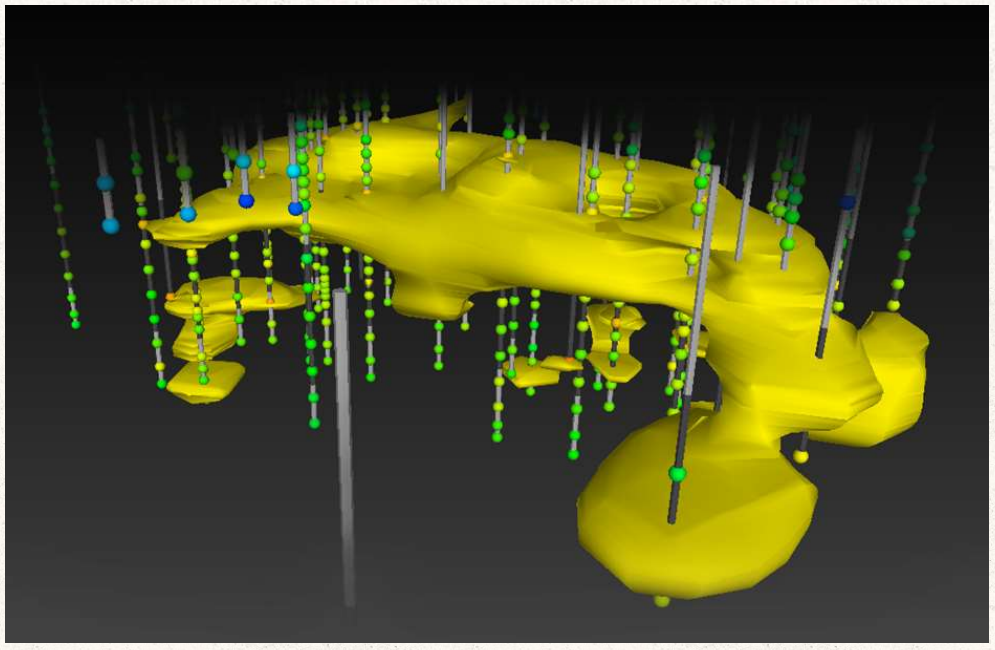
UNDERSTANDING TOTAL CONTAMINANT MASS TO PREDICT REMEDIATION COST, PERFORMANCE AND TIMEFRAMES

Mike Mazzarese

AST Environmental, Inc.

Denver, CO

Why aren't we always hitting home runs?

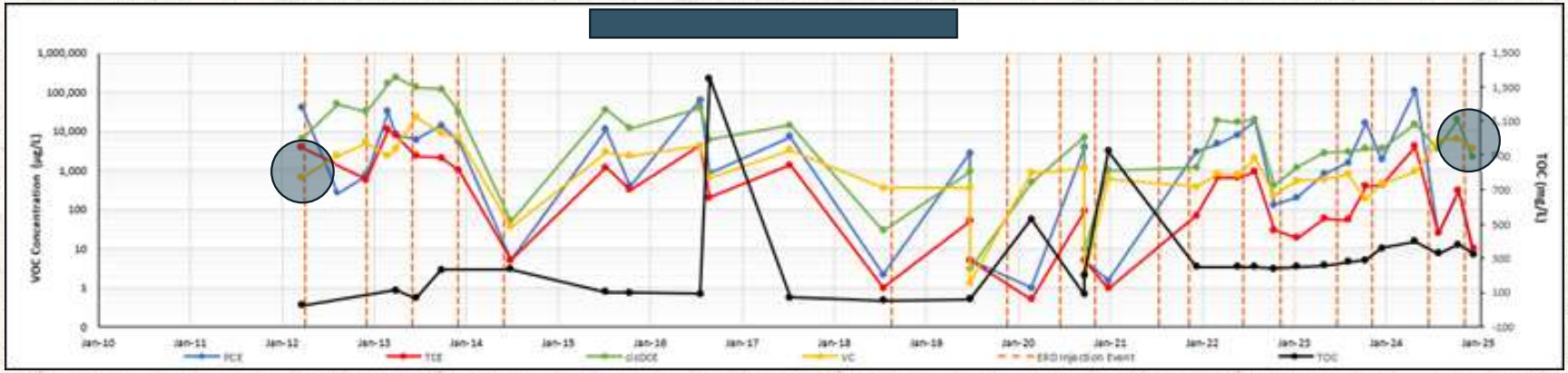


3D Image of Soil Sampling Data

Remediation chemistries work in a beaker – so why do we sometimes fail in-situ?

- Reagent Loading/Dosing
  - Technology Selection
  - Contaminant mass distribution
    - Complex
    - Scales with the heterogeneity of lithology
  - Soil mass contribution typically underestimated
- Contact

So, what's the definition of insanity?



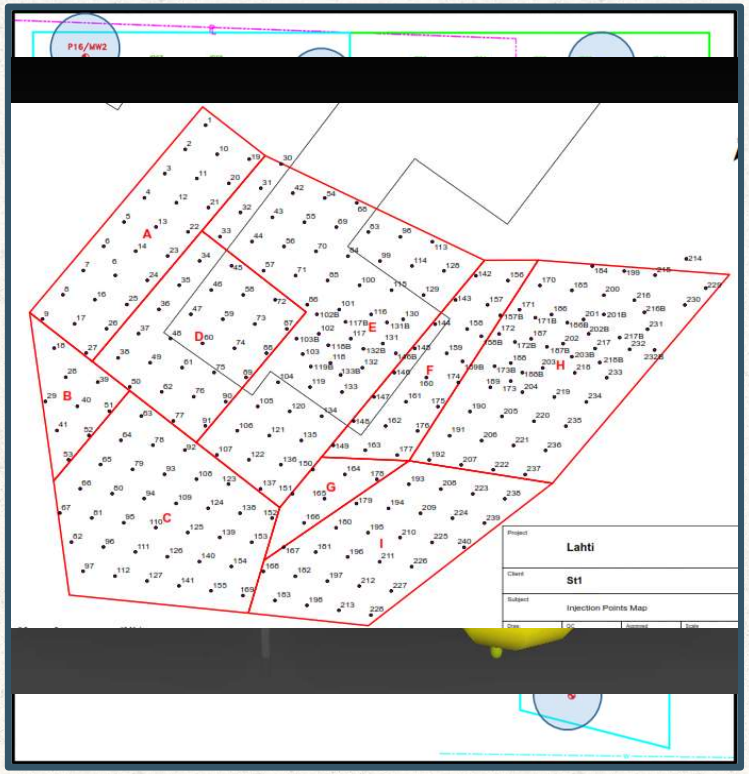
- 17 injection events over ~13 years
- "We think there may be some mass sorbed into the clay confining unit"

Characterization options/levels

- Nature and Extent
  - Defines vertical and horizontal extent
  - Helps develop preliminary remediation plan(s)
  - Typically weighted towards groundwater
  - Limited source area saturated soil data
  - Should NOT be used for final remedial design
- High-Resolution Site Characterization (HRSC)
  - Rapid **qualitative** data collection
  - Helps to define “the box”
  - Need to understand limitations
- Remedial Design Characterization (RDC)
  - Spatially and vertically dense soil and groundwater sampling
- qHRSC
  - **Quantitative** HRSC
  - Combines all data into 3-D model(s)

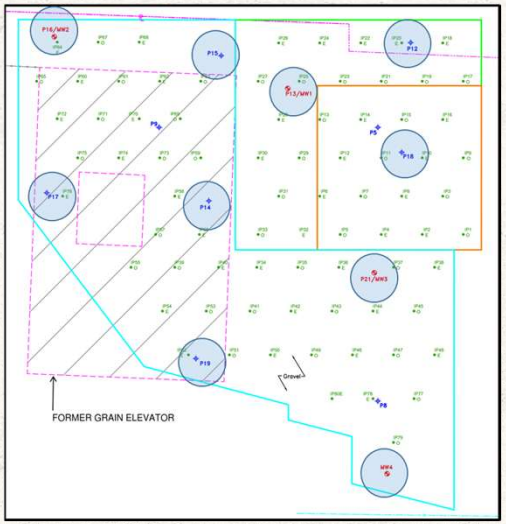
So what is an RDC?

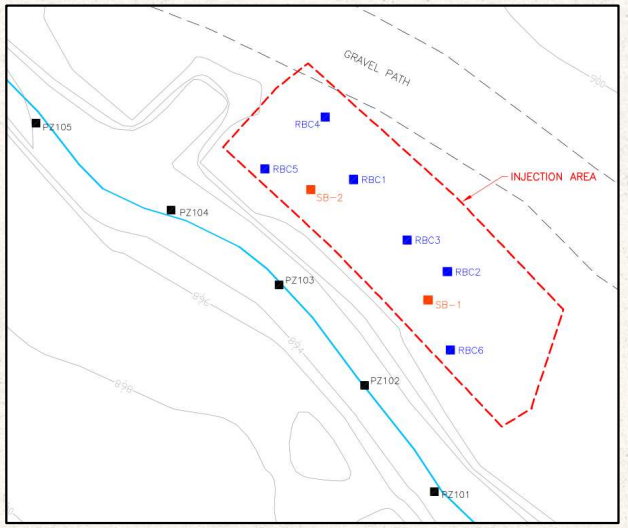
- Recognized in ITRC guidance document (Optimizing Injection Strategies and In-situ Remediation Performance)
- Detailed understanding of vertical and horizontal distribution of speciated AND total mass
  - Total mass critical for remedial design
  - Guides technology or combined remedy selection
  - Flux calculations are not a surrogate for total mass
- Collaborative process used to fine tune the CSM, fill data gaps, and optimize the remedial design
  - Dense soil vertical profiles (e.g. 2 ft) => vadose through saturated zone
  - Nested wells for groundwater (e.g. < 5 ft)
  - Leverage non-traditional lab services when possible to keep project costs down



RDC design considerations

- Dependent on many factors:
  - Data gaps
  - Age of data => data is perishable
  - COCs
  - Lithology
  - Goals
  - Remedial strategy
    - PRB v. Source

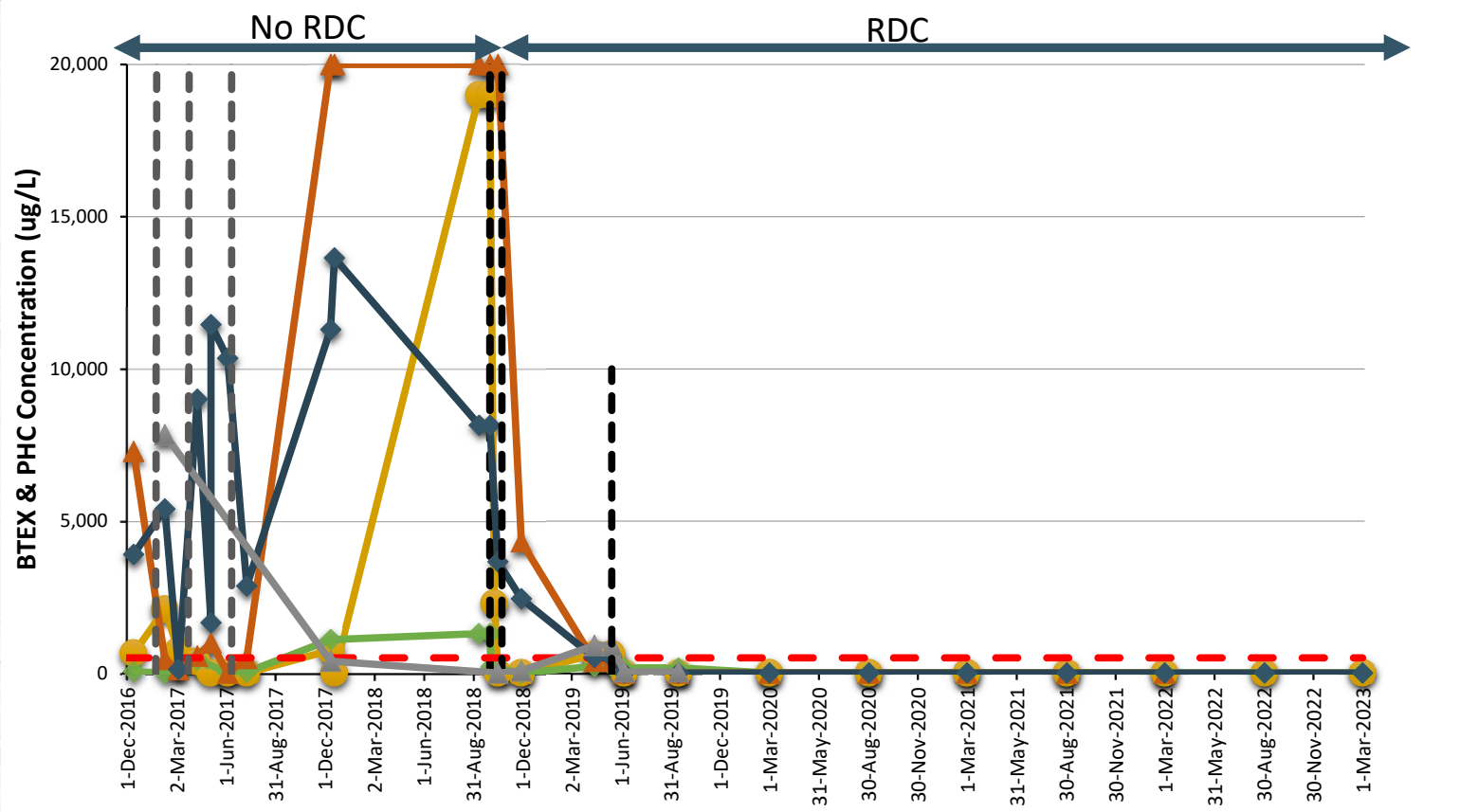




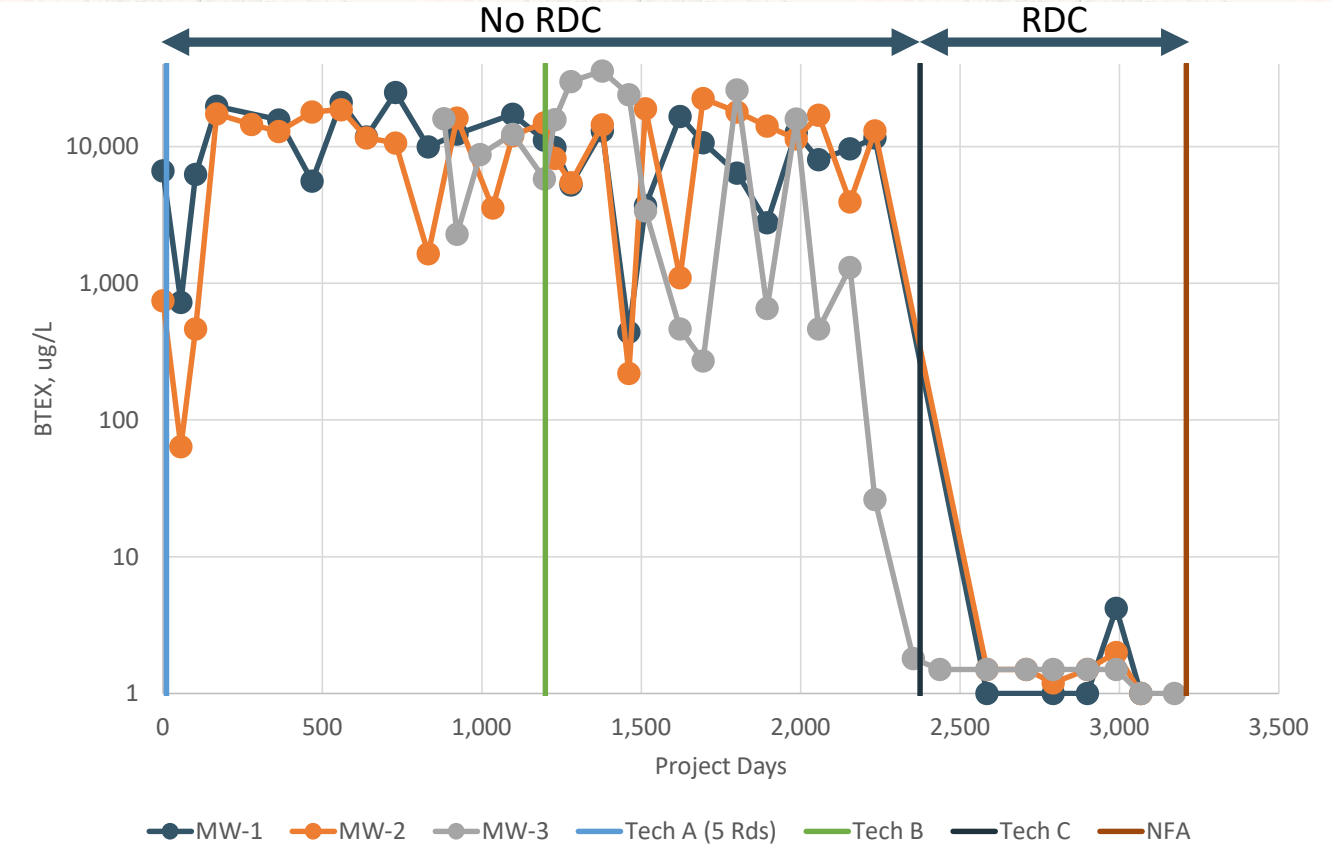
Soil data from diesel LNAPL site

Depth	SB-19	SB-20	SB-21	SB-23	SB-24	SB-26	SB-27	SB-28	SB-30	SB-31	SB-32	SB-33	SB-34	SB-35	SB-36	SB-39	
23			3,370			14,000			3,420								
24	219		ND	1,650		ND						5,760			258		
25		ND	7,180				9,390	214	17,000	4,500	7,050		643	789		4,650	GW High
26	ND		32,200	6,770	5,460	4,630	62,100					15,000					
27		13,900						ND	6,440	ND	7,720	28,200	13,700	14,300	218	ND	GW Avg
28	5,830	ND	2,370	1,480	473	ND	111	ND		28,600					1,610	1,510	
29	153			ND				137	165	12,600	6,500	753	9,330	82		ND	GW Low
30		2,910	258			104							ND			3,170	
31				25,900	ND		412				248	ND	3,060	ND	ND	306	
32		94								ND				5,590		498	
33				270			82						ND				
34				137	729						ND			333		ND	
35																	
36					118									ND			
DRO Soil Concentrations (mg/kg) - analyzed at RPI Quality Assurance Laboratory																	

No RDC v. RDC example (PRB)

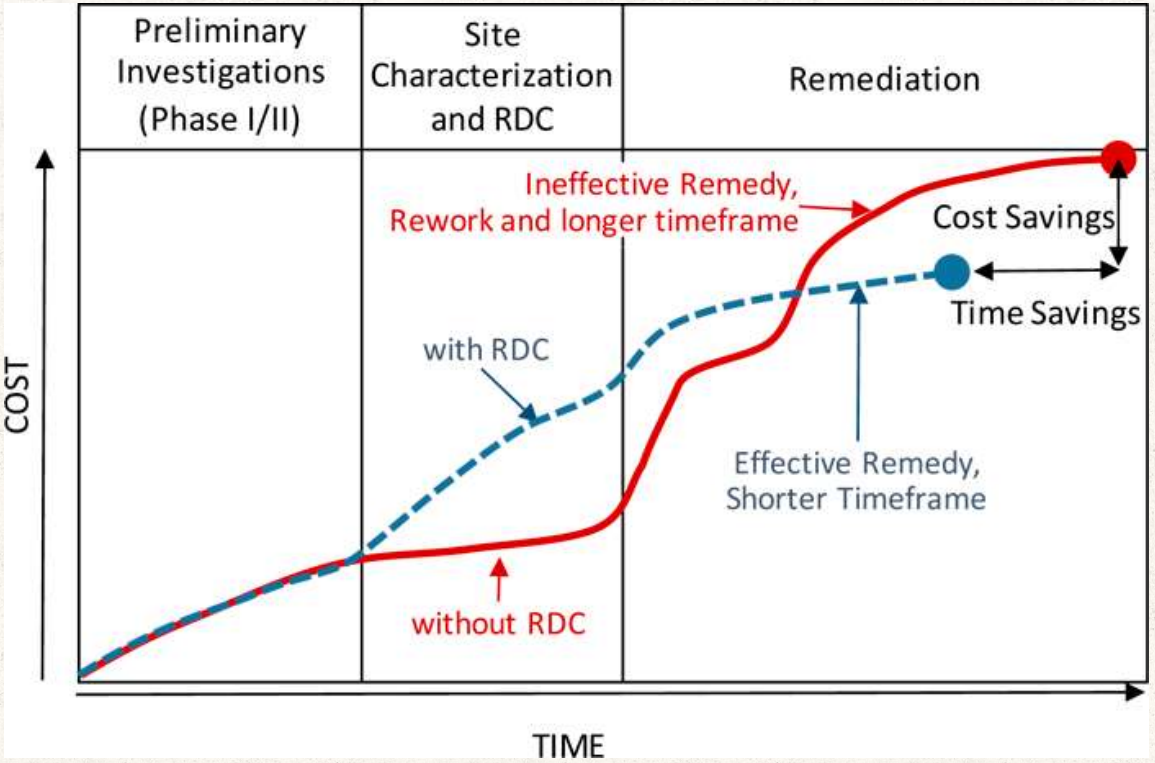


No RDC v. RDC example (Source)



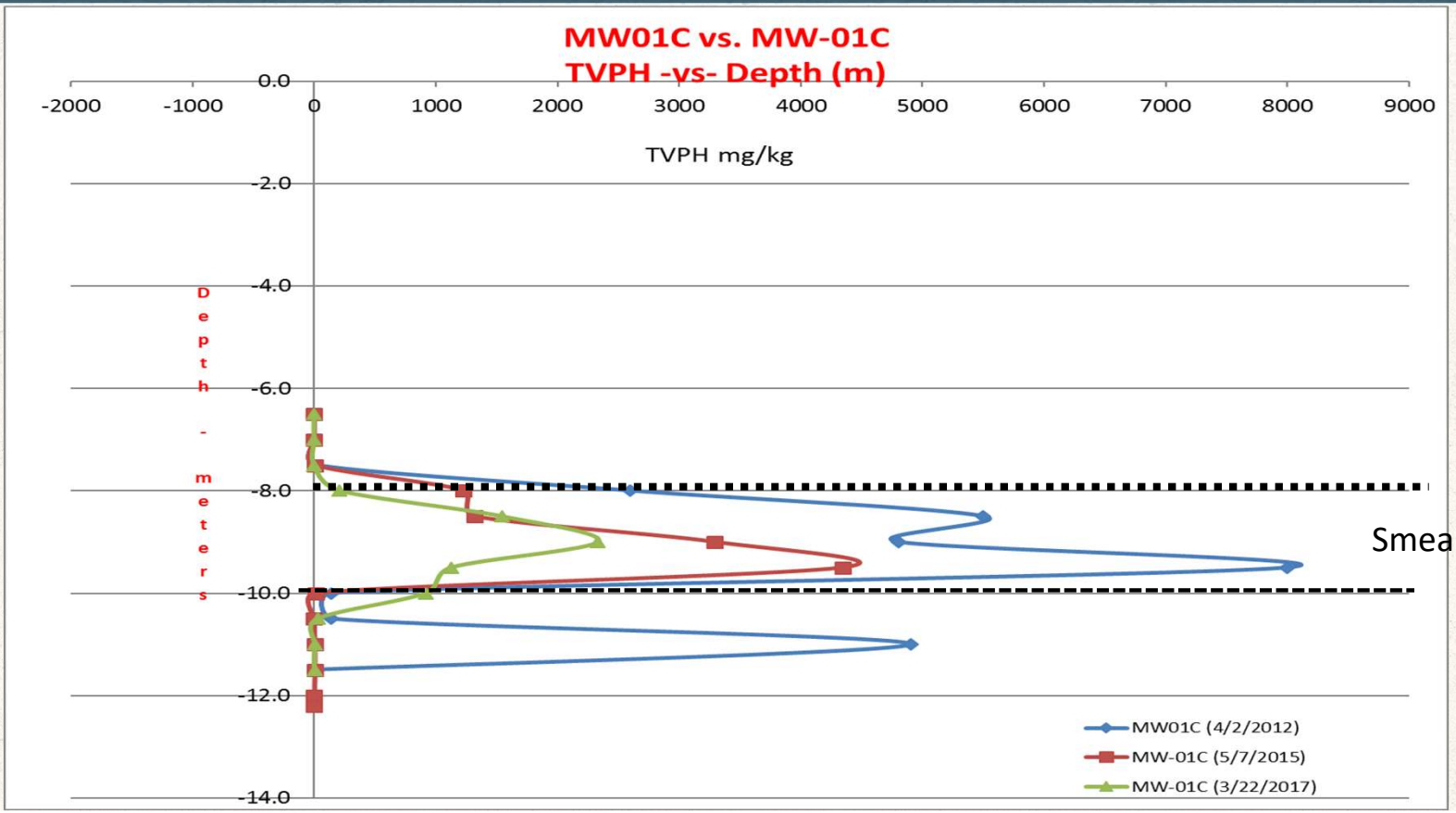
RDC and long-term remedial cost

- Project time and cost savings (in most situations)
- Avoid the land mines (e.g. unknown or unidentified source areas
- Manage expectations
- Guides combined remedy strategies



Source: Optimizing Injection Strategies and In-situ Remediation Performance

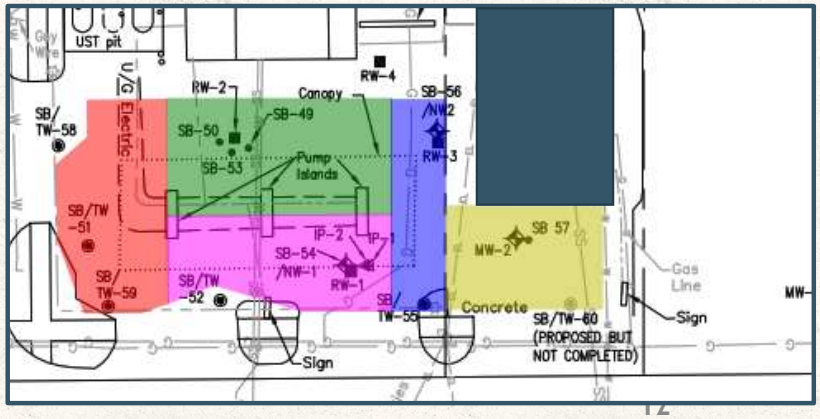
Managing Expectations



Smear Zone

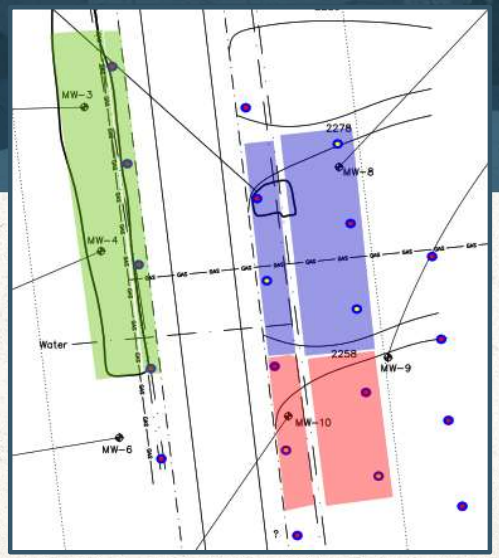
Prelim design v. post RDC – example #1

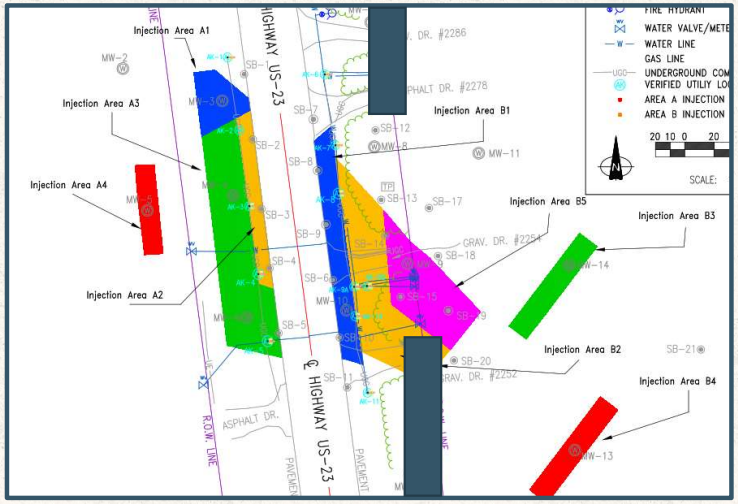
	Treatment Area (ft^2)	Treatment Thickness (ft-ft)	Product (lb)	# Field Days	Project $ (USD)	
Prelim Design	5,000	5-20	21,400	11	$153,000	(Budget)
Final Design	6,000	5-12	14,000	7	$115,600	(Actual)
				RDC	$5,750	
				Total	$121,350	
				Savings	$31,650	
					21%	



Prelim design v. post RDC – example #2

	Treatment Area (ft^2)	Treatment Thickness (ft-ft)	Product (lbs)	# Field Days	Project $	
Prelim Design	8,700	4-12	35,500	21	$330,000	(Budget)
Final Design	19,000	6-12	42,700	30	$416,000	(Actual)
				RDC	$23,000	
				Total	$439,000	
				Over Prelim	$109,000	
					33%	

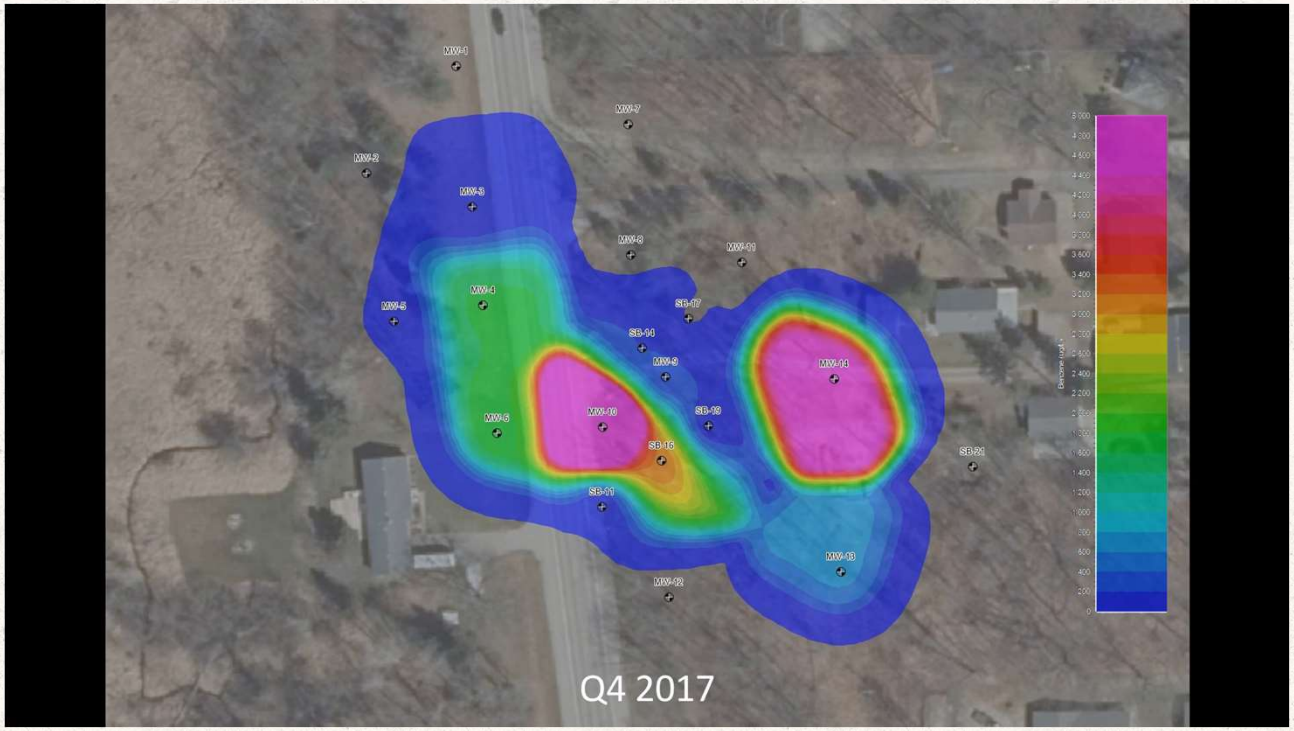




What is qHRSC – quantitative High Resolution Site Characterization?

- Provides a 3-D, quantitative model
  - Useful in stakeholder understanding of the CSM
  - Can integrate
    - High Resolution Site Characterization (HRSC) tools, e.g. MIP, HPT, LIF
    - Site features, e.g. tanks, excavations, etc.
    - Lithology
    - Remedial strategy, e.g. injection, excavation, etc.
  - A note regarding HRSC tool use – know what the data tells you and does not tell you
    - E.g. the MIP is qualitative (mV)
    - Per ITRC- Lithology, saturation, multiple compounds all make direct correlation problematic
    - Extrapolation of confirmation sampling is still not quantitative data

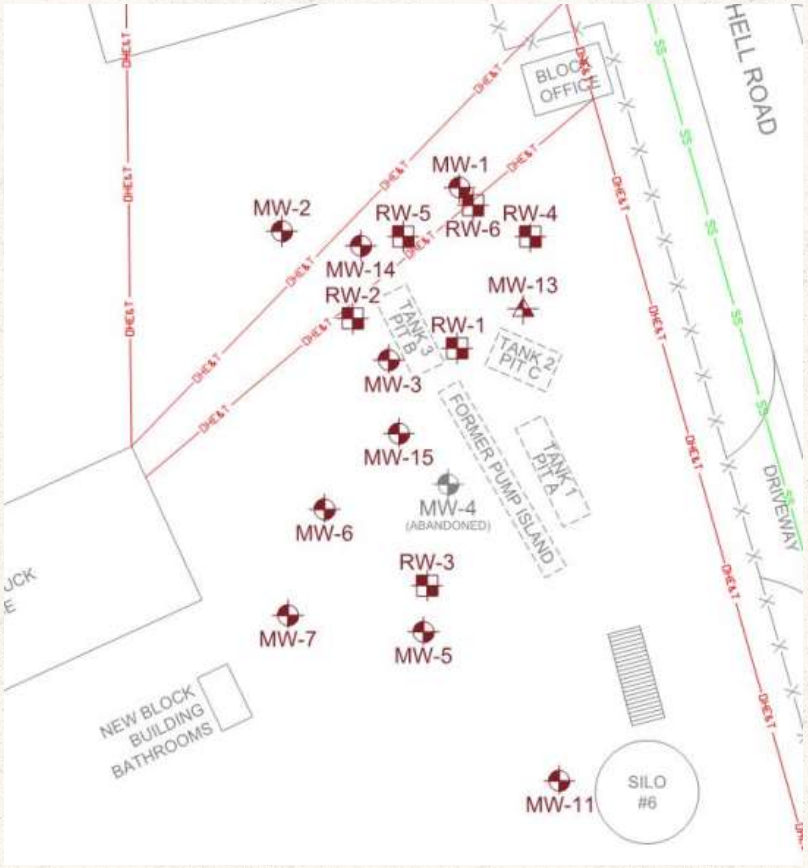
Benzene reductions over time



Project Example

UST Site – Southeast US

- 1993 USTs Closed In-place (3 USTs, 2 Gas and 1 Diesel)
- Current Operations – Heavy Equipment Storage and Maintenance for Paving Operations
- Geology – Sandy Clay, Clayey Sand, and Sand (coarsening with depth)
- Shallow Groundwater (~8 to 18 ft bgs)

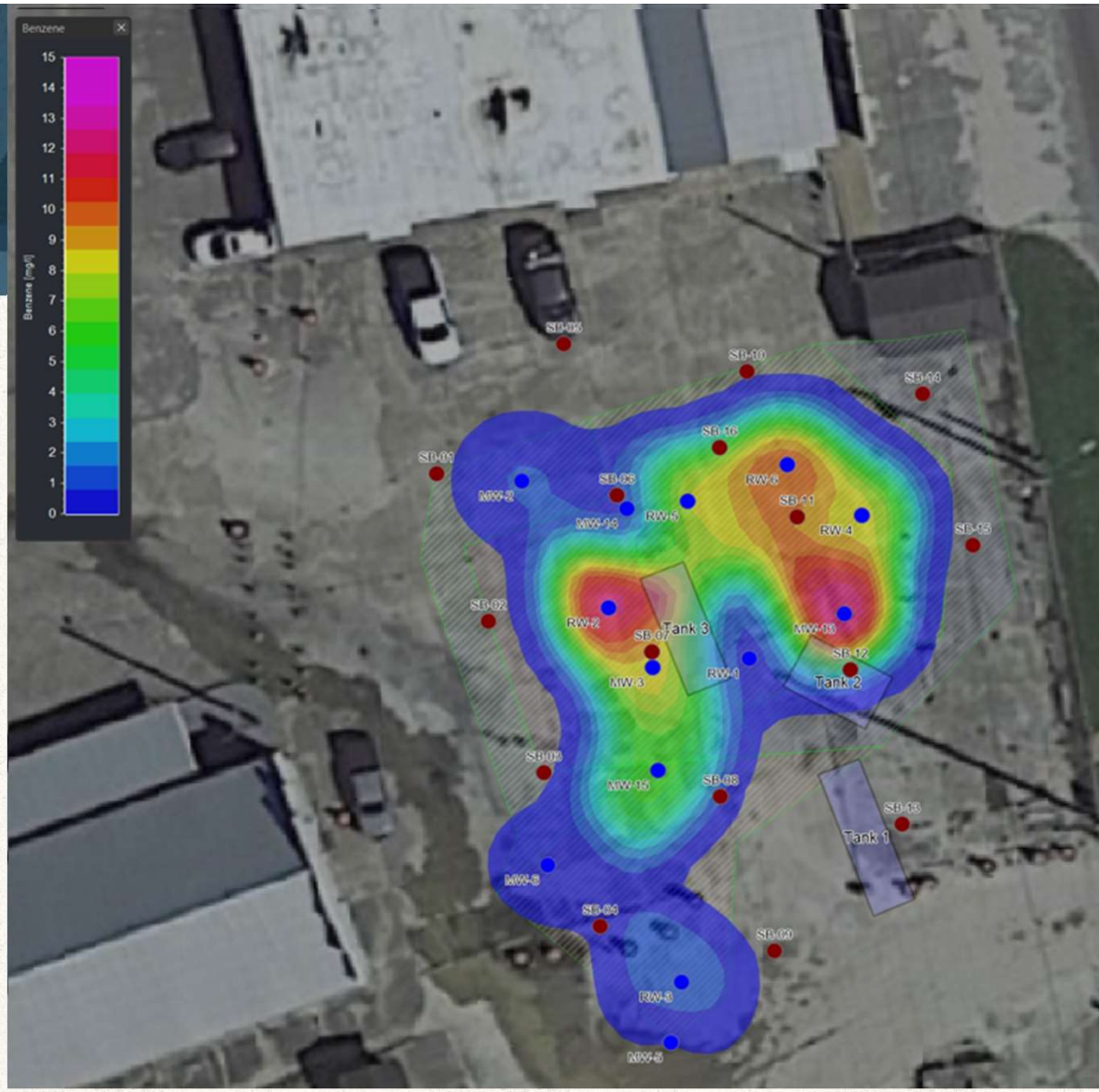


Remedial Design Characterization

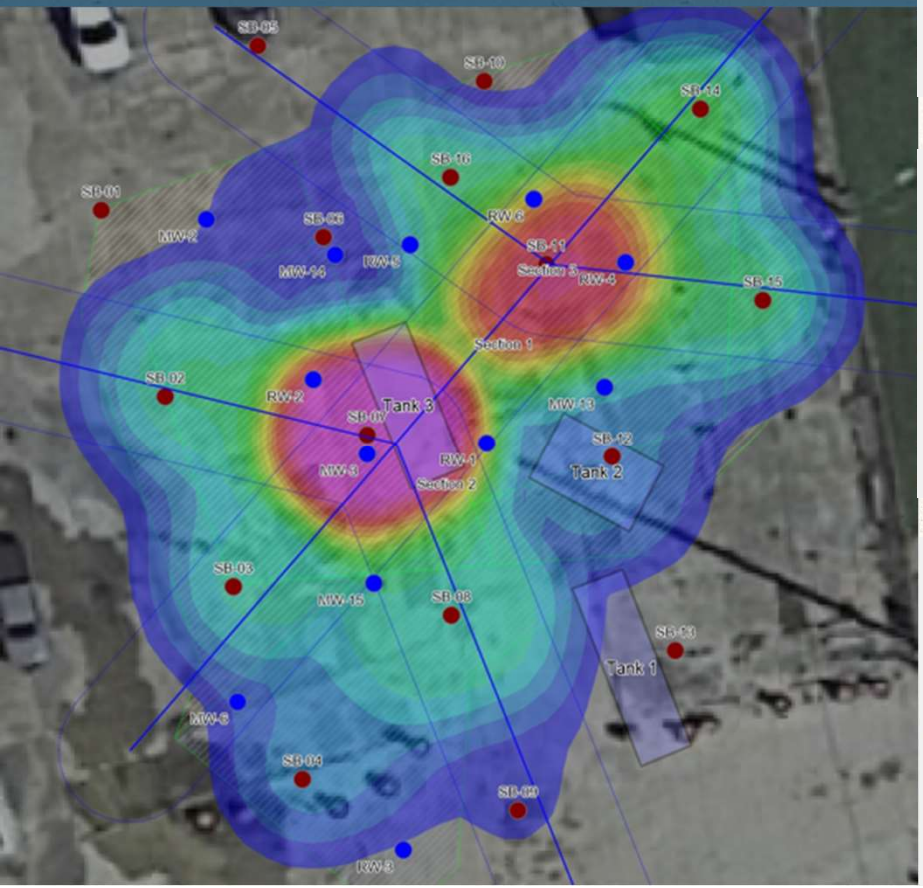
- 16 high density sampling locations of soil and groundwater to quantify and speciate contaminant mass (~30 foot spacing)
- 314 soil samples were collected and analyzed
- Microwell clusters constructed in the 16 soil borings (screened 6-12 ft, 13-20 ft, 21-30 ft, 31-35 ft)
- Groundwater samples collected and analyzed from microwells and 14 monitoring and recovery wells - 44 groundwater samples
- Remediation Products Inc, (RPI) Project Support Lab (Denver) provided soil and gw analysis pro bono
- $30,000

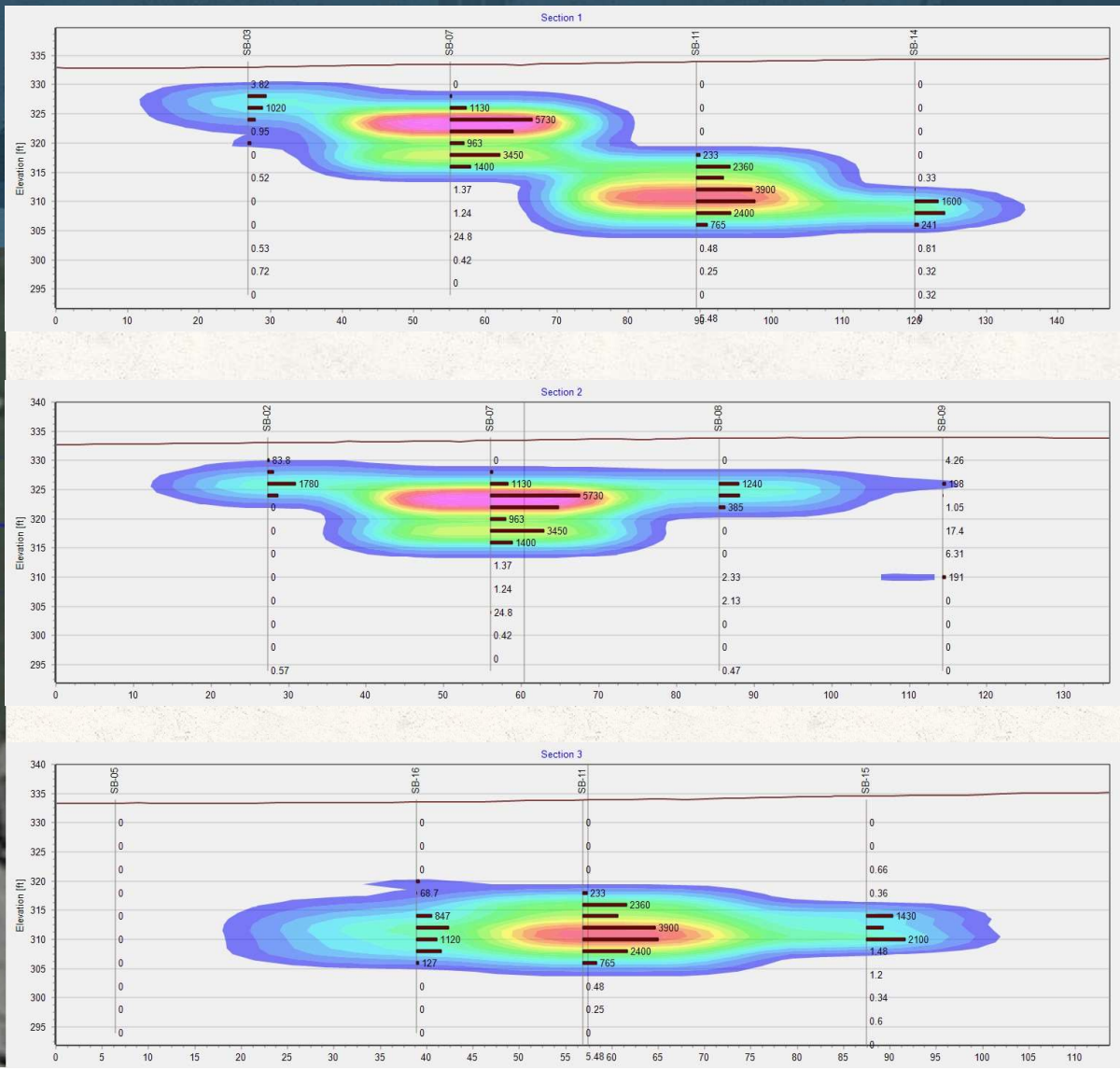
RDC Results

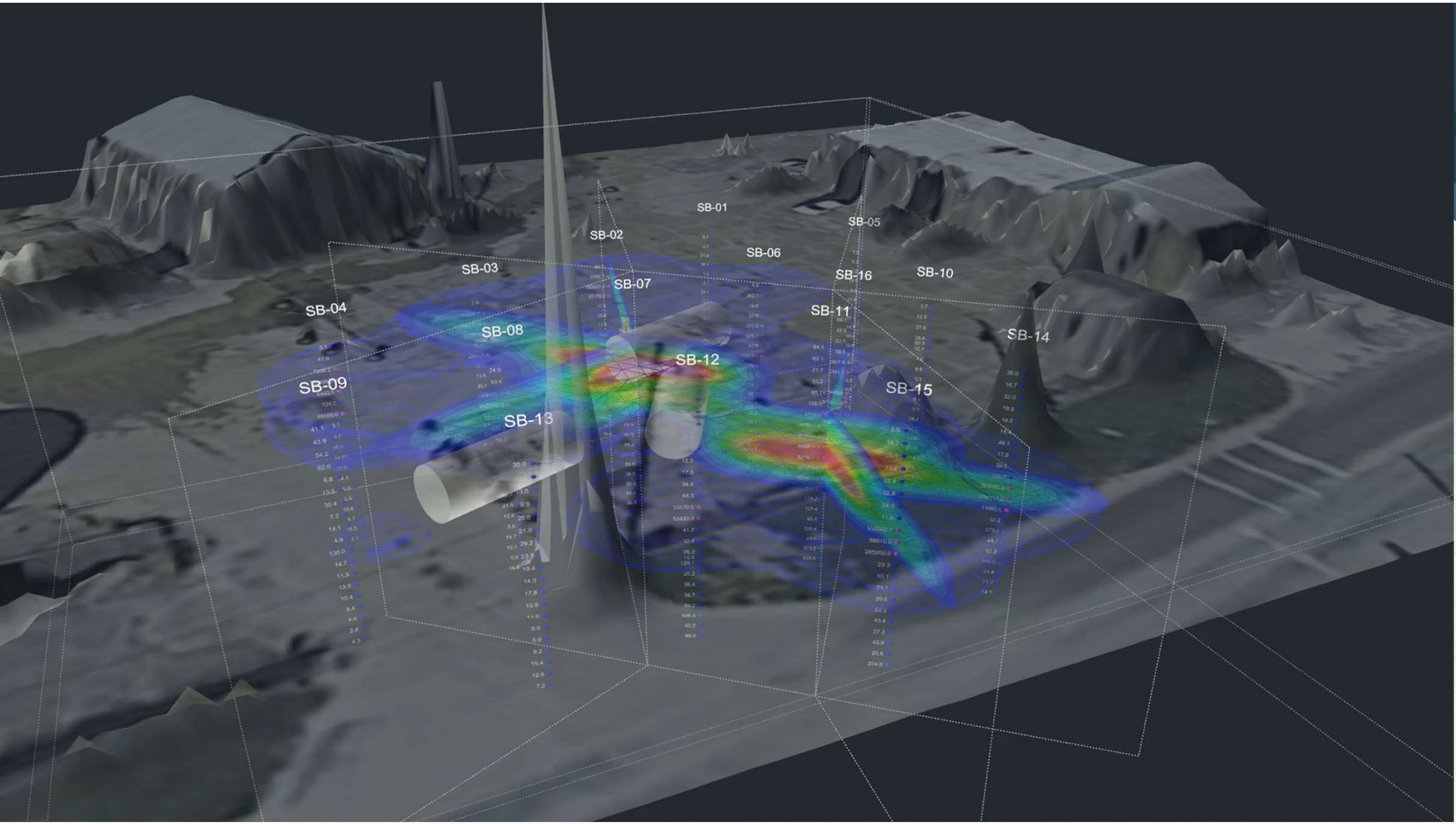
1. TVPH Soil
2. Benzene Soil
3. Benzene Groundwater



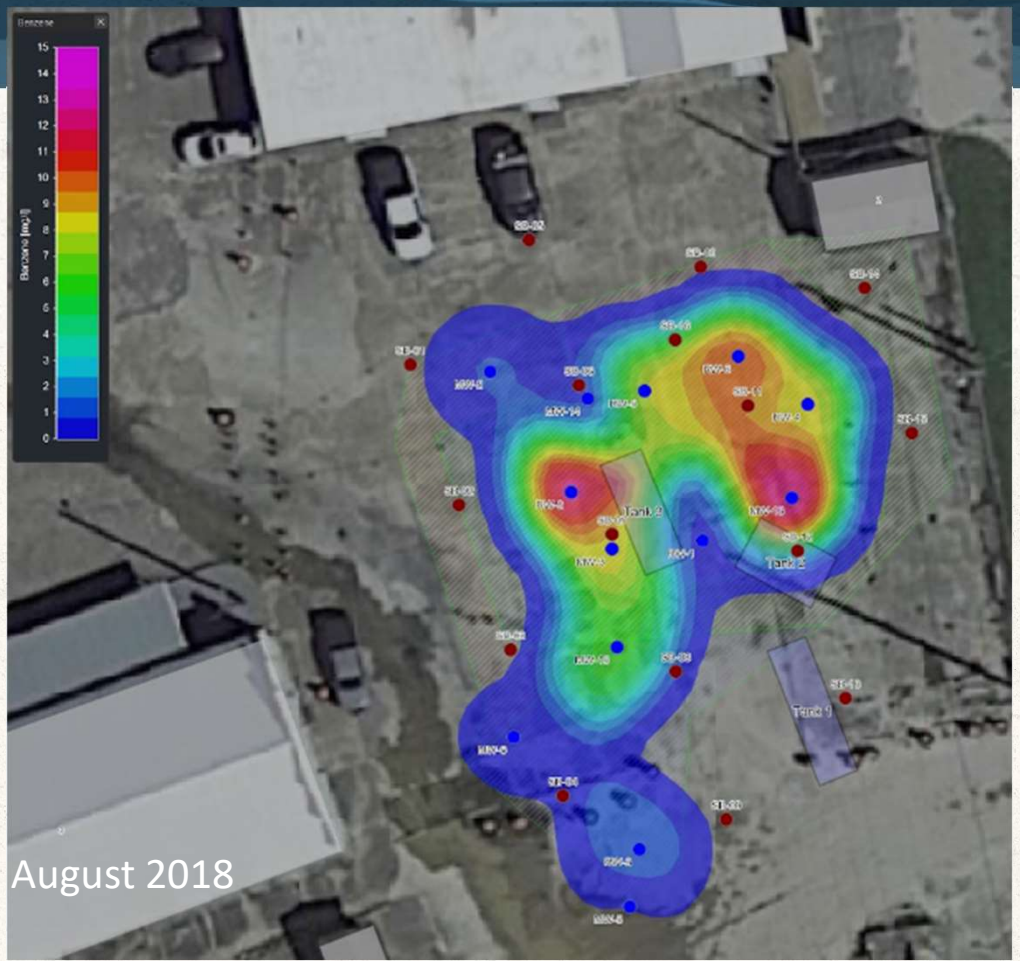
Cross Sections - TVPH

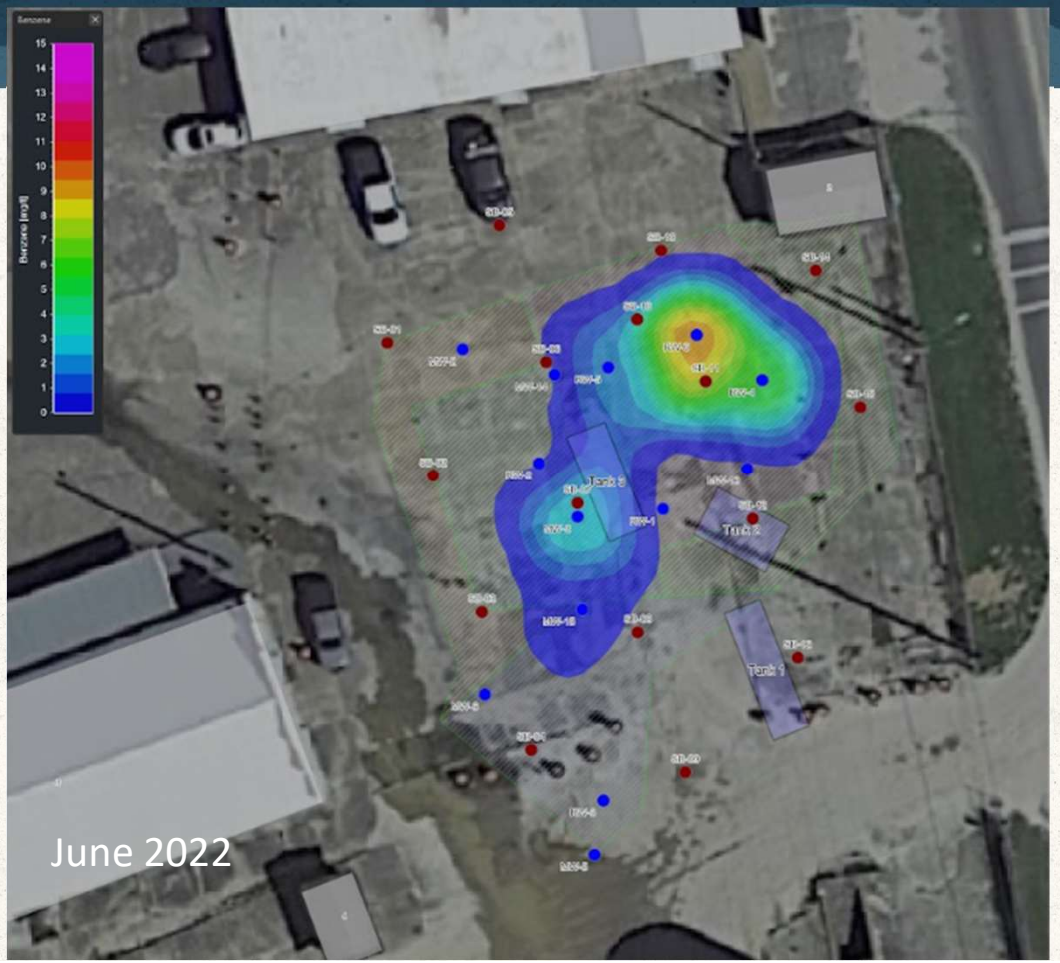





SB-01
SB-02
SB-03
SB-04
SB-05
SB-06
SB-07
SB-08
SB-09
SB-10
SB-11
SB-12
SB-13
SB-14
SB-15
SB-16

Results – Pre and post injection





Summary

- We need to understand the current total mass to make informed decisions regarding:
  - Technology or combined remedy strategy
  - Project timeframe
  - Setting realistic goals
- Integrate 3-D modeling and HRSC tools when appropriate
- Funds spent on the front end will always pay dividends (ROI)

Thank you! Questions?

Mike Mazzarese

mmazzarese@astenv.com