Best Management Practices for Site Characterization

The End of Poke and Hope?

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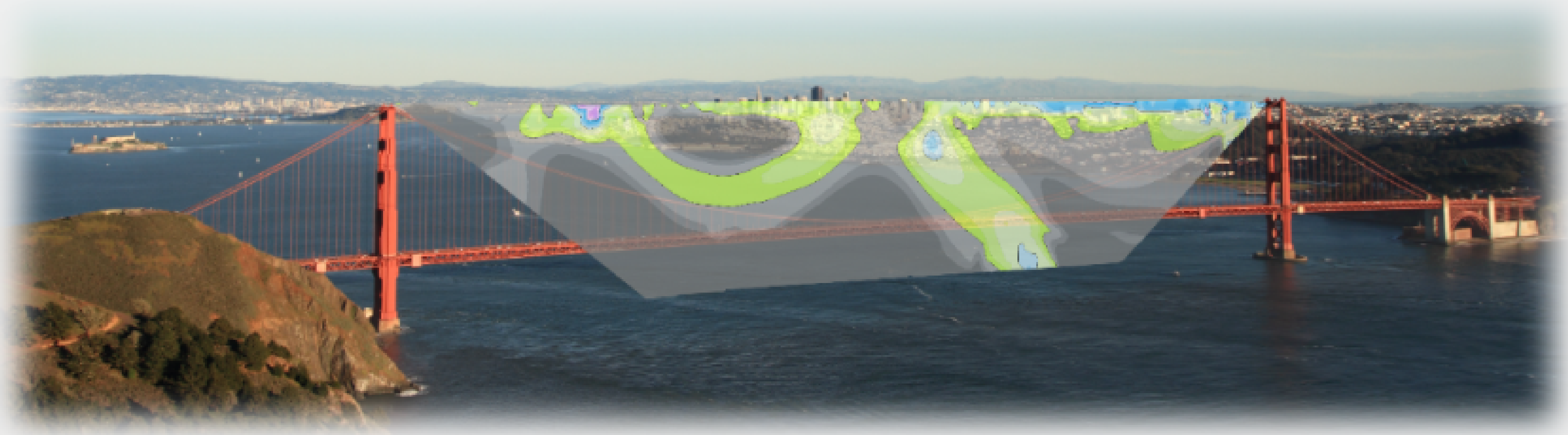
The End of Poke and Hope?

I. The Problem with Poke and Hope

II. Best Management Practices (Electrical Hydrogeology Process)

III. A New Hope: Benefits of Scanning First



Monitoring Well Misconceptions

- "Monitoring Wells" = "Characterization Wells"
- Early Site Assumptions:
  - Single source, single pathways
  - Homogeneous geology/hydrogeology
- Monitoring Well Assumptions:
  - Install without QA/QC or development
  - No routine maintenance needed
  - Samples representative of subsurface

Original HRSC!

3D contaminant migration

Cape Cod (LeBlanc et al. 1991)

Borden (Sudicky et al. 1983)

Scan then Target Approach: Aligning with Other Industries

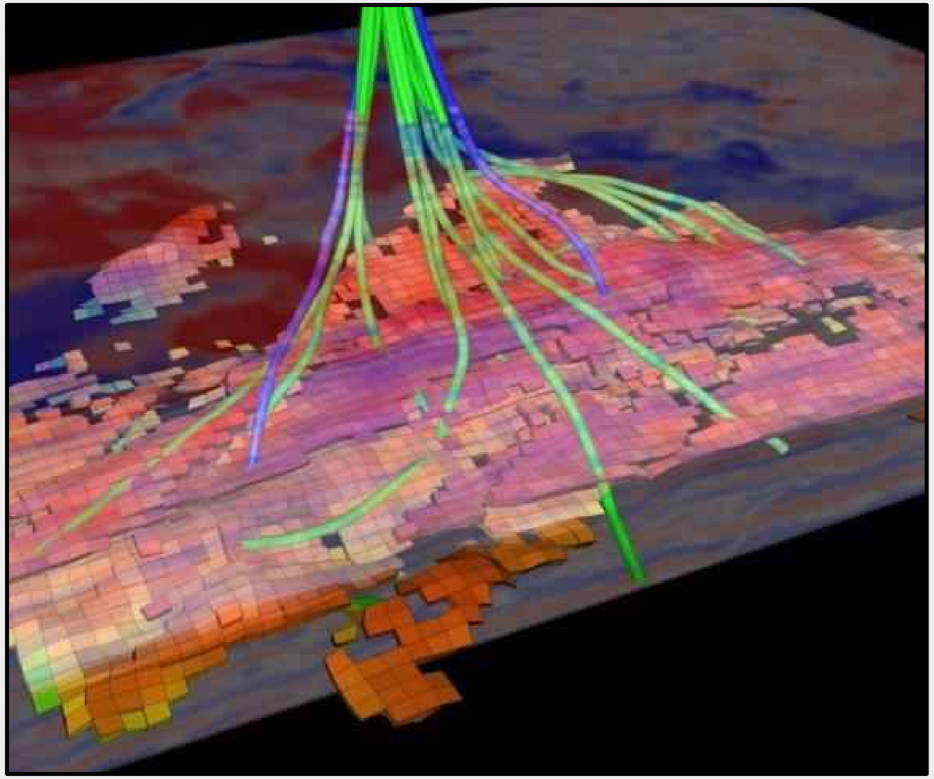
"(seismic) reflections were not even considered on a par with the divining rod, for at least that device had a background of tradition"

E. E. Rosaire

Other industries requiring data "below the surface" evolve to scan first then go invasive

X-ray of Skull

nydailynews.com



3-D Seismic North Sea

dgi.com

NAPL is Distributed as Blobs

- Sufficient data density to see NAPL distribution
- "Drillable" datasets
  (discrete targets for drilling)

Post-remediation evaluation of a LNAPL site using electrical resistivity imaging

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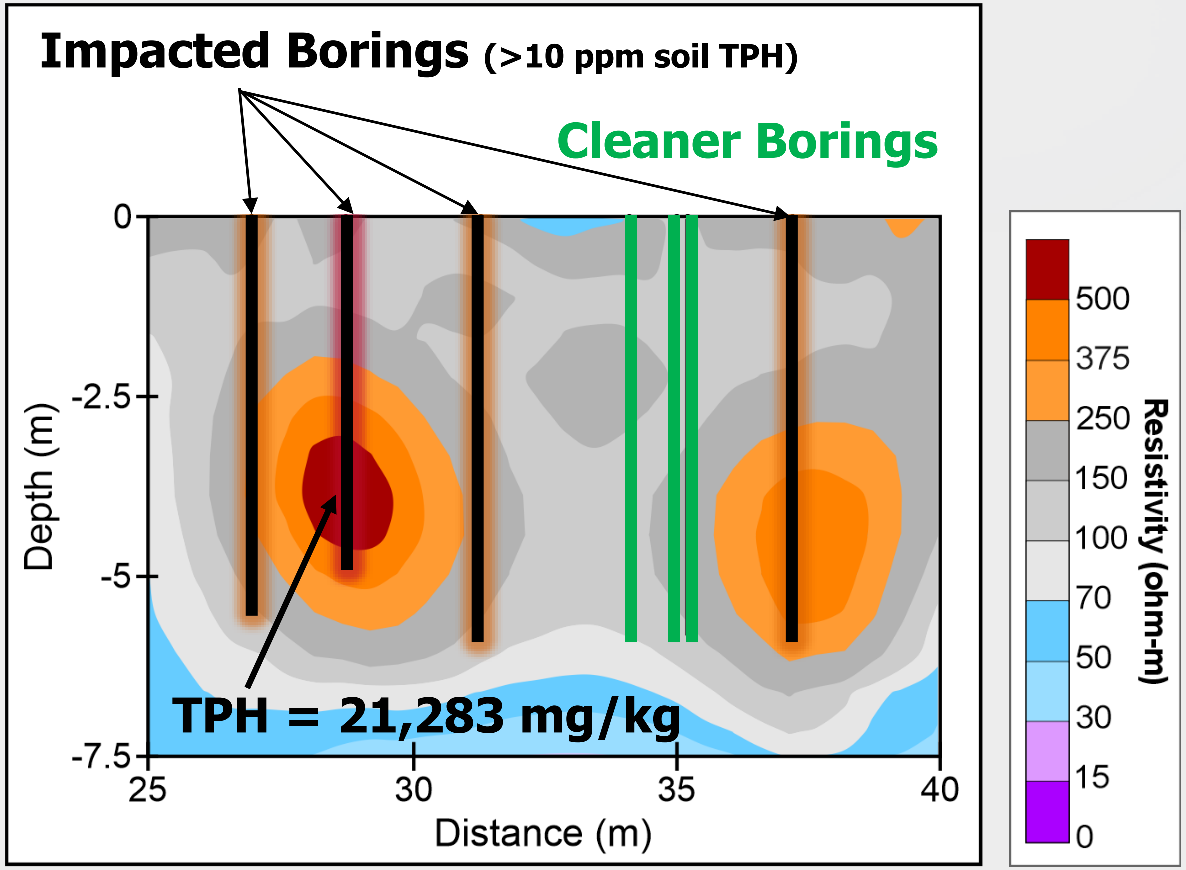
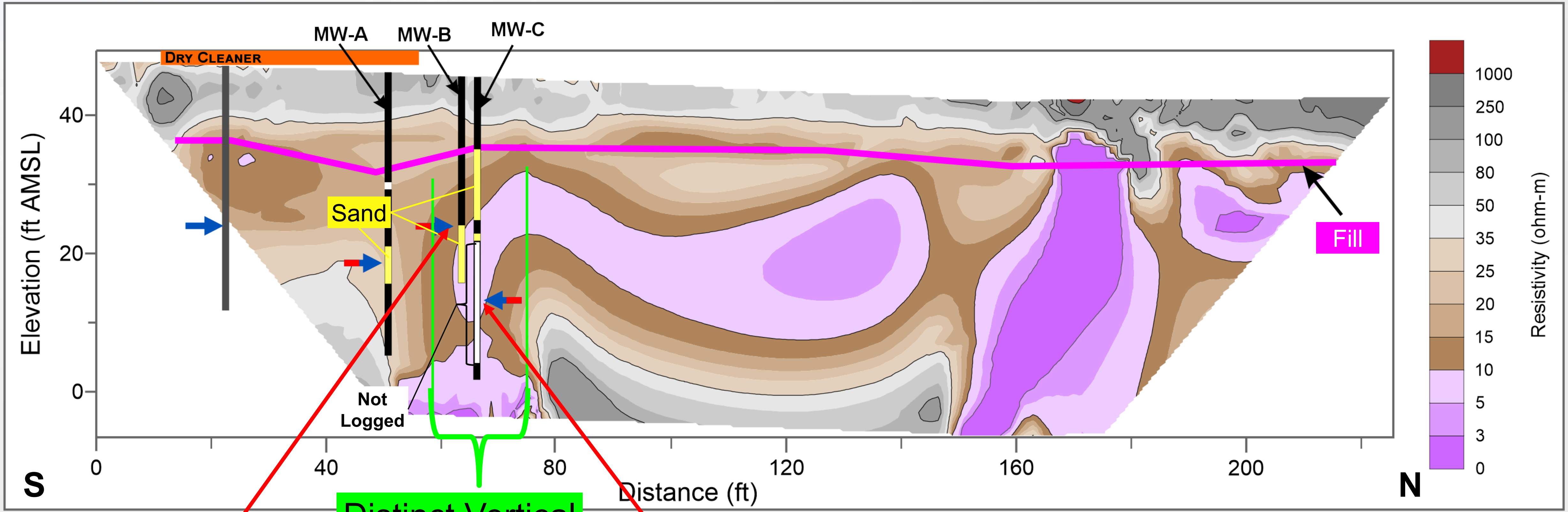


Flow Paths Are Discrete



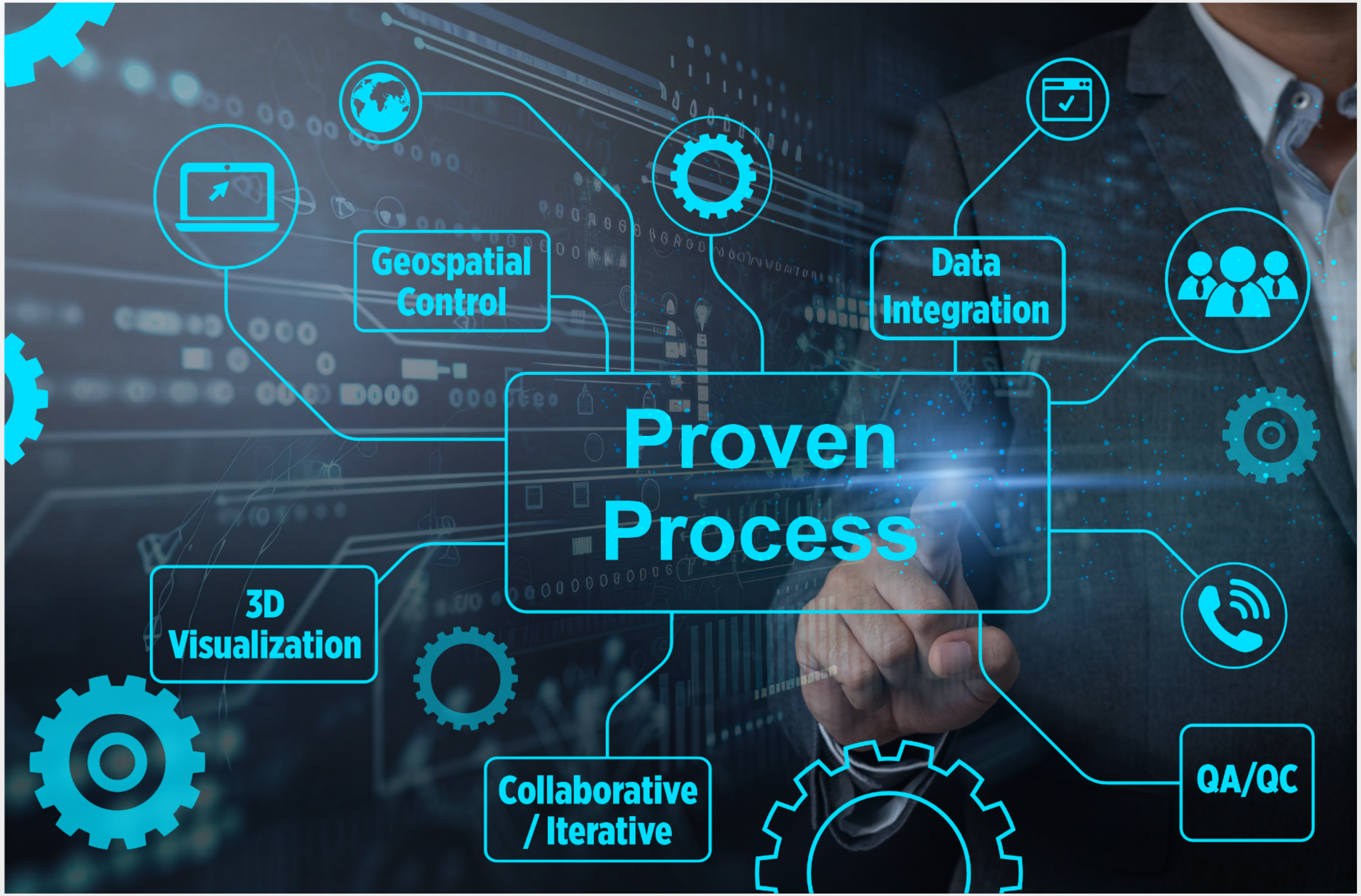
PCE – 120,000 µg/L TCE – 22,000 µg/L DCE – 15,000 µg/L

PCE – 25,000 µg/L TCE – 3,200 µg/L DCE – 15,000

DNAPL in glacial till
(Dry Cleaner Brownfield Site)

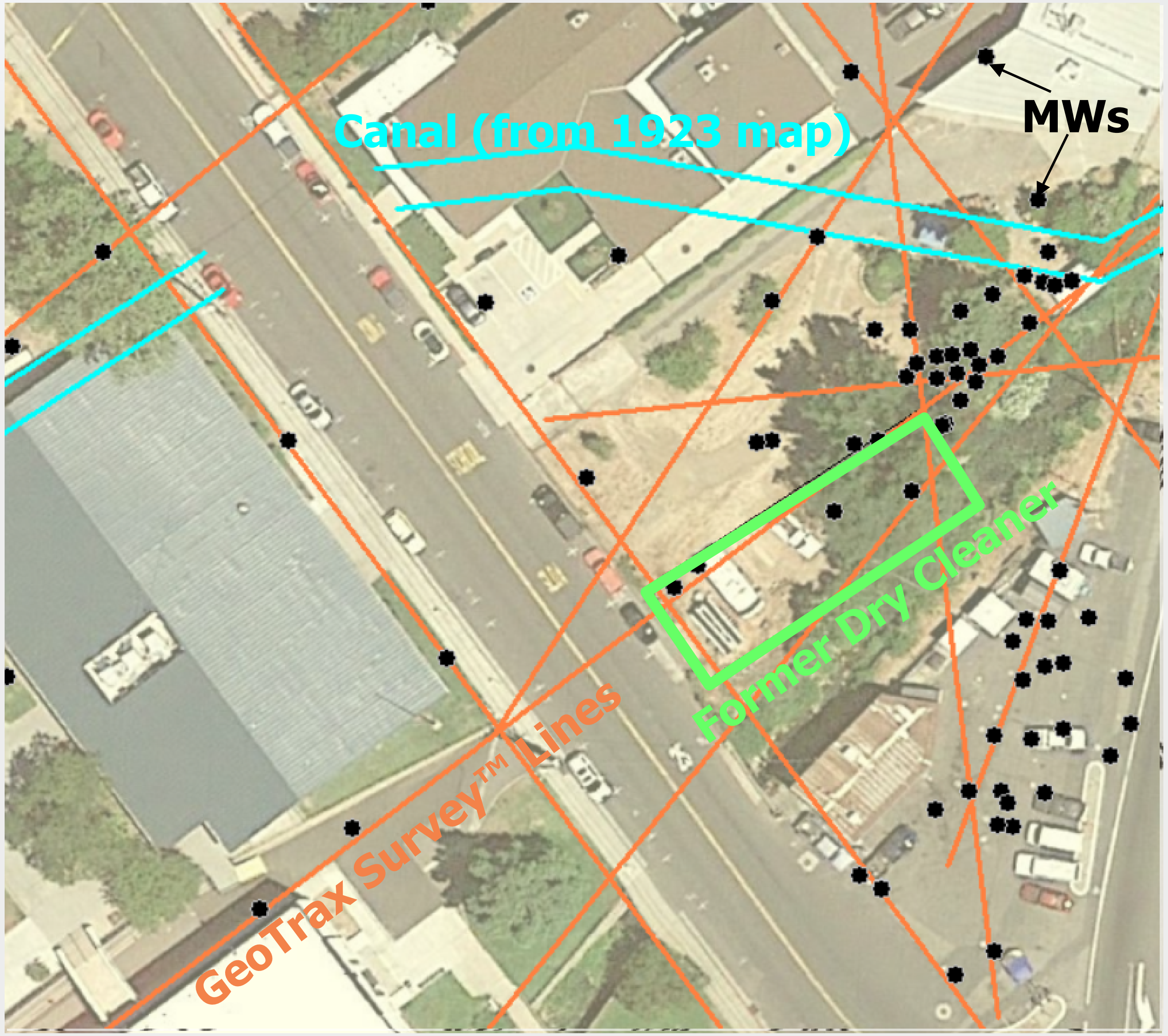
Targeted drilling

Best Management Practices



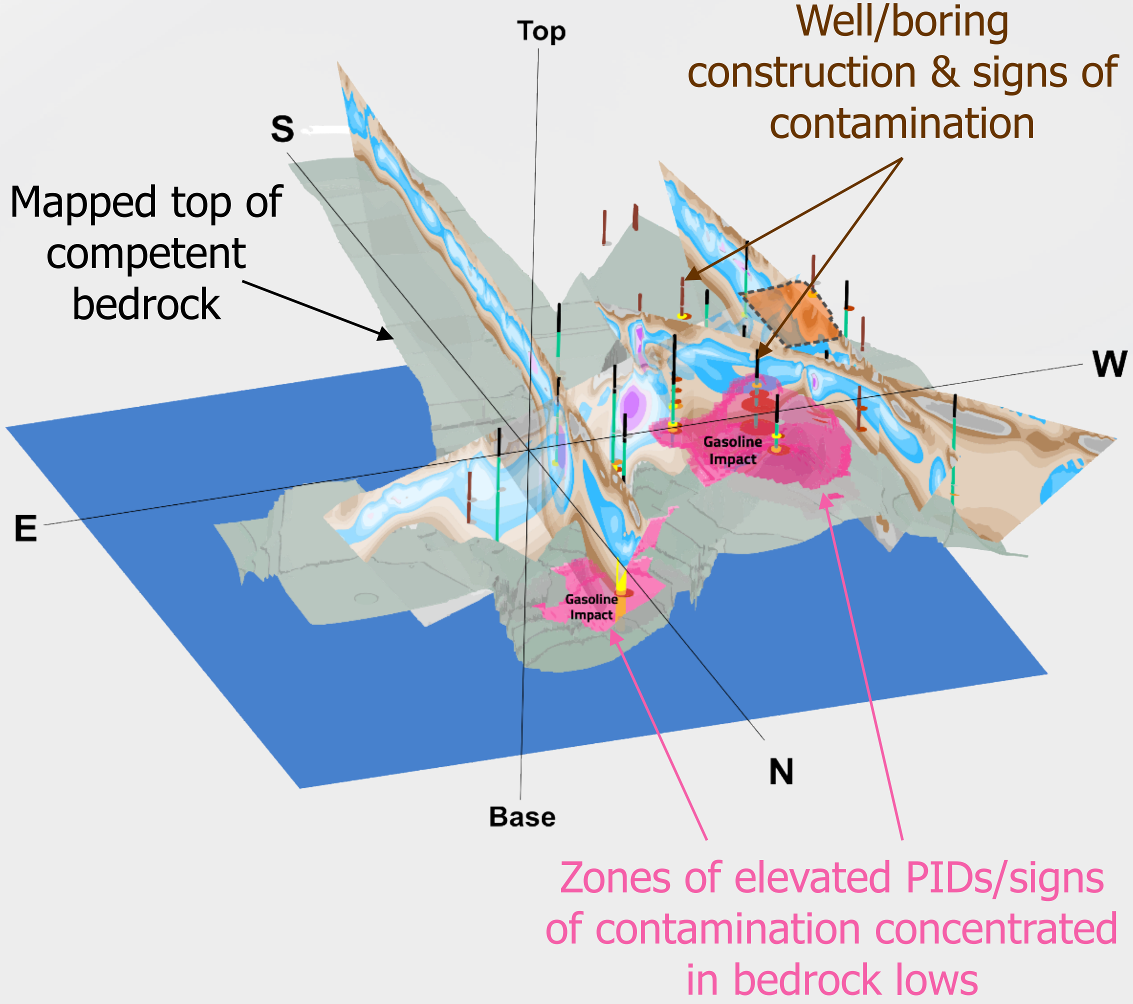
Data Integration & Geospatial Control

- Integrate all available data
  - Historical Records/Aerial, DEM, Regional Geology
  - Chemical Info and Previous Site Work/Remediation
- Multiple lines of evidence
- Robust data base
- Geospatial control is critical



3D Visualization

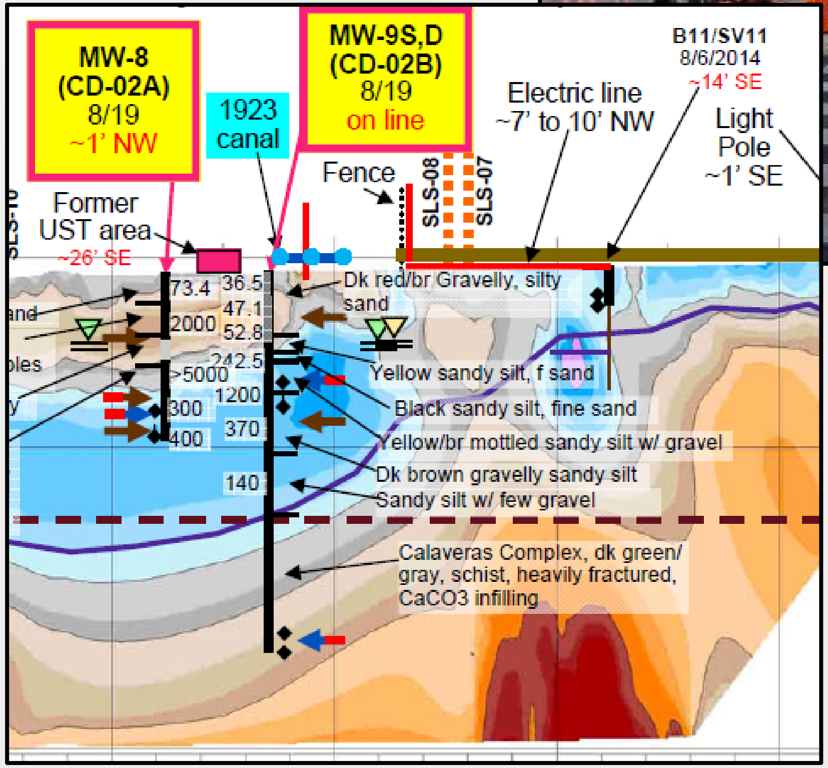
- Robust modeling capabilities
  - Geologic contacts
  - Contaminant extents
- Understand how multiple lines of evidence relate
- See data gaps to inform next steps
- Regulator, RP, & stakeholder buy-in



QA/QC

Critical at every step!

- QAPPs
- Data collection/ sampling
- Data base compilation
- Data integration
- 3D Modeling



Collaboration/Focused Next Steps

Collaborative Team Seeking Data-Driven Solutions

Expect Surprises/ Iterative Ops

Agree on Next Steps

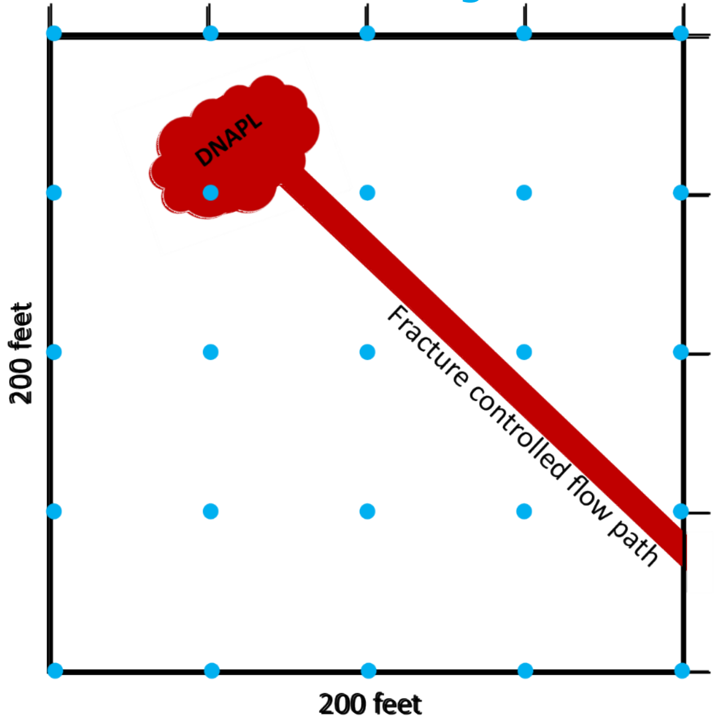
Use Proven Process

Electrical Hydrogeology (Scan First) Workflow

1	2	3	4	5
Visualize Existing Site Data in 3D	**Ultra-High Resolution Electrical Scan**	**Interim Report (w/Hypotheses)**	**Confirmation Drilling (by Client)**	**Final CSM+ Report**
- Client sends existing site data to Aestus	- Field Acquisition: *GeoTrax Survey™* 2D Imagery	- Integrate/QC data sets in 2D&3D (*GeoTrax Viz™*)	- Targeted drilling & sampling; test CSM hypotheses	- Integrate confirmation data (*GeoTrax Viz™*)
- Must occur prior to field work (Step 2)	- Use dynamic work strategy with QA/QC	- Select confirmation drilling (biopsy) locations with client	- Client sends final confirmation drilling data to Aestus	- Finalize GeoTrax CSM+™

Scanning Increases Characterization Certainty

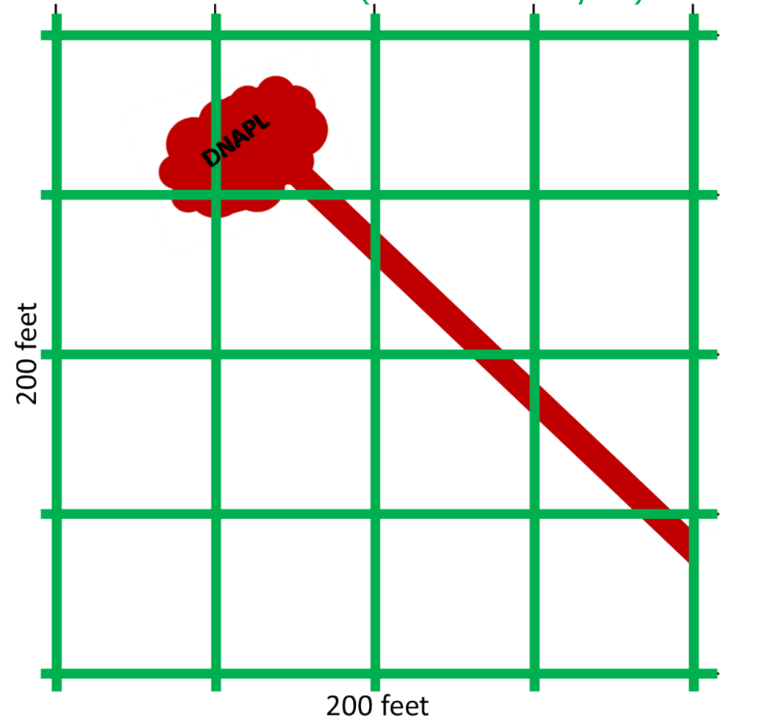
Grid of Monitoring Wells



	MWs	Scans
Number of Wells/Surveys	25	10
Impacted Zones Detected	1	8
Impact Extents Understood?	No	Yes
3D Model Included?	No	Yes
Targeted Areas for Additional Investigation?	No	Yes
Total Approx. Cost	$114k	$200k
Approx. Cost / ft²	**$230**	**$20**

Sampling interval of 50 ft for both MWs & ERI Scans
Values calculated assuming 30 ft drilling depth, 2" PVC

Grid of Scans (GeoTrax Surveys™)

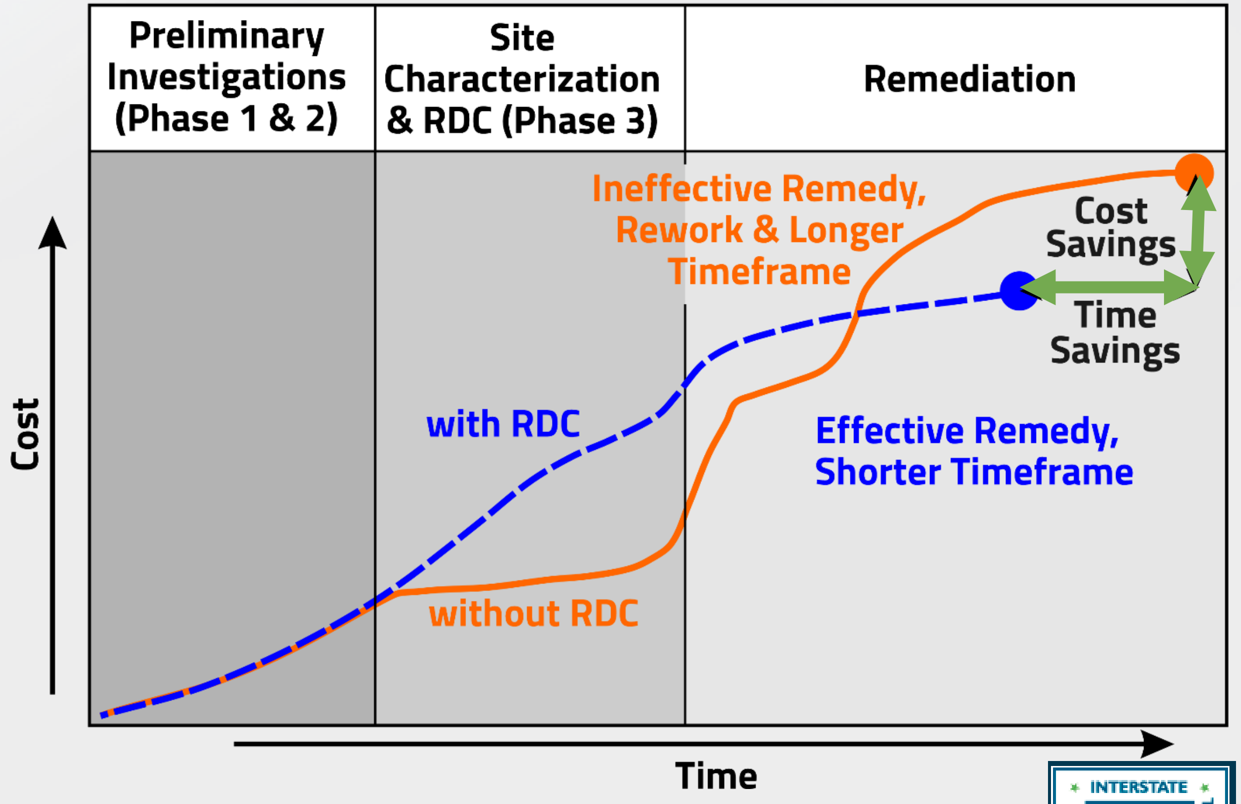


Most sites aren't this simple!

Scanning first is more cost effective and provides clear next steps

Characterization & RDC Saves Time and Costs

- Investing in remedial design characterization (RDC) will save significant ***time and money*** on an overall project basis
- Electrical hydrogeology (scan first) process → more certainty in next steps

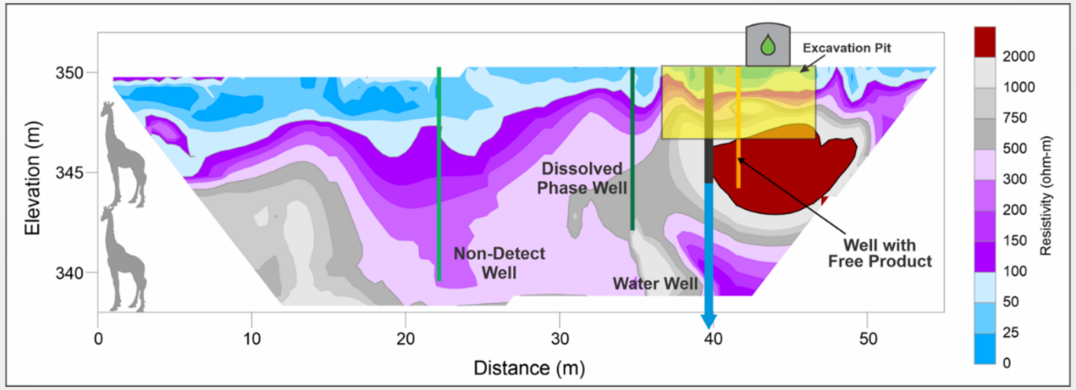


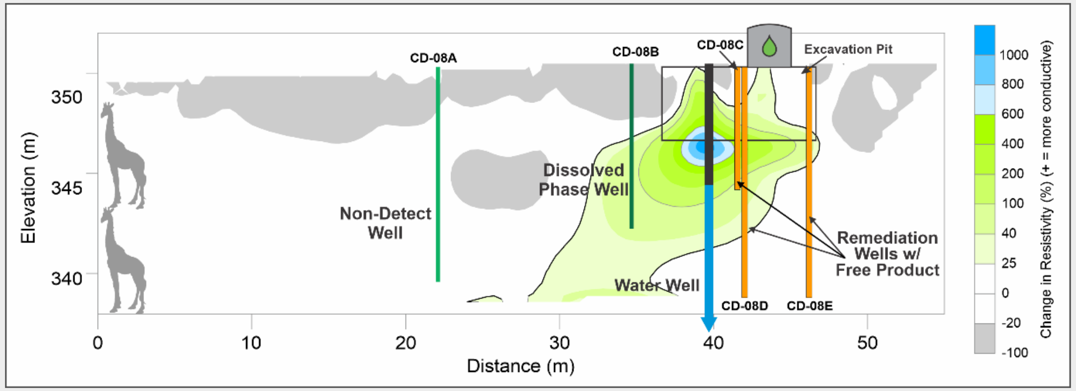
After Interstate Technology & Regulatory Council. 2020.

Every $ spent on characterization can save $$$ on remediation

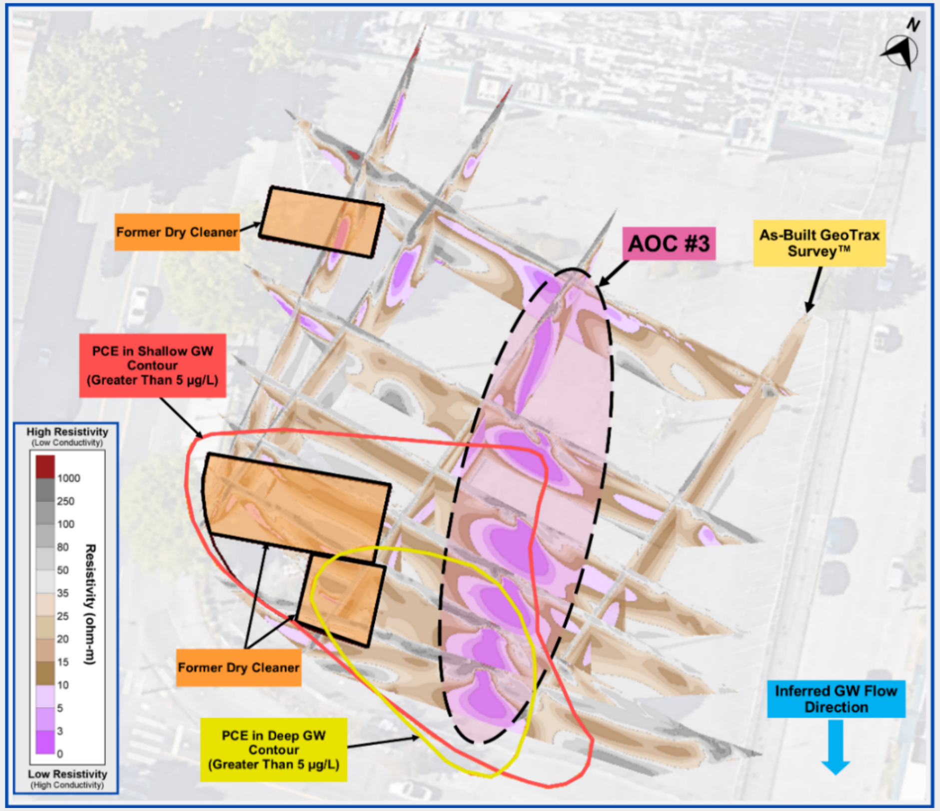
Following the Process: Time and Cost Savings Realized

TIME: LNAPL in Karst (OK)
<u>Site Closure in Less Than 2 Years</u>





COST: CVOCs in Glacial Till (WA)
<u>~$3.7M Saved on Remediation</u>



Cost vs Benefit?

Can we afford to scan prior to remediation?

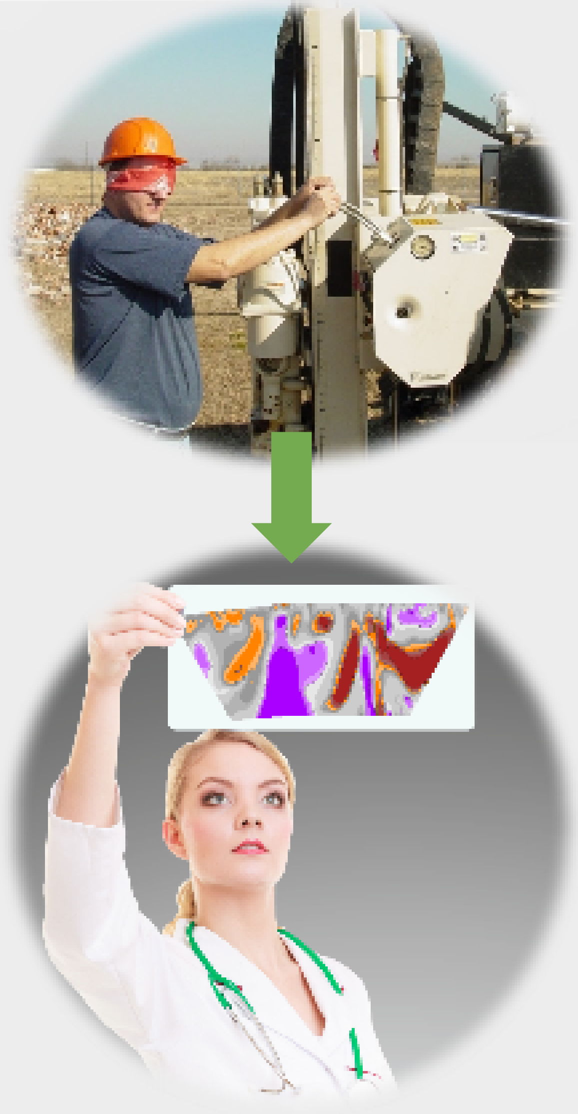
Cost vs Benefit?

~~Can we afford to scan prior to remediation?~~

Can we afford NOT to scan prior to remediation?

Best Practices for Modern Characterization

- **Monitoring Wells ≠ Characterization Wells**
- Successful site characterization requires integrated process:
  - QA/QC & safety protocols
  - Integrated geospatial database
  - Scan (or other HRSC) prior to remediation
  - 3D visualization
  - Iterative & collaborative evaluation
- Electrical hydrogeology yields time and cost savings for remediation with minimized trailing liabilities



Acknowledgements & References

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Greystone Environmental

References:

California Waterboard, 2023, Underground Storage Tank Cleanup Fund 2023 Cost Guidelines Update: https://www.waterboards.ca.gov/water_issues/programs/ustcf/docs/2023/2023-costguidelines.pdf (accessed April 2024)

Halihan, T., Albano, J., Comfort, S., Zlotnik, V., 2012, Ground Water Monitoring and Remediation, v. 32, no. 1, p. 43, doi: 10.1111/j.1745-6592.2011.01361.x.

Halihan, T., Paxton, S., Graham, I., Fenstemaker, T., Riley., M., 2005, Post-remediation evaluation of a LNAPL site using electrical resistivity imaging: Journal of Environmental Monitoring, v. 7, p. 283-287, doi: 10.1039/b416484a.

Interstate Technology & Regulatory Council, 2020, Optimizing Injection Strategies and In situ Remediation Performance, OIS-ISRP-1, Washington, D.C.: Interstate Technology & Regulatory Council, OIS-ISRP Team.

LeBlanc, D. R., S. P. Garabedian, K. M. Hess, L. W. Gelhar, R. D. Quadri, K. G. Stollenwerk, and W. W. Wood, 1991, Large-scale natural gradient tracer test in sand and gravel, Cape Cod, Massachusetts: 1. Experimental design and observed tracer movement, Water Resour. Res., v. 27, no. 5, p. 895–910, doi: 10.1029/91WR00241.

Sudicky, E.A. , Cherry, J.A., Frind, E.O., 1983, Migration of contaminants in groundwater at a landfill: A case study: 4. A natural-gradient dispersion test, Journal of Hydrology, v. 63, no. 1–2, p. 81-108, doi: 10.1016/0022-1694(83)90224-X.

QUESTIONS?

Thank you for your time!

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