Characterization of Bedrock Hydrogeologic Conditions in Support of Solid Waste Landfill Expansion.

Lea Anne Scott Atwell, P.G. & Paul Rydel, P.G.

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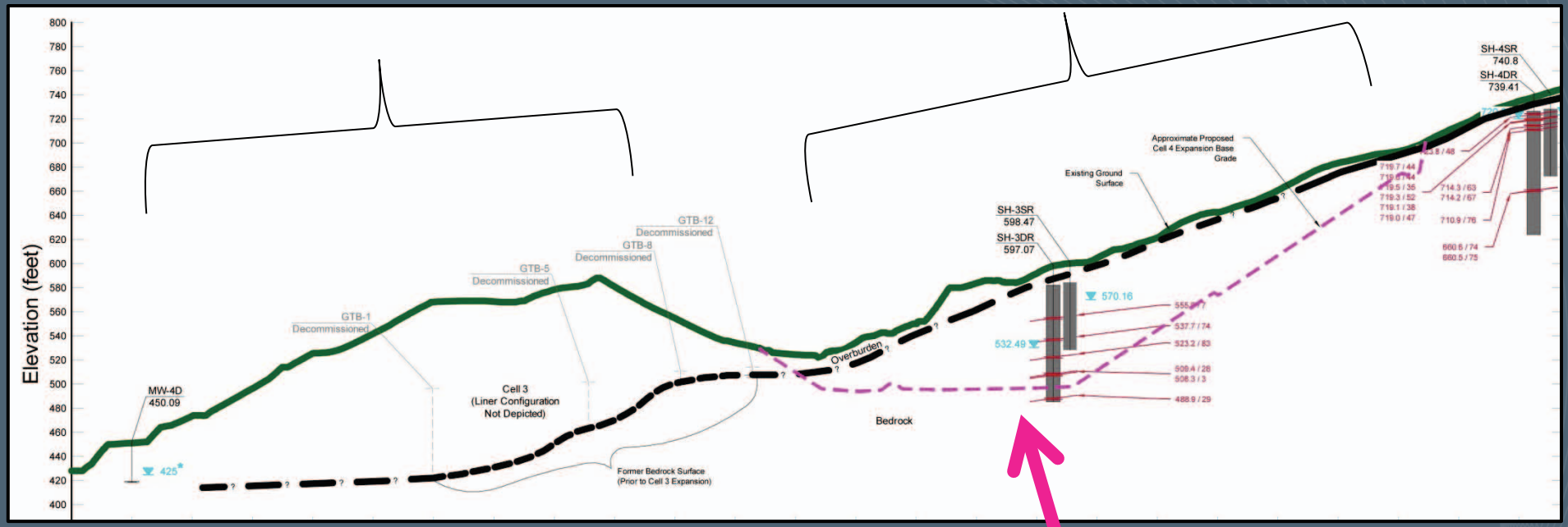
N
W
E
S
300' 150' 0 300' 600'
Feet

Existing Landfill

Proposed Expansion

N

S



Proposed Cut

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Thorough bedrock characterization is crucial to project success.

Bedrock / Hydrogeology Characterization

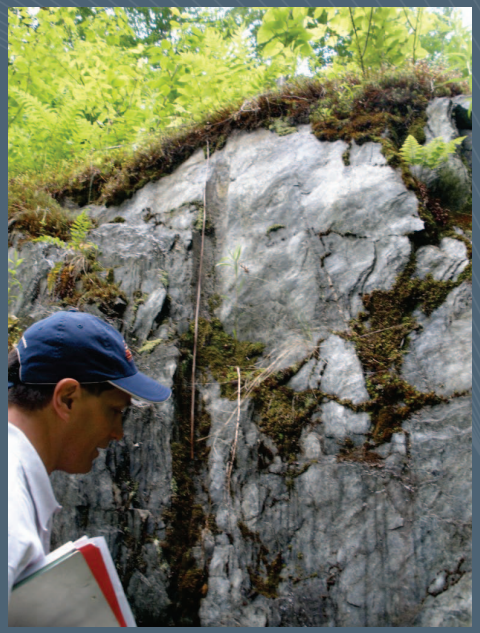
Geotechnical Design

Groundwater Monitoring

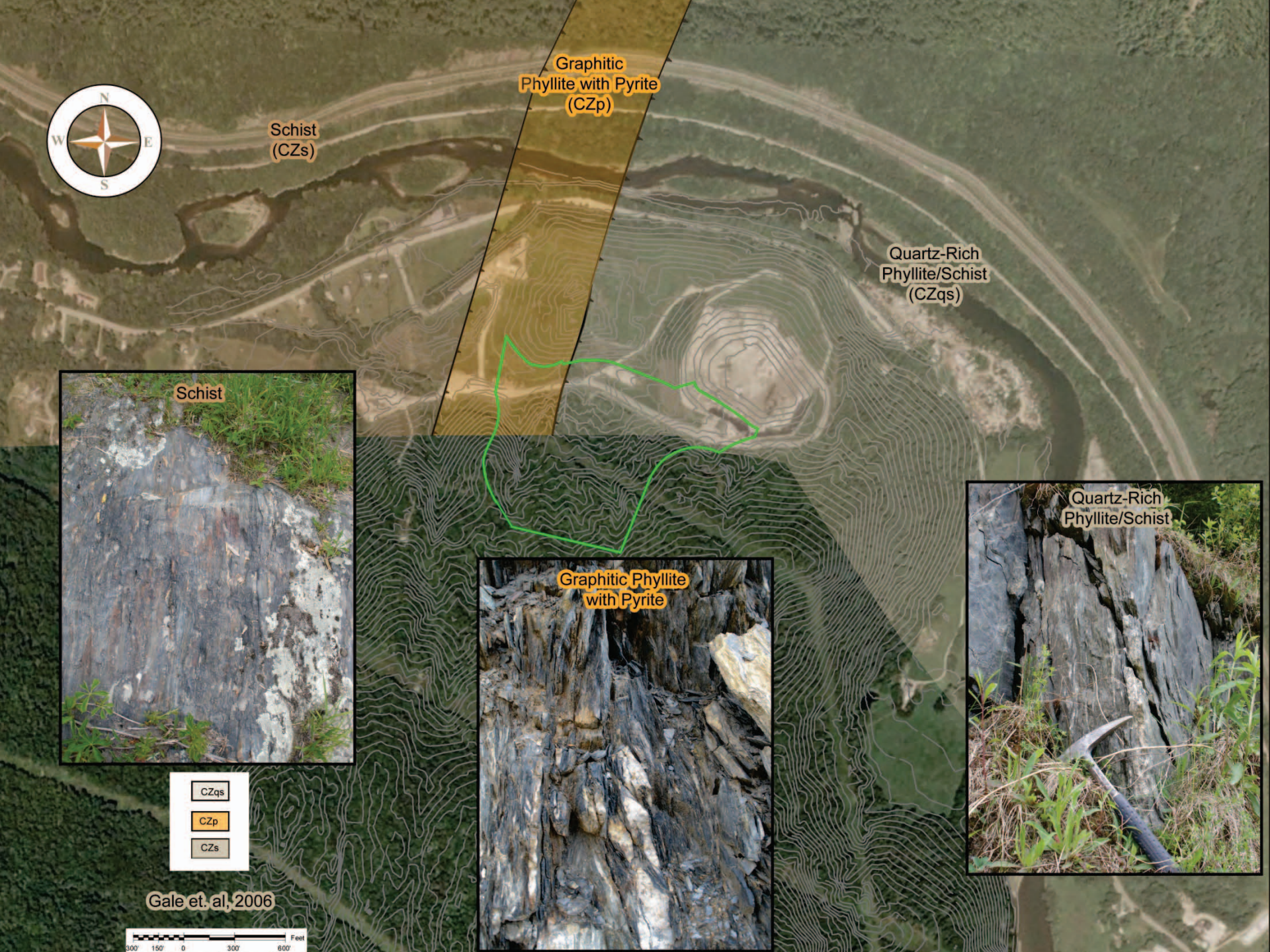
Client, Regulators, Public

Approach

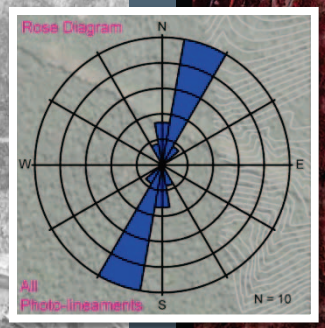
- Bedrock Investigation
  - Fracture trace analysis
  - Outcrop observations
  - Monitoring well installations
  - Borehole geophysics

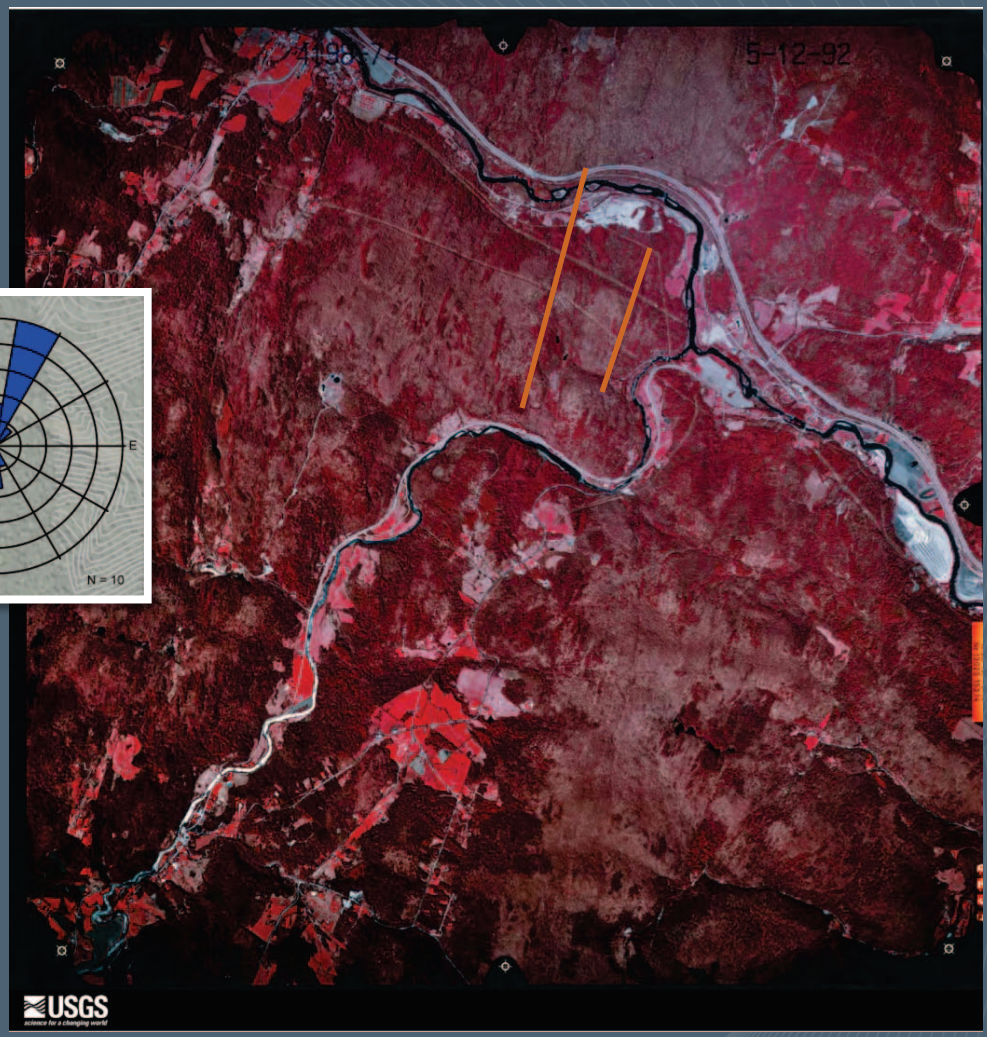


- Pumping tests (short duration, single well & long duration with observation wells)

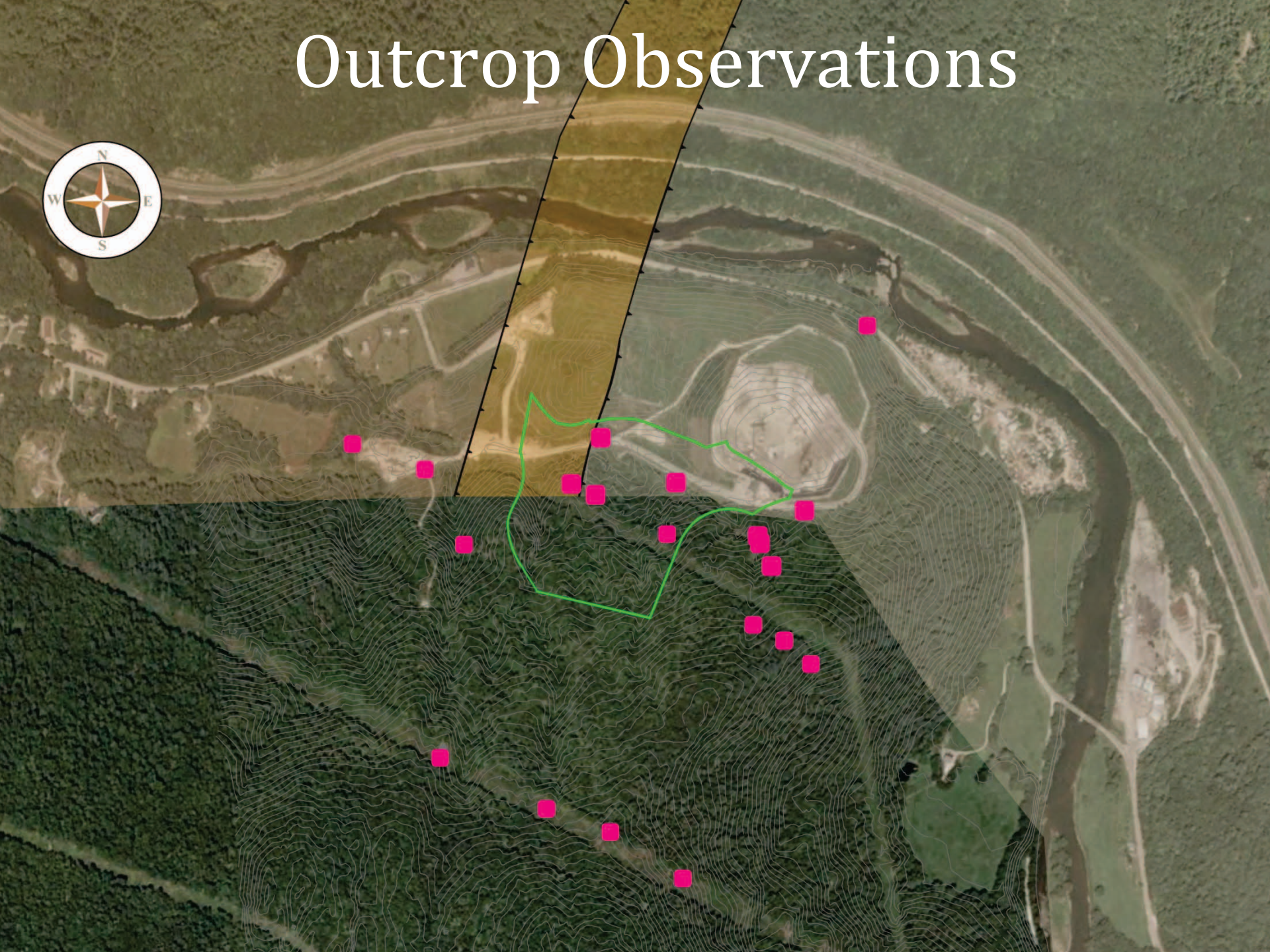

Graphitic
Phyllite with Pyrite
(CZp)
Schist
(CZs)
Quartz-Rich
Phyllite/Schist
(CZqs)
N
W
E
S
Schist
Graphitic Phyllite
with Pyrite
Quartz-Rich
with
Phyllite/Schist
CZqs
CZp
CZs
Gale et. al, 2006
300'
150'
0
300'
600'
Feet

Fracture Trace Analysis





Outcrop Observations

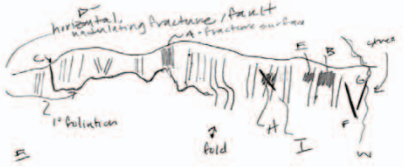


Detailed documentation adds transparency to our findings.

Outcrop Field Form - Moretown, VT
Outcrop 2

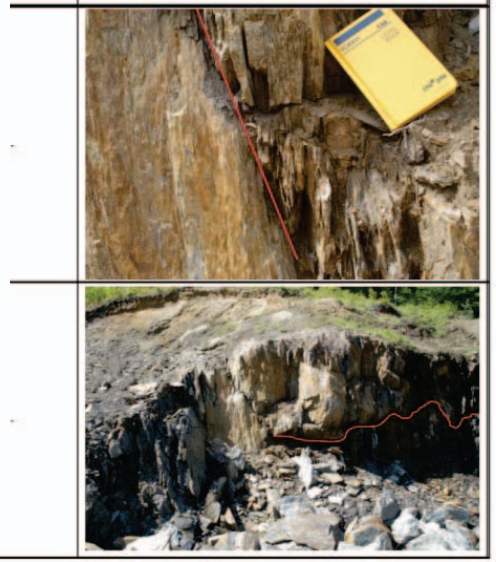
Outcrop #	2
Lat/Long	N44° 18' 34.2" / W072° 42' 23.9"
Location	Road south of blasting area (new bedrock stormwater basin)
Outcrop Orientation	285°
General Comments (outcrop quality)	Road-cut exposure. Highly fractured and weathered, local folding, iron staining prominent. Small spring flowing across top of west side of outcrop and some water observed at base of west side of outcrop.
Rock Type(s)	Gray to red brown graphitic phyllite to schist, locally more quartz-rich, with thin lenses and 2-3" layers of quartz

Field sketch of outcrop:



June 5, 2009, Sunny 70°s, 0900 hours; June 10, 2009, Overcast, 70s, 1715 hours

Foliation / Fracture Group	Orientation: Strike	Orientation: Dip	Orientation: Dip Direction	Length	Spacing	Planarity (1=straight, 4=curved)	Nature of Termination	General Observations (Weathering, Water Present, etc.)	Comments	Outcrop Photograph
1	171°	75°	W	-	-	2	N/A	Foliation and fractures parallel to foliation. Some foliation in east-central portion of outcrop is highly contorted. Little to minor weathering on some surfaces. Seep observed at base of western side of outcrop.	East side of outcrop.	
	181°	82°	W			2			East side of outcrop.	
	200°	68°	W			3			East side of outcrop.	
	203°	90°	-			3			East side of outcrop	
	189°	90°	-			2			West limb of small fold.	
	178°	70°	W			2			More quartz-rich rock, west of small fold.	
	211°	90°	-			2			West of small fold.	
	211°	78°	W			2			West of small fold.	
	180°	75°	W			2			-	
	213°	84°	W			2			-	
A	353°	90°	-	4'	-	2	Cross-cut by horizontal fracture?	Weathered surface with iron staining.	-	Photograph not available.
B	148°	85°	W	4'	-	2	Cross-cut by horizontal fracture?	Weathered surface with iron staining.	-	See photograph below (fractures E, F, and G).



surface - fault?

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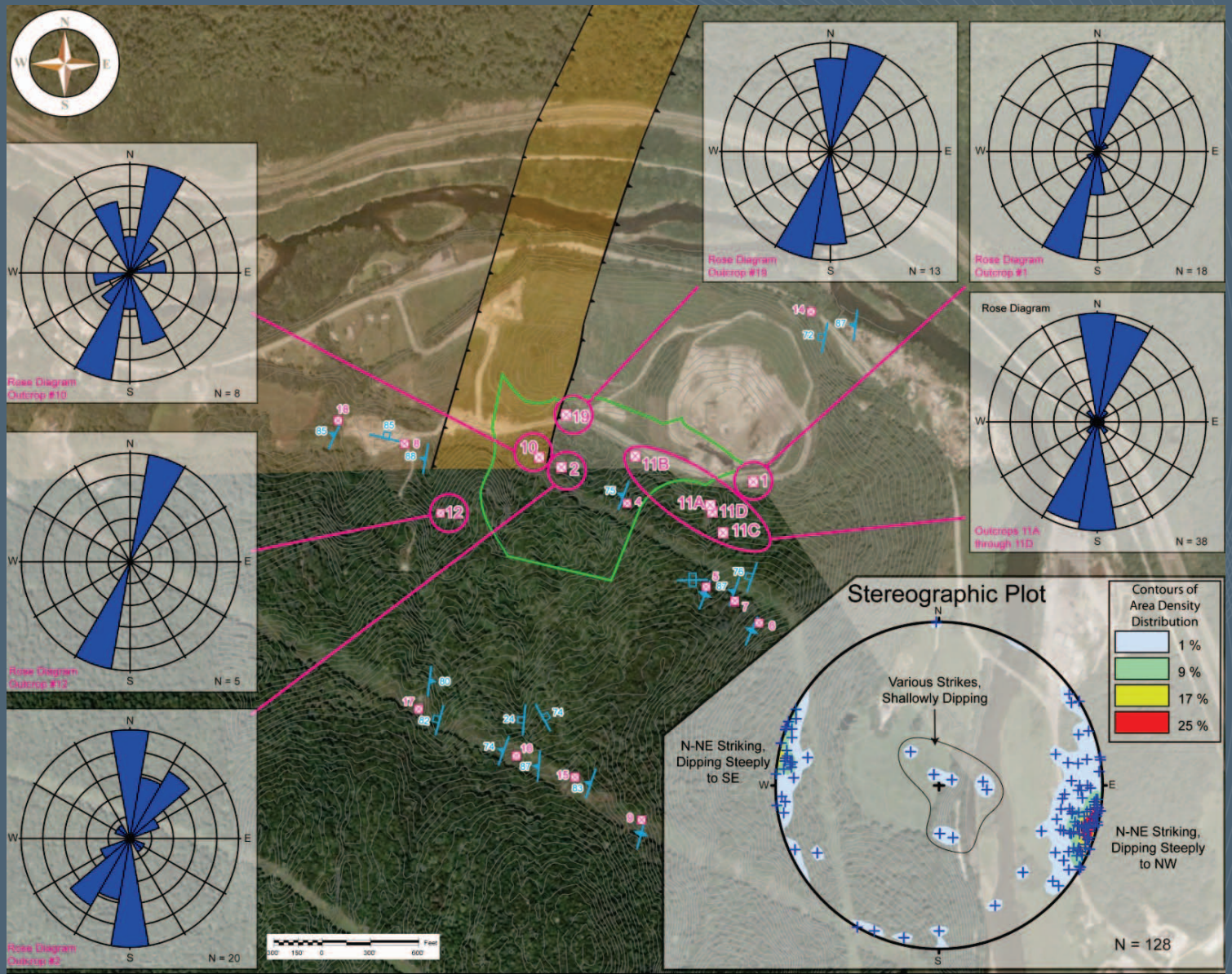
Compilation of field measurements for easier comparison of data.



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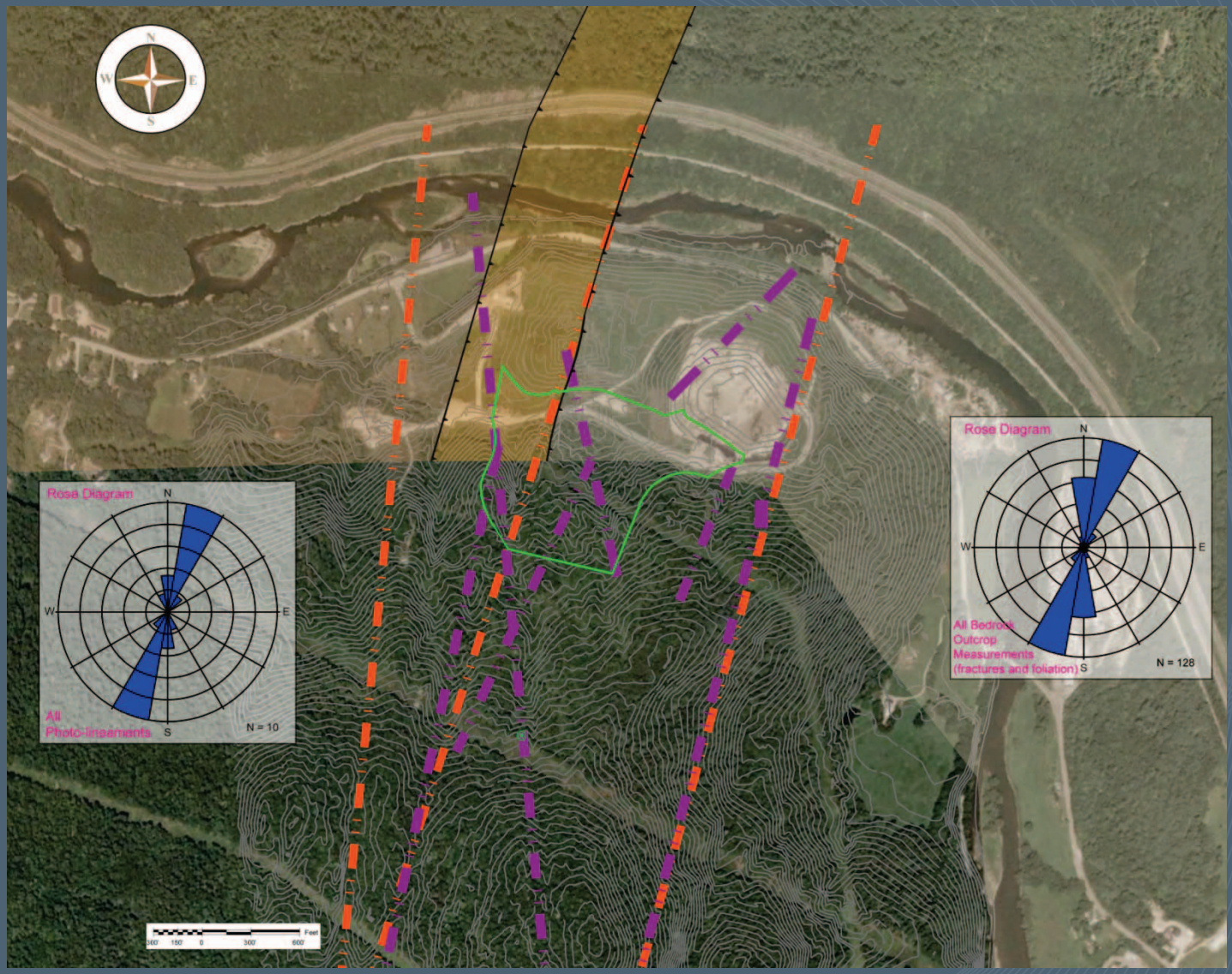
Correlation of fracture trace and outcrop data.



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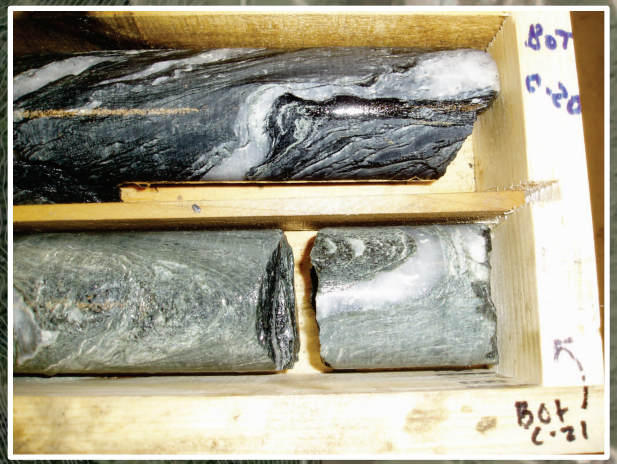
Monitoring Well Installations

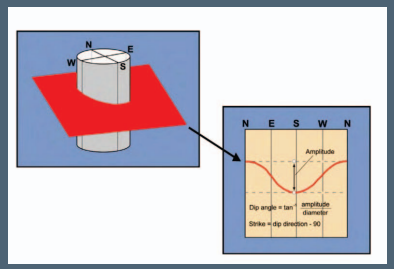


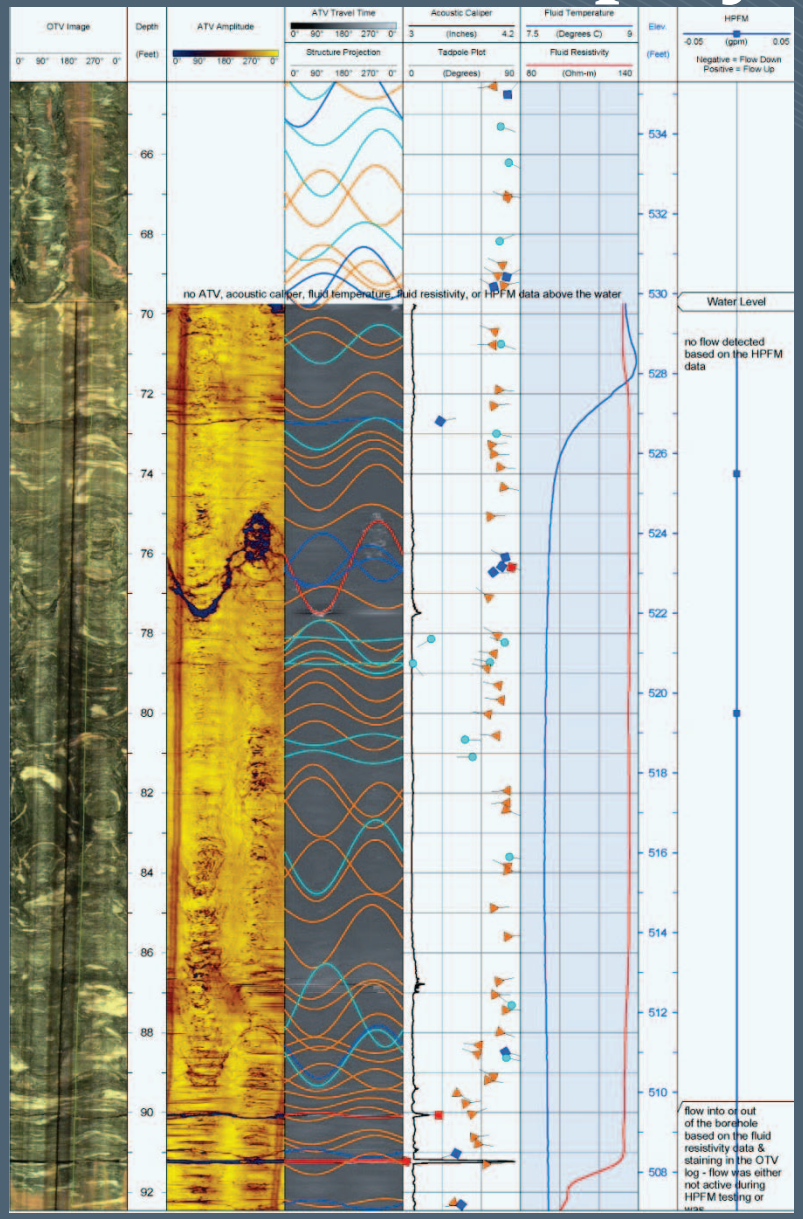
Feet
300' 150' 0 300' 600'

HAGER-RICHTER GEOSCIENCE, INC.

Borehole Geophysics

- Optical & Acoustic Televiewers
- Acoustic Calipers





- Fluid Temperature
- Resistivity

- Heat Pulse Flow Meter

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Key Findings

- Low permeability
- Limited connectivity between fractures
- Small volume of water into excavation
- Design considerations

Acknowledgements

- Hager-Richter Geoscience, Inc. HAGER-RICHTER GEOSCIENCE, INC.
- Joel Prellwitz, Erin Wright, Andrew Ashton, Tim White – Sanborn Head

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