Pragmatic Approaches to Remedial Investigation, Technology Selection, and Remediation Success

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ERTP
Environmental Response Training Program

SUPERFUND TASK FORCE RECOMMENDATIONS

Recommendations in response to Administrator Scott Pruitt's request on May 22, 2017. The recommendations address: expediting cleanup and remediation process; reducing financial burden on all parties involved in the entire cleanup process; encouraging private investment; promoting redevelopment and community revitalization; and, building and strengthening partnerships.

***RECOMMENDATION 5**: Clarify Priorities for RI/FS Resources and Encourage Performing Interim/Early Actions During the RI/FS Process to Address Immediate Risks*

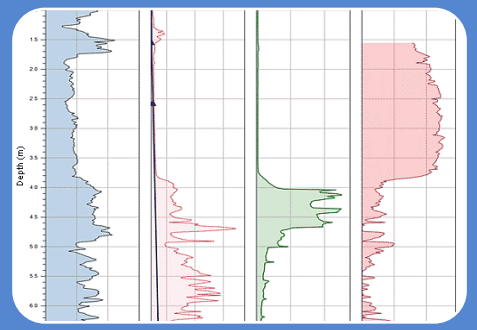
Recent developments in real-time investigation technologies and data visualization techniques offer opportunities to build robust understanding of site conditions portrayed in CSMs focused on root causes and high-value, targeted, remedial actions. Advances in electronic data capture and distance collaboration platforms enable project stakeholders to work as a team on RI/FS and Remedial Design/Remedial Action (RD/RA) activities, ensuring all stakeholder concerns are considered as the work is performed. In this way, the team can focus on taking actions that drive sites toward completion.

***RECOMMENDATION 9**: Utilize State-Of-The-Art Technologies to Expedite Cleanup*

Specific Actions:

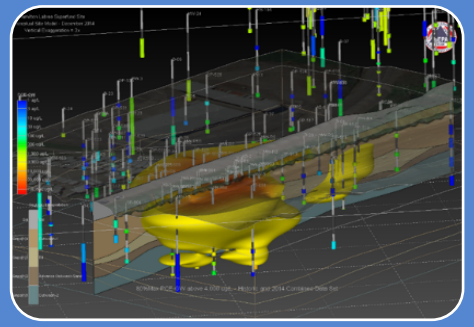
- Expand the use of real-time investigation technologies and data visualization techniques.
- Determine other available state-of-the-art technologies on at least an annual basis.
- Compile annual report of new technologies and their applicability.

Real-Time, Collaborative, Decision-Making -- A Better Way?



Direct-Sensing/High-Resolution Technologies

- Spatial distribution of COCs – where to remediate
- Matrix distribution of COCs – how to remediate
- VOCs, Metals, PAHs/PHCs ----- Lithology, Permeability, Hydraulic Conductivity
- Dense vertical data sets – Accuracy of CSM depends on horizontal density of borings



Data as a Deliverable

- Real-time data capture in the field
- Daily uploads to SCRIBE/EQUIS
- Immediate interpretation – visualization, models, etc.

Collaborative Decision-Making and Actions

- Data visualizations uploaded to SharePoint, response.epa.org, or FTP sites
- Data available to all stakeholders for multiple uses (independent or group)
- Reach consensus on Conceptual Site Model, data gaps, and next actions

Pragmatic Approaches

Pragmatic Investigation Opportunities:

Greater than 98% of contaminant mass often resides in less than 2% of the contaminated soil mass

Solubilities of DNAPLs and LNAPLs are typically less than 0.1%

Don't get hung up on shades of gray when overriding considerations make the decision black or white.

Remedial Investigation – Five Basic Questions

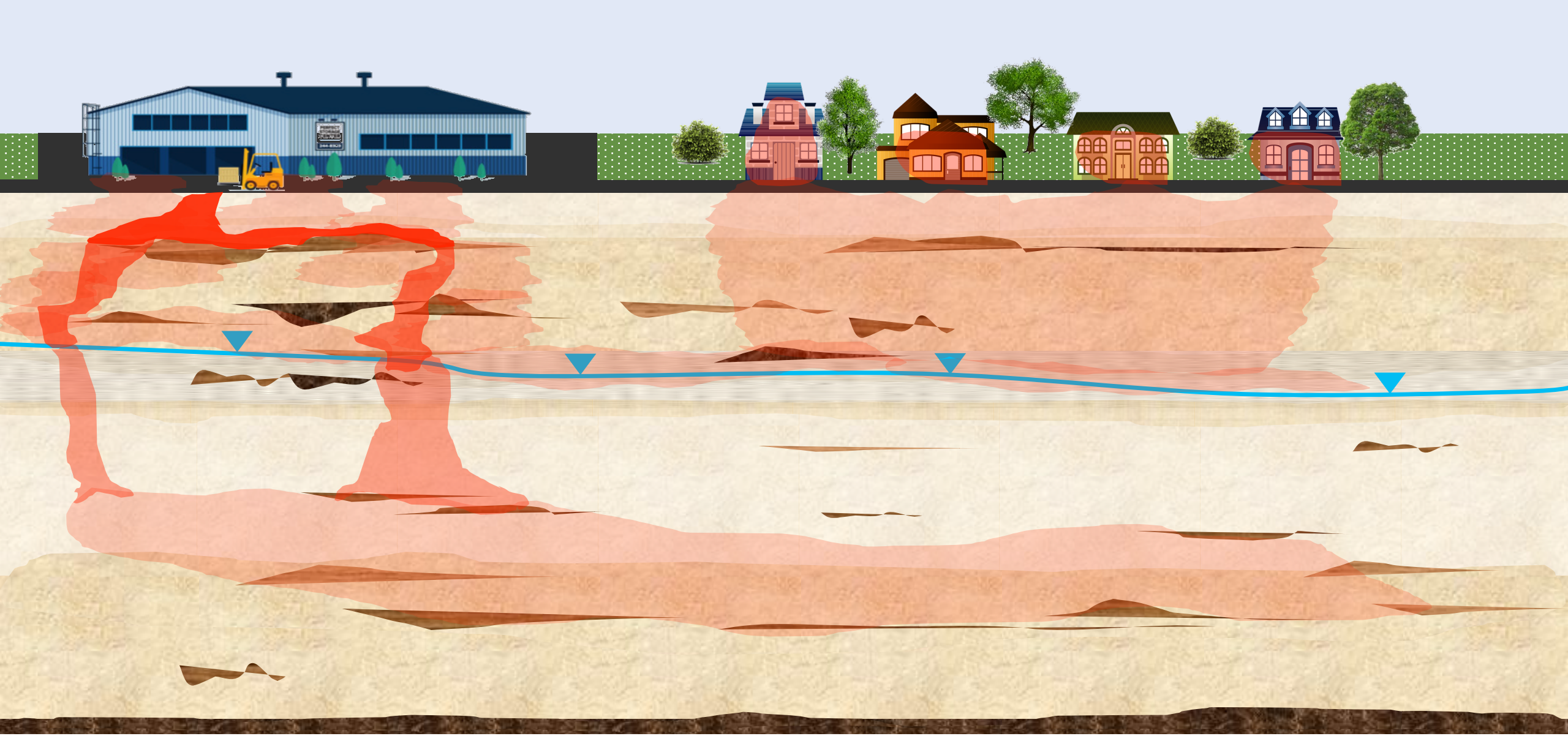
1. Is there an "unacceptable risk" that warrants action?
   - Human health or the environment
   - Third party lawsuits
   - Corporate reputation or brand image
   - Increased project complexity, costs, and duration
   - Property value

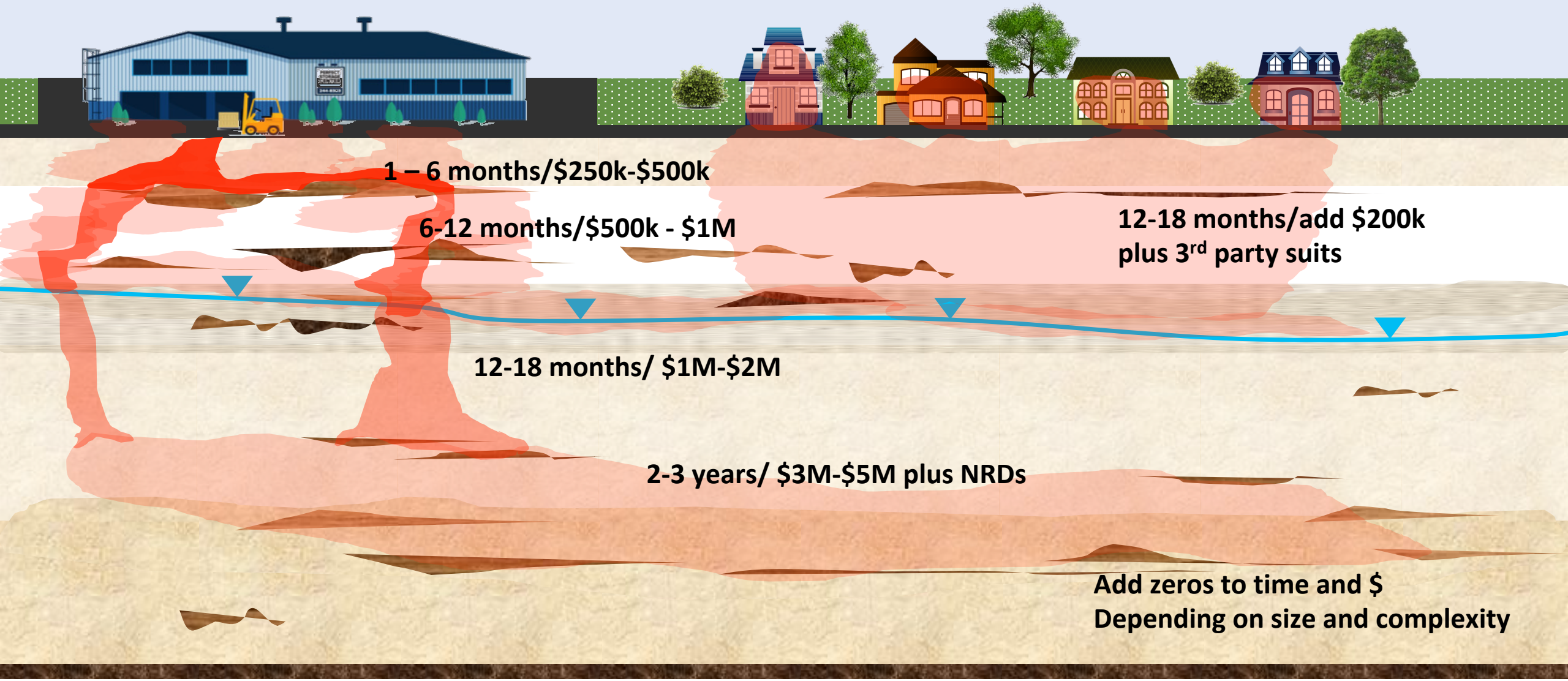
2. If so, what is the root cause?
   - Follow the 98/2 rule!
   - Find the mother lode

   Hint: If the contaminant is not "water soluble" the mother lode is not in the water!

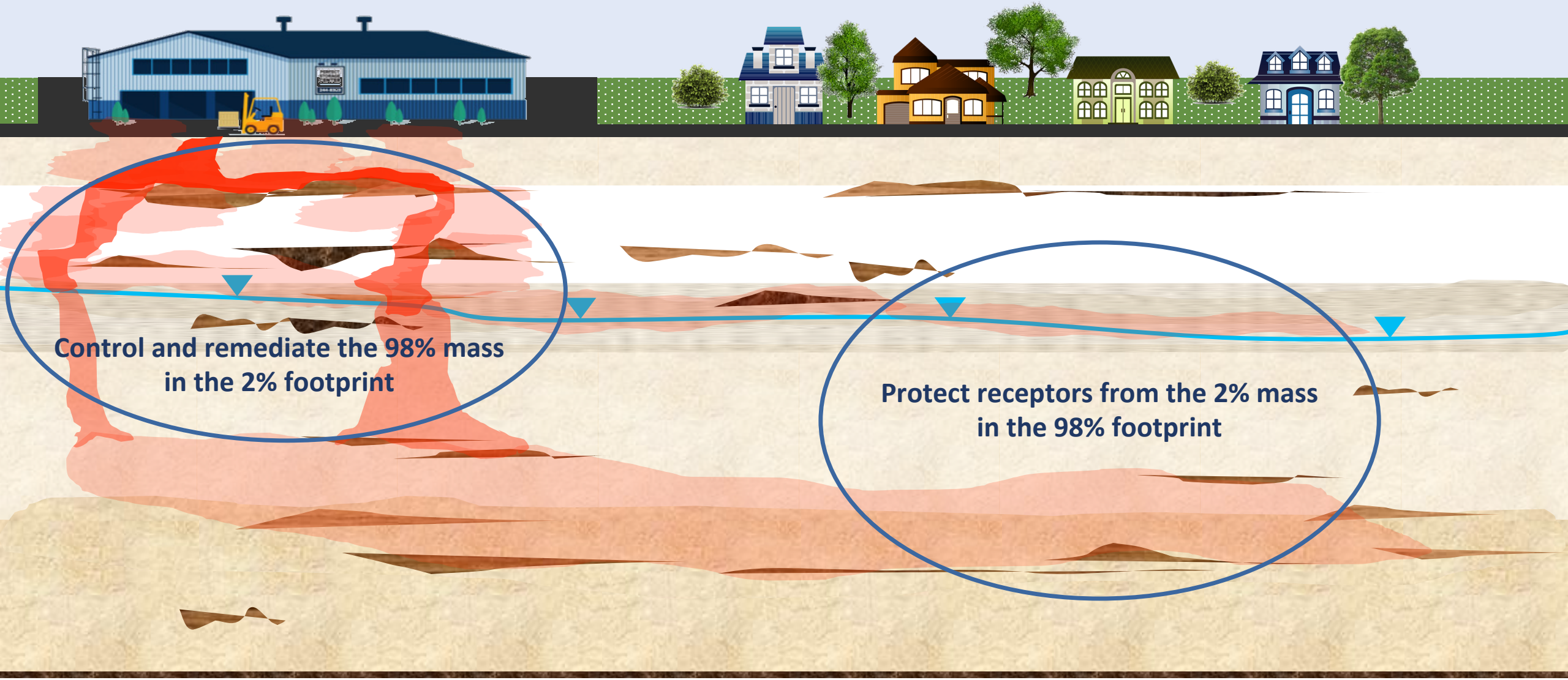
Remedial Investigation – Five Basic Questions

3. What actions will control the root cause quickly and cost-effectively?
    - Spatial distribution – where to remediate
    - Matrix distribution – how to remediate
    - Field pilot – optimize performance and costs
4. Are there secondary problems (symptoms) that may require action?
5. Do we have high confidence the above actions will accomplish the following?
    - ✓Stabilize the situation – “Time no longer working against us”
    - ✓Improve the situation – “Time working for us”
    - ✓Set the conditions for natural attenuation – “Acceptable timeframe”





The Cost of Time



But what if this is already my situation?

What about HRSC at historical releases?

- Source (root cause) often not adequately characterized
- Investigations and remedies often focused on symptoms
- Remedies consequently ineffective and costly (low mass / high volume)
- Investigations continue well beyond the remediation zone

Ten Things to Know and Why

1. Source in the vadose zone
    - Groundwater threat
    - Vapor intrusion threat

2. Porosity/permeability of vadose zone
    - Vapor control options
    - Time until groundwater impact
    - Extraction options
    - Treatment options

3. Depth to water
    - Time until groundwater impact
    - Direction of groundwater flow
    - Potential groundwater receptors
    - LNAPL/DNAPL complexities

Ten Things to Know and Why

4. Water table fluctuation
    - Smear zone (LNAPL)
5. Permeability of smear zone
    - AS/SVE, Injection, Excavation options
6. Direction of groundwater flow
    - Off-site migration
    - Potential receptors
7. Plume thickness and depth
    - How/where to treat, contain or intercept

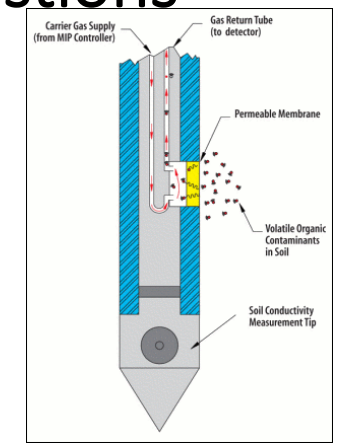
Ten Things to Know and Why

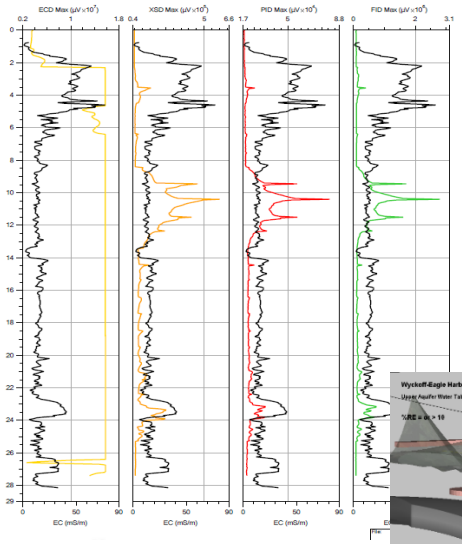
8. Permeability lenses in saturated zone
   - Transport zones?
   - Storage zones?

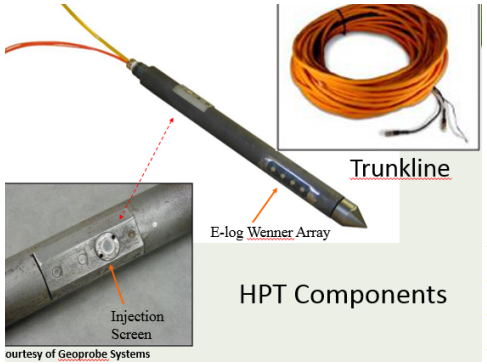
9. Mass distribution
   - High-mass footprint? (Root cause – 98:2)

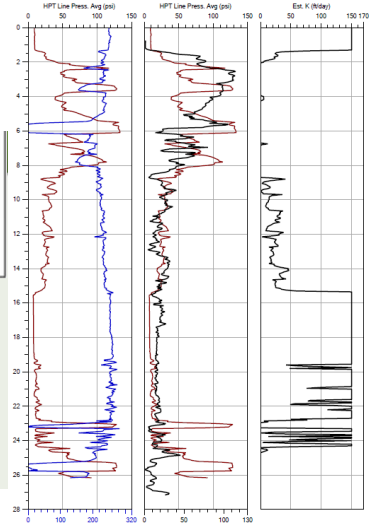
10. Matrix distribution
    - Remediation options (contact, residence time, conditions, driving force)

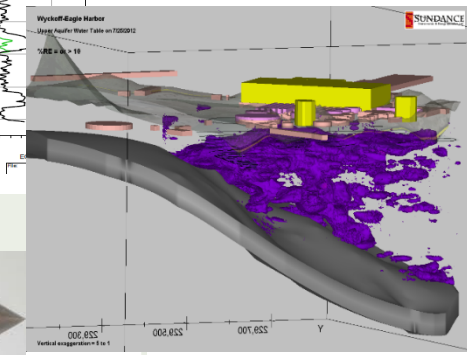
Many direct sensing tools
Provide real-time answers to these questions

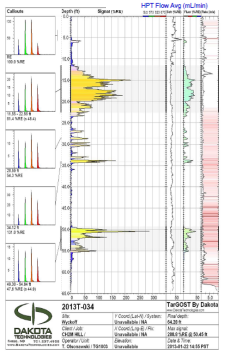


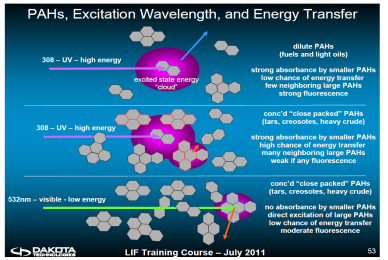


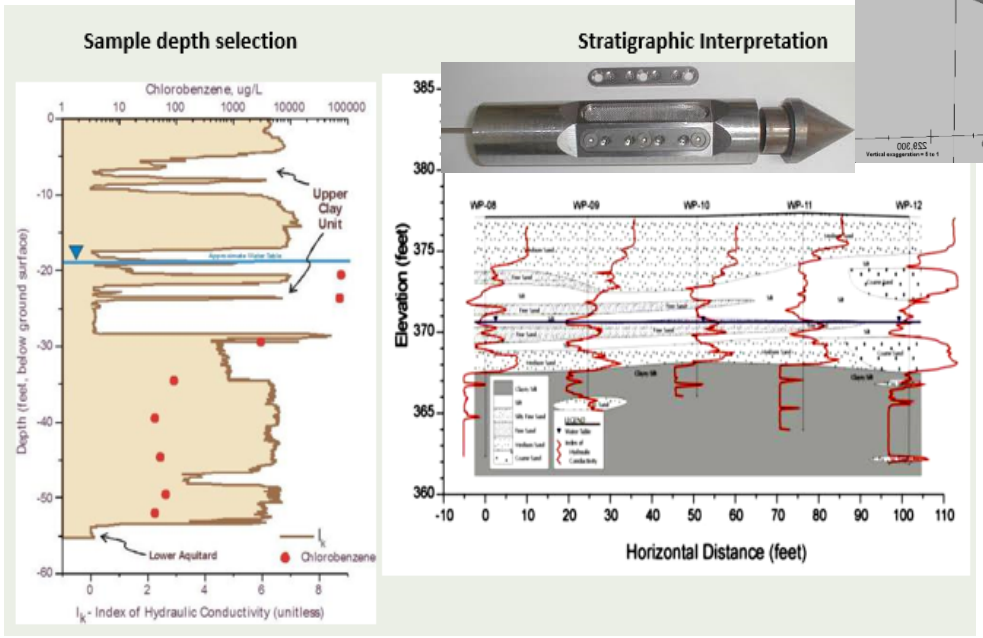


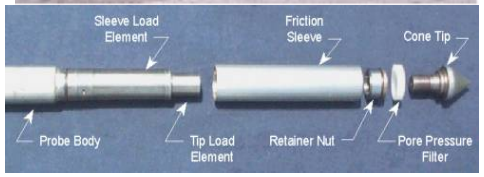


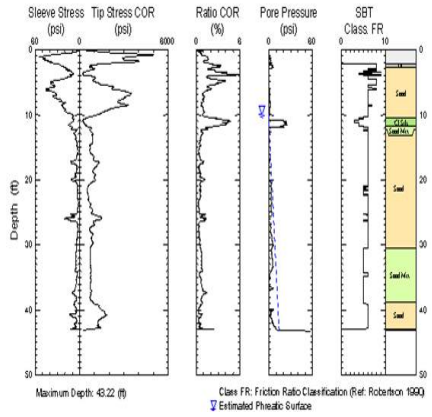


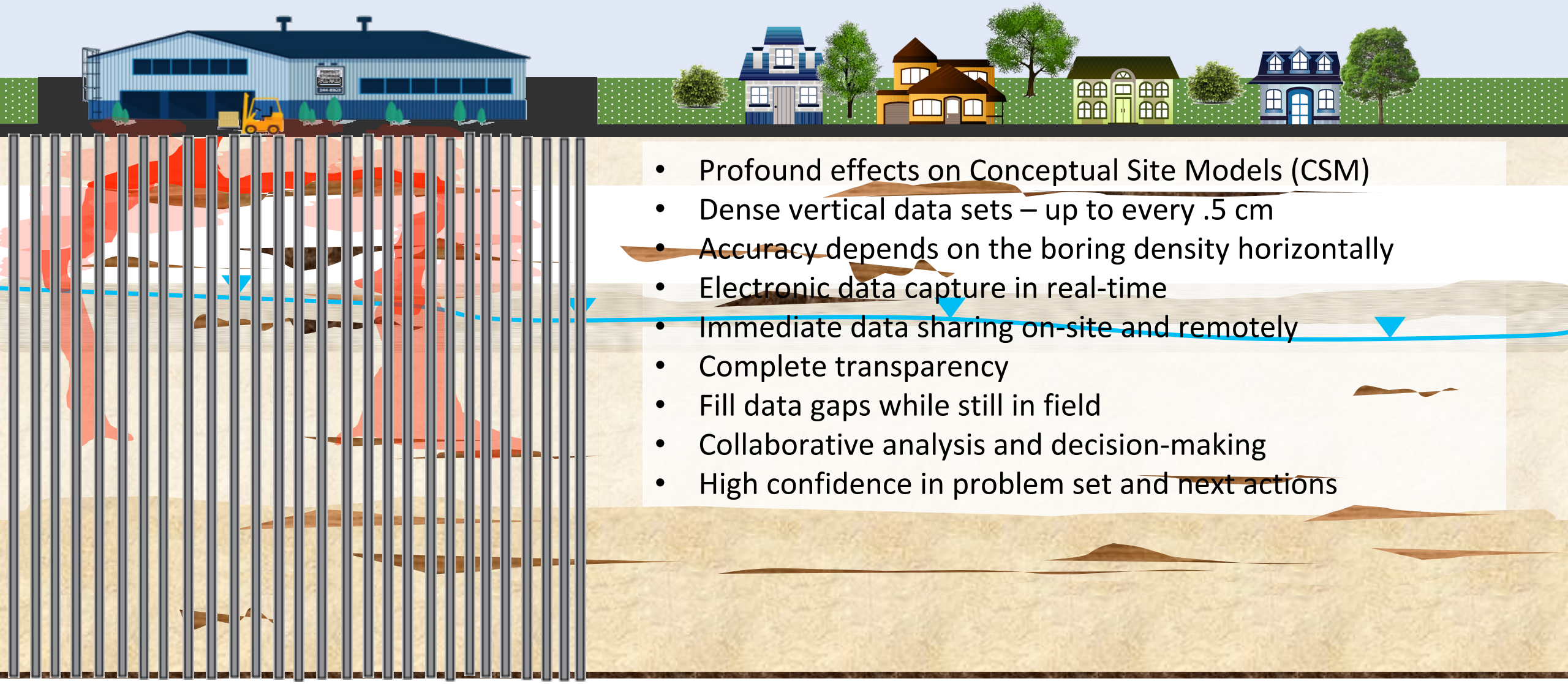










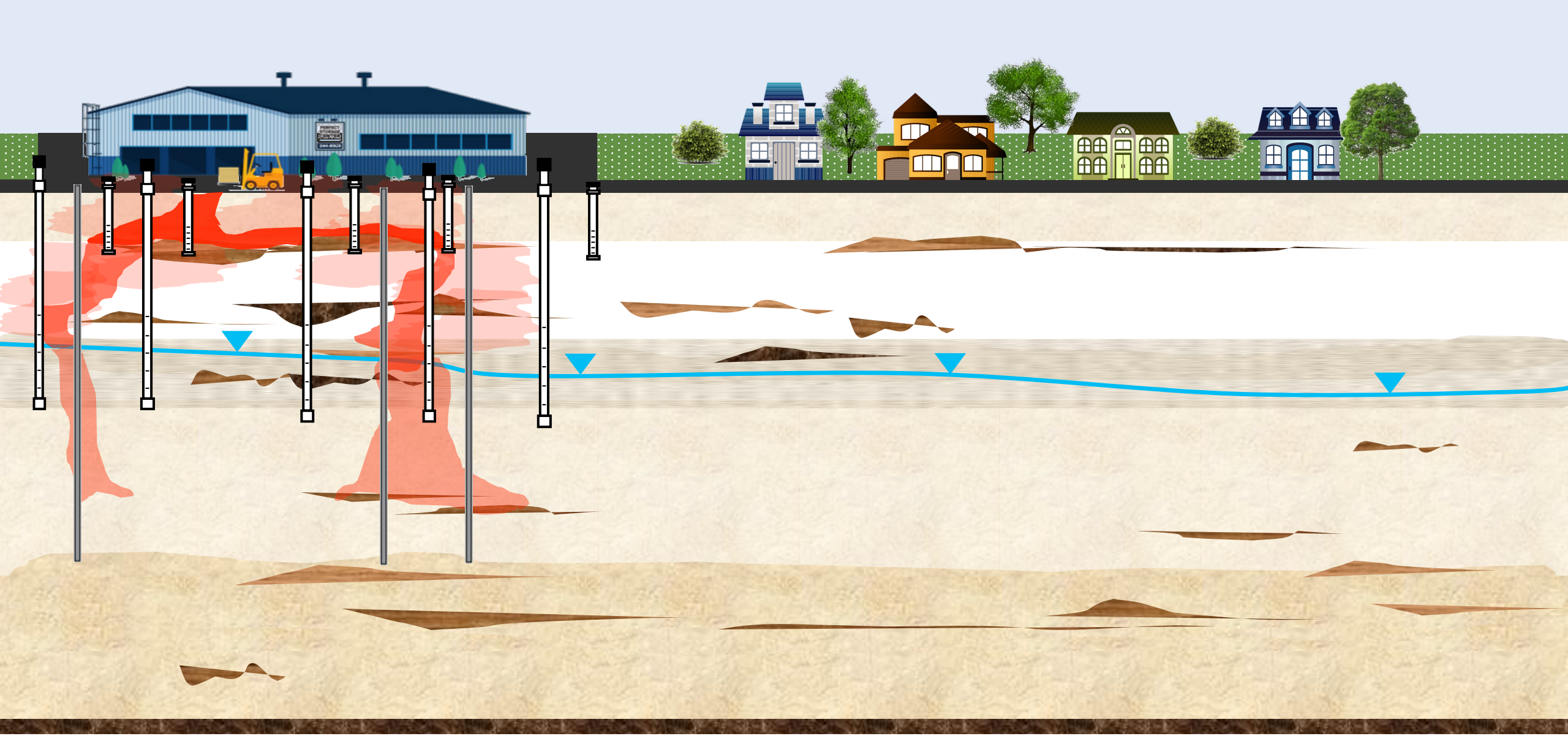


- Profound effects on Conceptual Site Models (CSM)
- Dense vertical data sets – up to every .5 cm
- Accuracy depends on the boring density horizontally
- Electronic data capture in real-time
- Immediate data sharing on-site and remotely
- Complete transparency
- Fill data gaps while still in field
- Collaborative analysis and decision-making
- High confidence in problem set and next actions

The power of direct sensing and high-resolution

Pragmatic Remediation Opportunities:

While every site may be a snowflake …

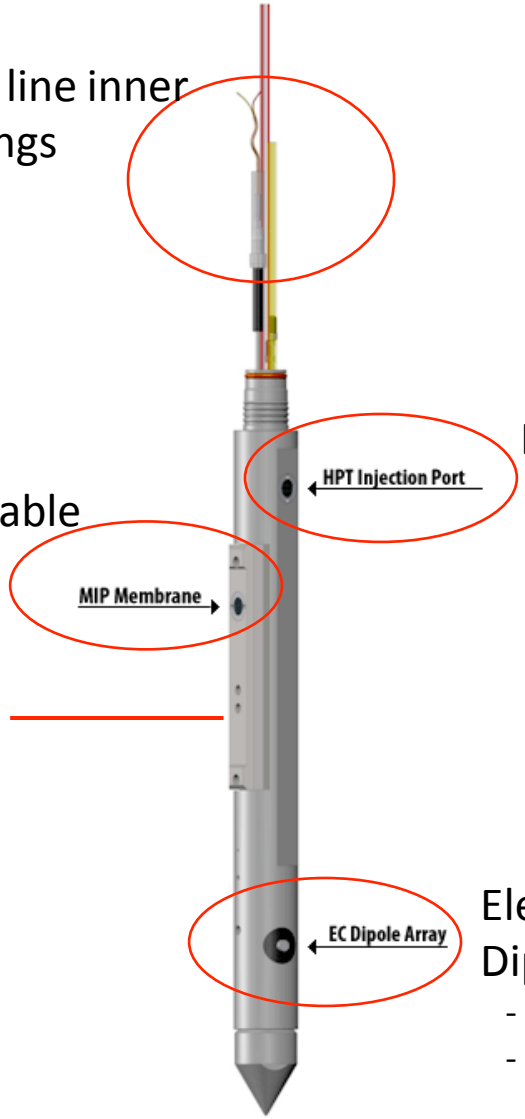


Early migration controls and remediation of high mass footprint (Root Cause)

- **Eliminates secondary problems (symptoms)**
- **Can save years and millions in assessment, remediation, and ancillary costs**

Membrane Interface Hydraulic Profile Tool (MiHpt)

Trunk line threaded through drill rods



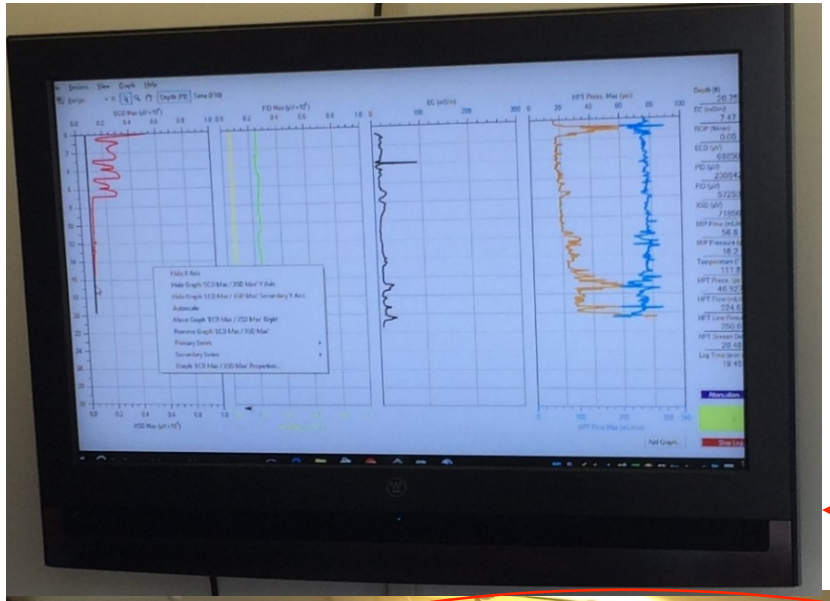
Trunk line inner workings

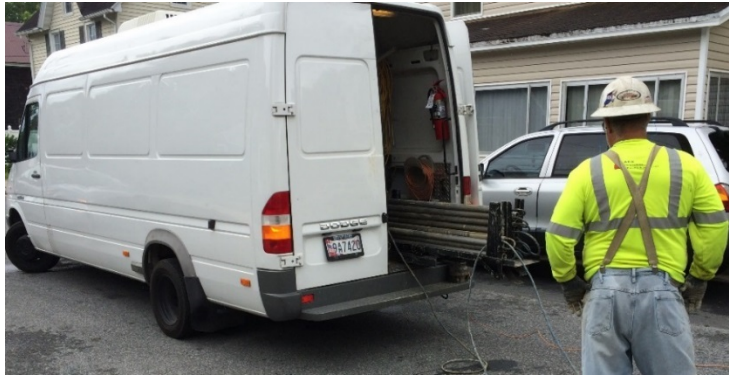
Hydraulic Pressure/Flow
- High P / Low Flow = low perm
- Low P / High Flow = high perm

Semi-permeable membrane

Heat Plate
~120°C

Electrical Conductivity (EC) Dipole Array
- High EC = fine grain soils
- Low EC = coarse grain soils

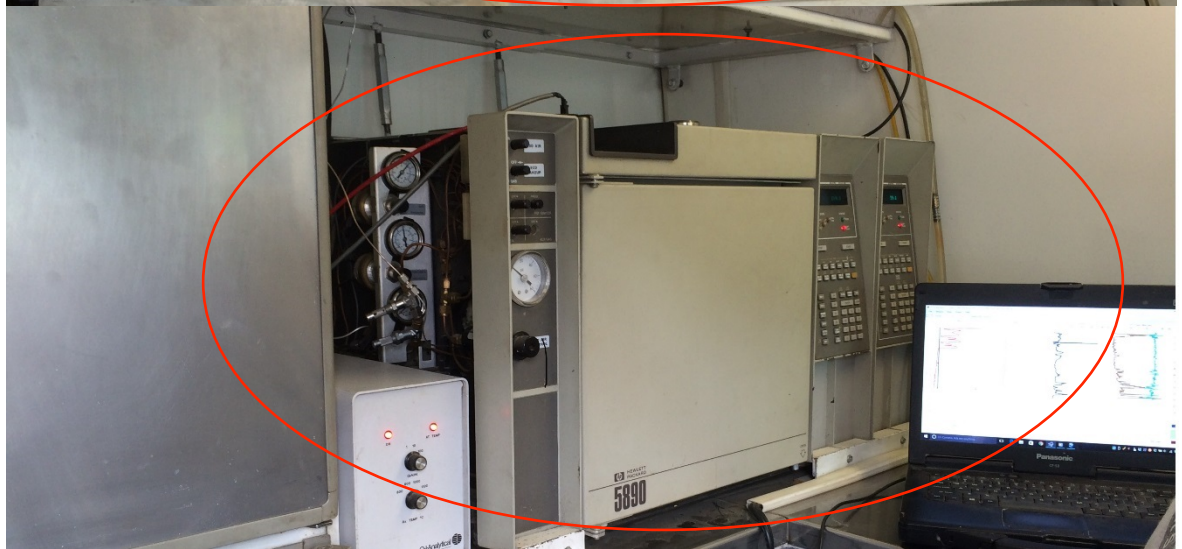




Typical MiHPT Support Van

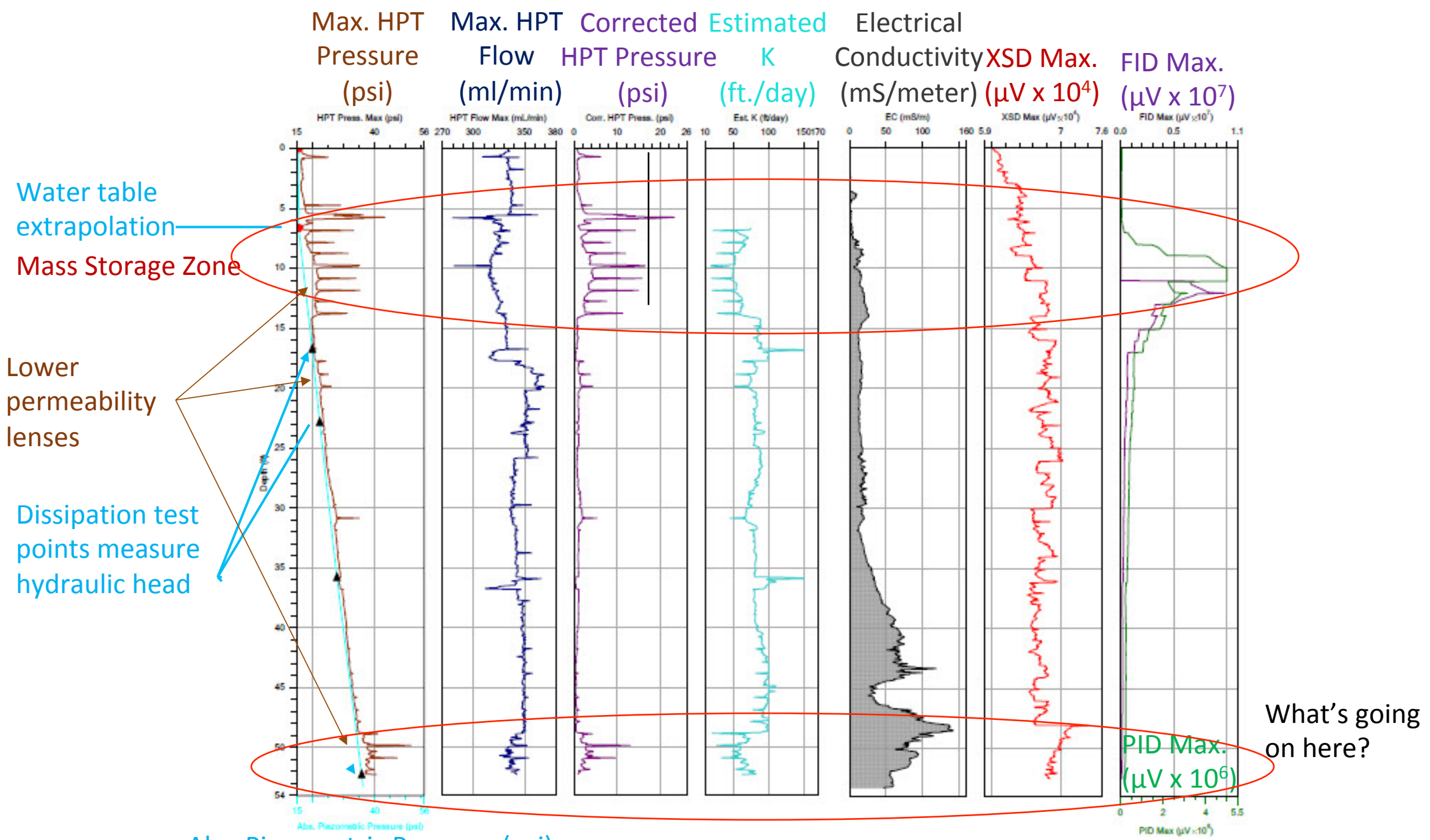
Real time display

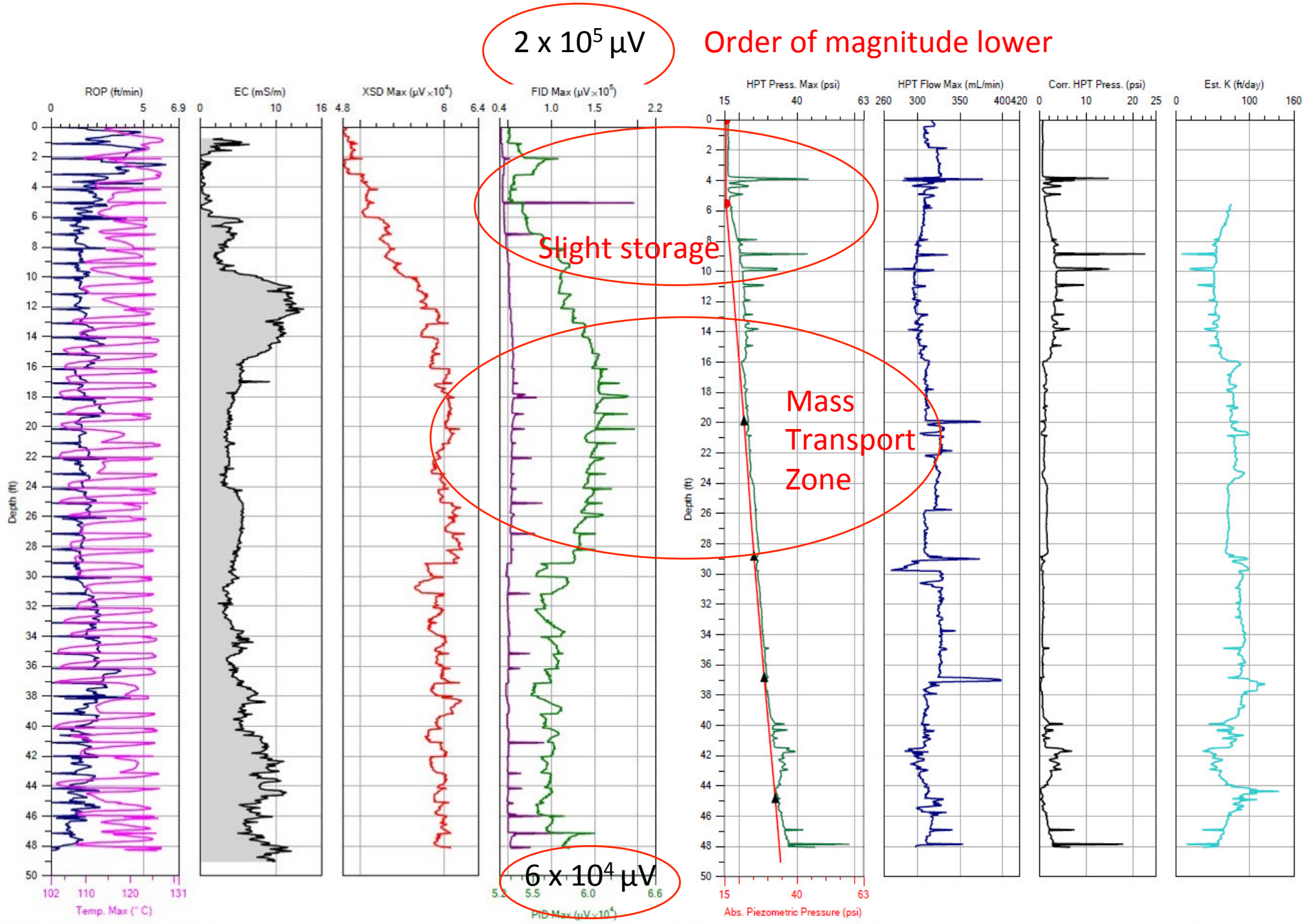
Trunk line controls



Lab-Grade Contaminant Detectors

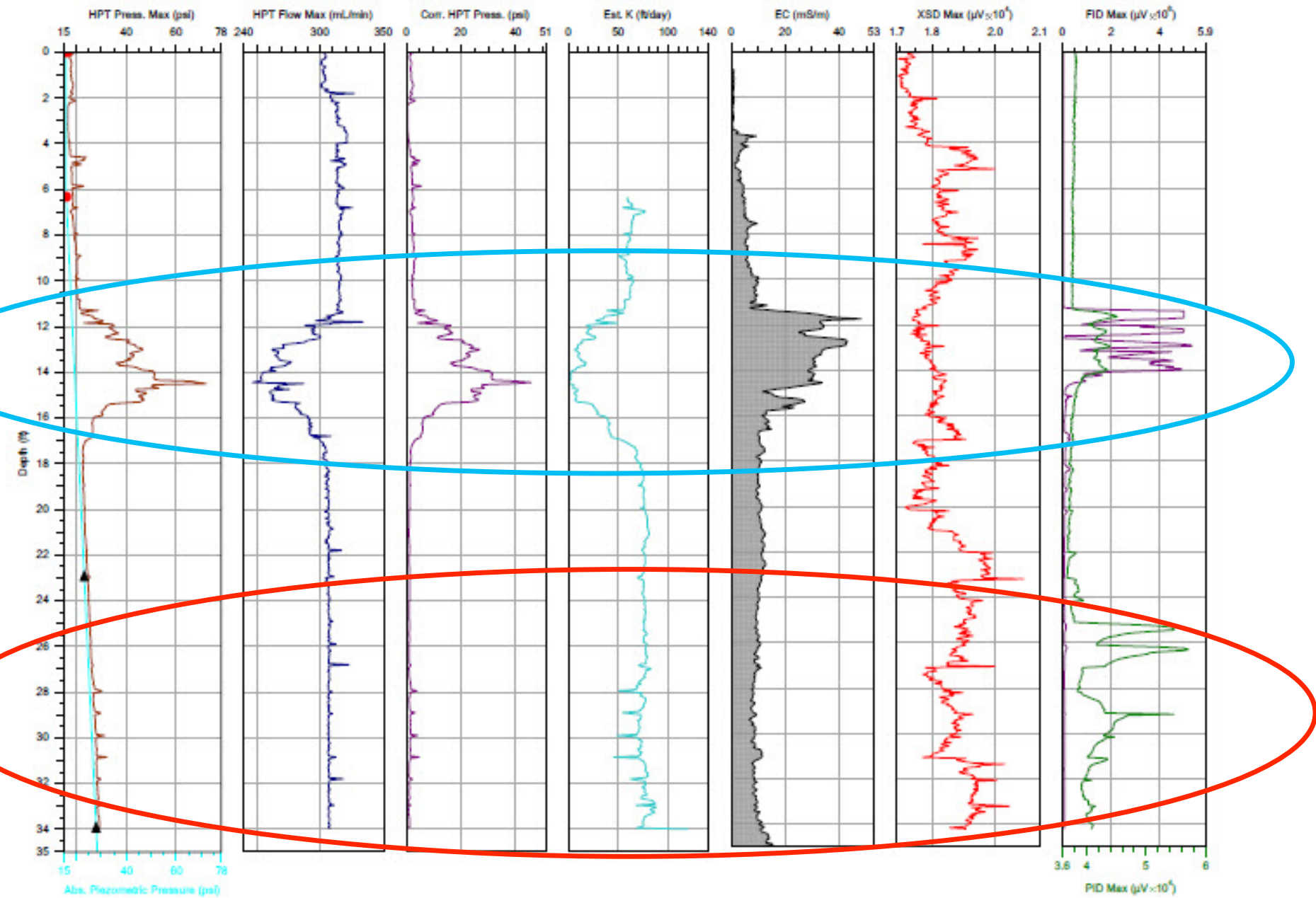
- Photoionization (PID)
- Flame ionization (FID)
- Electron capture (ECD)
- Halogen specific (XSD)


Max. HPT Pressure (psi)
Max. HPT Flow (ml/min)
Corrected HPT Pressure (psi)
Estimated K (ft./day)
Electrical Conductivity (mS/meter)
XSD Max. (µV x 10^4)
FID Max. (µV x 10^7)
HPT Press. Max (psi)
HPT Flow Max (mL/min)
Corr. HPT Press. (psi)
Est. K (ft/day)
EC (mS/m)
XSD Max (µV x10^4)
FID Max (µV x10^7)
Depth (ft)
Abs. Piezometric Pressure (psi)
PID Max (µV x10^6)
Water table extrapolation
Mass Storage Zone
Lower permeability lenses
Dissipation test points measure hydraulic head
PID Max. (µV x 10^6)
What's going on here?
Abs. Piezometric Pressure (psi)

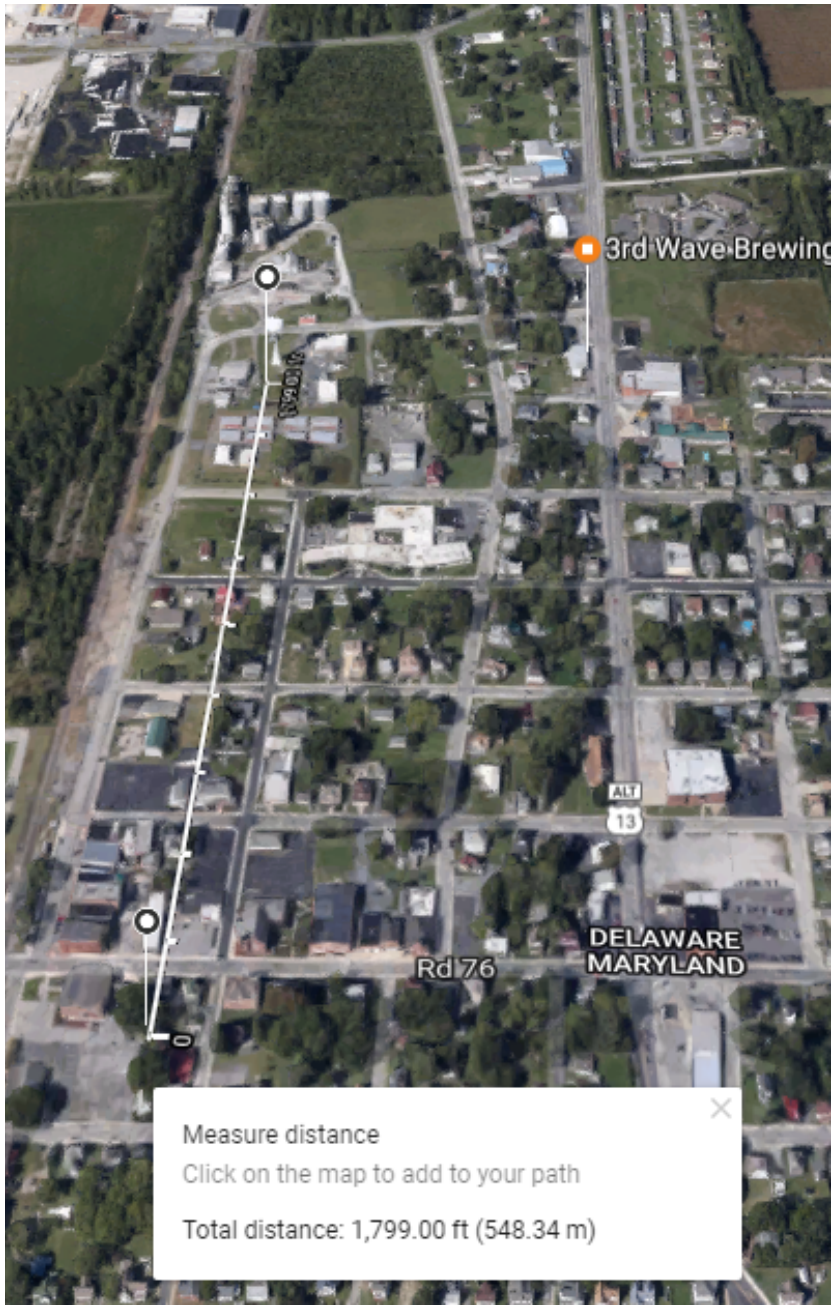

2 x 10^5 µV
Order of magnitude lower
ROP (ft/min)
EC (mS/m)
XSD Max (µV×10^4)
FID Max (µV×10^5)
HPT Press. Max (psi)
HPT Flow Max (mL/min)
Corr. HPT Press. (psi)
Est. K (ft/day)
Slight storage
Mass Transport Zone
Depth (ft)
Temp. Max (° C)
PID Max (µV×10^4)
Abs. Piezometric Pressure (psi)
6 x 10^4 µV
Order of magnitude lower

Mass Storage Zone

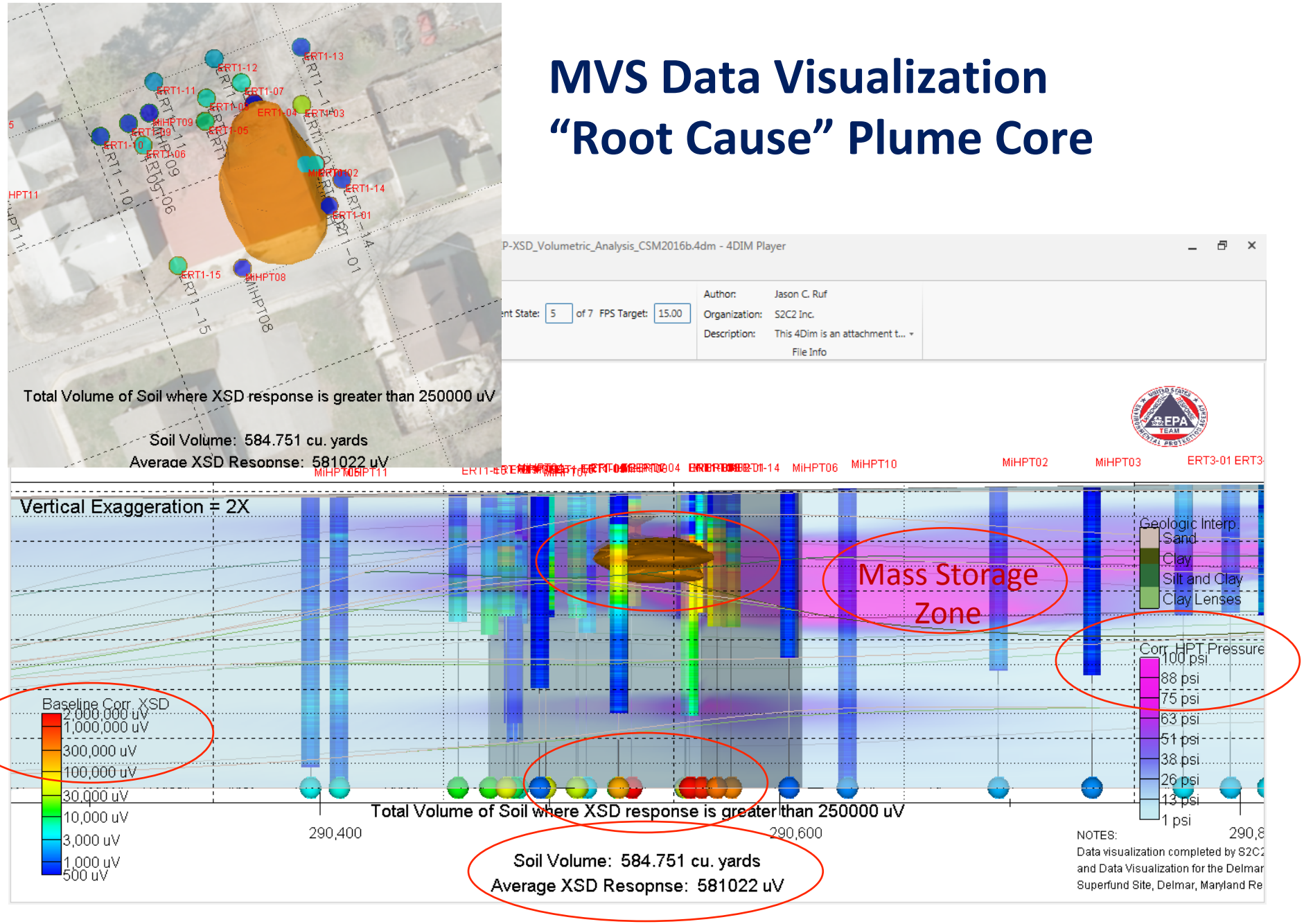
?



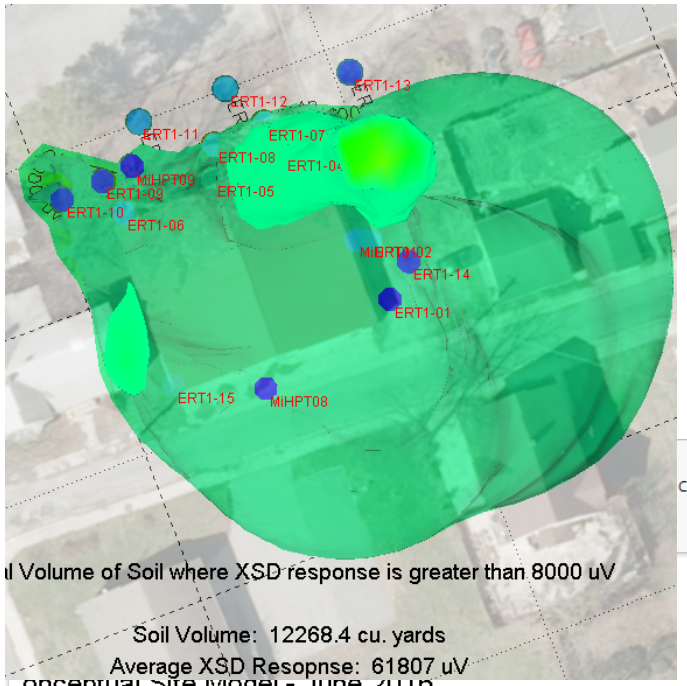
PCE Source Impacting Municipal Wellfield

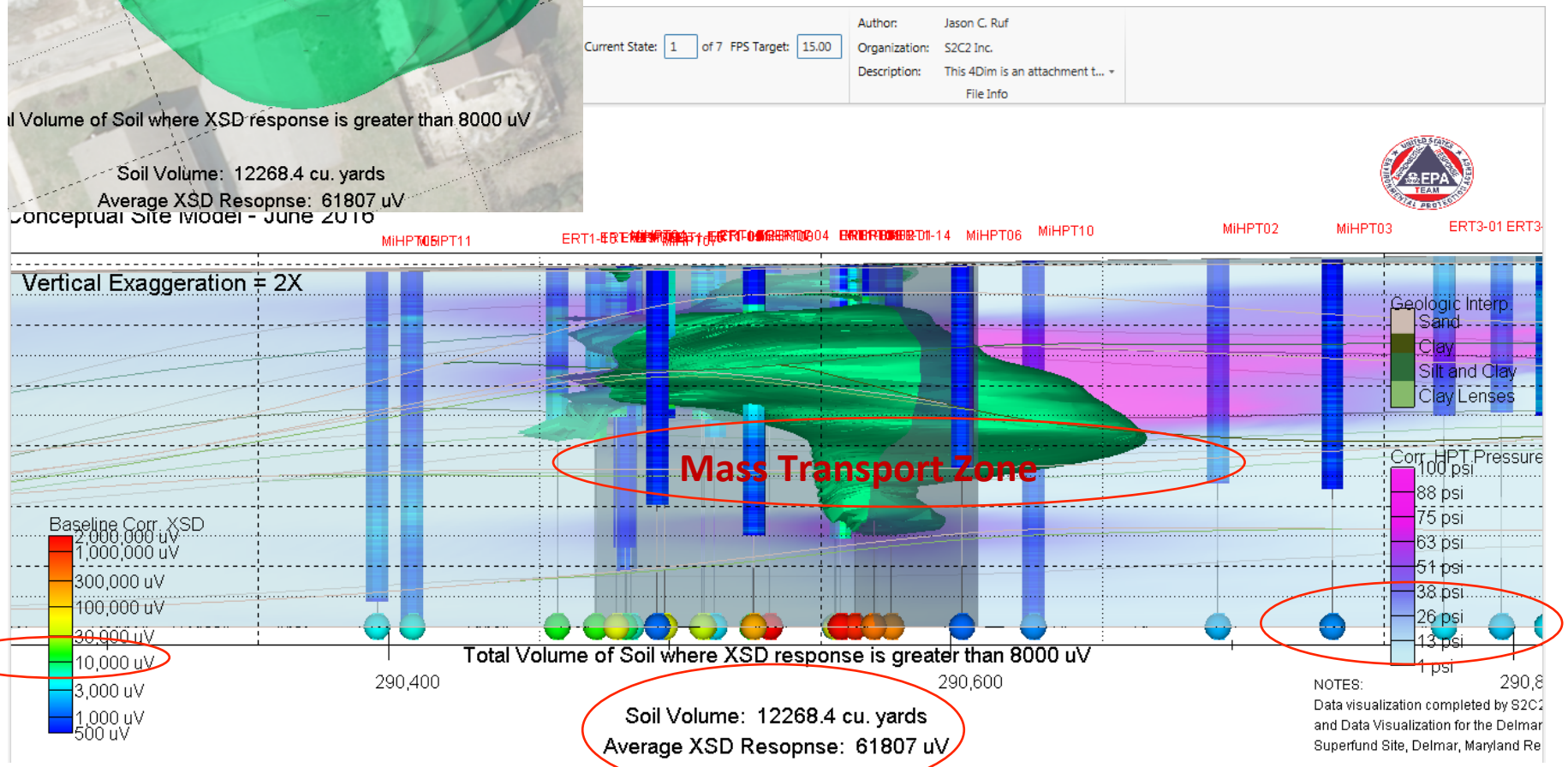


MVS Data Visualization
"Root Cause" Plume Core



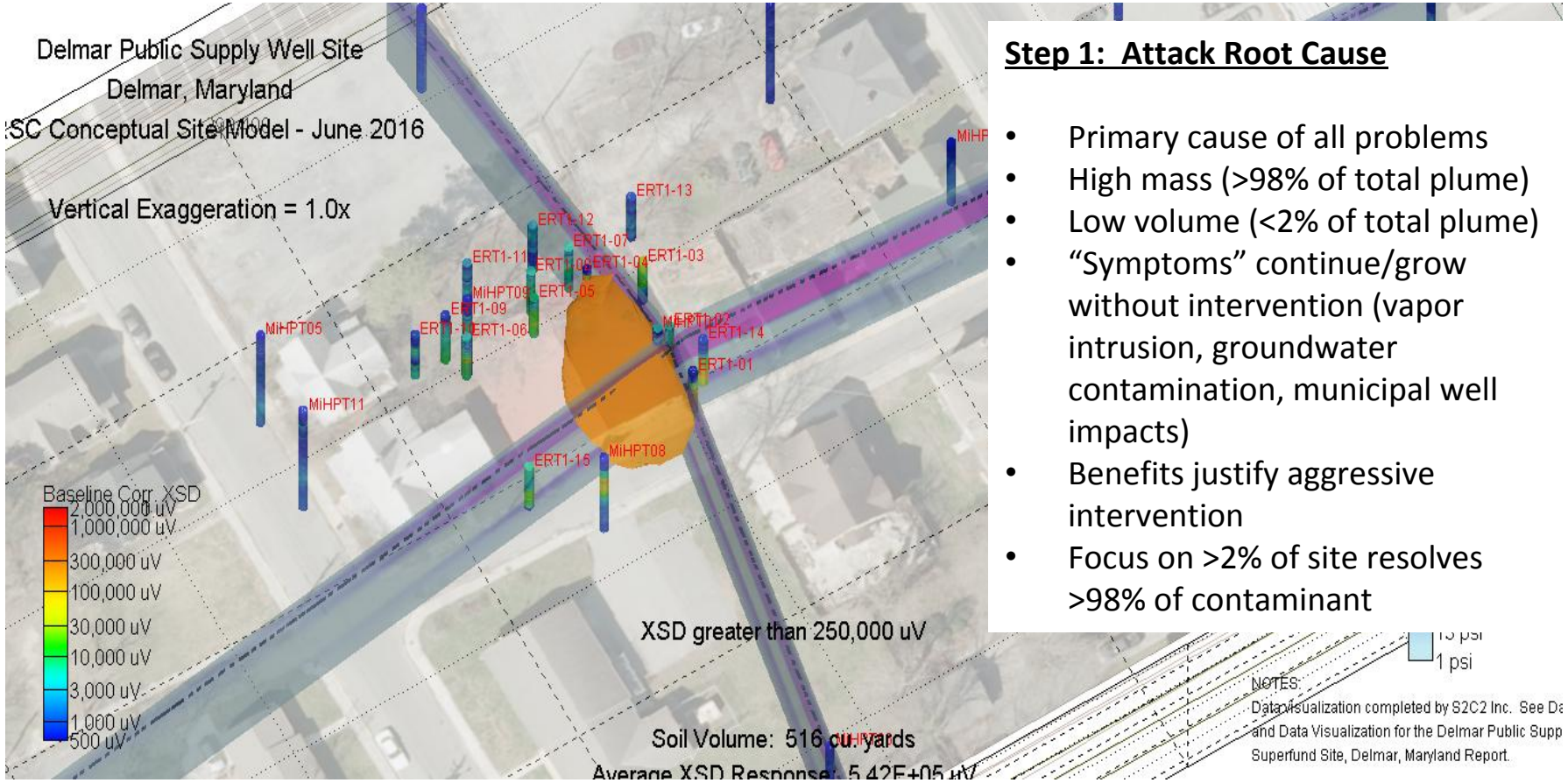
MVS Data Visualization
"Buffer Zone" Plume Core





Attack Root Cause

What remedial approach would you take?

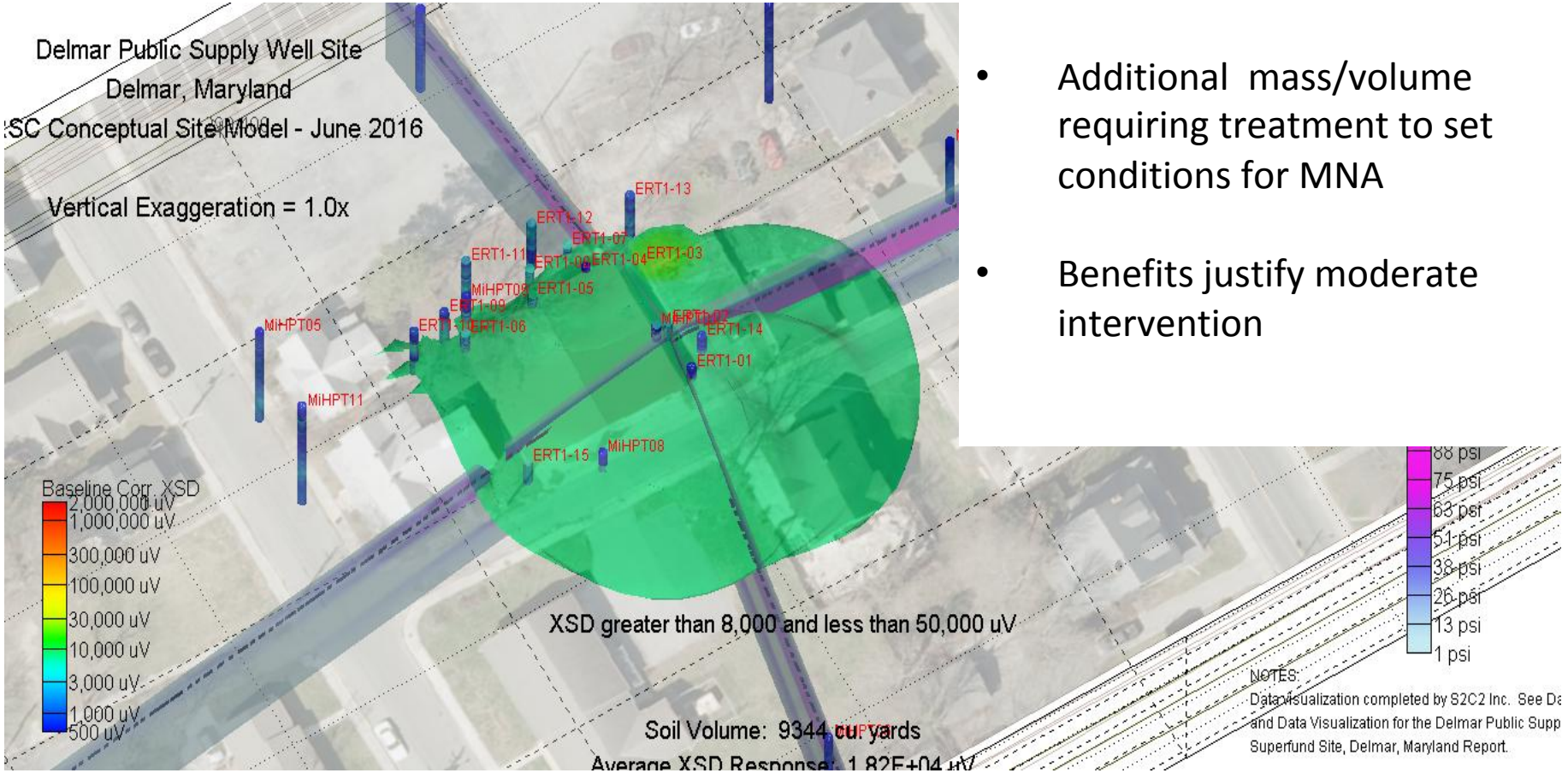


Step 1: Attack Root Cause

- Primary cause of all problems
- High mass (>98% of total plume)
- Low volume (<2% of total plume)
- "Symptoms" continue/grow without intervention (vapor intrusion, groundwater contamination, municipal well impacts)
- Benefits justify aggressive intervention
- Focus on >2% of site resolves >98% of contaminant

Address Buffer Zone

What remedial approach would you take?

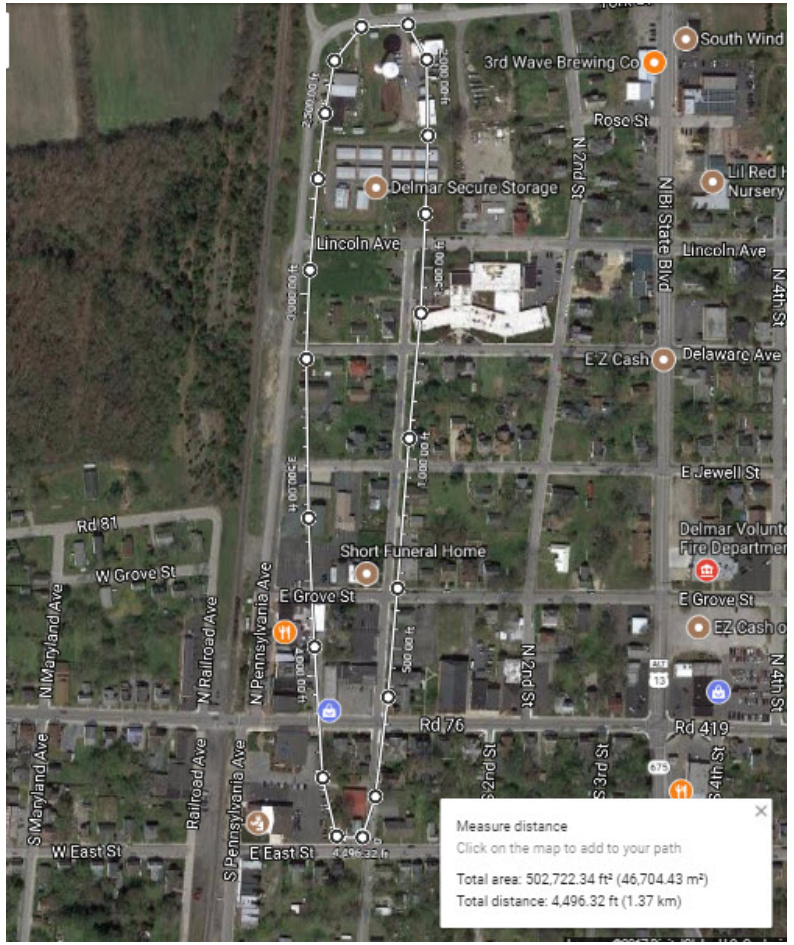


Step 2: Address Buffer Zone

- Additional mass/volume requiring treatment to set conditions for MNA
- Benefits justify moderate intervention

Monitor/Manage Attenuation Zone

What approach would you take?



Step 3: Attenuation Zone

- Monitor to ensure attenuating plume (low cost)
- Manage risk with institutional or engineering controls (low cost)
- Attenuation zone remediation unlikely

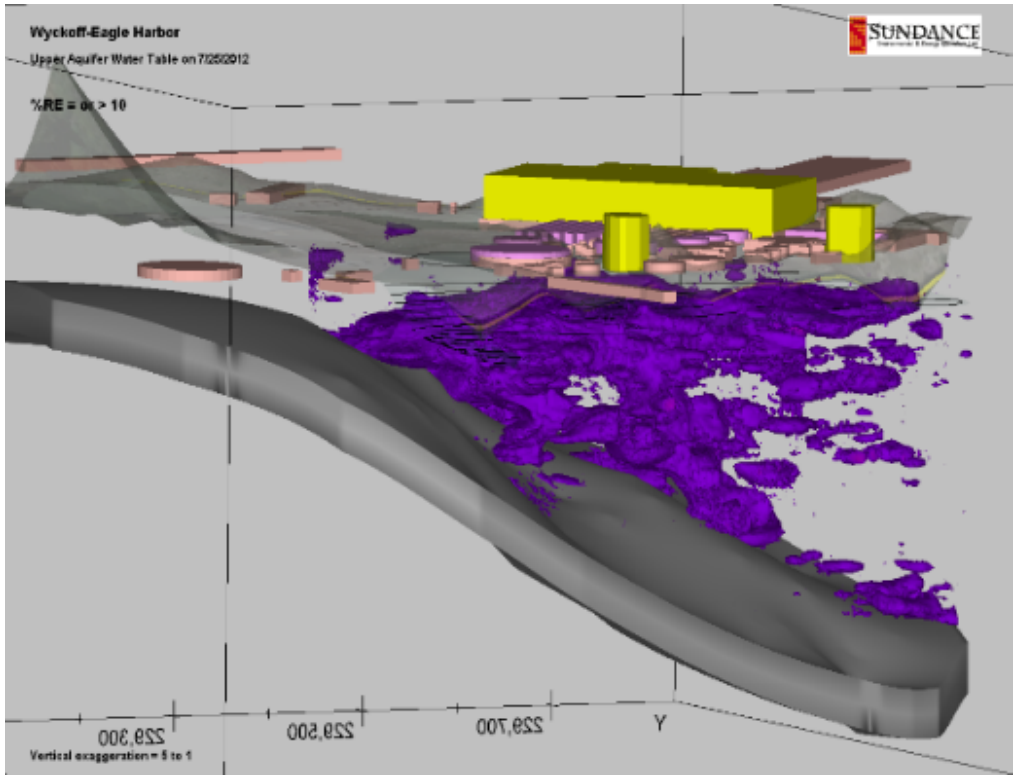
  Focus time and money on FS activities for the root cause and buffer zones
- Investigation and remedial strategy shown in these figures:

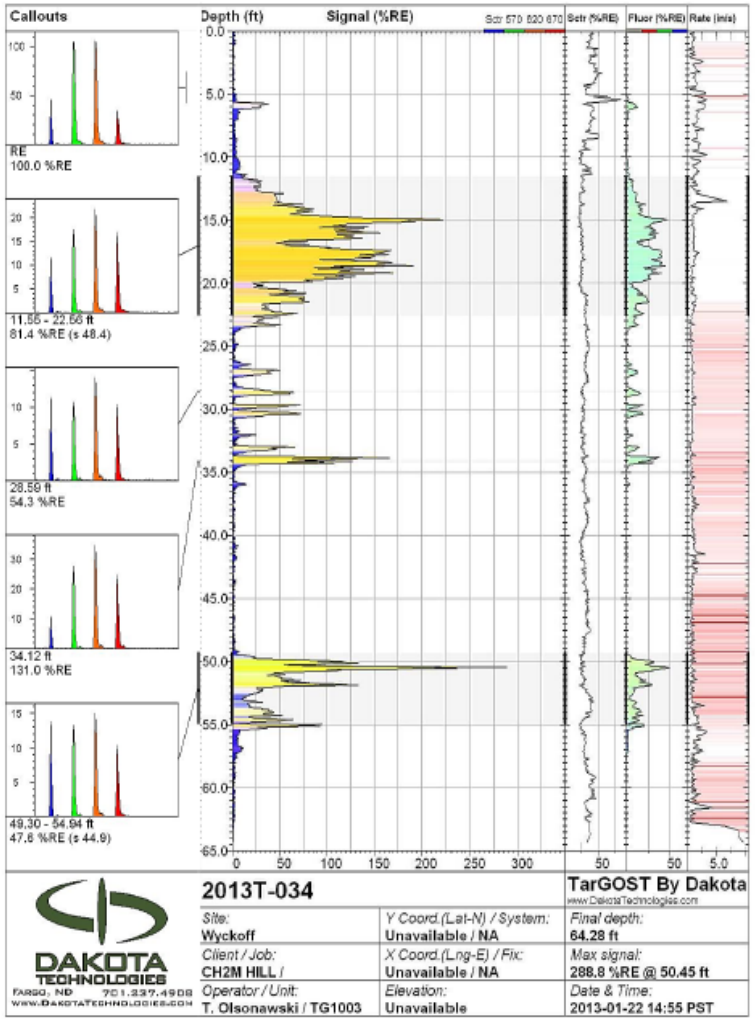
  5 Days -- $65k

The Power of Sharing Platforms

Wyckoff-Eagle Harbor, Historic Creosote Site

Same principles apply to complex sites





Conventional Assessment Techniques Necessary?

- Quantify and verify direct-sensing information
- Fill specific data gaps
- Focus on root causes and effective solutions
  - Water problem in soil?
  - Soil problem in water?
- Optimally placed monitoring wells, soil borings, vapor points, etc.

Rules of Thumb

- Production rates
  - GeoProbe (MIHPT): 125-150 feet per day
  - CPT (LIF, XRF, MIP): 250-300 feet per day

- Typical boring depths
  - GeoProbe: 30-50 feet
  - Cone Penetrometer: 50-100 feet

- Daily costs: $7500

- 3-D Visualization -- $5000 to $25,000

- 2-D Visualization – Can do it yourself (download GeoProbe's DI viewer)

Limitations

- Direct Push Technologies
  - Must be able to push to/through contaminant layer
- Typical Detection Limits
  - VOCs -- >100 ppb
  - LIF – free product
- MIP and LIF are not compound specific
- Subsurface utilities must be known!
- Need qualified subs (things break!)
- Need qualified oversight professionals

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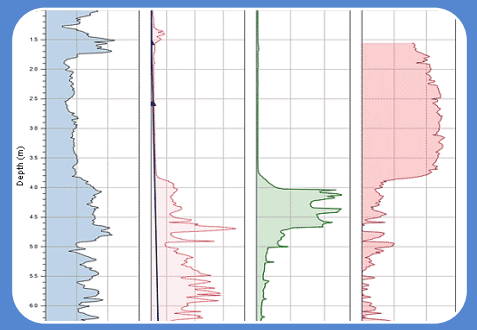
Real-Time, Collaborative, Decision-Making -- A Better Way?



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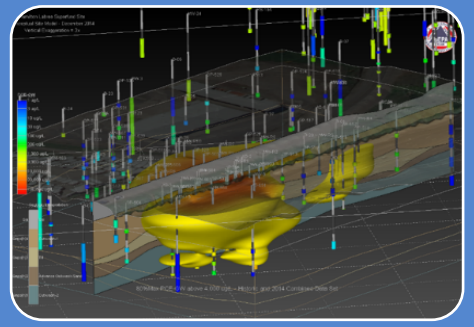

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- Immediate interpretation – visualization, models, etc.

Collaborative Decision-Making and Actions

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- Data available to all stakeholders for multiple uses (independent or group)
- Reach consensus on Conceptual Site Model, data gaps, and next actions

Pragmatic Approaches

- Begin with the end in mind
- Develop conceptual site models via direct sensing techniques (less time / less $)
- Attack root cause (mass, not molecules – percentages, not ppb)
- Protect receptors in low mass zones
- Set up conditions for natural attenuation (buffer zone treatment)
- Move faster than the conventional regulatory process (capture and share data, make collaborative decisions)

Roger Bannister broke the four-minute mile on May 6, 1954. “It just didn’t seem to be capable of being broken,” he said. Credit Associated Press

The Proposition

Identify appropriate sites

Engage willing RPs/RPMs

Run the four-minute mile