Geophysical Applications to Subsurface Investigations: Reducing Uncertainty and Minimizing Risk

17th Annual Technical Forum for Geohazards Impacting Transportation in the Appalachian Region

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Blacksburg, Virginia

Presented By

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Why Perform Geophysical Testing?

- **Sometimes provides information that you cannot get through invasive sampling.**
- **Fills in the blanks: Invasive sampling gives detailed information at one location; geophysics provides less detailed information over a broader area.**
- **Value: Reduces uncertainty and allows a targeted approach to invasive sampling.**

Sinha, Thomas, Wang & Jung (2007) Penn State Study--Meta-analysis of cost-benefit studies of PADOT and VADOT projects

$1 spent up-front on geophysics saved (on average) $7 in total project cost

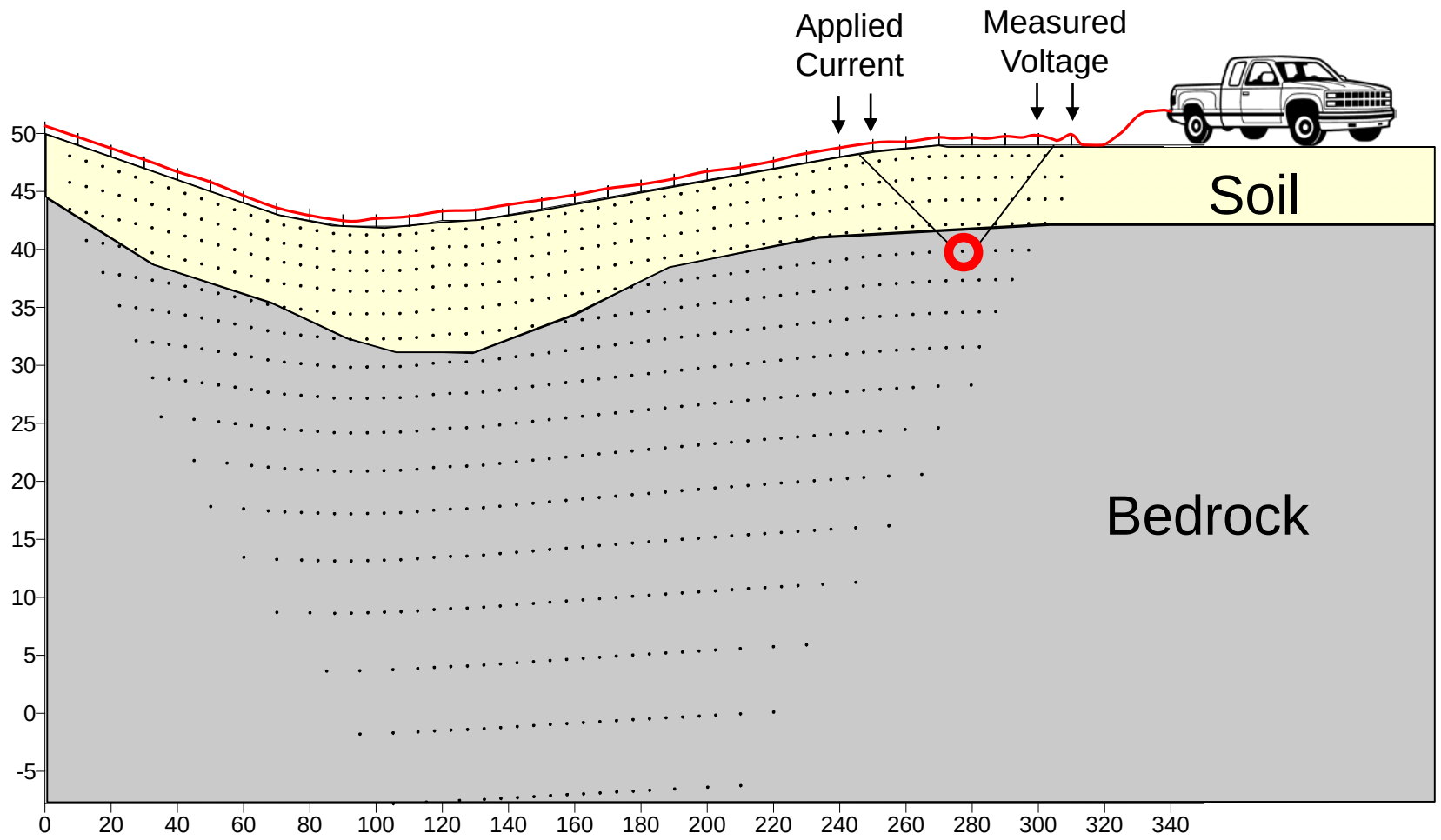
Resistivity

- **The property of a material to inhibit or resist the flow of electric current**
- **Resistivity versus Resistance**

- **Primary Factors that Affect Resistivity**
  - **Moisture Content**
  - **Material Grain Size**

Collecting 2-D Resistivity Data

Data Acquisition



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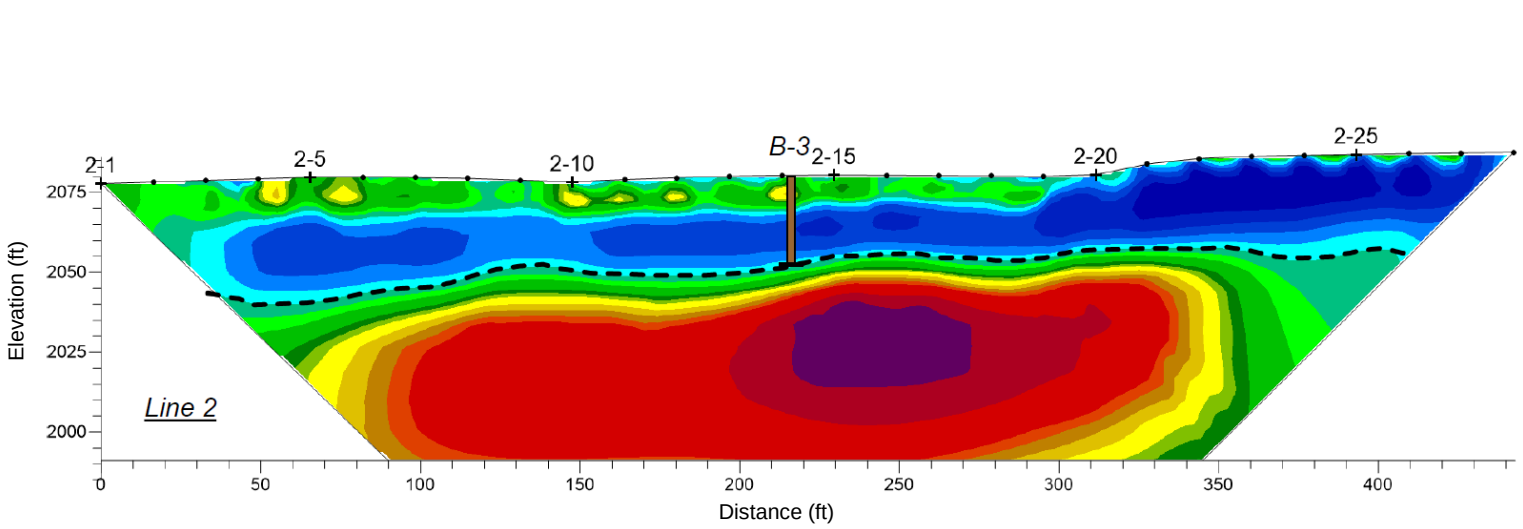
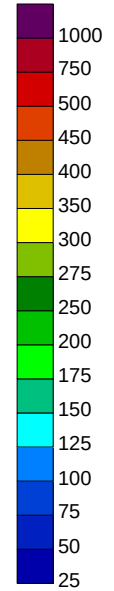
Resistivity Model





Resistivity Scale
(ohm-meters)

Explanation

B-2 = boring ID

= soil

= auger refusal

= estimated top of bedrock

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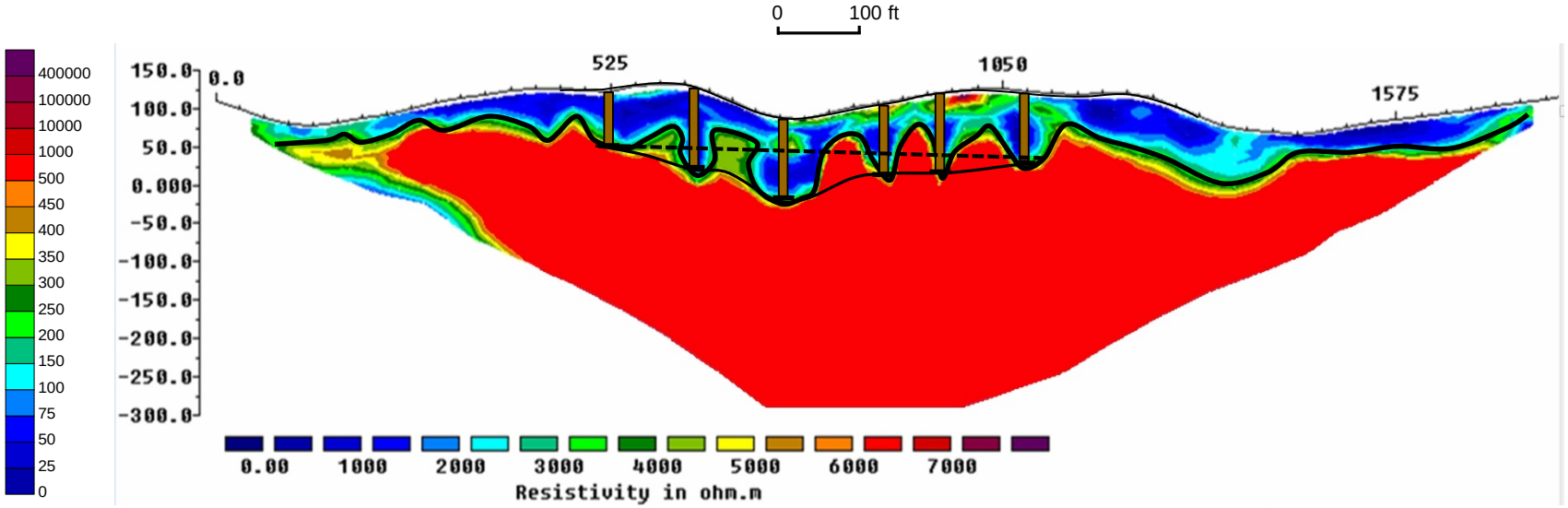
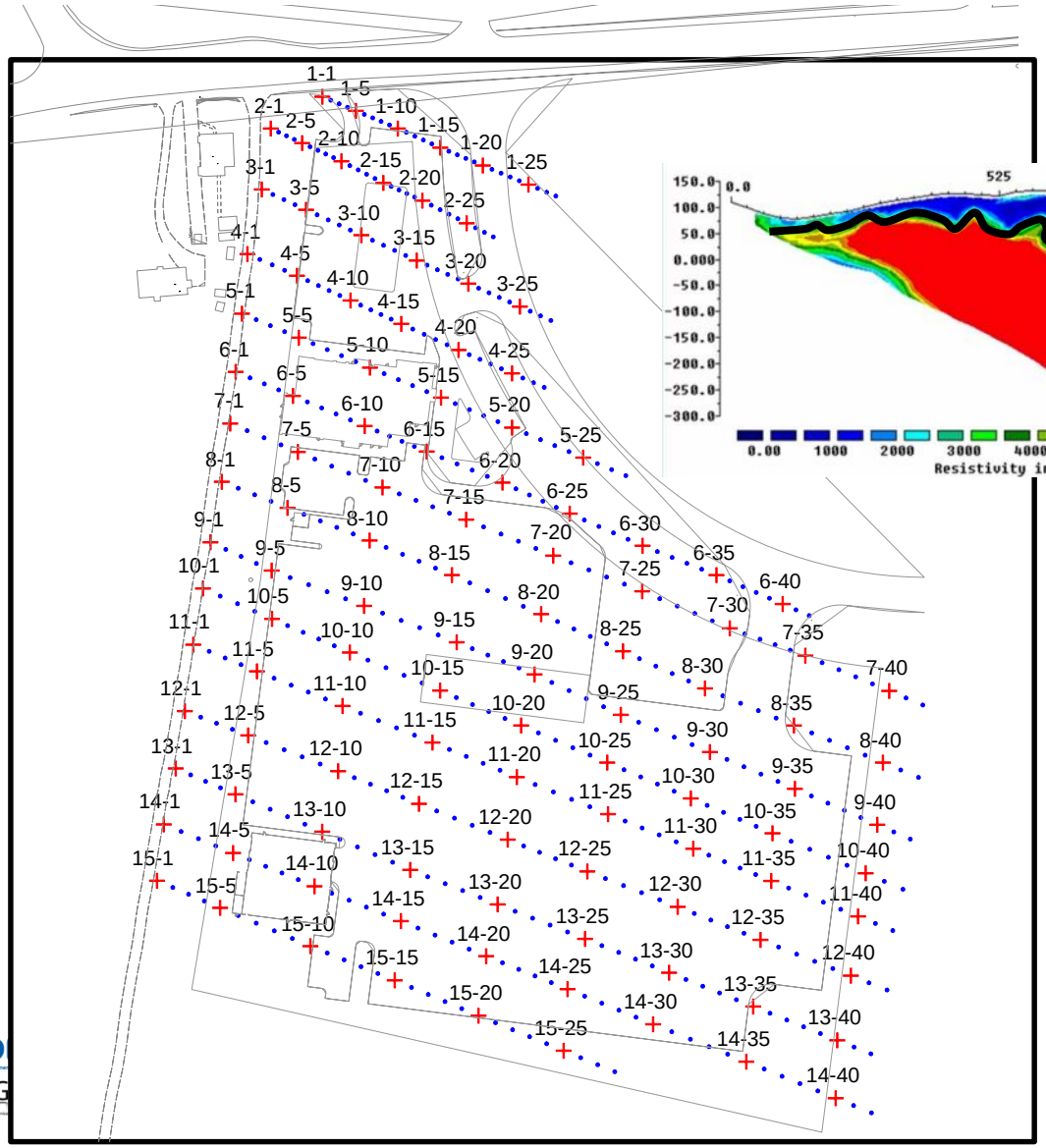
Bedrock Surfaces

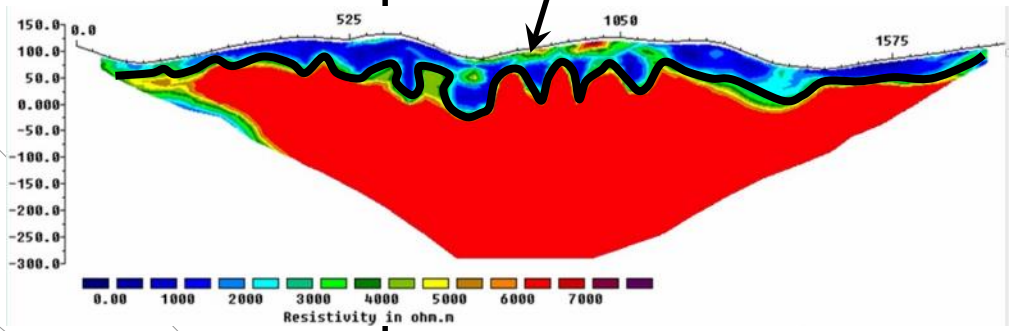


Resistivity Scale
(ohm-meters)

Mapping Bedrock



Digitize the Bedrock Surface
To Obtain an X, Y, Z Data Set



Feet
0 200 400

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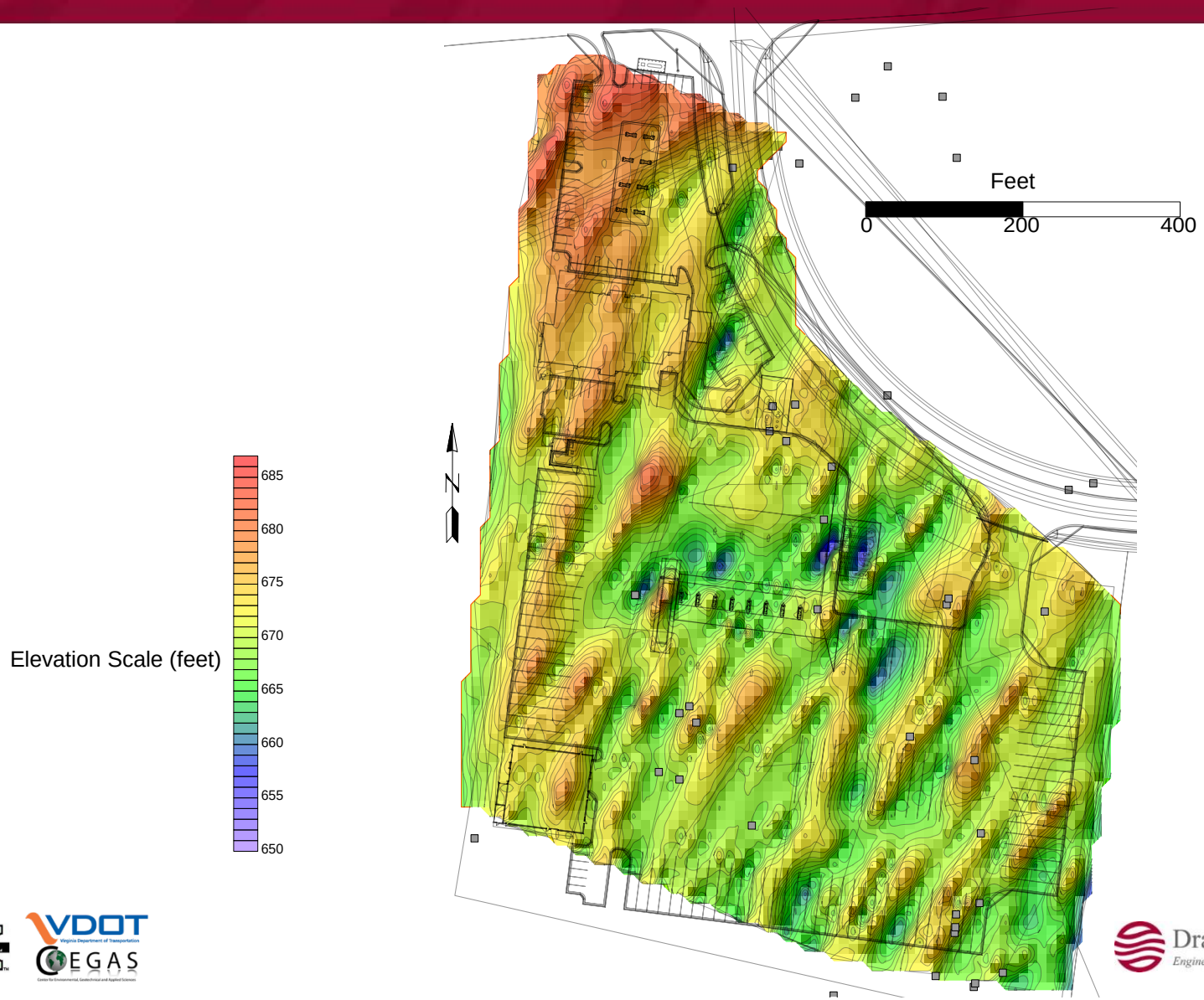
Contour Map of Bedrock Surface



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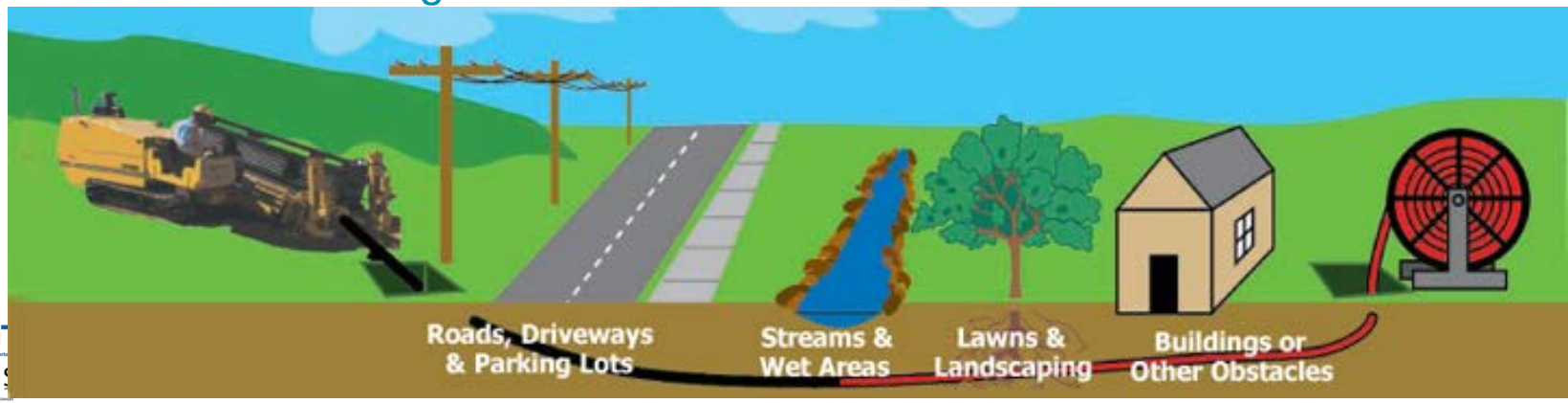
Horizontal Directional Drilling (HDD)Projects

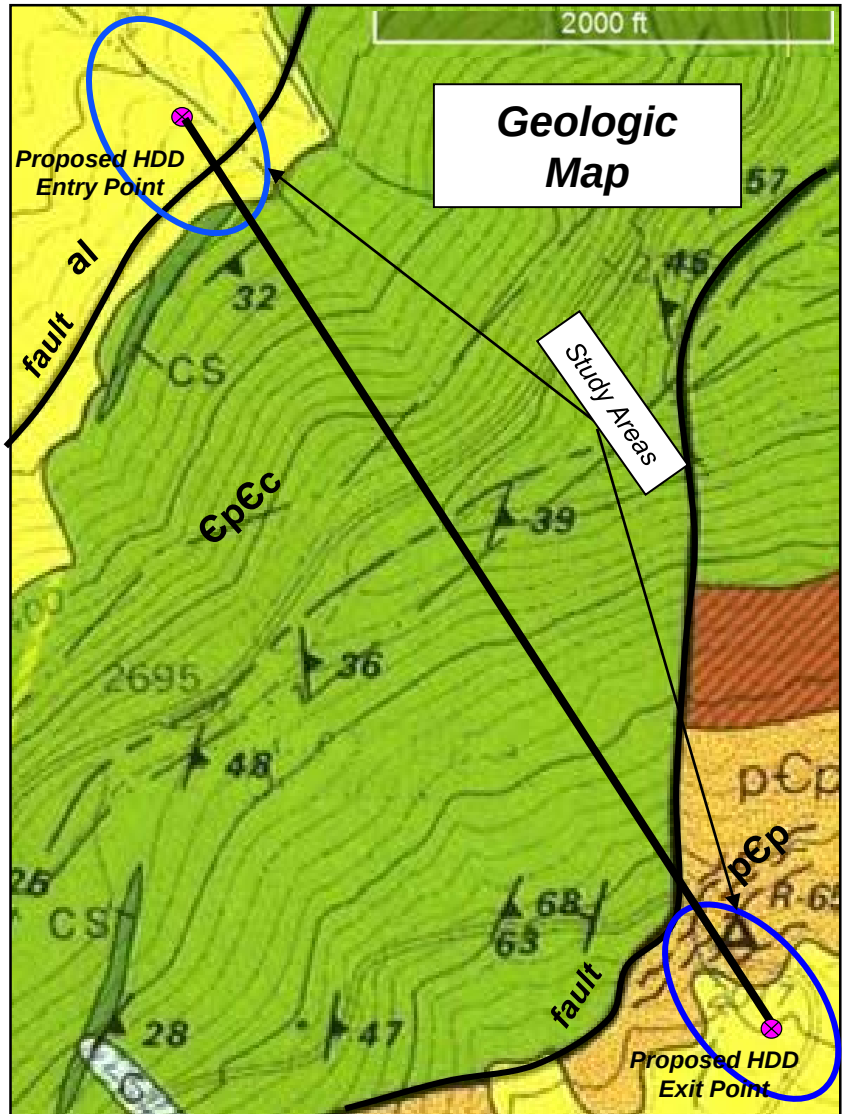
- When Trenching is Undesirable or Impractical
- Crossing Sensitive Areas Such as:
  - Roads
  - Bodies of Water
  - Conservation Areas
  - Buildings
  - Cemeteries or Archaeological Areas



Common Questions to Answer on HDD Projects

- **How thick is the overburden?**
  - **May effect casing estimates**
  - **If the drilling is to take place in the soil we may want to avoid the rock**
- **What is the stratigraphy?**
- **How competent is the rock?**
- **Are there major fracture zones?**

Mountain Crossing



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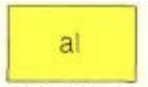
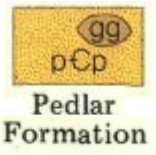


Gravel, sand, silt, and clay with boulder and cobble deposits in steeply dipping stream beds

Ꞓp Ꞓc

Dark green, massive metamorphosed basalt containing local metavolcanic breccia. Gray-purple fine grained siltstone/phyllite interbedded with metabasalt near the top

pꞒp



Dark greenish gray, massive to foliated, garnet bearing, fine to medium grained granodiorite

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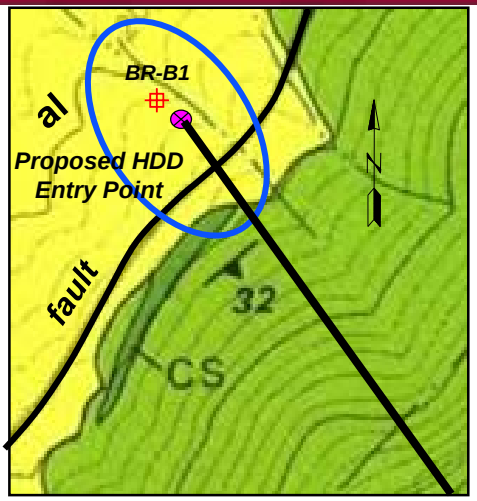
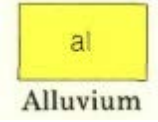
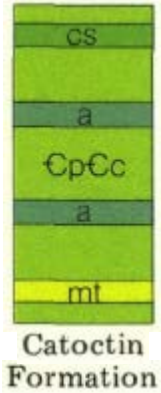
Entry Point

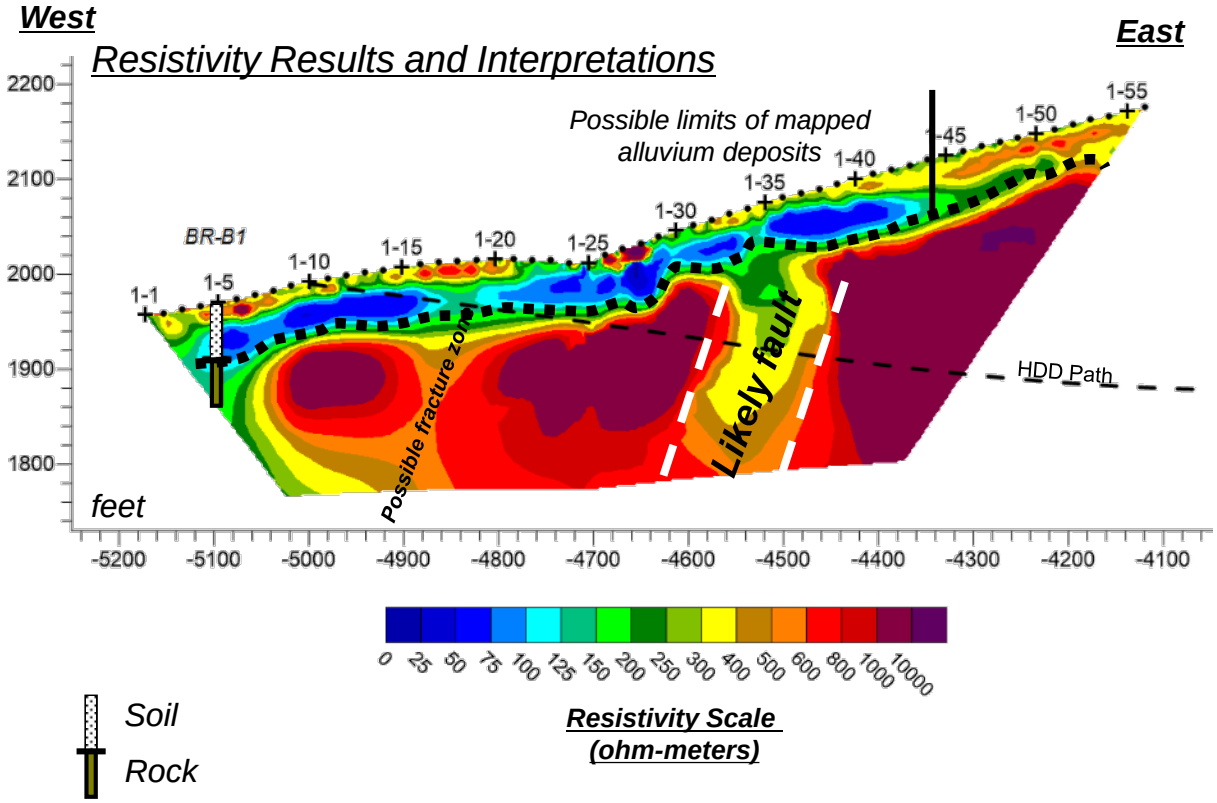




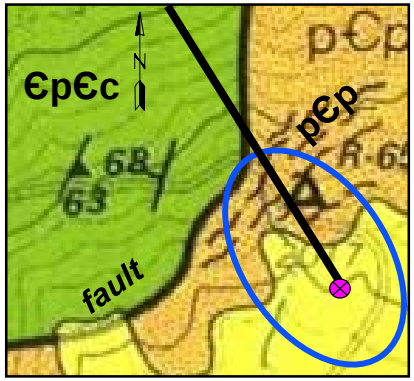
Gravel, sand, silt, and clay with boulder and cobble deposits in steeply dipping stream beds



Dark green, massive metamorphosed basalt containing local metavolcanic breccia. Gray-purple fine grained siltstone/phyllite interbedded with metabasalt near the top



Exit Point



al
Alluvium

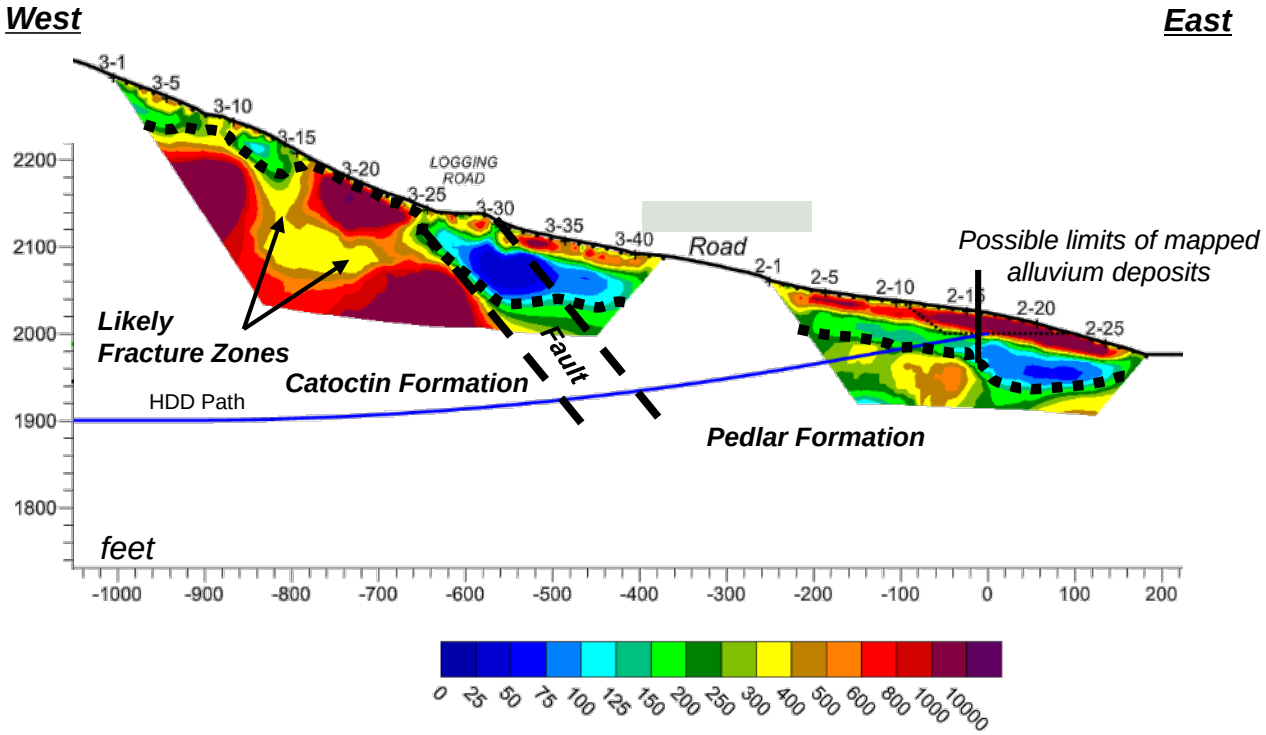
Gravel, sand, silt, and clay with boulder and cobble deposits in steeply dipping stream beds

cs
a
CpCc
a
mt
Catoctin Formation

Dark green, massive metamorphosed basalt containing local metavolcanic breccia. Gray-purple fine grained siltstone/phyllite interbedded with metabasalt near the top

gg
pCp
Pedlar Formation

Dark greenish gray, massive to foliated, garnet bearing, fine to medium grained granodiorite



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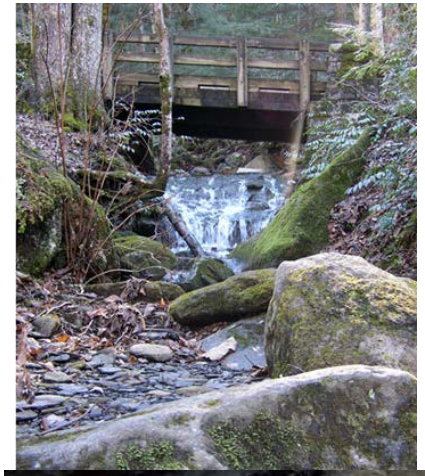
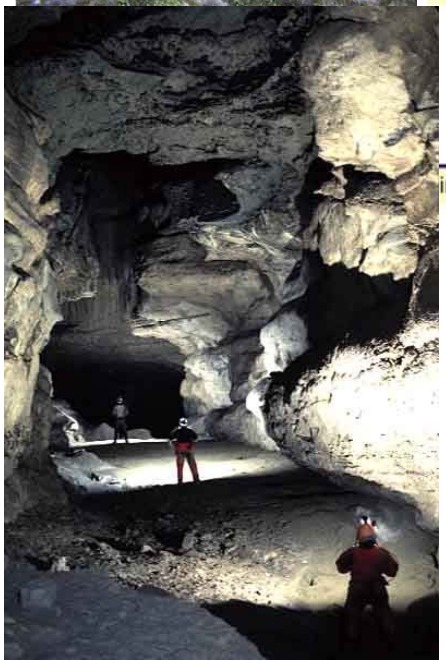
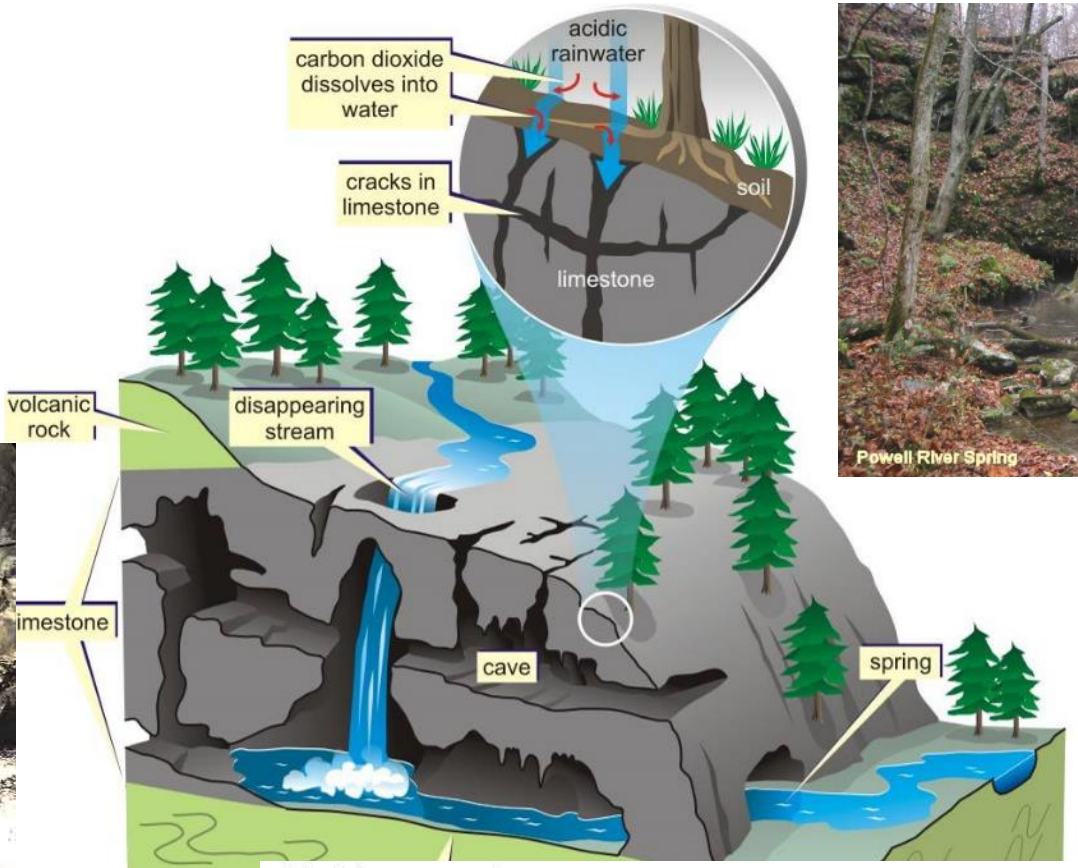
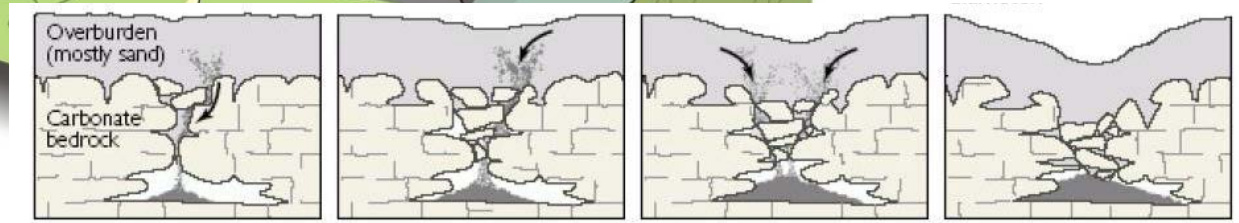
The Karst Environment

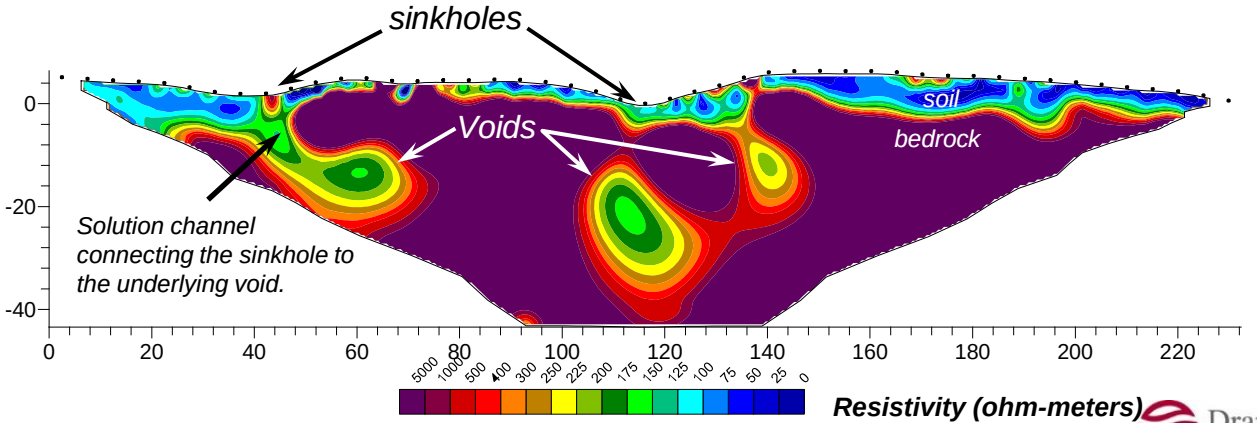








Connecting the Surface to the Subsurface



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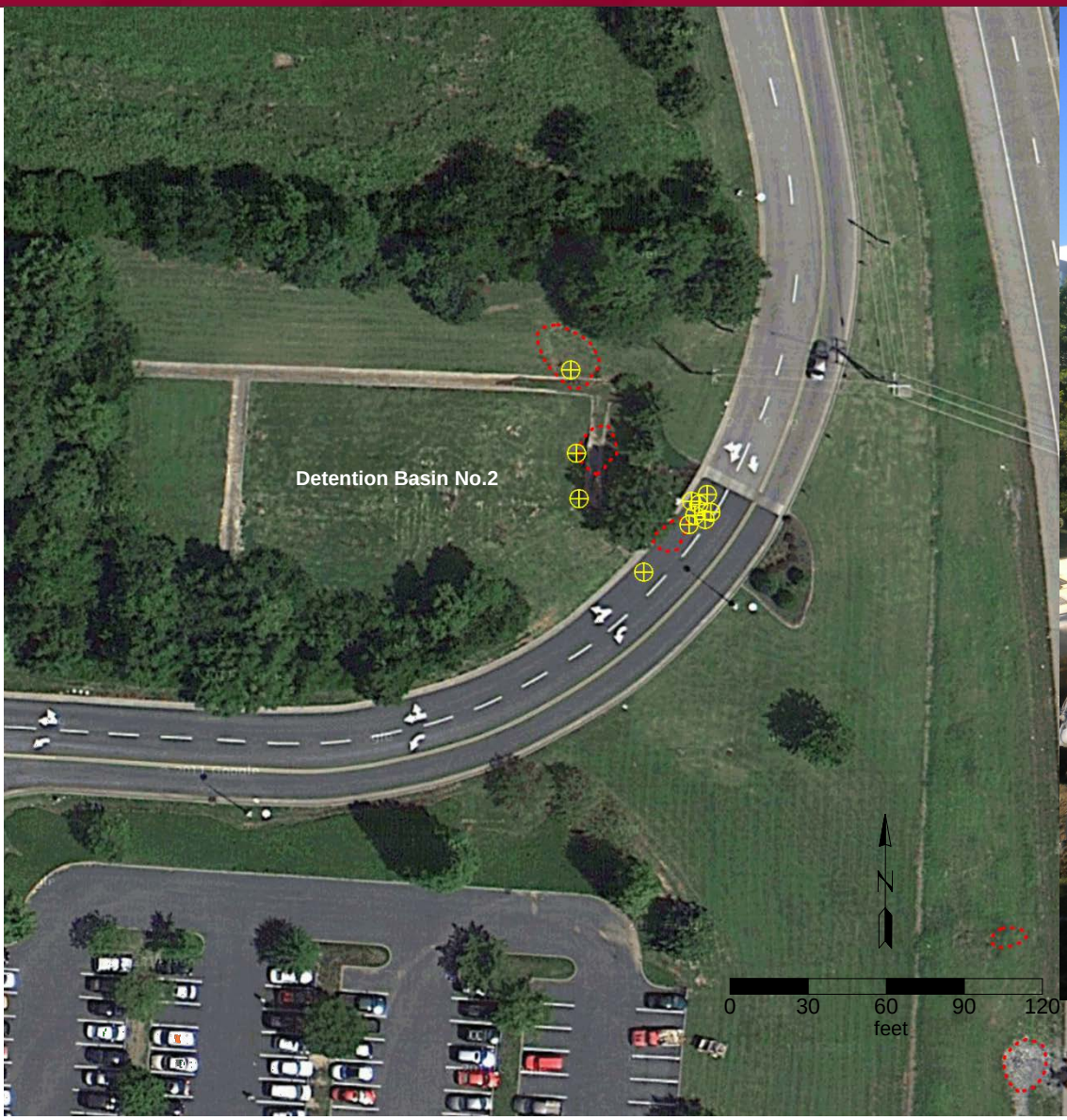

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Resistivity Lines

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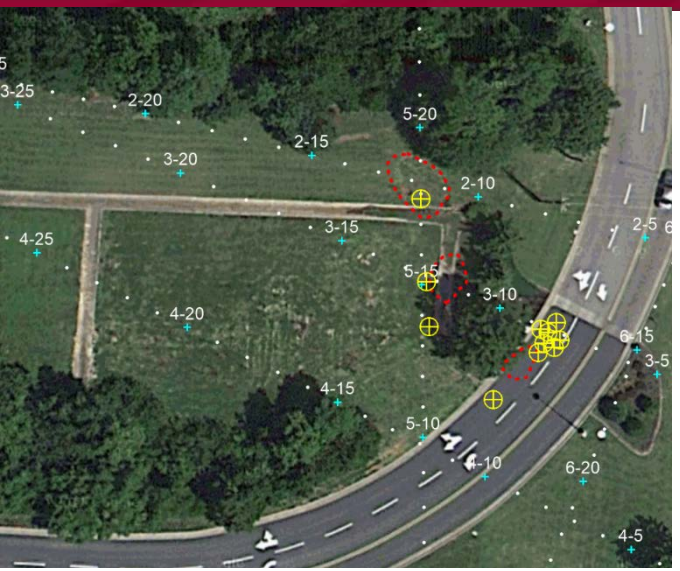
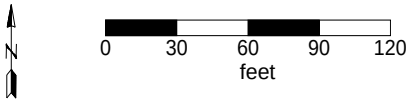
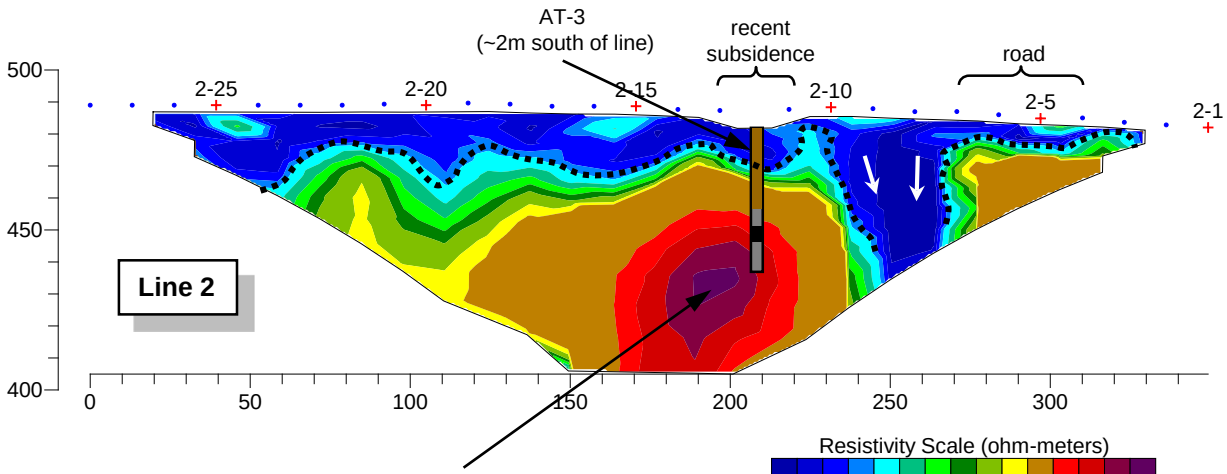
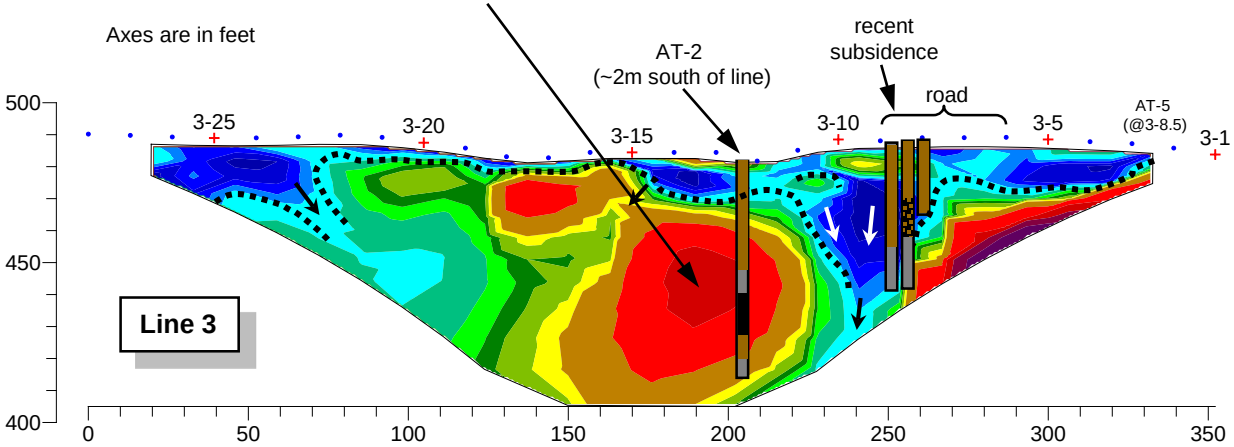
Resistivity Results



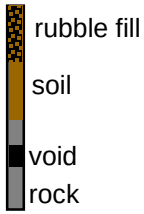




Axes are in feet



Boring Explanation:



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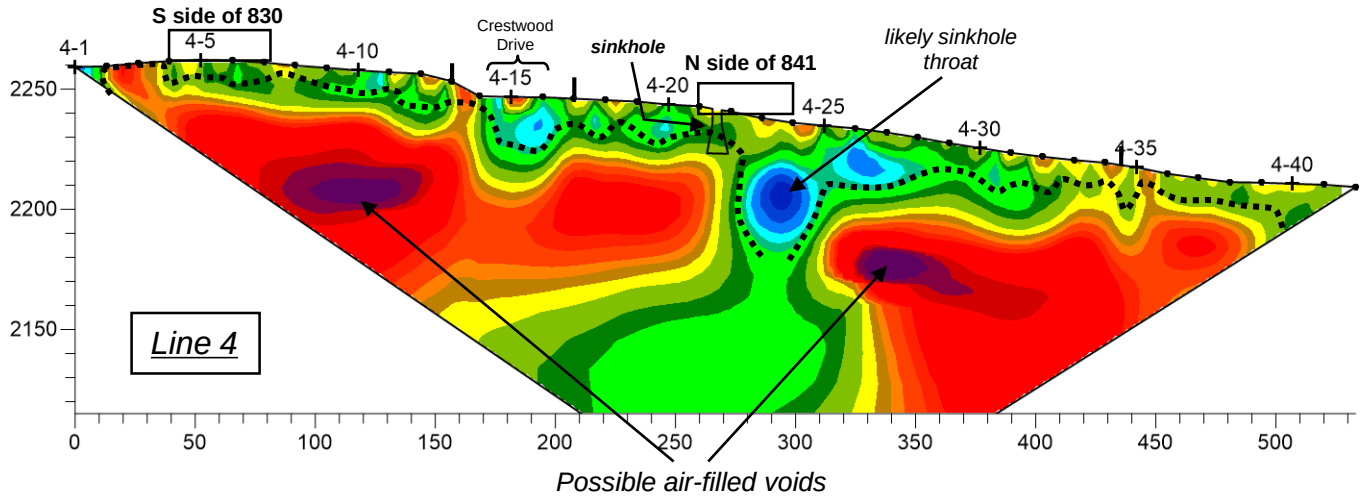
Offset Throat

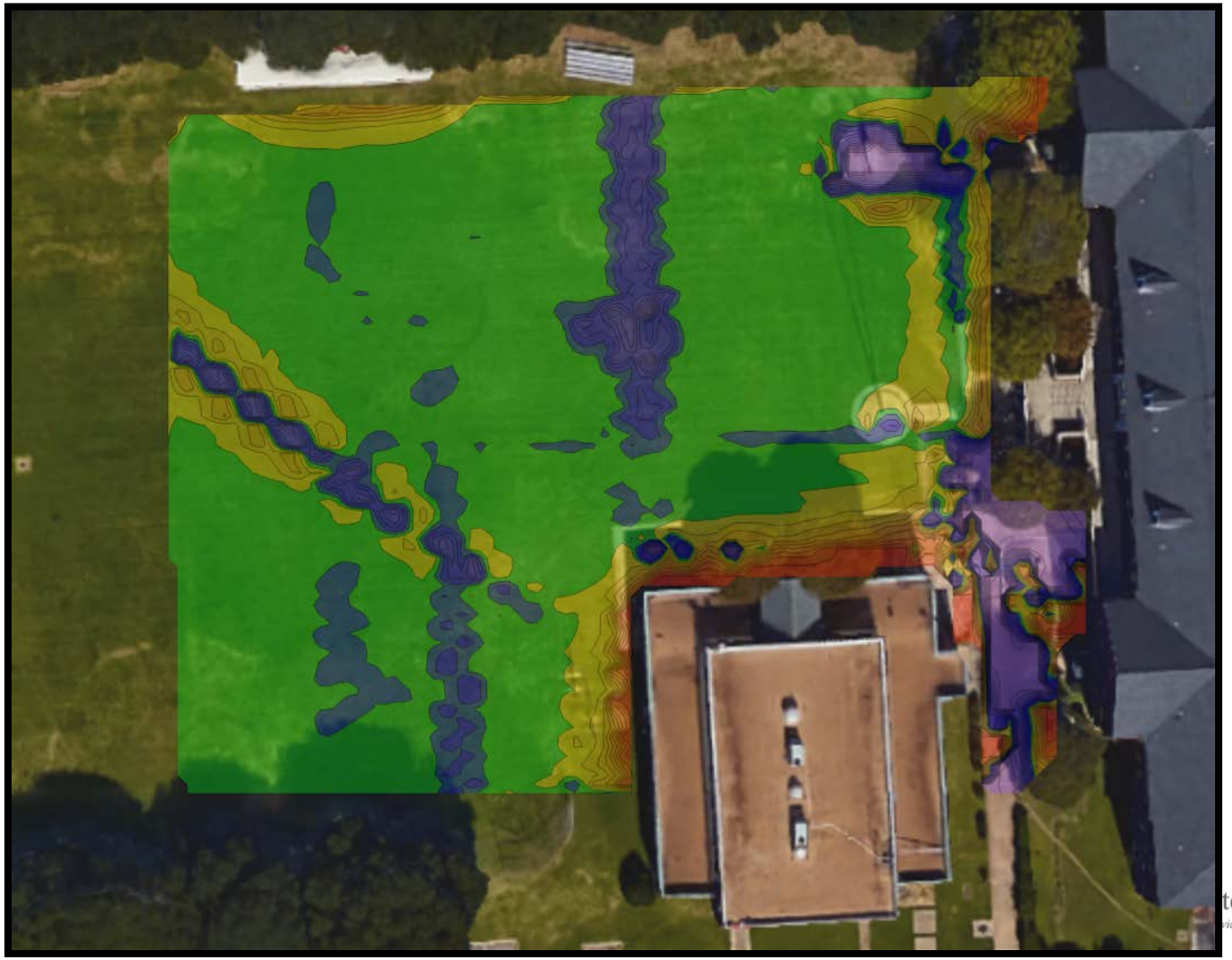


Electromagnetic Induction

- **Also Called Terrain Conductivity: measure of how well the subsurface conducts an electric current.**

- **Applications:**
  - **Landfills and trenches**
  - **Buried drums, tanks, utilities**
  - **Buried structures**

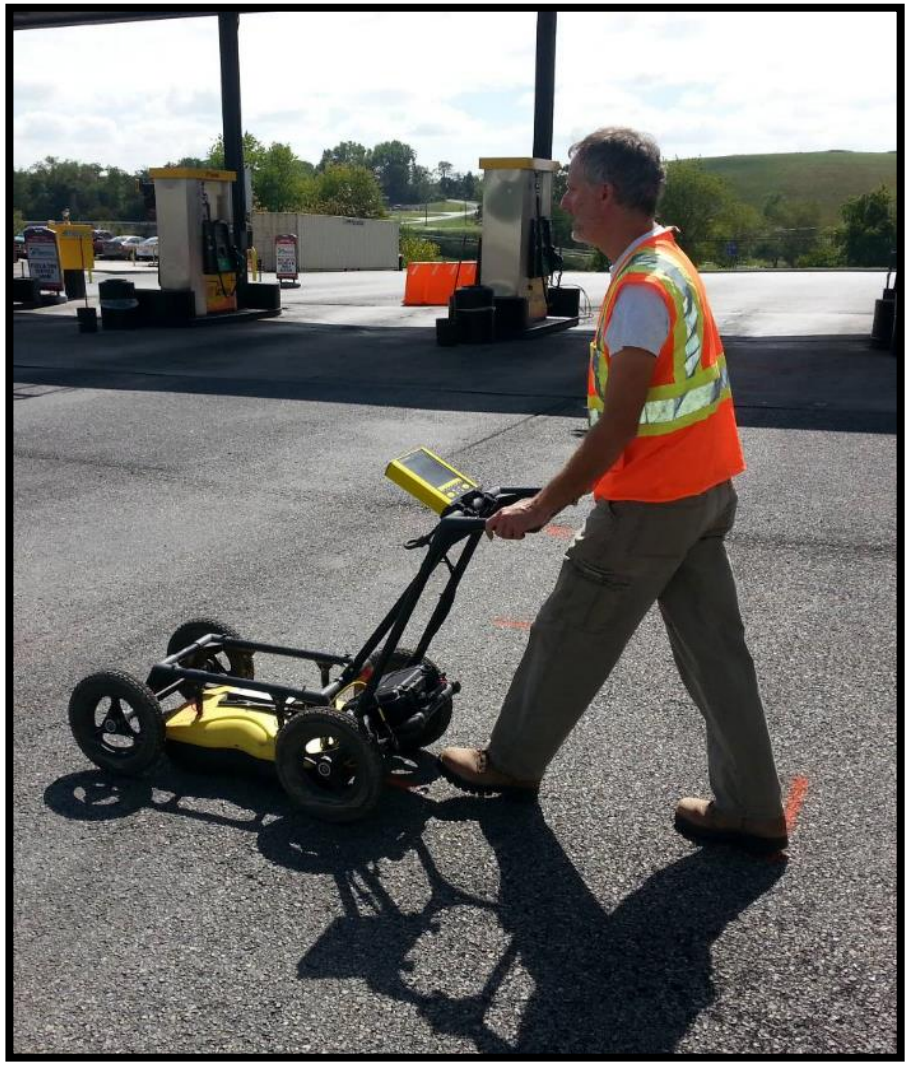
Structures and Utilities



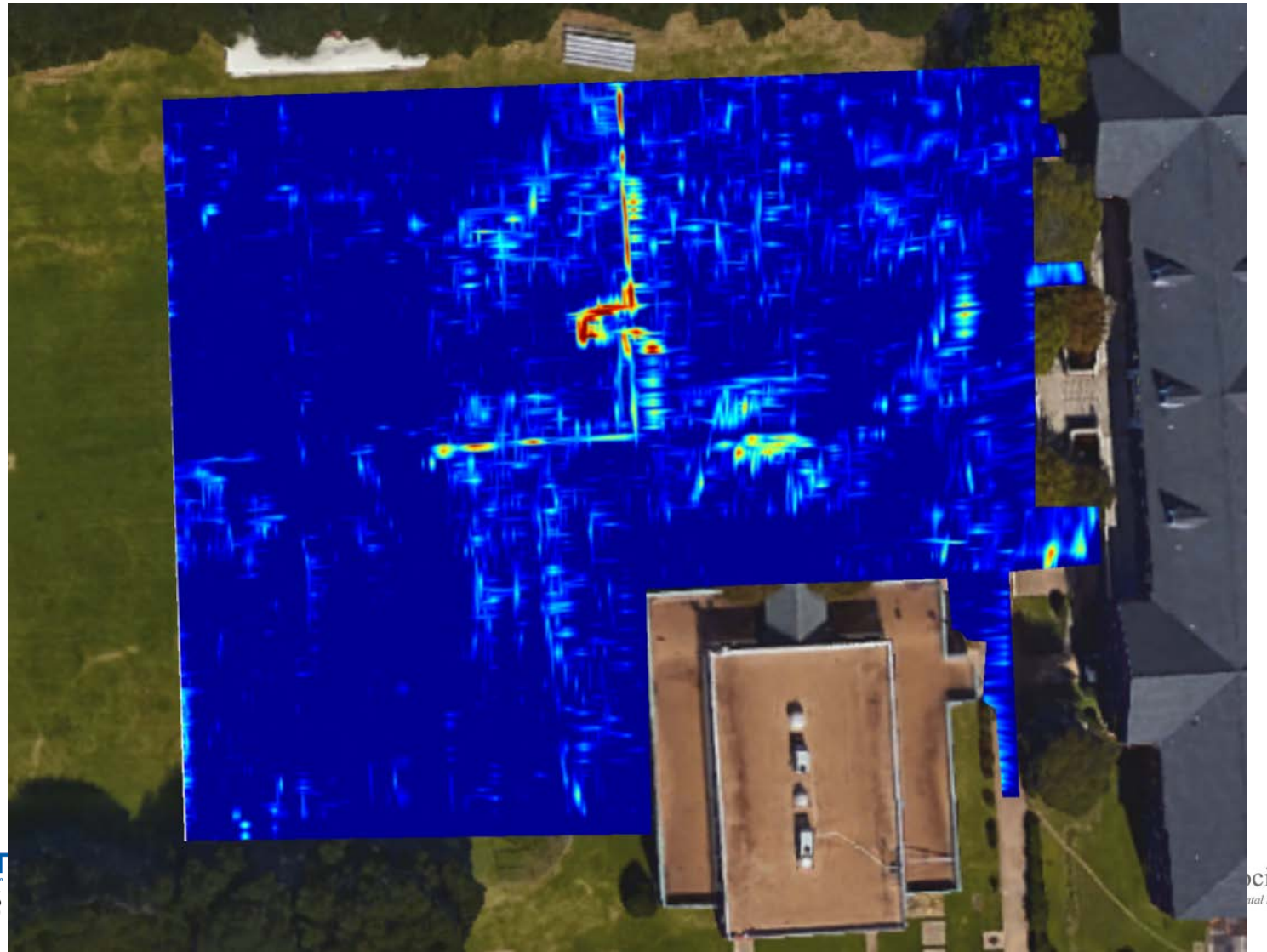
Ground Penetrating Radar

Applications:

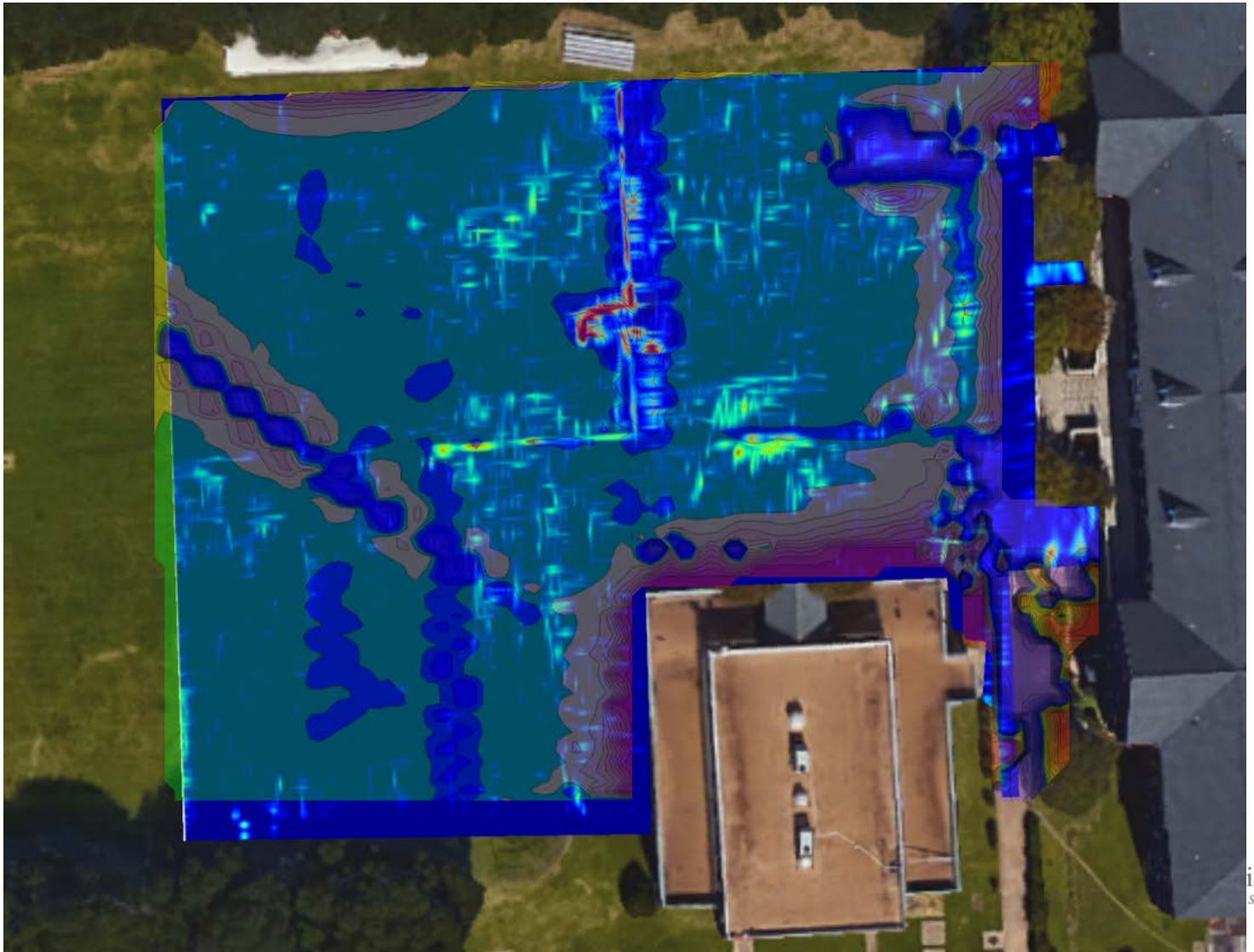
- Location of Buried drums or tanks
- Location of Buried Utilities
- Archeological-forensic studies
- Reinforcement Steel
- Subslab Voids



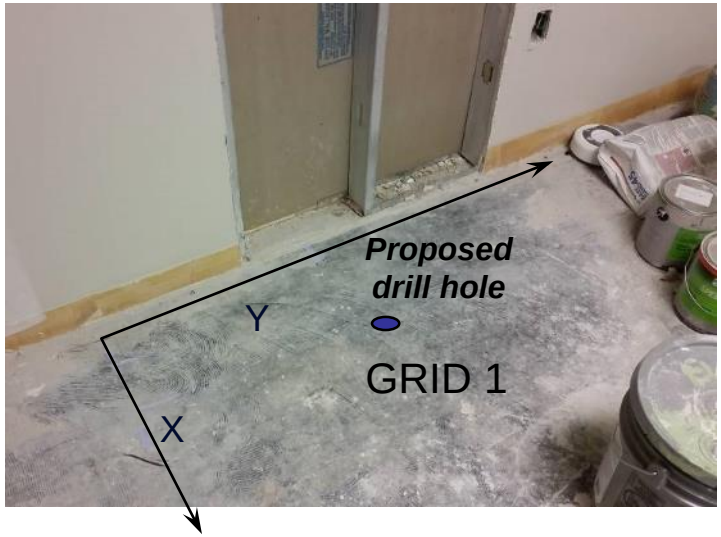
2.5-3 Feet Depth Slice

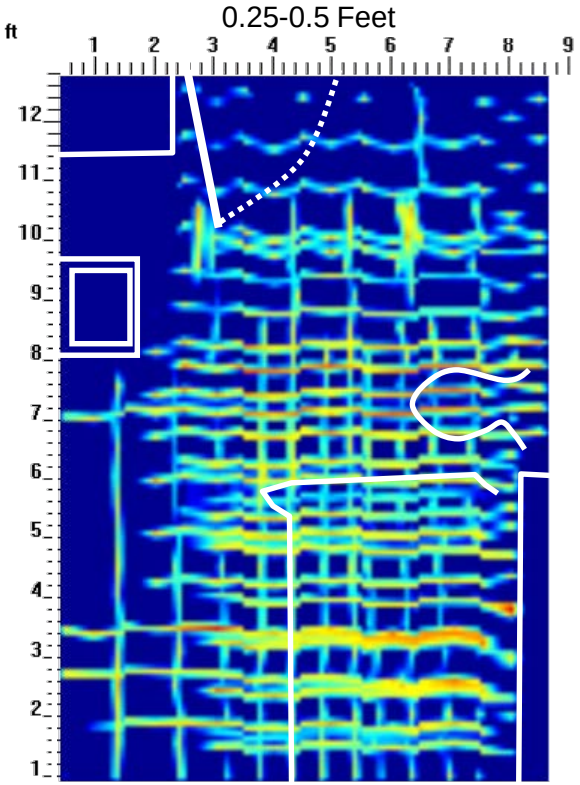


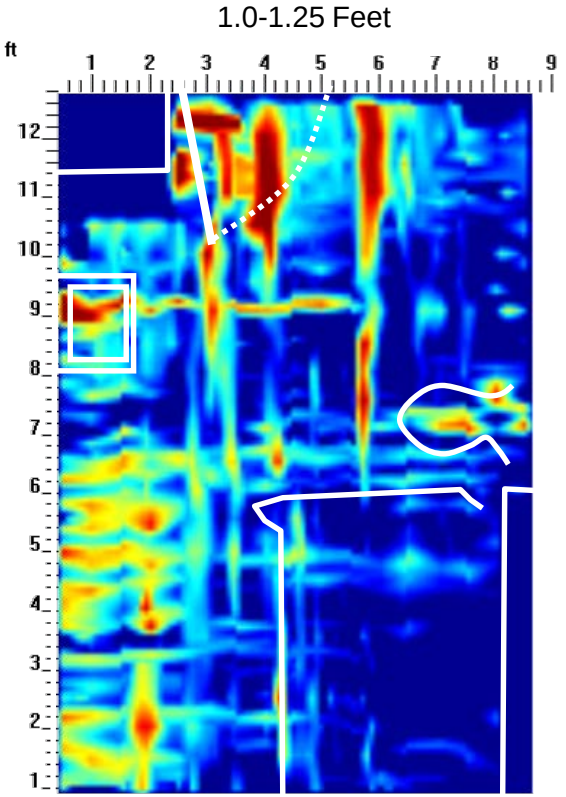
2.5-3 Feet Depth Slice with EM Overlay



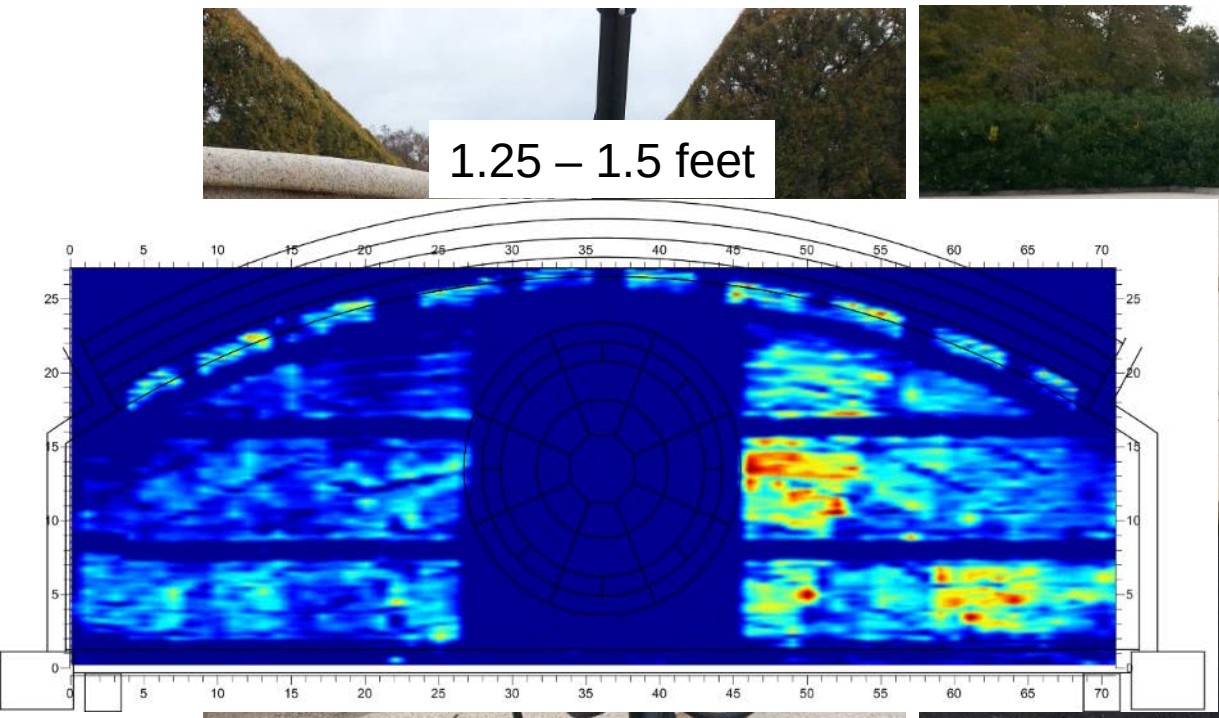
Concrete Reinforcement and Utilities



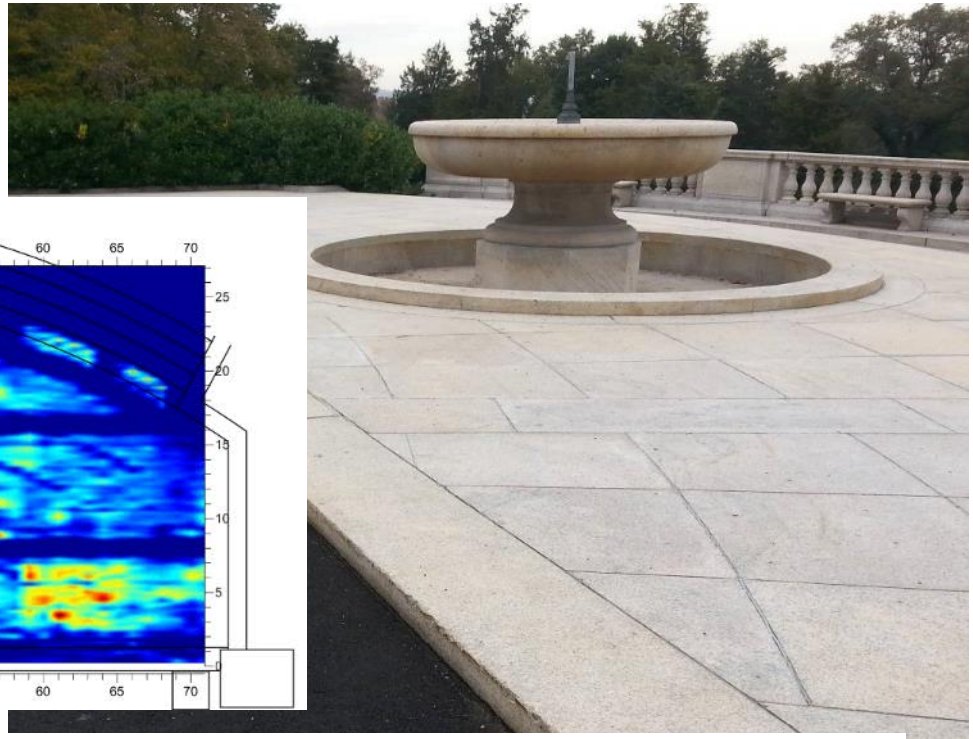


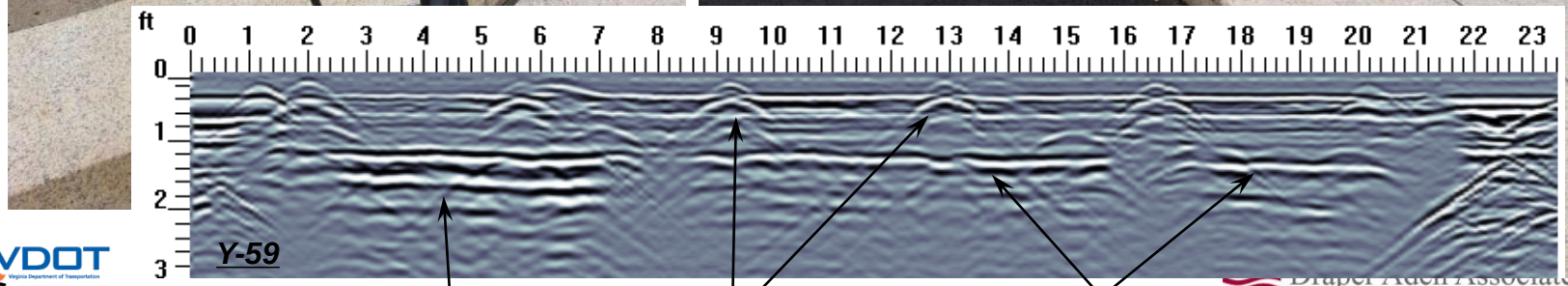


Sub-slab Voids



1.25 – 1.5 feet





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- Questions?