NEIWPCC EPA ASTSWMO pennsylvania

NTC 2022

Electrical Hydrogeology of LNAPL Impacts in Fractured Rock Aquifers

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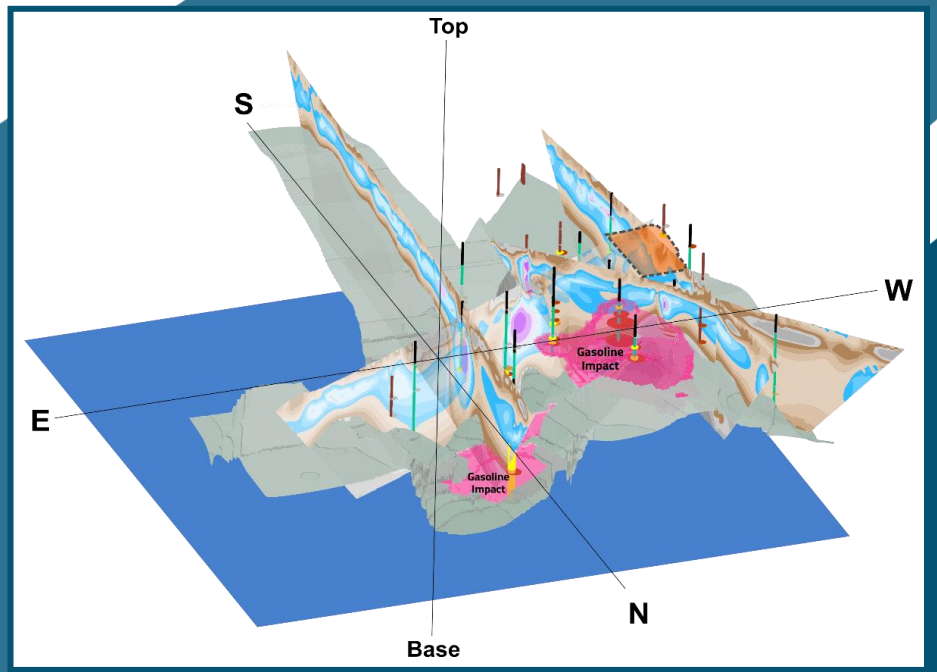
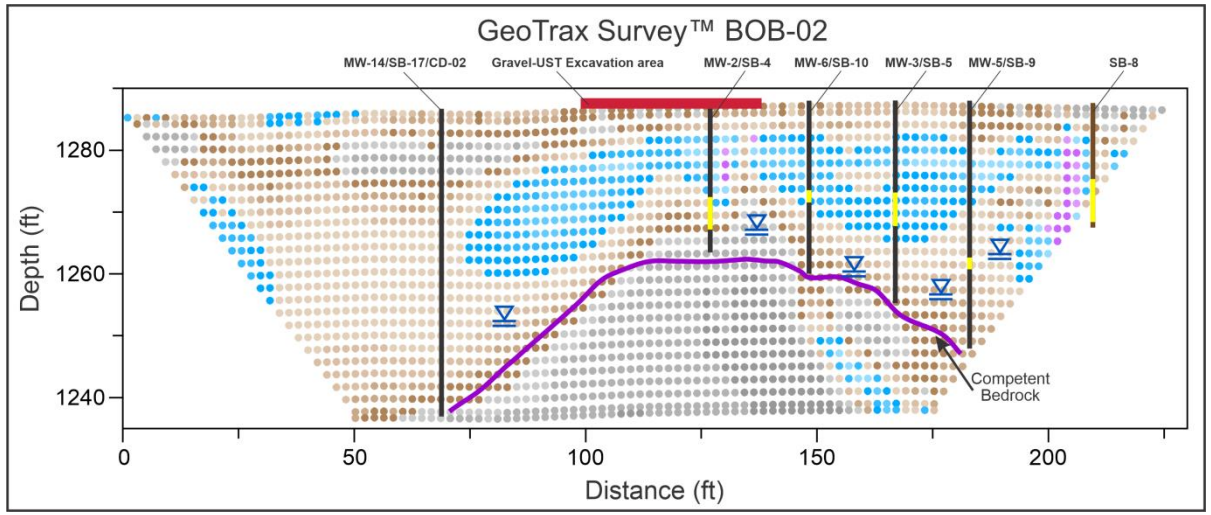


OSU

Aestus
Aestus, LLC

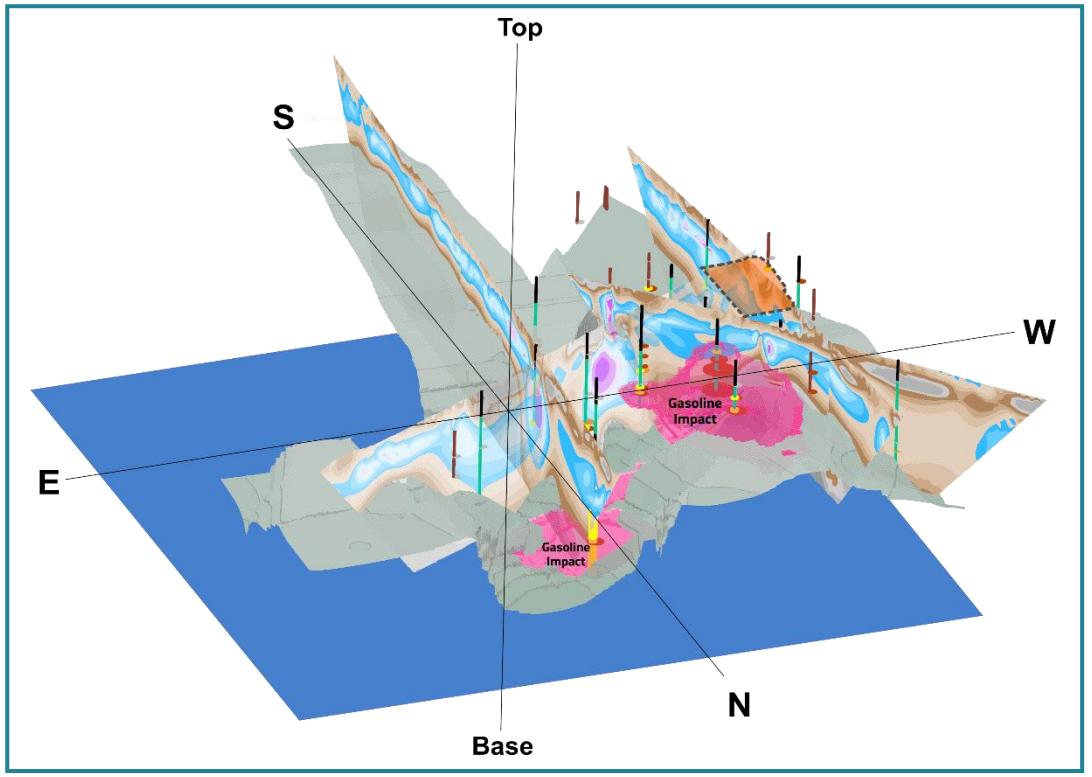
20 Years of Electrical Hydrogeology

Missouri Karst LNAPL Site



Scan, then confirm

- >2K electrical data points
- 6 borings
- BTEX data
- PID data



3D Conceptual Site Model

- 22,000 electrical data points
- Pathways delineated

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Low and High Electrical Resistivity

Conductive (<10 ohm-m)

- Clay
- Salt water
- Microbes

Resistive (>250 ohm-m)

- Clean Gravel or Sand (no fines)
- Undegraded Fuels
- Undegraded Solvents

Looking at Electrical Features in Bedrock

Electrical Imaging of Dipping Features

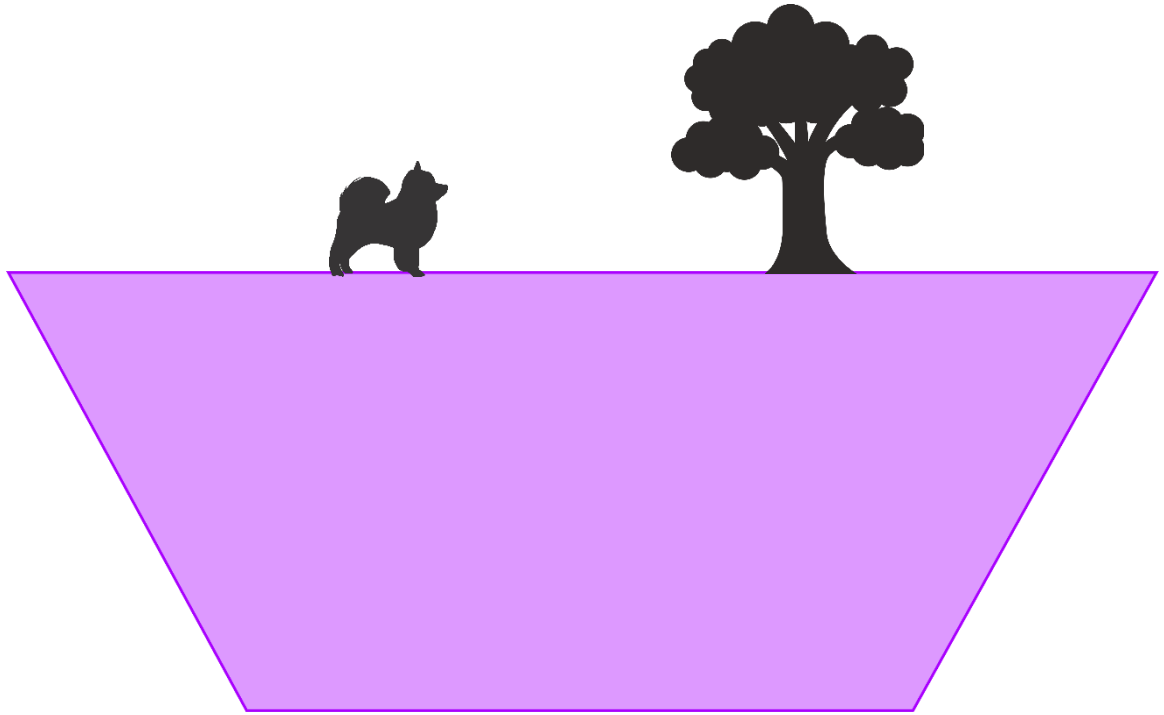
A. Scan after "Surgery"

Gasoline in fractured sandstone/siltstones

B. Scan before "Surgery"

Diesel in fractured karstic carbonates

Electrical Structural Geology: GeoTrax Image vs Dipping Geology



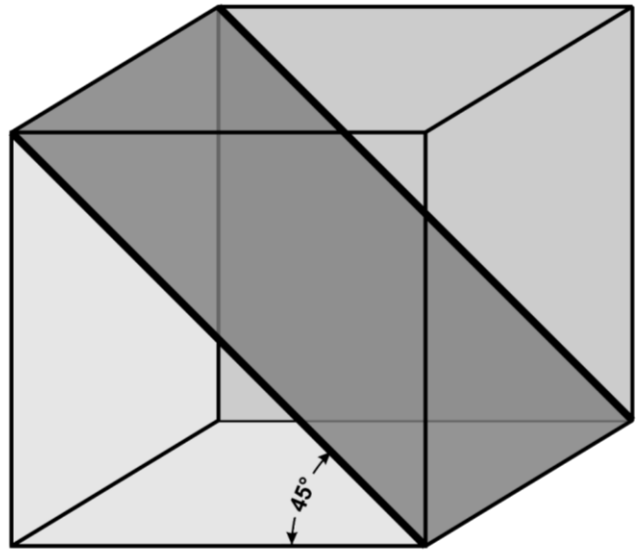


Image along Dip (perpendicular to strike)

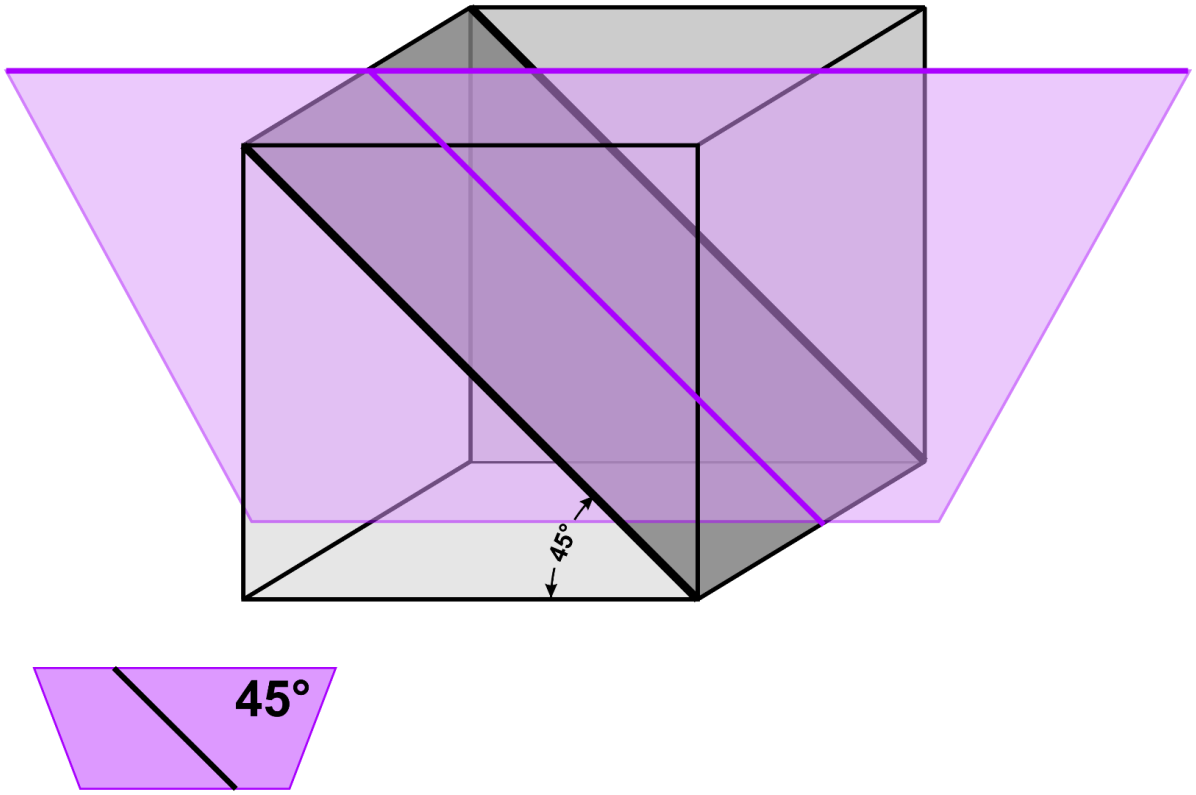


Image 45 Degrees from Strike

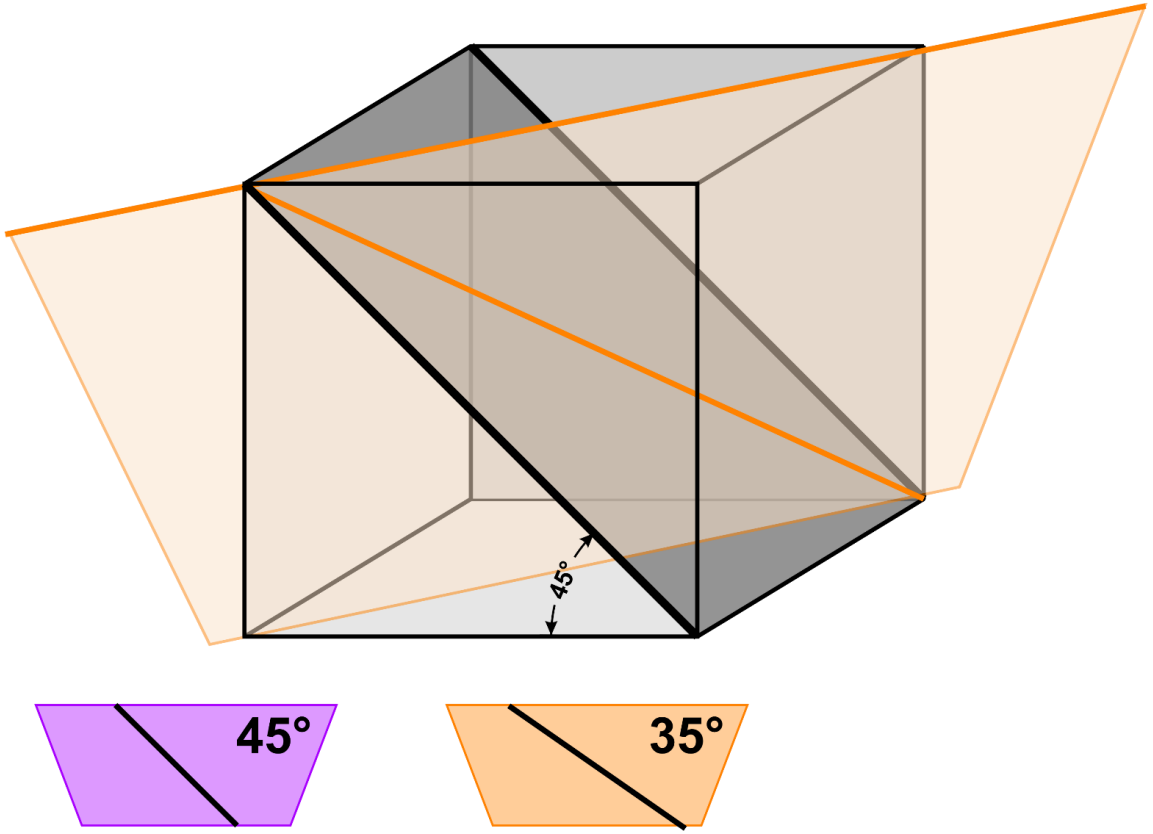
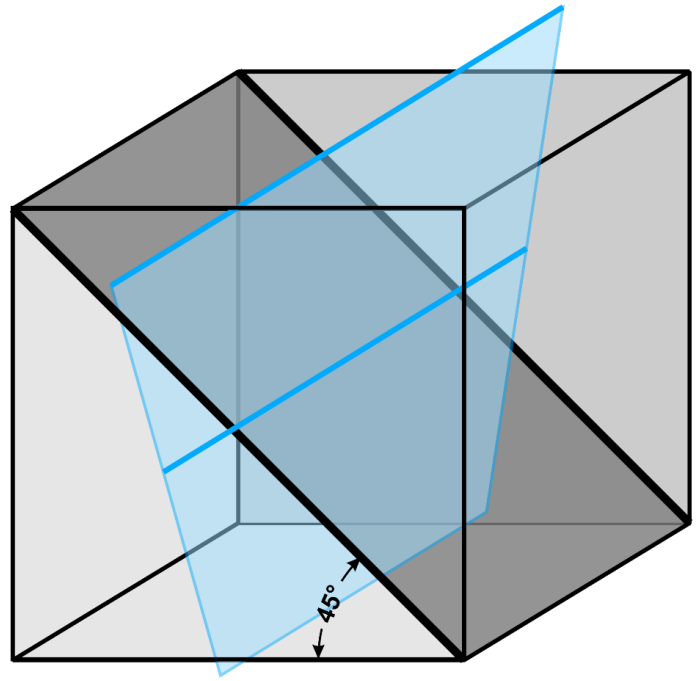
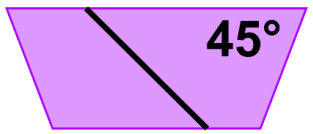
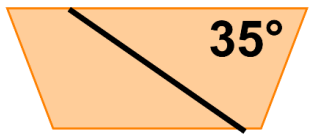
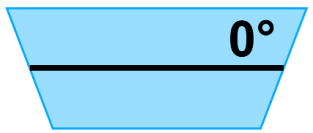


Image along Strike









Following a Process is Key

1 Data Transfer to Aestus

- Visualize historic site data using *GeoTrax Viz*™

2 Scan — Ultra-High Resolution Scan

- Acquire *GeoTrax Survey*™ 2D Imagery
- Use Dynamic work strategy with QA/QC

3 Interim Report (w/Hypotheses)

- Integrate data sets in 2D & 3D (*GeoTrax Viz*™)
- Select confirmation drilling locations

4 Biopsy — Confirmation Drilling (by Client)

- Perform targeted drilling/sampling to test CSM

5 Final CSM+ Report

- Integrate confirmation data (*GeoTrax Viz*™)
- Finalize *GeoTrax CSM+*™

Conceptual Site Model Components

1. Geologic CSM – Where are the rocks?
2. Hydrogeologic CSM – Where is the water?
3. Bioactivity CSM – Where are the bugs?
4. Contaminant CSM – Where are the impacts?

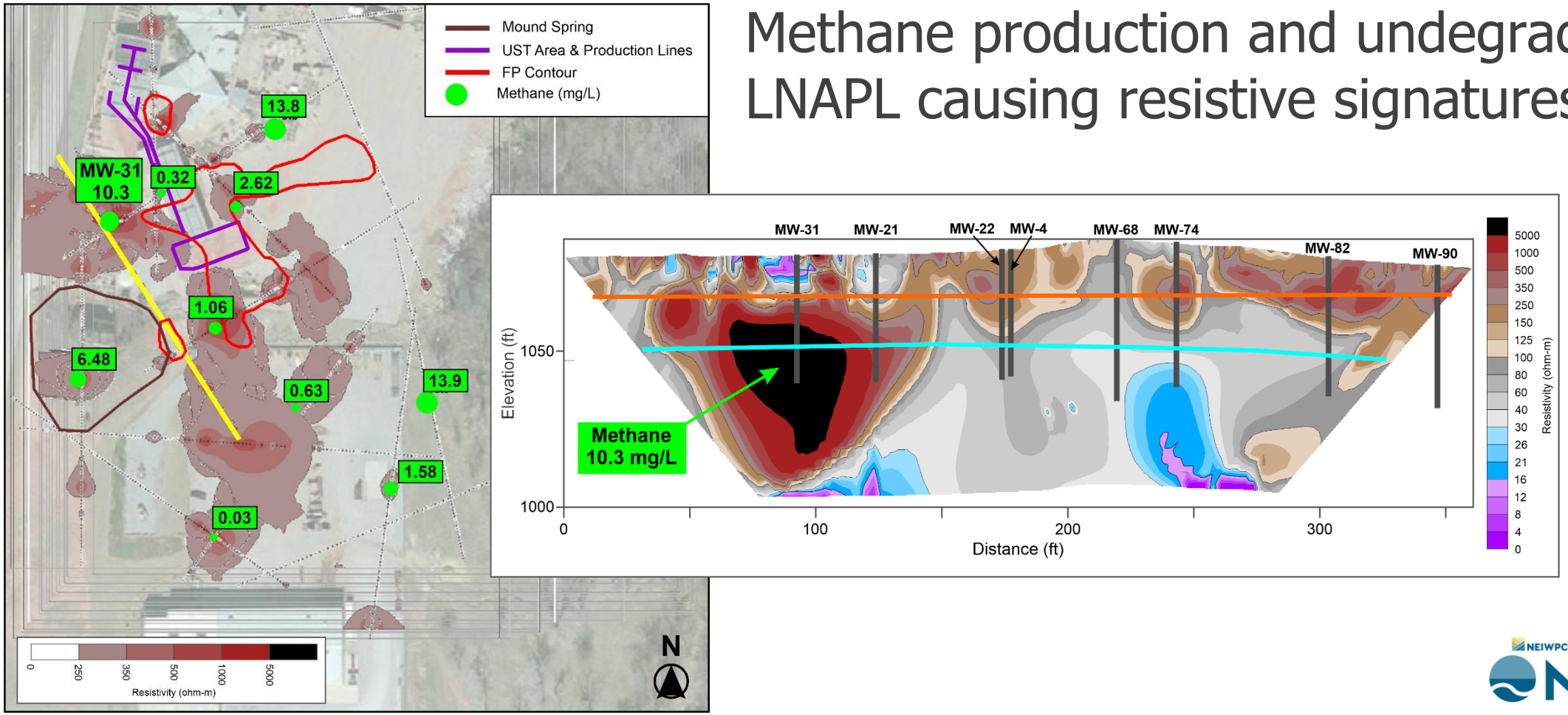
End Result: Integrated Conceptual Site Model

High Density Electrical Data + Wells/borings in Critical Locations

A. Gasoline in fracture sandstone/siltstones

- Investigation began in 1990s, 7 USTs removed, ~70 total wells
- Scans in 2020 to determine source of recalcitrant LNAPL

A. Bioactivity CSM
Electrically Resistive Anomalies



Methane production and undegraded LNAPL causing resistive signatures

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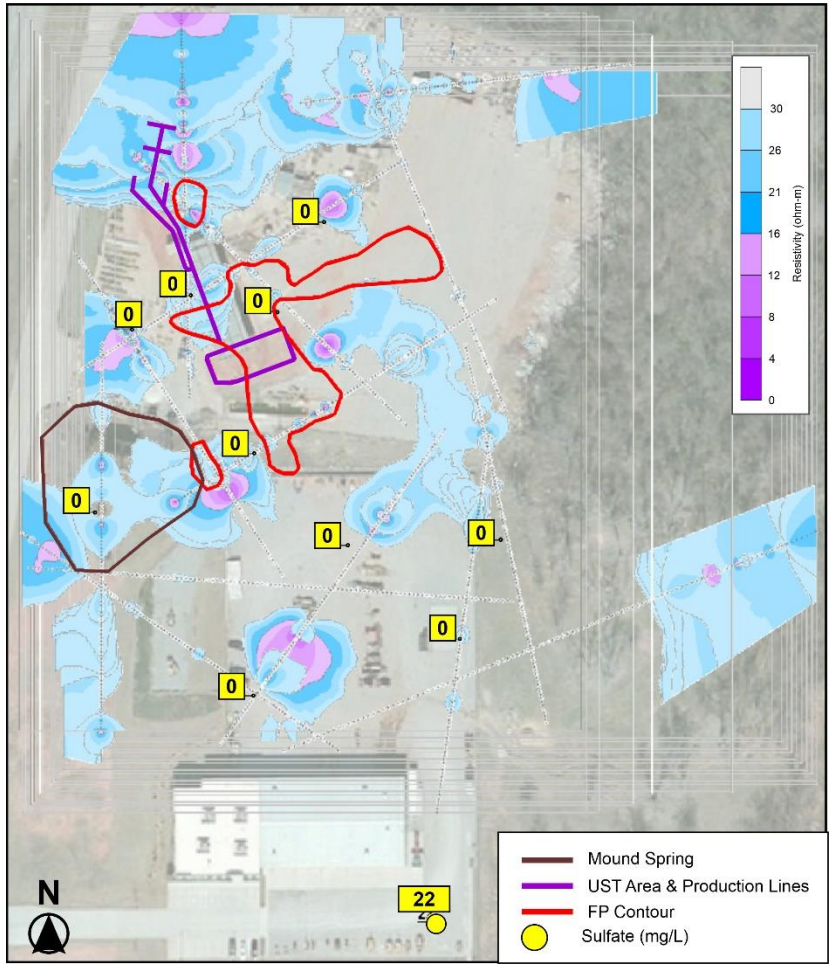
A. Bioactivity CSM
Electrically Conductive Anomalies



- Conductors likely correspond with zones of bioactivity
- Located on plume fringes
- Bioactivity appears limited
  - Presence of undegraded product
  - Lack of sulfate near plume

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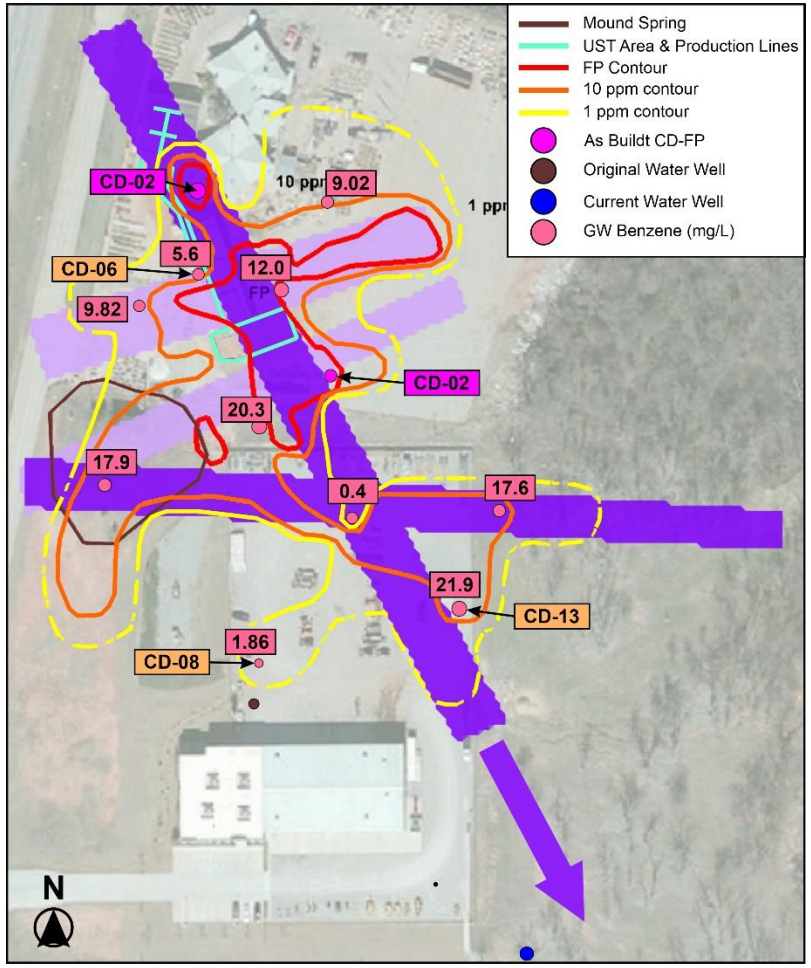
A. Final Report CSM Update Summary



- 4 fracture zones identified that influence groundwater flow and contaminant migration
- Some degradation occurring in source area, but limited due to loss of sulfate
- Vertical extents are deeper, below water table, in fracture zones
- Vadose impacts cause remaining free product

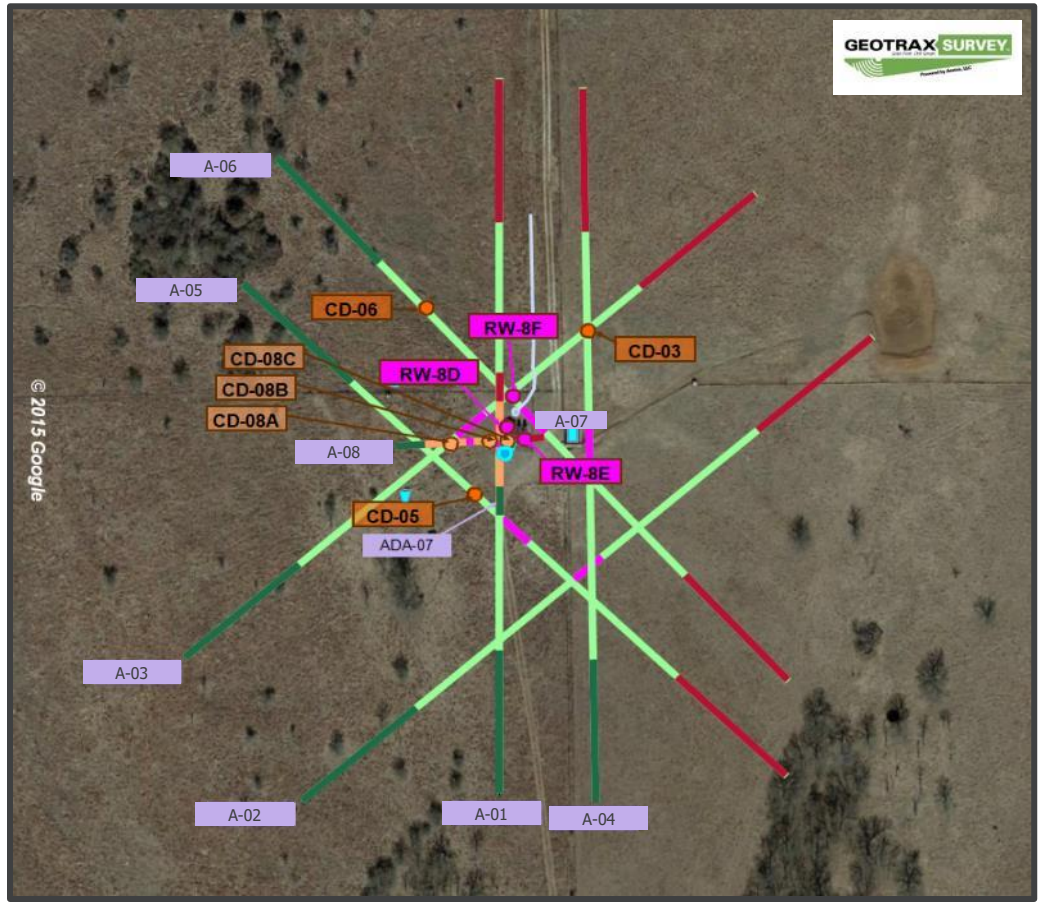
B. Diesel in fractured karstic carbonates

- AST Released 2000 gal diesel in 2015
- 1 LNAPL impacted water supply well
- Scans in 2015 to determine distribution of LNAPL
- Remediated in under 2 years, all wells non-detect

work with Greystone Env. and Layne Christensen

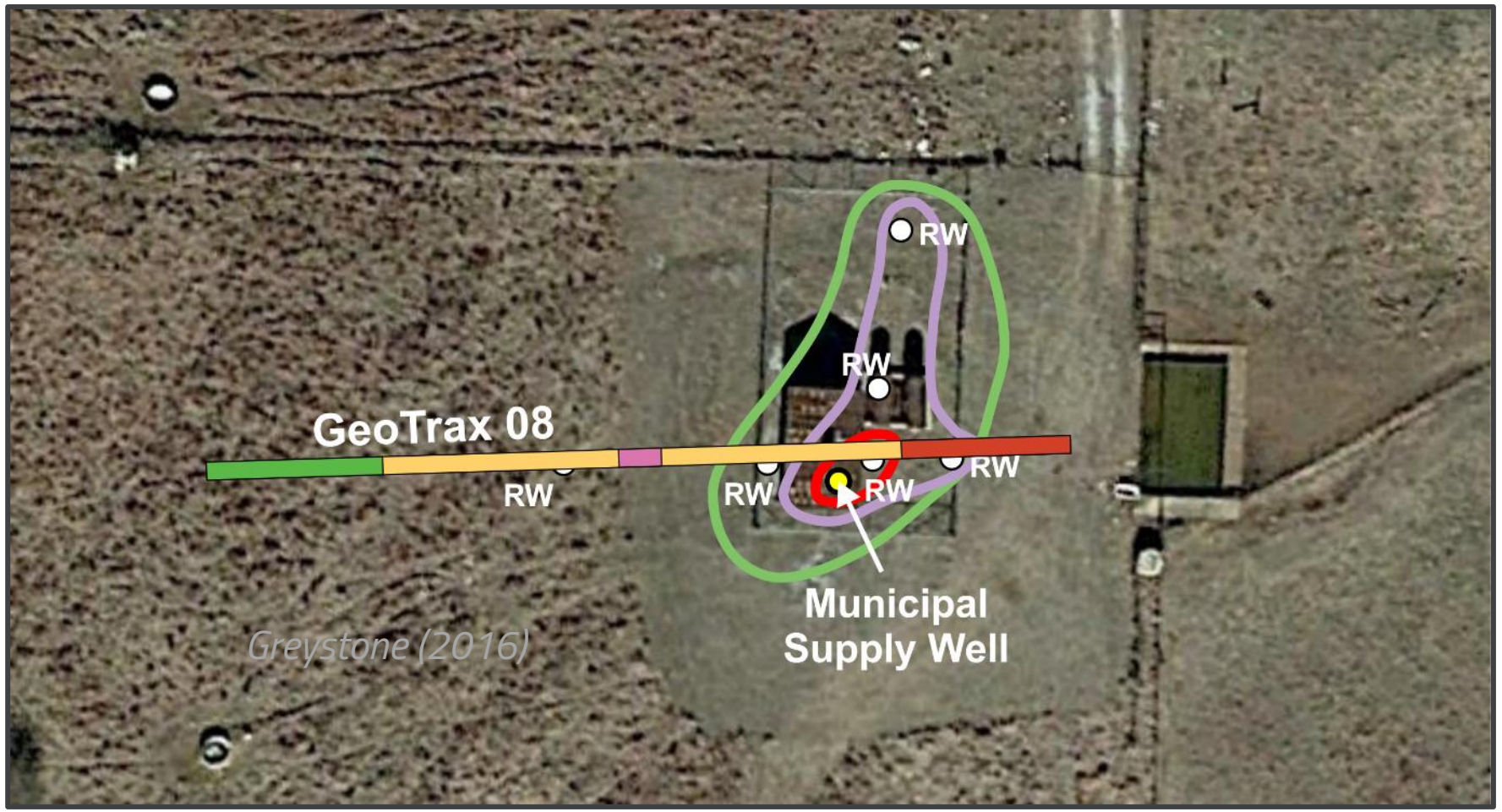
B. Municipal Supply Well Impact

3D CSM

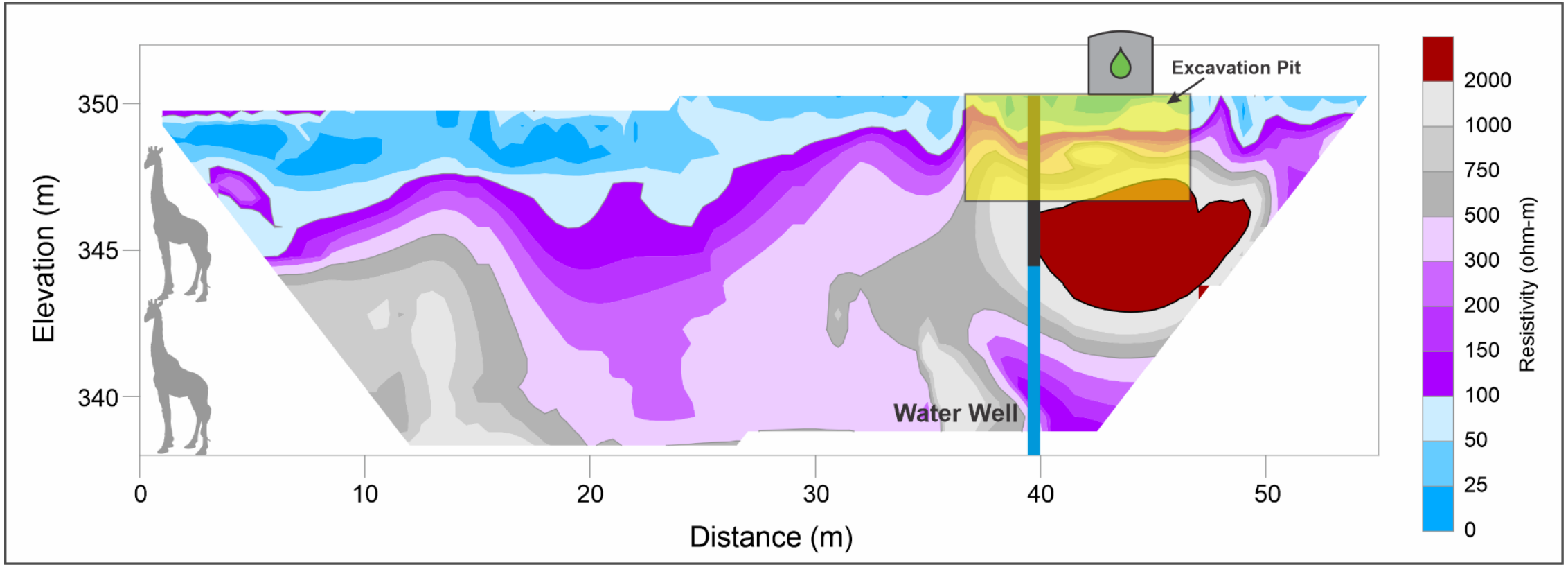


Targeted Remediation

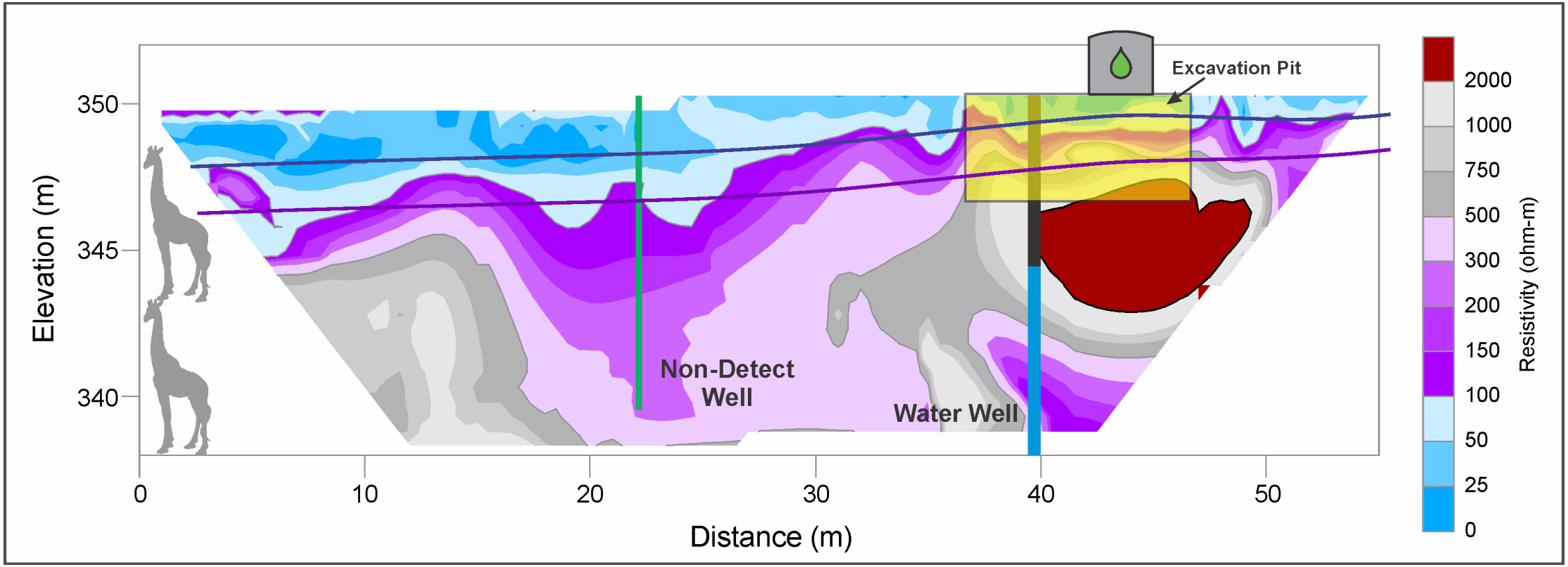
B. Integrated Data Sets: Horizontal Spill Extent



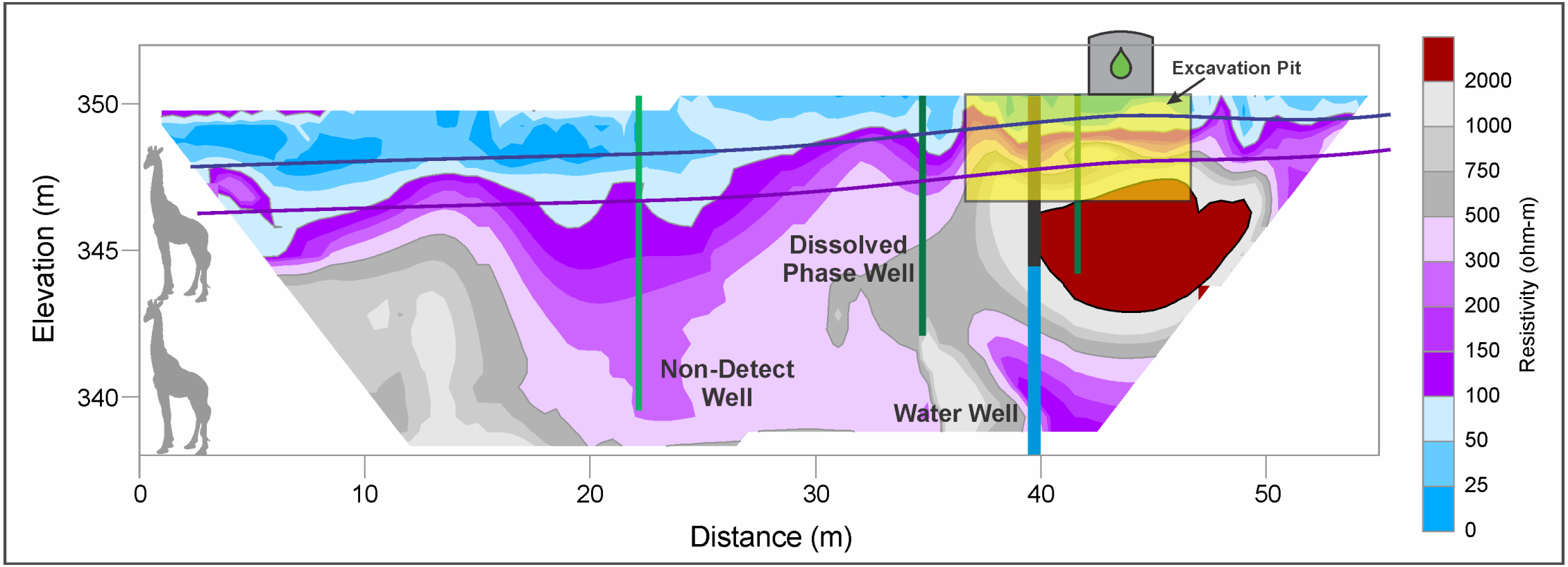
B. Data Integration Synthesis to CSM



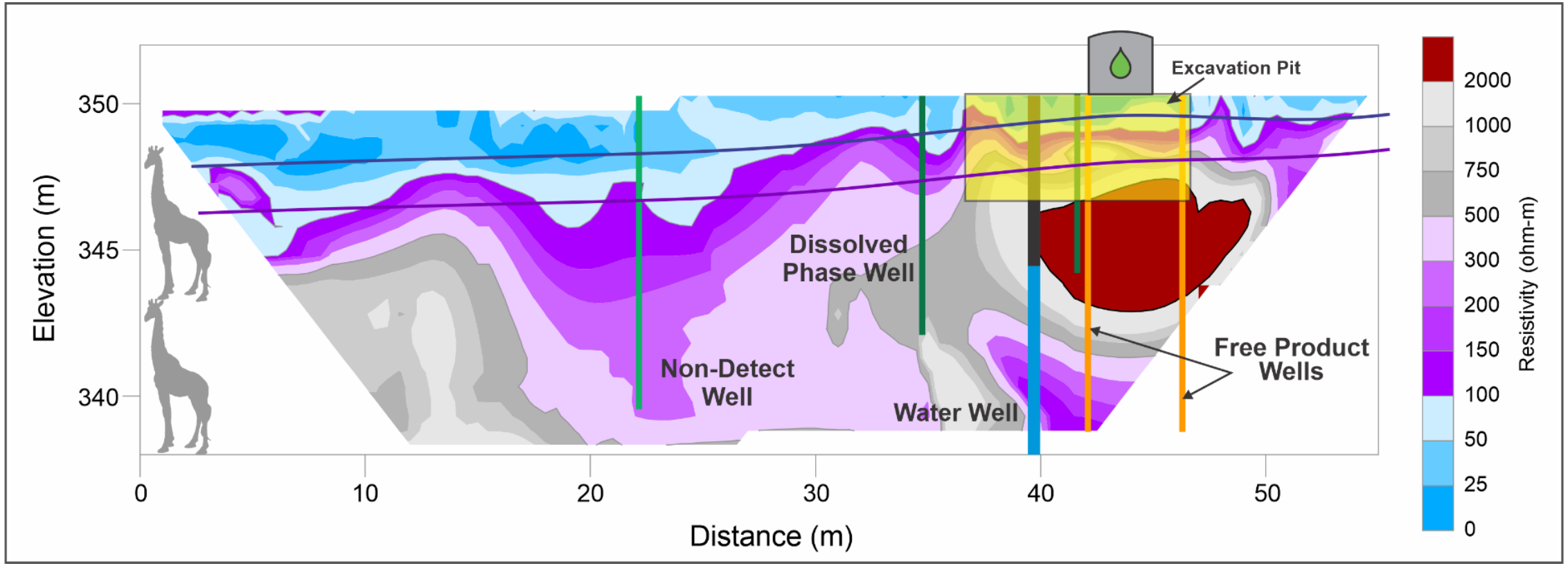
B. Data Integration Synthesis to Geology CSM



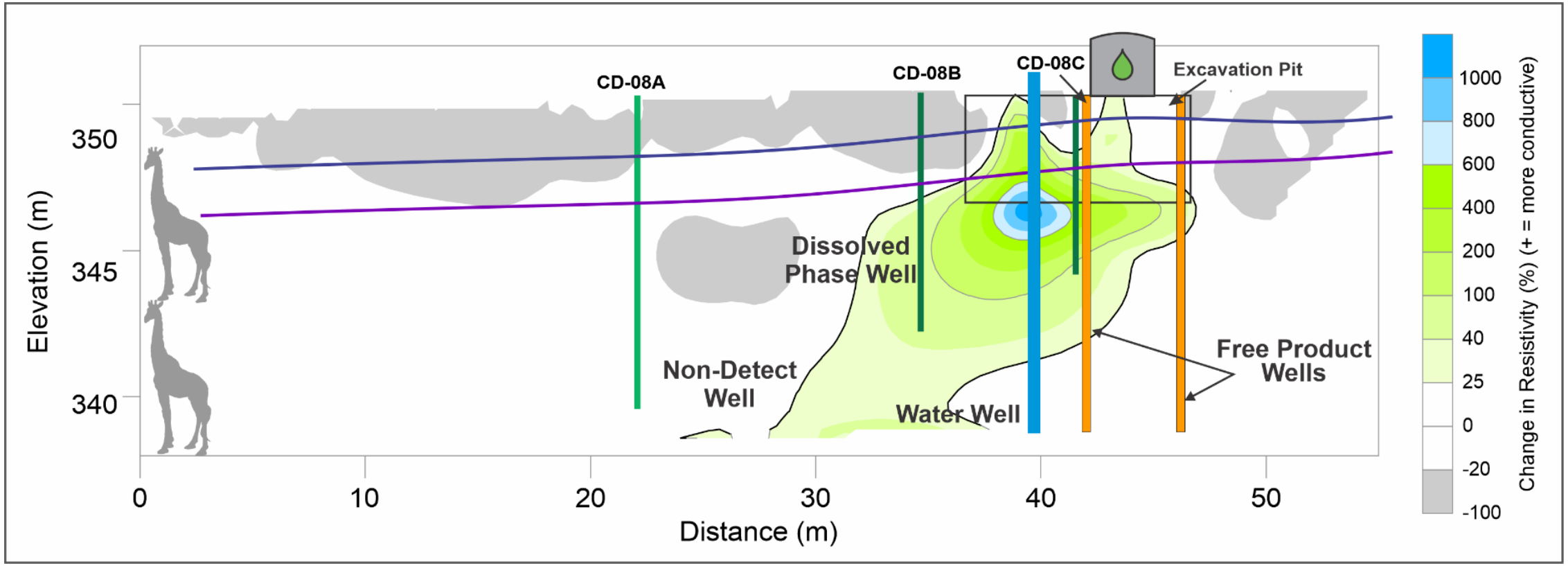
B. Data Integration Synthesis to Contaminant CSM



B. Data Integration Synthesis to Contaminant CSM

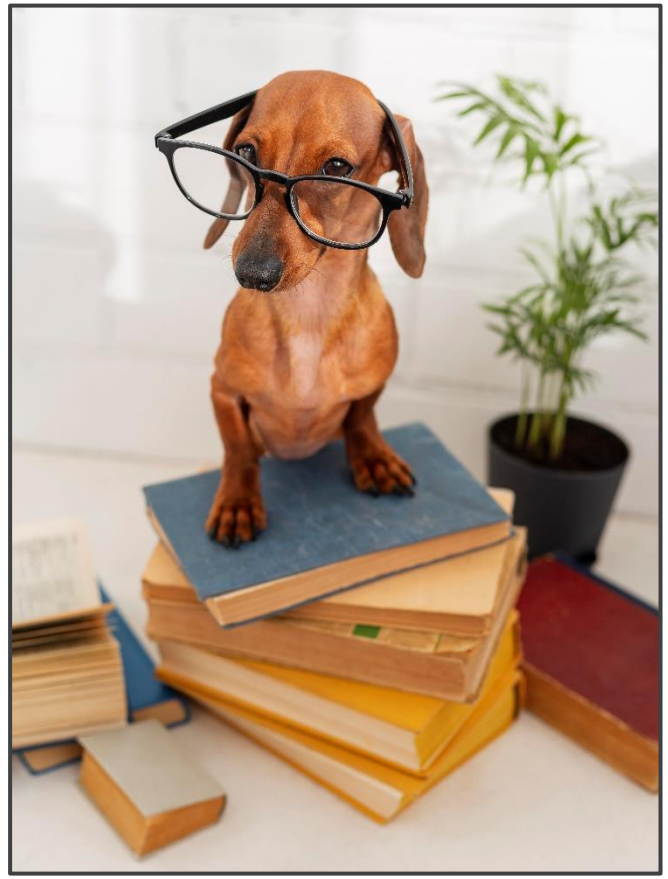


B. Data Integration Synthesis to Bioactivity CSM



20 Years of Lessons Learned

1. Impacted bedrock sites are a dog's breakfast of 3D flowpaths and biogeochemical reactions
2. Scanning first provides drilling targets to develop a useful CSM
3. Wells DO NOT work in isolation!
4. Volume reduction and biochemical analysis during characterization leads to cheaper, focused remediation



Future

1. Characterization of structural flowpaths
   (analogous to seismic attribute analysis)

2. Temporal ERI (TERI)
   - Short term: Injection or thermal remediation monitoring
   - Long term: Site monitoring (like a well, but 1000 ft instead of 2 inches)

QUESTIONS?

Thank you for your time!

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