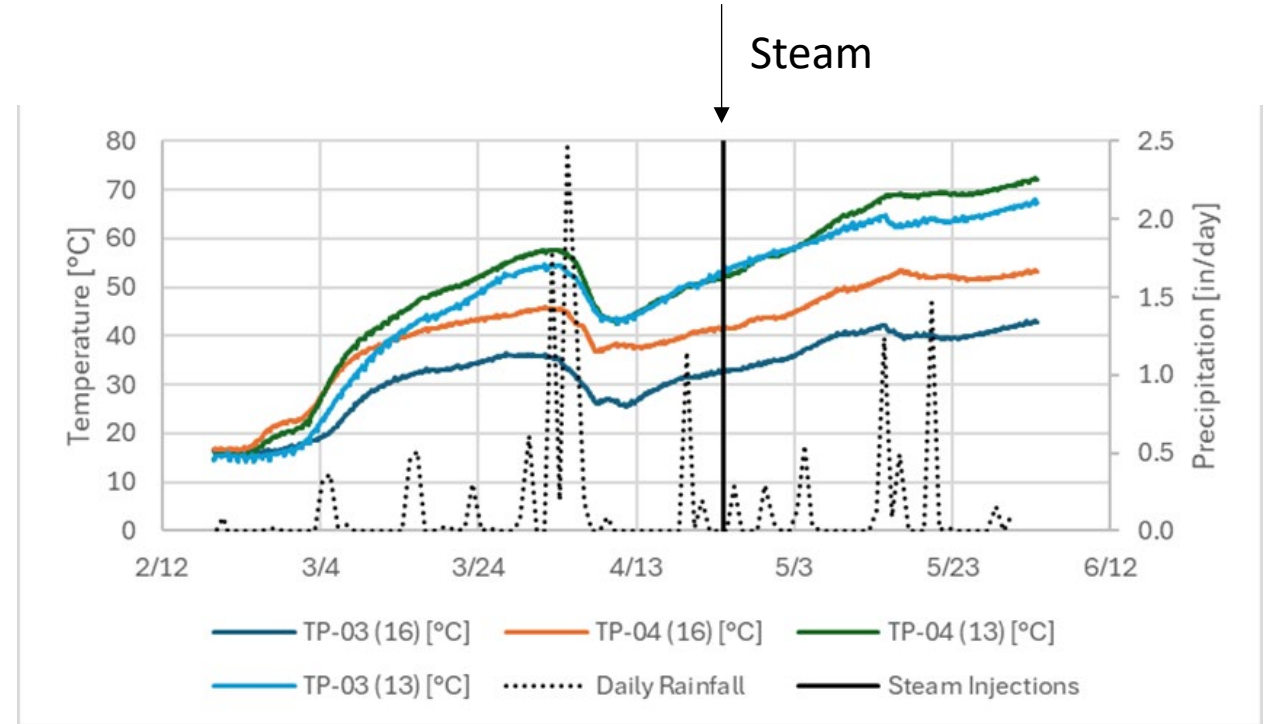
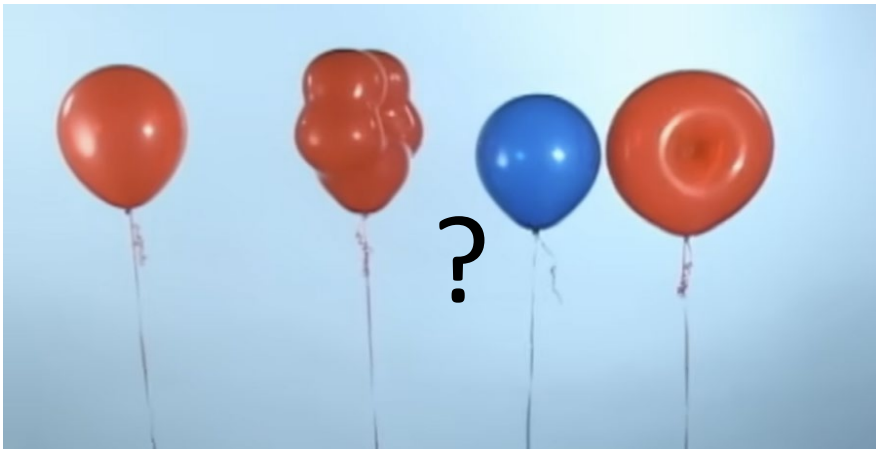


Zone targeted by Steam Injections



# #3: Operation

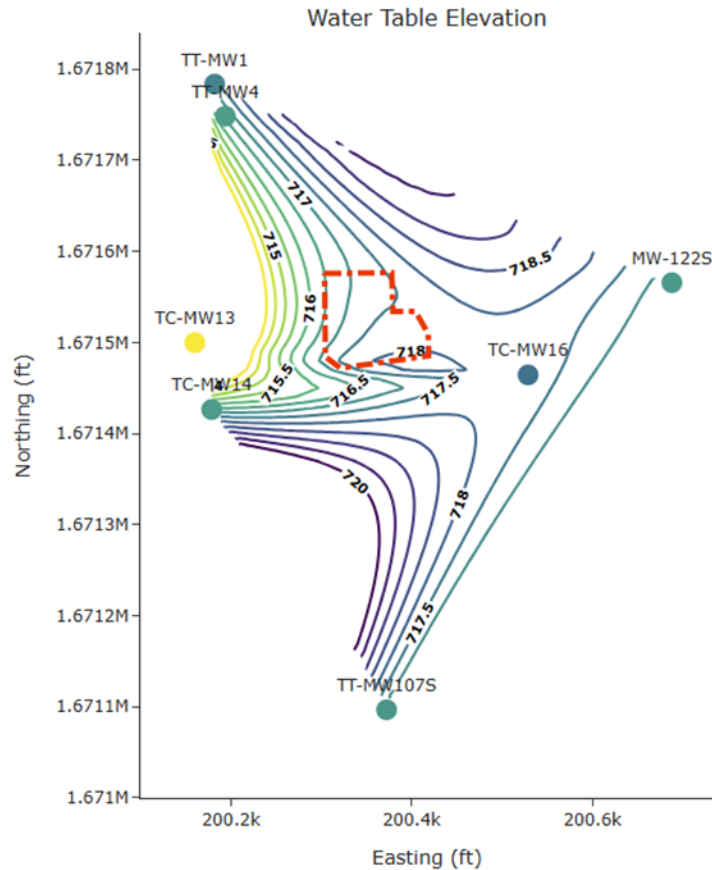
- Steady increase in temps until...
- Initiated steam: 220 lbs/hr
- Marginal improvements



Steam: ~80 kW  
TCH: ~700 kW

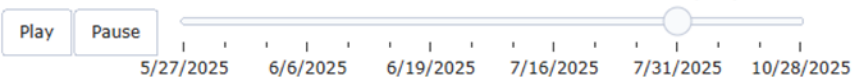
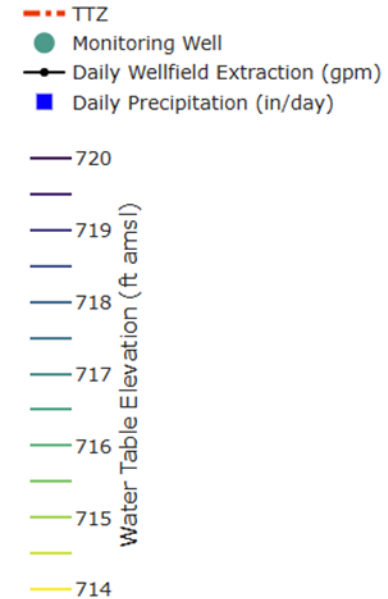
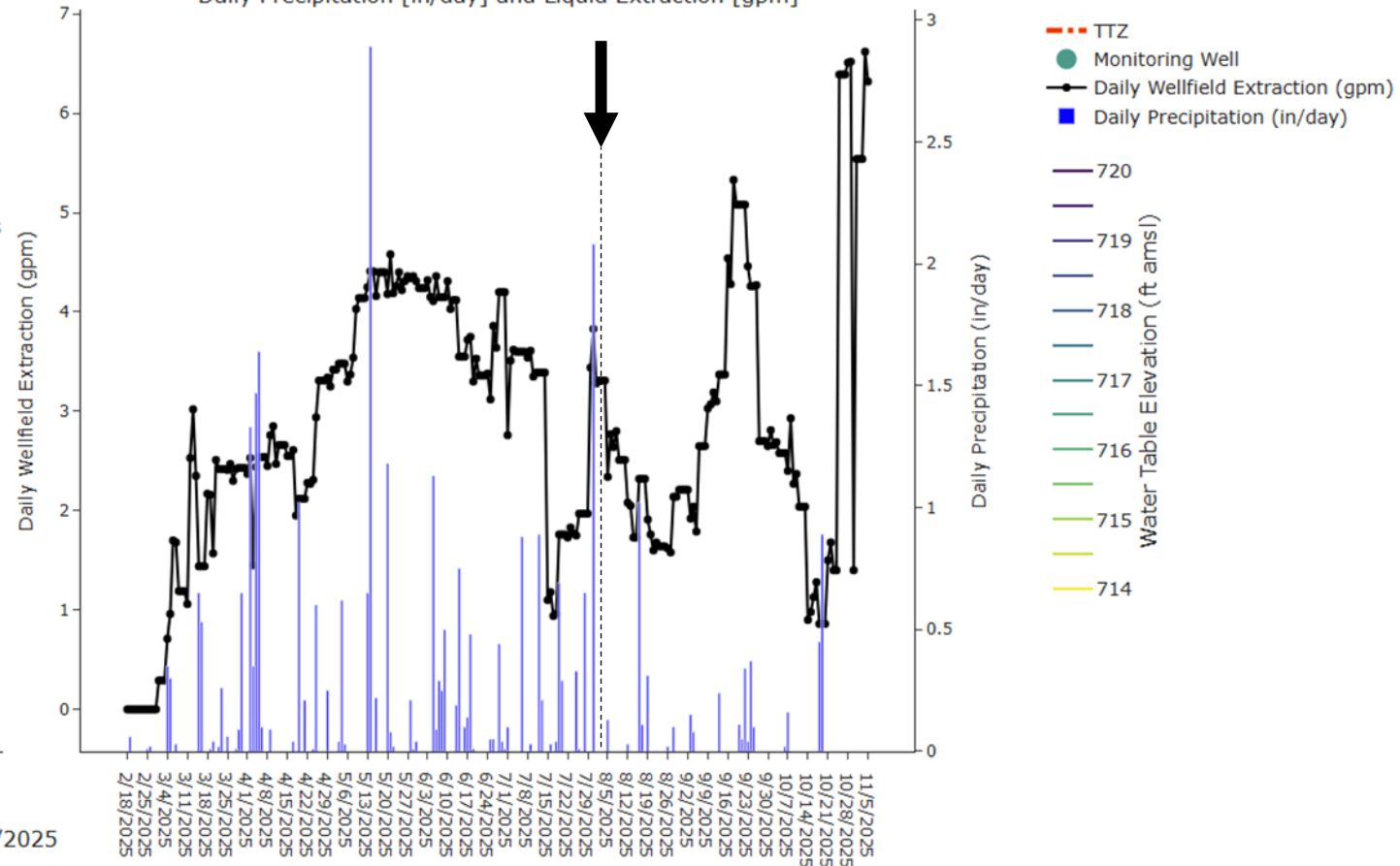
# #3: Water Surface Elevation: Rapid Change in Gradient with Rain

Keystone Water Table Elevation - 7/31/2025



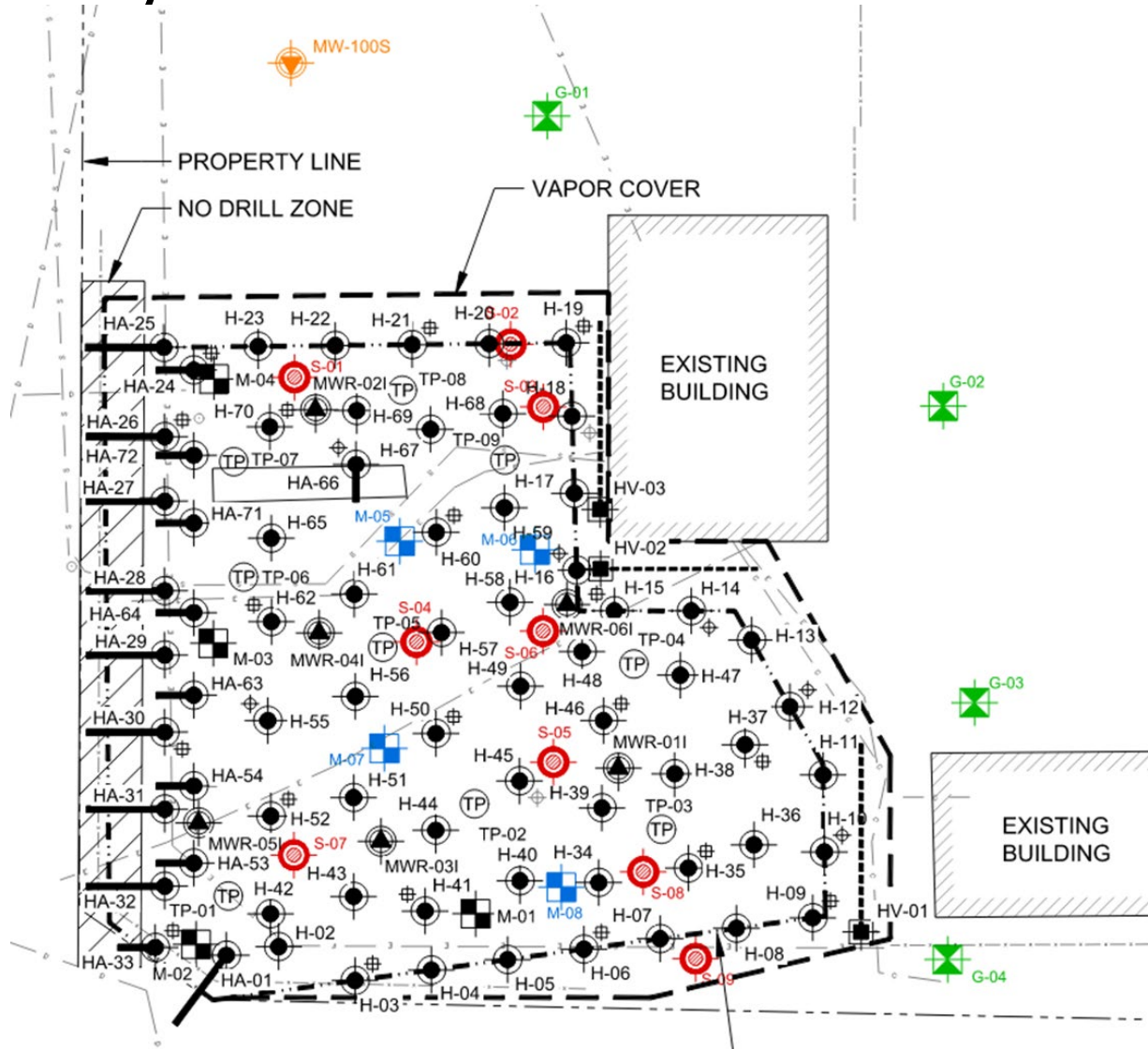
Date: 7/31/2025

Daily Precipitation [in/day] and Liquid Extraction [gpm]



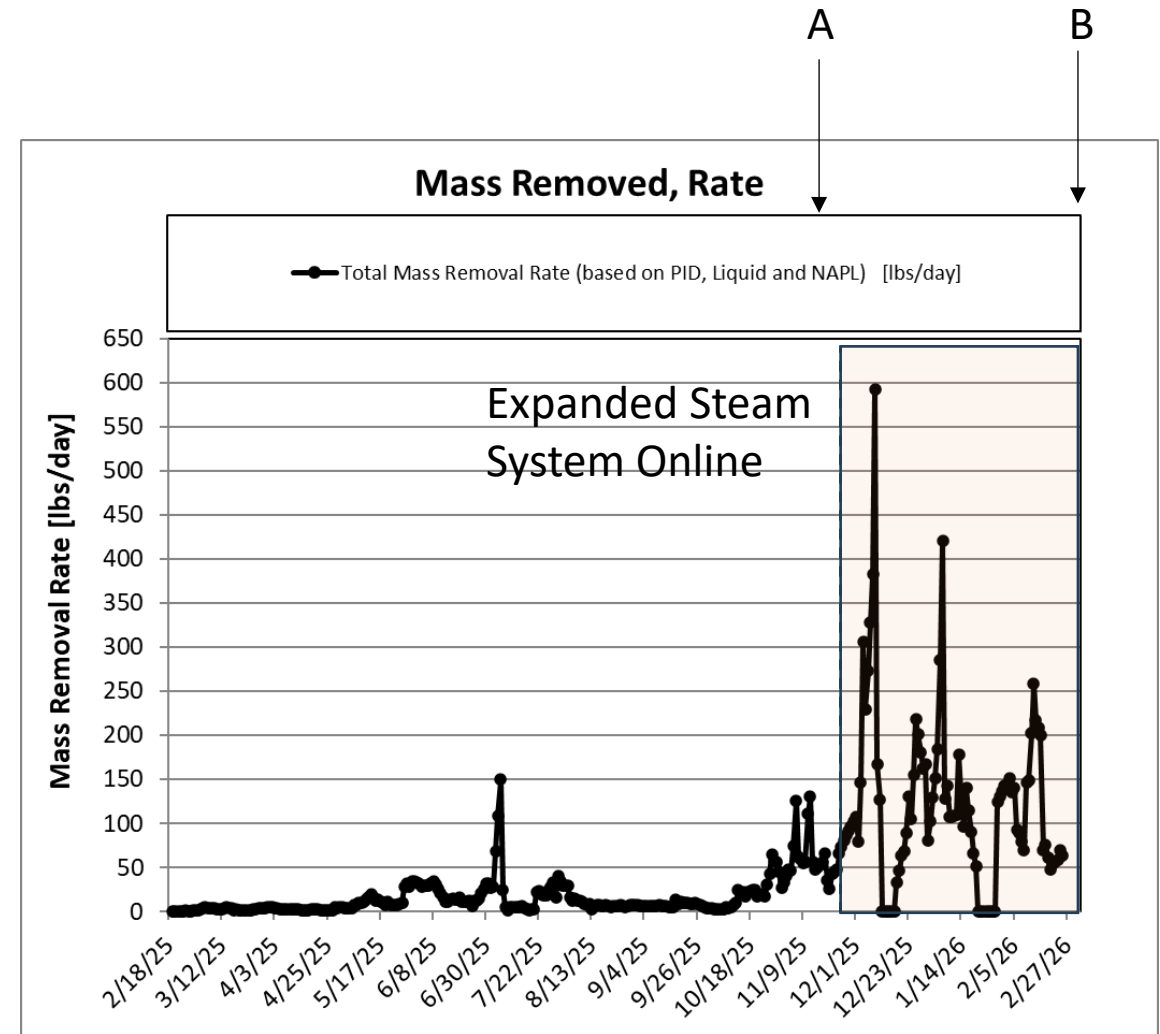
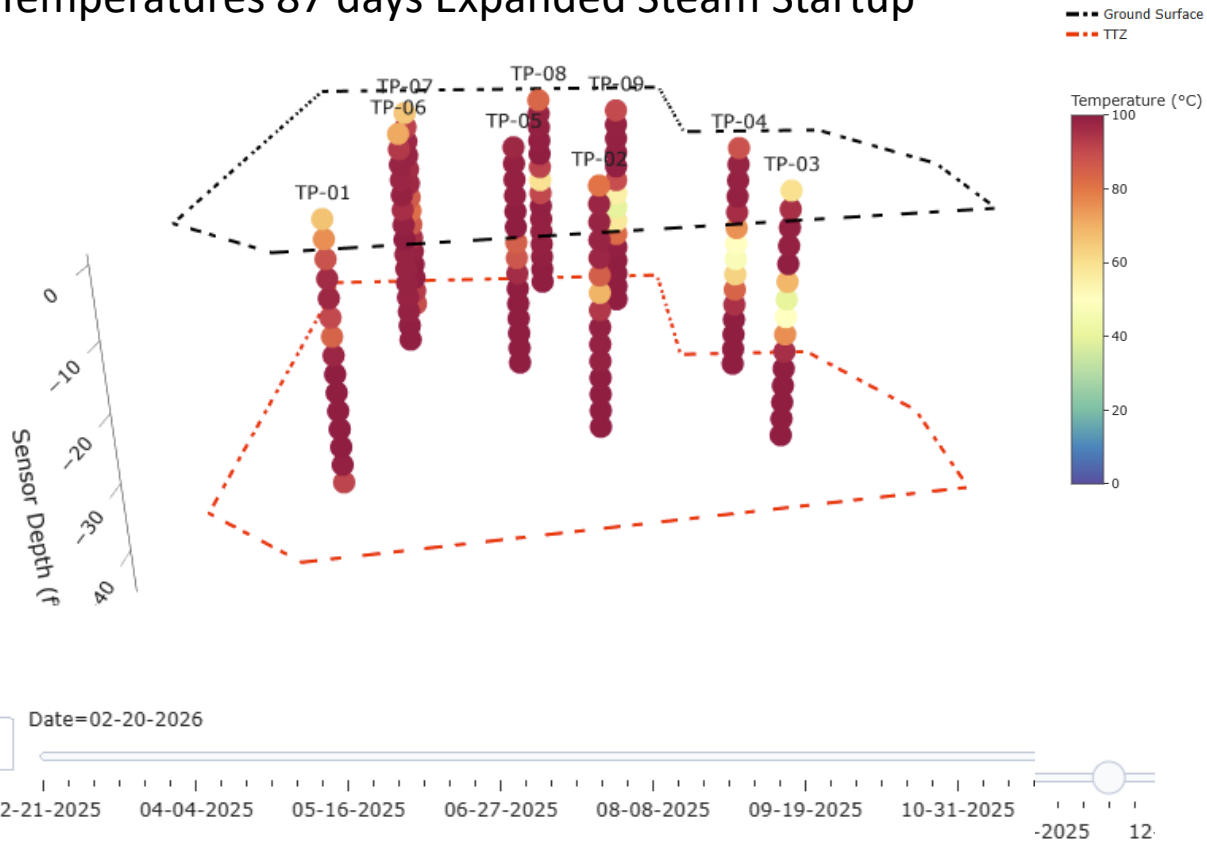
# #3: Install Expanded Steam System

- 9 new Steam Injection Wells
- 4 MPEs
- 4 Upgradient GW Extraction Wells
- Larger Boiler – 3,000 lbs/hr design
  - Steam: 800-1,000 kW
  - TCH: ~700 kW
- Treatment System upgrades



# #3: Operational Status – Expanded Steam System

B: Temperatures 87 days Expanded Steam Startup



# Shout Outs and Acknowledgements

- EA Engineering, Science, and Technology – Federal Teaming partner
- EPA and USACE – Project partners on multiple ISTR RAs

