Quantitative High-Resolution Site Characterization (qHRSC) and Lessons Learned: An Example

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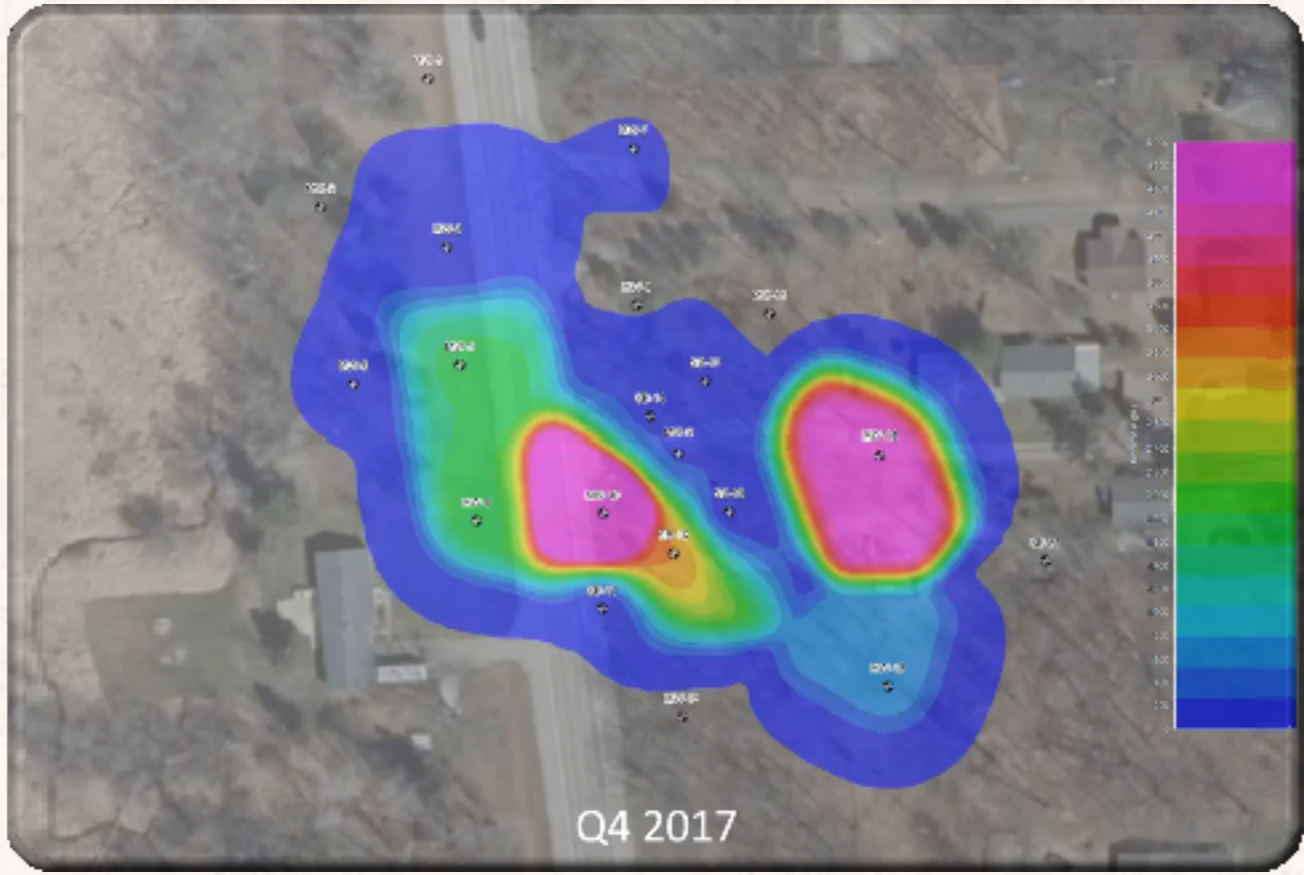
RPI GROUP

Characterizations

- Conceptual Site Model
  - Evolving visual and/or written summary
  - Develop remediation plan
- High-Resolution Site Characterization (HRSC)
  - Rapid data collection
  - Sensing tools
  - Define “the box”
  - Unique abilities, specifications, and limitations
- Remedial Design Characterization (RDC)
  - Spatially and vertically dense soil and GW sampling
  - Analytical data
  - Contaminant concentrations and locations
- qHRSC



This presentation focuses on overburden characterization. Other methods are used for bedrock/PWR/saprolite/till.

What is qHRSC?

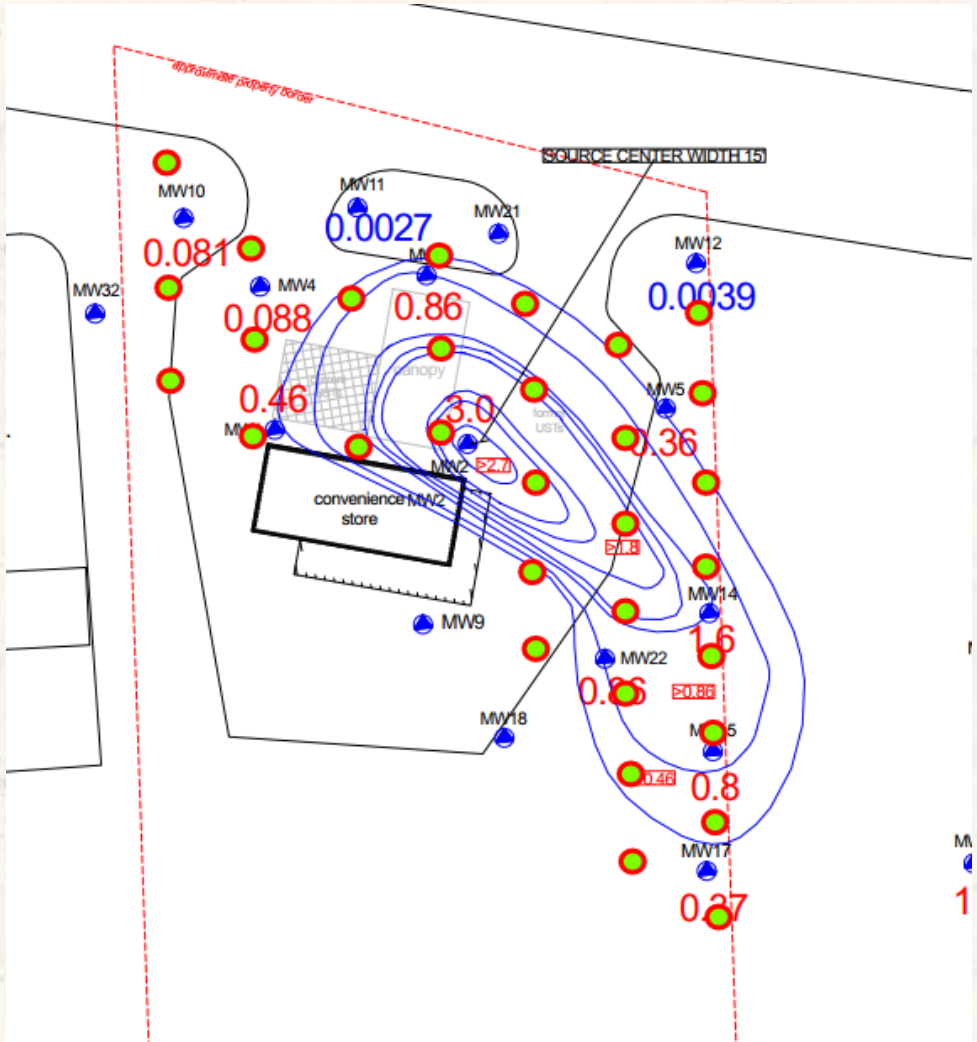
- Remedial design-focused site characterization program
- Bridges data gaps created by:
  - Historical characterization and sampling
  - High Resolution Site Characterization (HRSC) tools
    - e.g. MIP, OIP and UVOST®
- Provides a 3-D, quantitative model
  - ACTIONABLE DATA
  - Project decisions
  - Develop stoichiometric remedial approaches
- Set expectations
  - Time
  - Budget
  - Remediation endpoint(s)

Data Review & Preliminary Design

- Collaborative review
  - Client, stakeholder(s)
  - Soil and groundwater data
  - Geologic/hydrogeologic data
  - Data is perishable
- *"What's the story?"*
- Identify data gaps
- RDC and HRSC
- Preliminary design and approach

RDC Example

- Existing
  - Quarterly GW monitoring
  - Limited soil data (10+ years old)
- 31 high density soil borings
  - Quantify (and speciate) contaminant mass
  - 209 soil samples
  - Twinning targeted borings adjacent to MWs
- Sample existing MWs
- Trimble to survey locations
- Project Support Lab



Project Support Laboratory

- 6 – GC/MS (Volatiles) 8260b, TVPH
- 1 – GC/MS (Semi-volatiles)
- 1 – GC ECD SCVOC
- 1 – GC FID/PID (TPH-DRO)
- 1 – Heated Headspace VOC GC/FID
- 1 – HPLC
- 2 – IC (Gradient Pump)
- Micromeritics ASAP 2010 Chemisorption
- Pro bono (RPI)

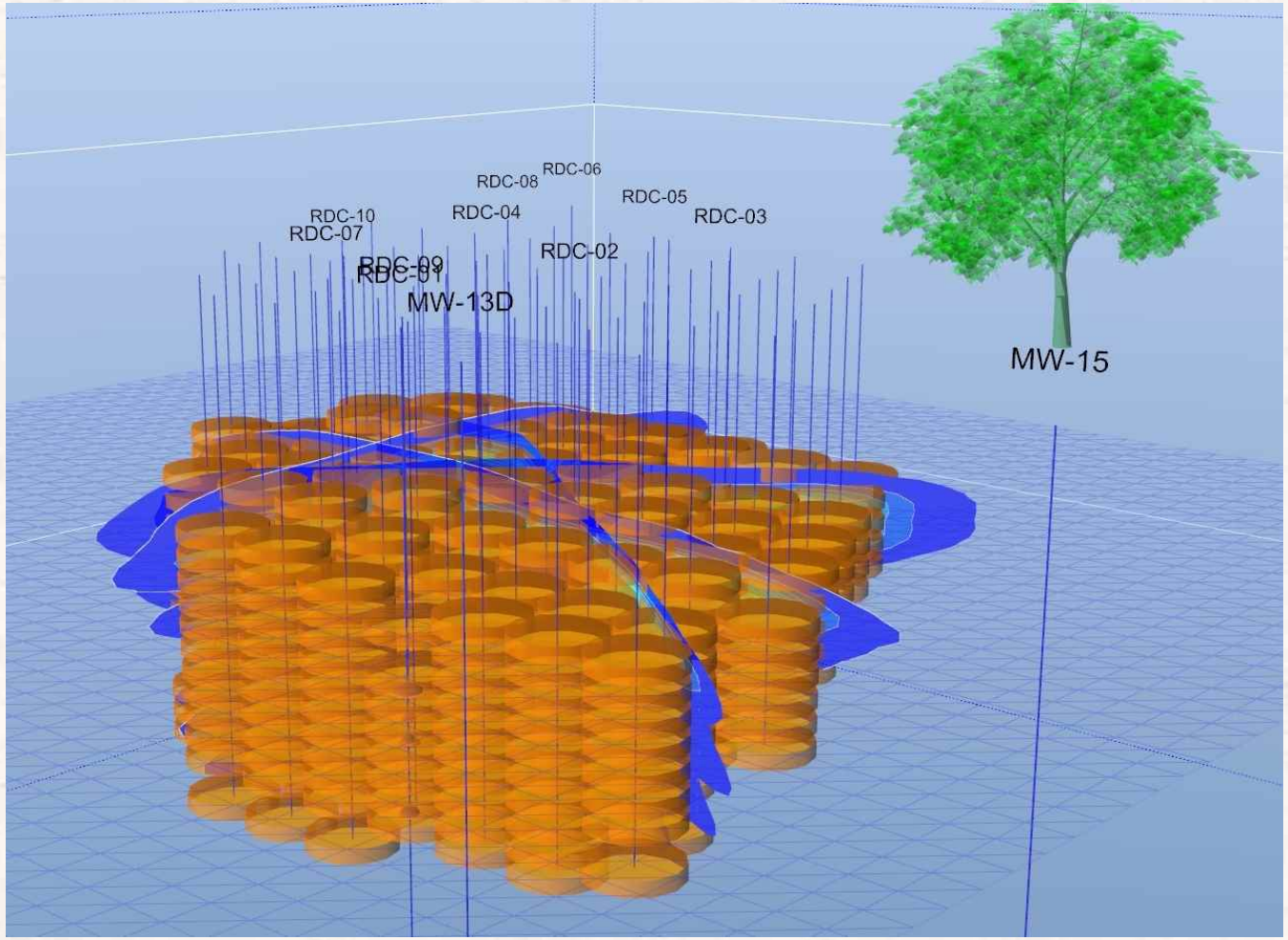
3-D Quantitative Model

- Incorporates
  - Qualitative and quantitative soil and groundwater data
  - Lithological information from boring logs
  - Display distribution of contaminants
  - Hydrogeological frame-work of the site
  - HRSC as appropriate
    - e.g. MIP = qualitative
    - Extrapolation of confirmation sampling is still not quantitative data
- Integrates traditional qualitative models and remedial design

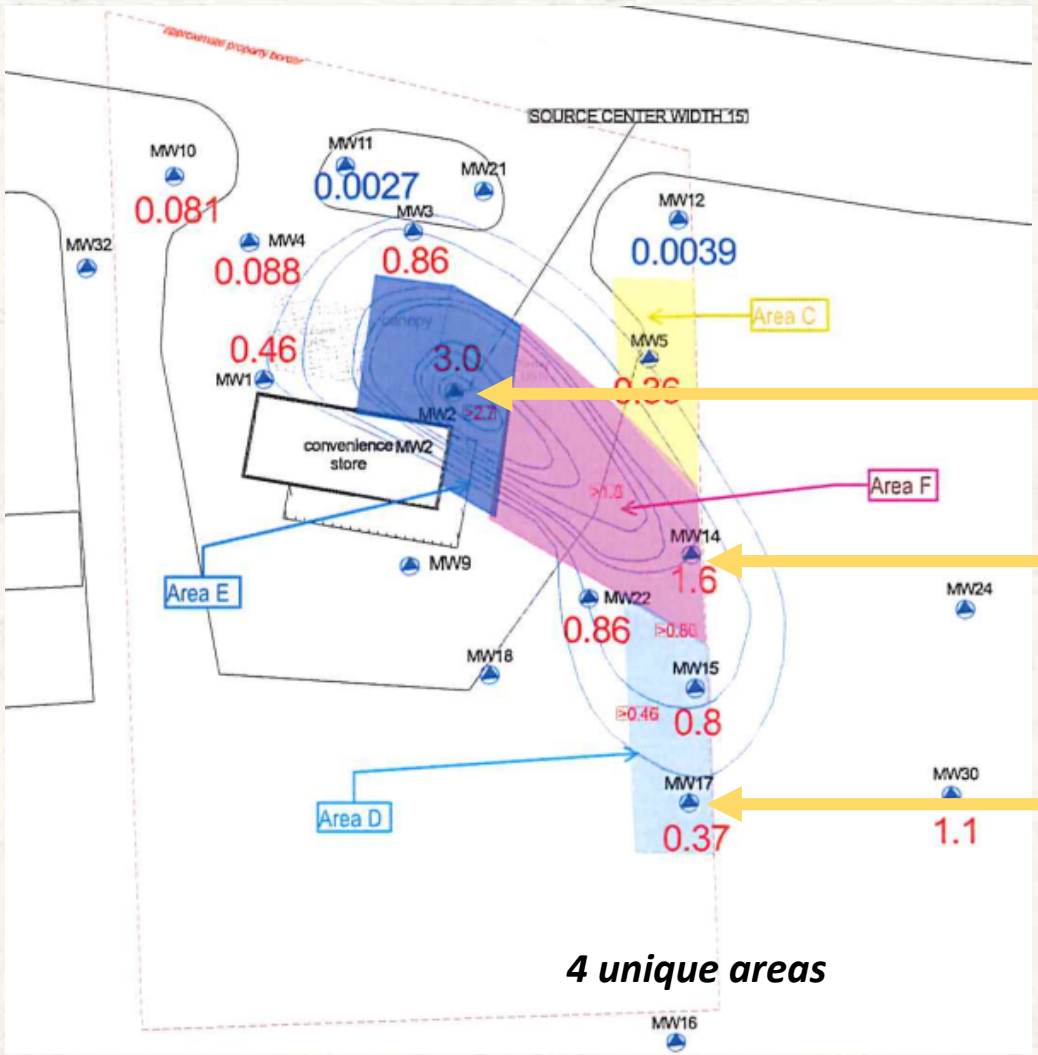
3-D Remedial Design Model

- Remediation approach(es) applied to quantitative model
- Easy visualization
- Updated real-time in the field
  - Flexible decisions
  - Adaptable trajectory
  - Step-outs, TWs, etc.
- Surgical

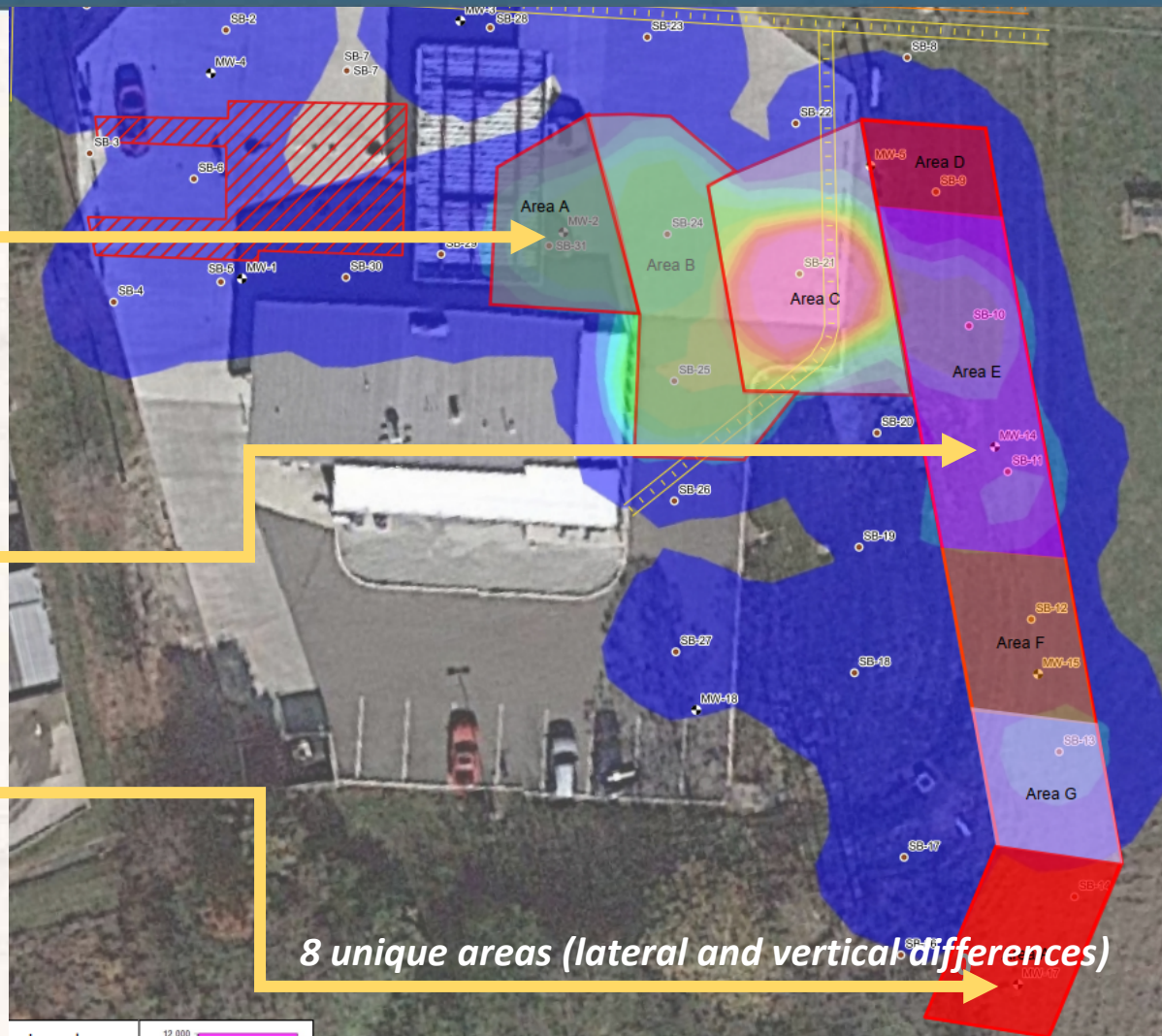
- First discussion point
- “See the problem”
- Easy communication



Optimization: Preliminary vs. Final Design



4 unique areas

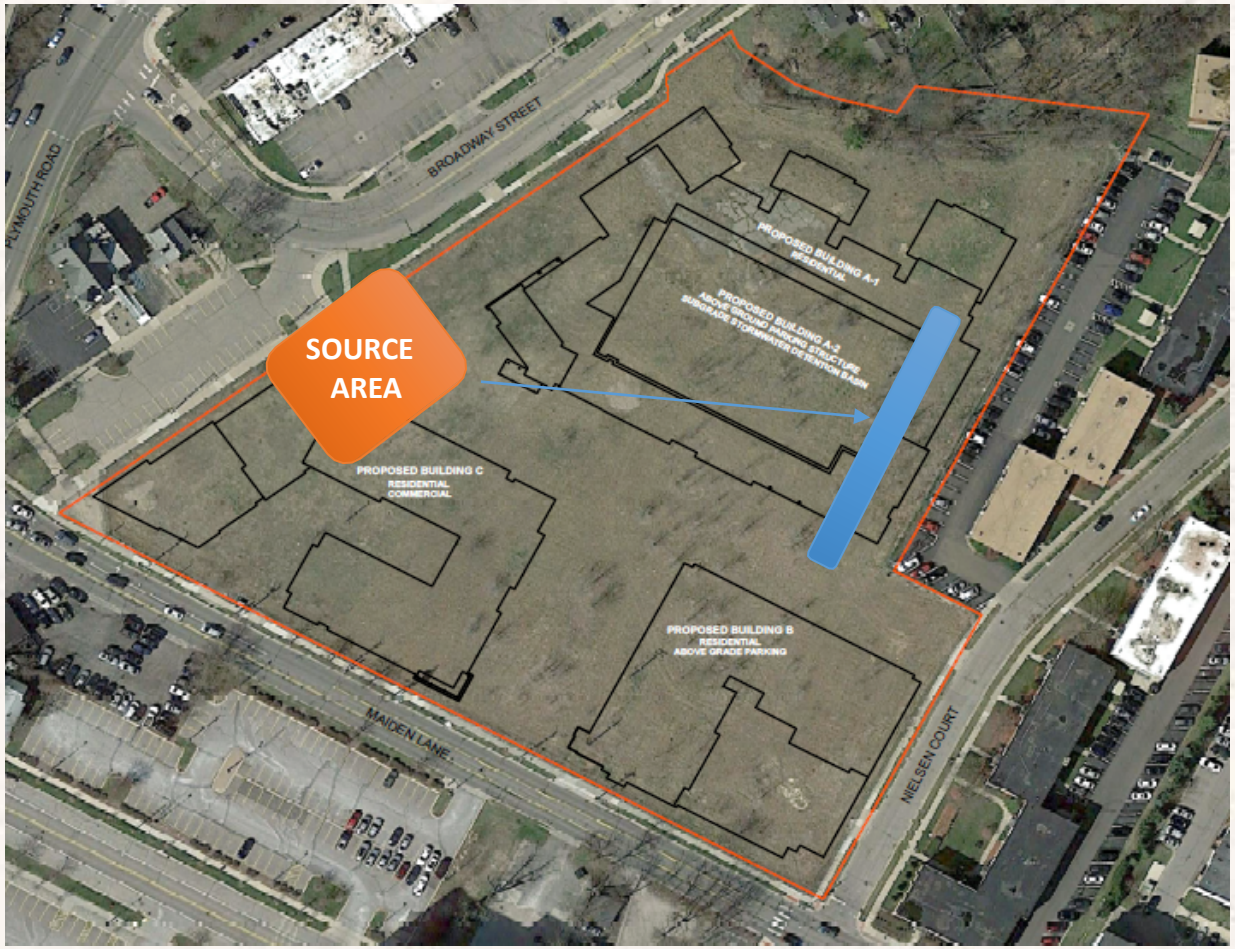


8 unique areas (lateral and vertical differences)

qHRSC Case Study

Broadway Redevelopment
Ann Arbor, Michigan

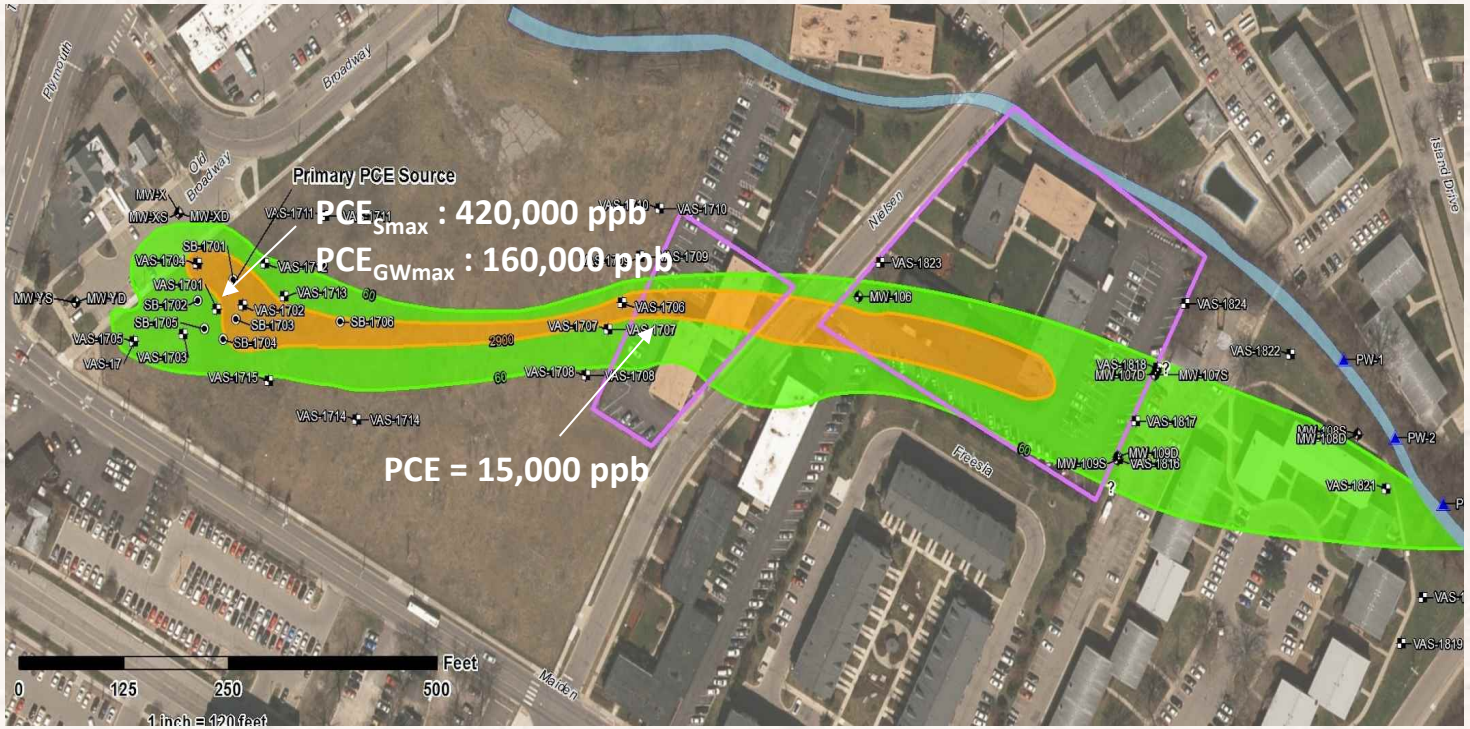
Brownfield Redevelopment Project



- Developed since at least the late 1800s
  - City block
  - Two former dry cleaners
  - Car wash
  - Junkyard operations
  - Other commercial and residential uses
- Various investigations on- and off-site
- Env. challenges ≠ redevelopment
- Significant chlorinated solvent contamination - soil and groundwater
  - Source = Broadway coin laundry
  - Operated from 1961 through early 2000s

Special Thanks - Agnes Taylor and Mark Quimby, SME

CVOC Plume



- Fill underlain by ***variable*** sand, silts, and clays
- Groundwater
  - Encountered 6 to 13.5 ft-bgs.
  - Extended to at least 40 ft-bgs.
- Eastward groundwater flow
- Impacts
  - Up to 33 ft-bgs. west
  - Up to 16 ft-bgs. east
  - Off-site migration

Existing Data vs. Data Gaps

- Limited, fragmented data sets
  - Soil and groundwater
  - Contaminant conditions

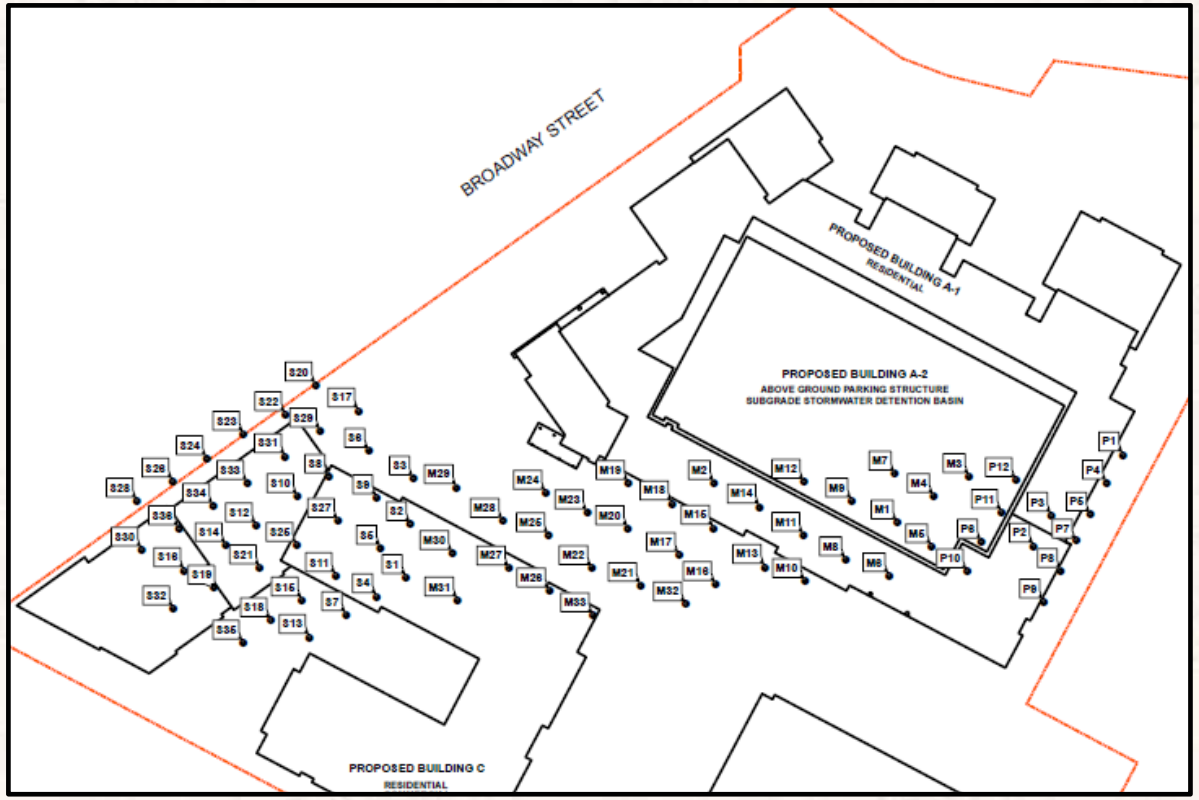
- **Option 1**
  - Rely on existing source data
  - Model potential contaminant flux (30 yr.) through PRB
  - ***High uncertainty***

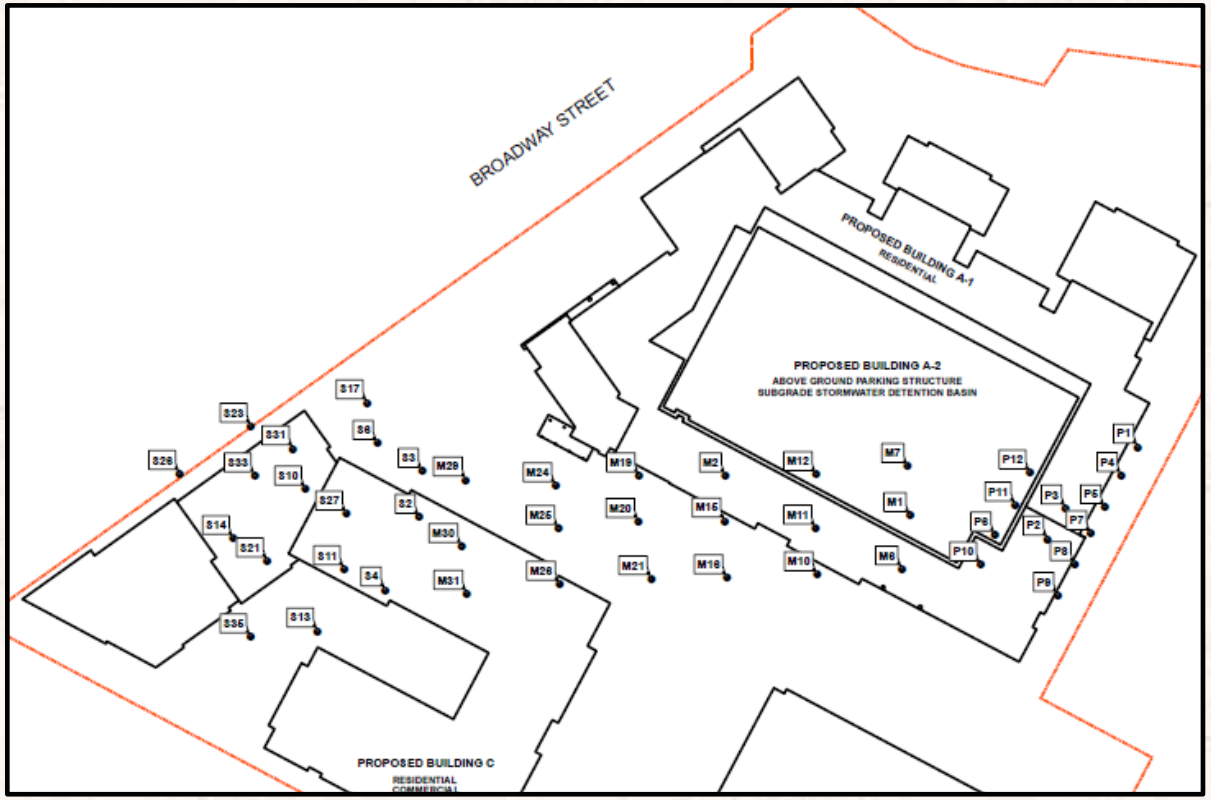
- **Option 2 – qHRSC Program**
  - Discern cVOC mass in soil/groundwater at source, mid-plume, and property line (mass distribution)
  - *PRB design based on known location and character of PCE mass*
  - ***High confidence in remedy (selected)***

RDC

- 79 soil borings to ~40 ft-bgs.
  - Logged soils
  - Sampled every 2 vertical feet
- 46 nested GW well clusters
  - 142 individual wells sampled
  - Slug tests
- 1,120 soil and 185 groundwater samples
  - cVOCs; speciation
  - Dissolved gases
  - Anions
- Confirmed
  - Hydraulic conductivities
  - Calculated seepage velocities and gradients
  - Soil mass; mass flux

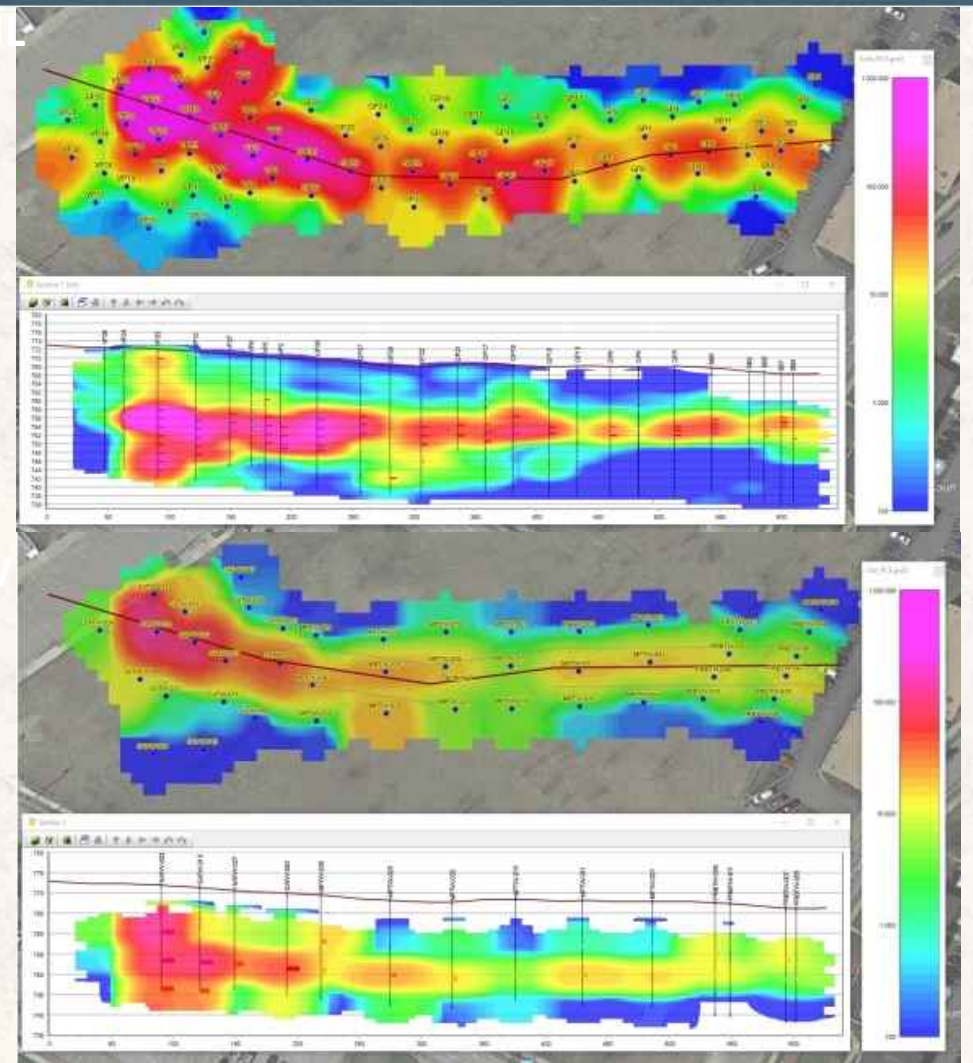
Soil Borings & Nested Implant Clusters





qHRSC Findings

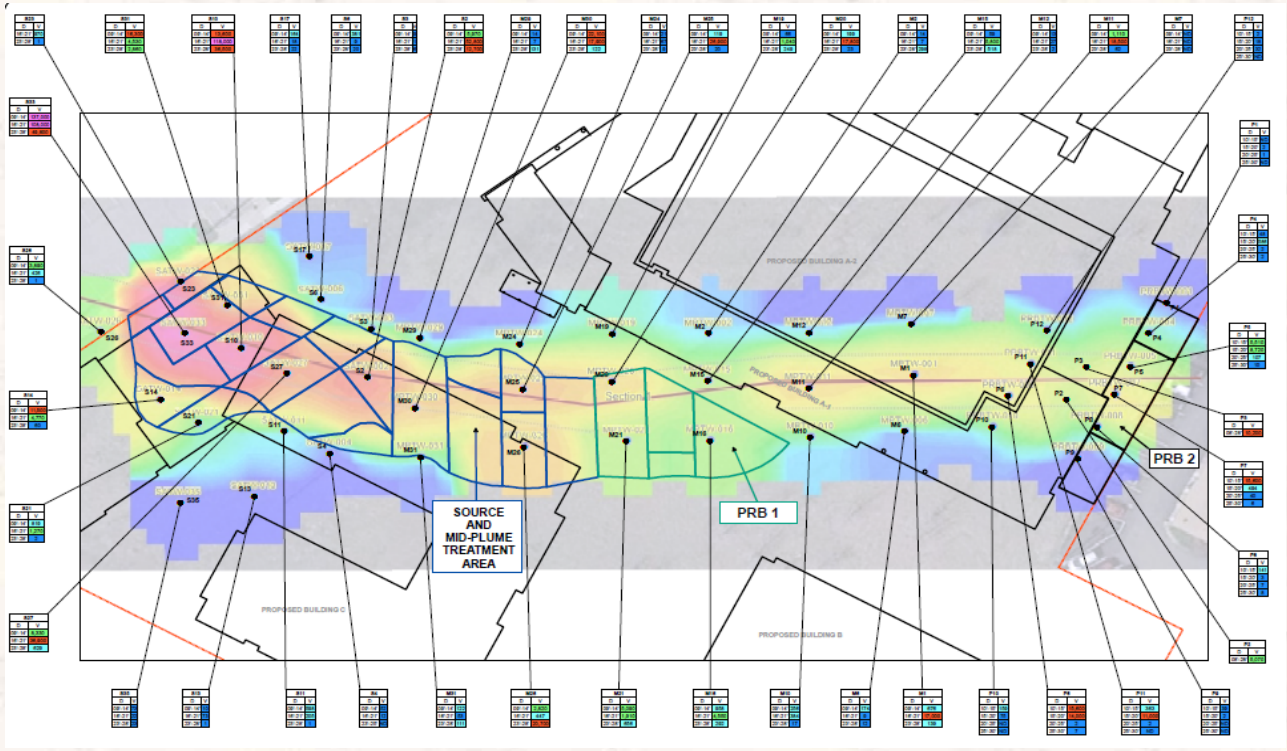
- 4,125 lbs. of PCE present in a 60 ft band
- Soil concentrations higher than '**old**' data
  - 4,640,000 ppb – source area
- Magnitude of GW concentrations on par…
  - …but more pervasive
  - 137,000 ppb in source
  - 14,000 – 27,000 ppb in axis of mid plume
- 99% of mass was PCE
- *Very* little natural degradation (GW = oxic)
- Refined soil profile and hydrogeology



Ability Gained: Mass-Driven Treatment Design

- Source & Mid-Plume – CAT 100
  - Loadings designed on cVOCs/DNAPL
  - Eliminate high-mass areas
  - Capable of managing oxic environment
- PRB1 – CAT 100
  - Design: source area mass flux
  - Design: cVOC mass within PRB1 footprint
  - 5-year lifetime
  - Seepage velocities calculated (slug tests)
- PRB2 – BOS 100®
  - Mass within footprint of proposed Building A
  - Mass present within footprint of PRB2
  - 30-year lifetime

- Received $1 million EGLE grant
- Added source area treatment
- Extended longevity of PRBs



Implementation

- Approach allowed for a mass-driven design
- Customized to the site
- Increased accuracy

- Pilot Study
  - CAT 100 as source
  - PRB1 treatment media
  - Dec 2018 through Feb 2019
- Full scale injections
  - Spring-Summer 2019
  - Concurrent with construction/redevelopment
- Fall 2022
  - Average PCE reduction in source and PRB1 of 99.99%
  - Average PCE reduction in PRB2 of 96%

Lessons Learned From qHRSC Programs

- Budget constraints?
  - Catch-22?
  - Hobson's choice?
- Limited, aged, or no information…?
  - Quantitative data
  - Soil data
  - Geology or hydrogeology
  - Data is perishable!
- HRSC pitfalls
  - Not "wet chemistry"
  - Correlation data is limited and margin of error
  - "Tool is a tool"
- 3-D imaging underutilized
  - Develop remedial strategies
  - Relay complex data sets to stakeholders

- Close data gaps
- Set Expectations
- Plan for success
- Adapt with the unexpected
- Living Models/Summaries
  - CSM
  - RDC
- Optimization =
  - Discovering "new" problems
  - Eliminating existing problems
  - Data is data
    - Data drives optimization
    - Optimization drives injections
    - Injections drive success

Questions?

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