Using Subsurface Temperatures to Evaluate Vacuum Extraction System Performance

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October 14, 2021

Outline

- Vacuum Extraction Overview
- Site Setting
- Methods
- Temperature Discussion
- Pressure Comparison
- Recap and Next Steps

At this site, groundwater temperature changes are indicative of surface water and groundwater interactions, particularly during freshet

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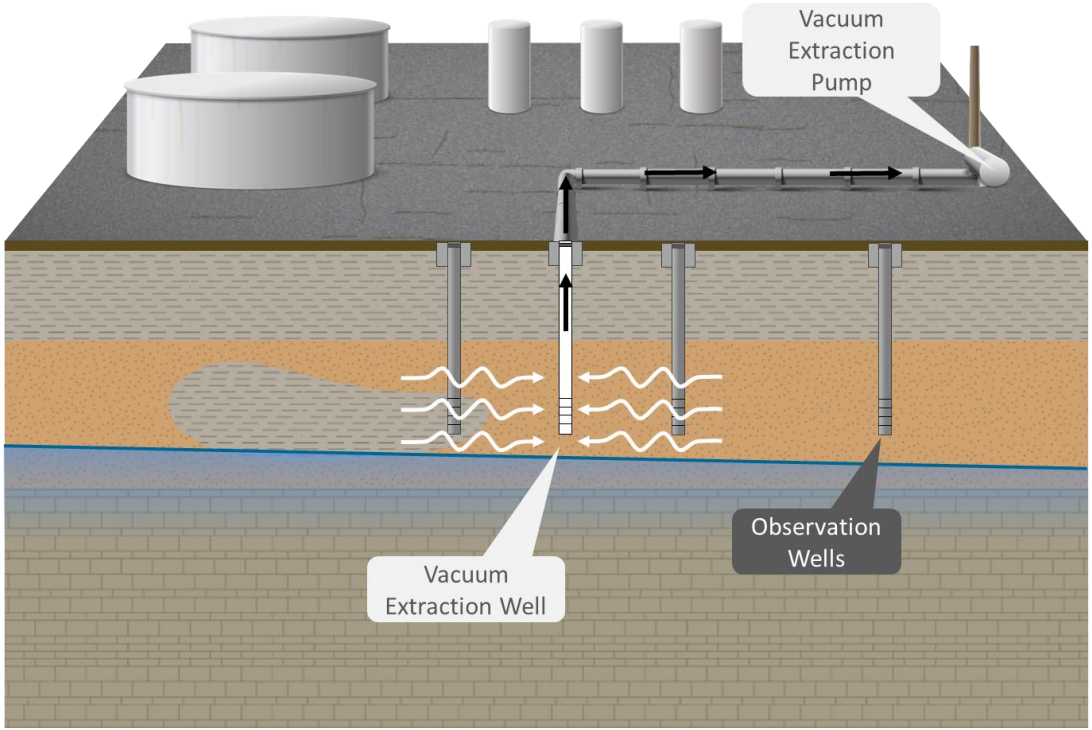
Vacuum Extraction Overview

- Apply negative suction (vacuum) to subsurface
- Determine pneumatic (air) radius of influence (ROI)
- Measure pressure on surrounding observation wells



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Vacuum Extraction Overview

- Vacuum <0.01 inH_2O (0.25mm) is difficult to measure
- Limits determination of ROI
- 0.1 inH_2O (2.5mm) commonly used as a conservative indicator of pneumatic ROI

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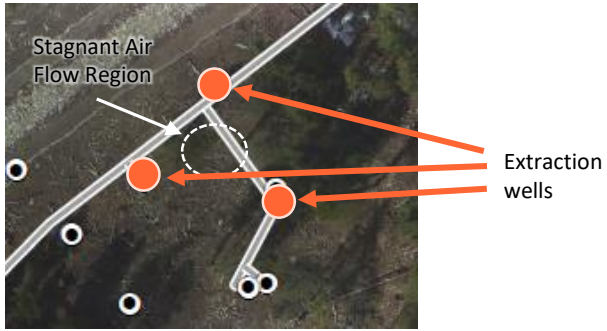
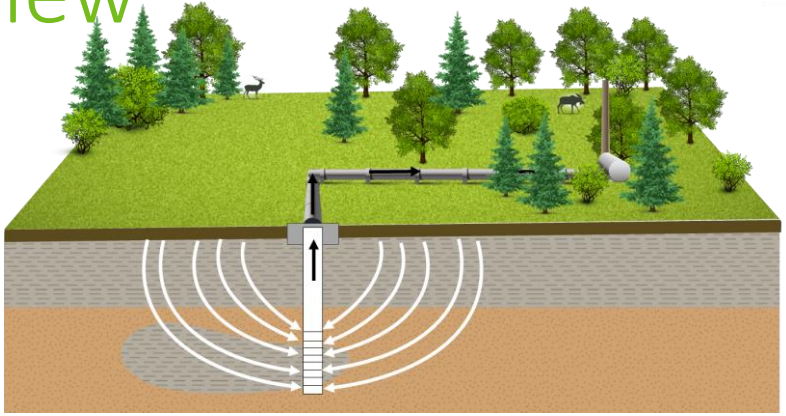
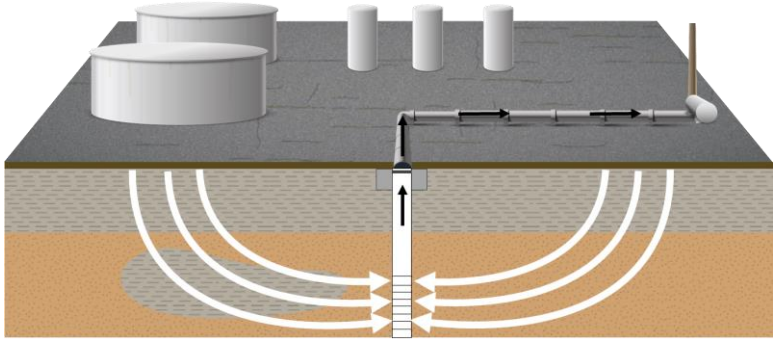
Vacuum Extraction Overview

- What affects ROI?
  - Permeability
  - Heterogeneity
  - Surface seals
  - Stagnant zones





Unconsolidated Surface



Impermeable layer

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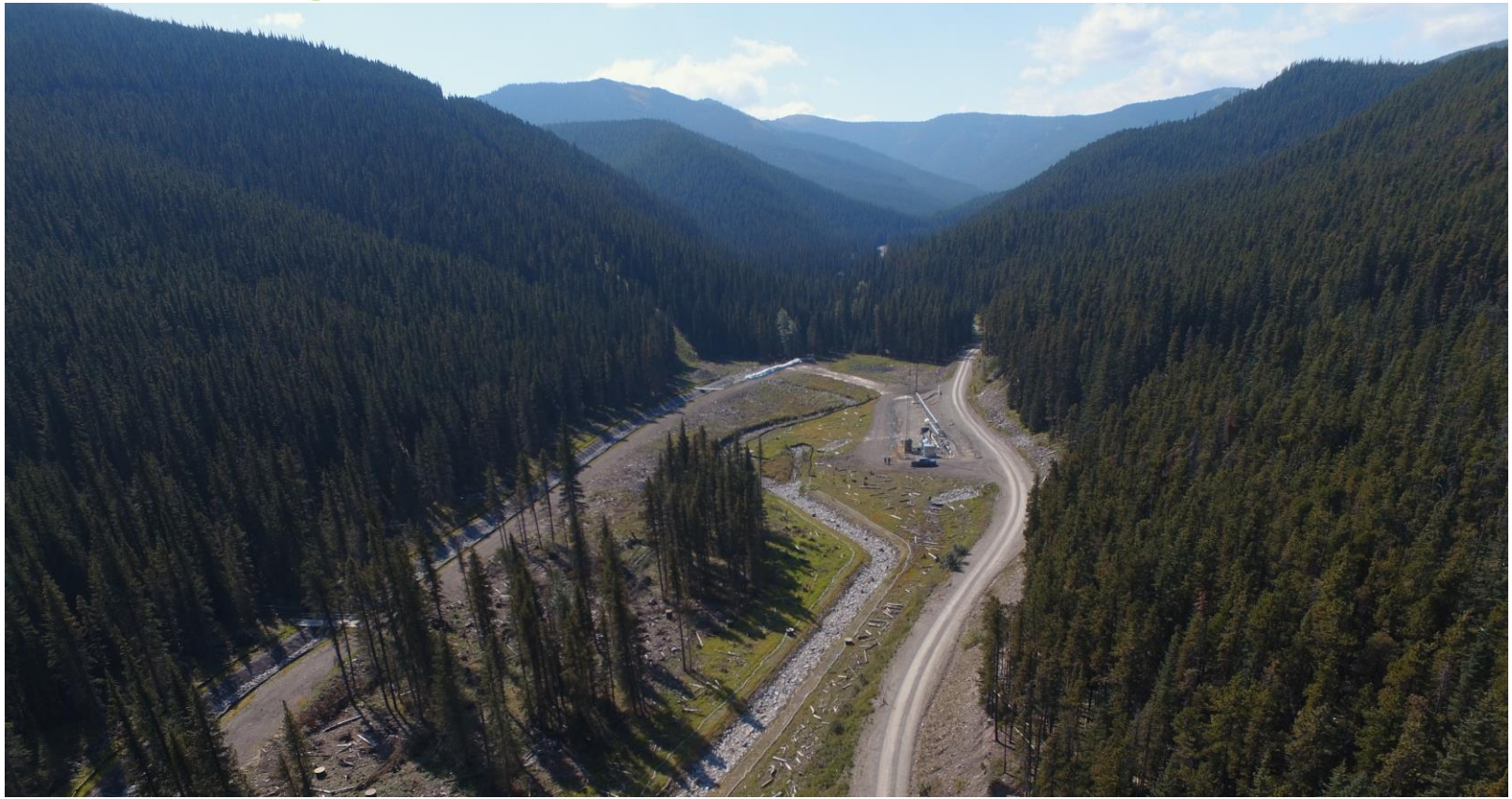
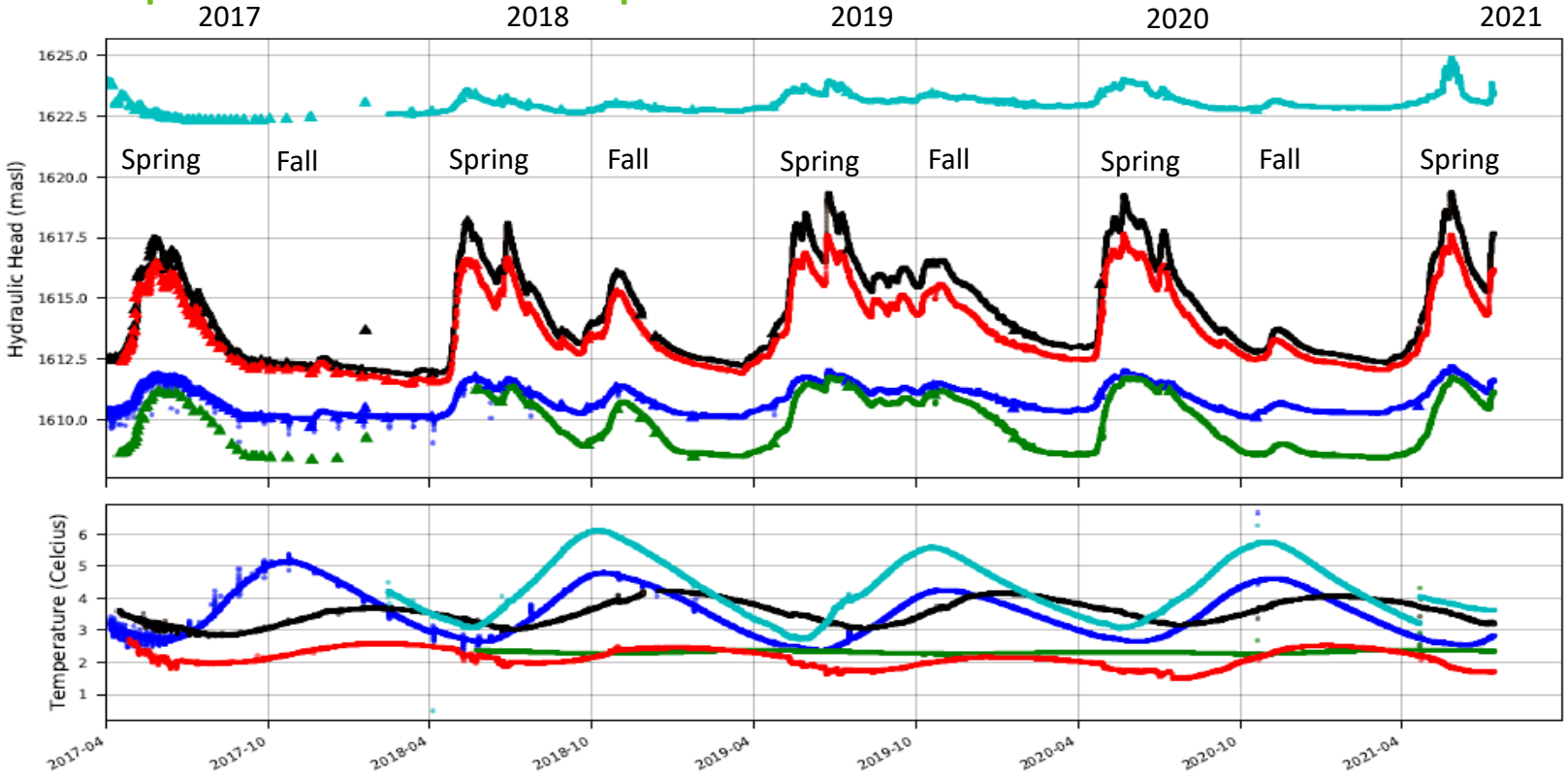
Site Setting



Site Setting

- Quaternary Geology
  - Drift (heterogenous); silt, sand, gravel, boulders, occasional discontinuous clay layers
- Bedrock Geology
  - Fractured shales
- Groundwater Δ5 - 10 m

Temperature Response



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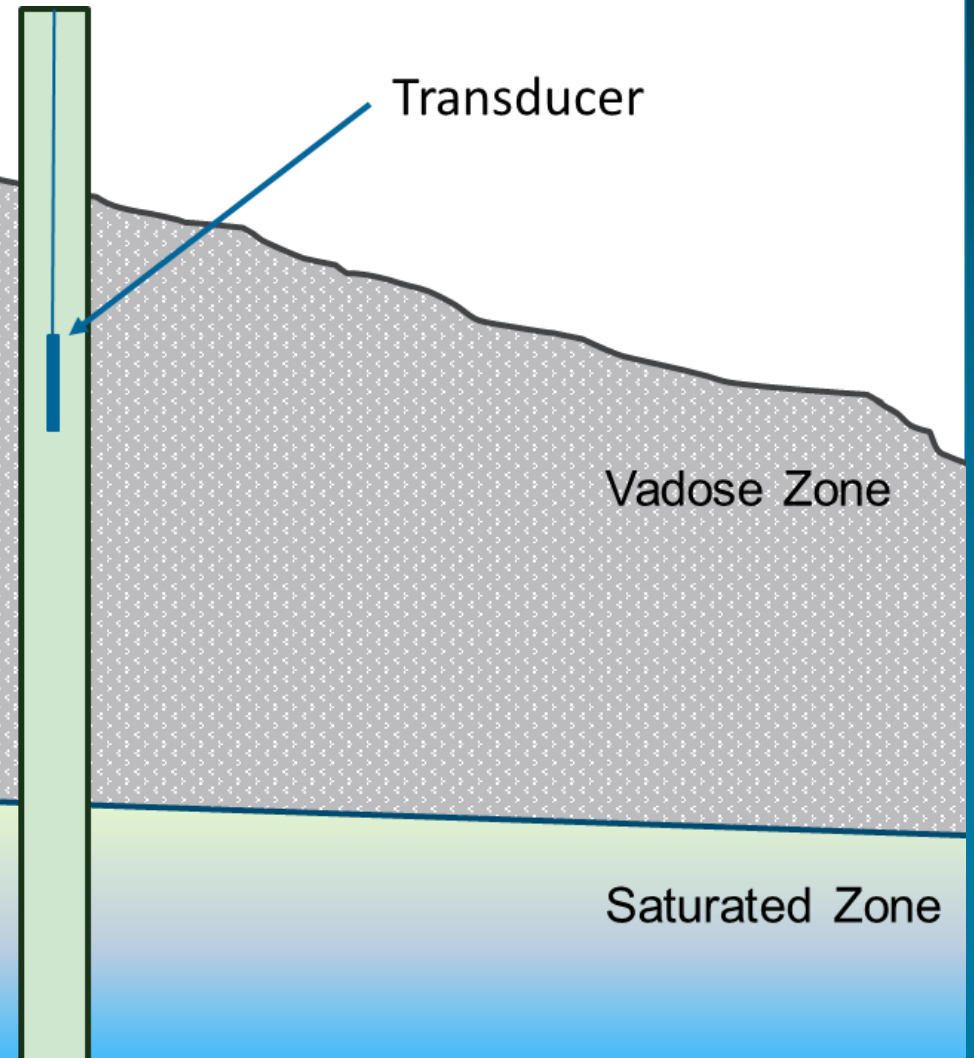

Methods

- Used standard pressure transducers for water level measurement
- Hung in wells ~2-3m below ground surface
- Selected wells that are typically dry or with large sections of open screen in the unsaturated zone (vadose)
- Wanted to see affect of pressure and temperature in the unsaturated zone during SVE Operation

Methods - Continued

- 3 observation wells in the drift
- 1 observation well in the bedrock (part of nested pair)

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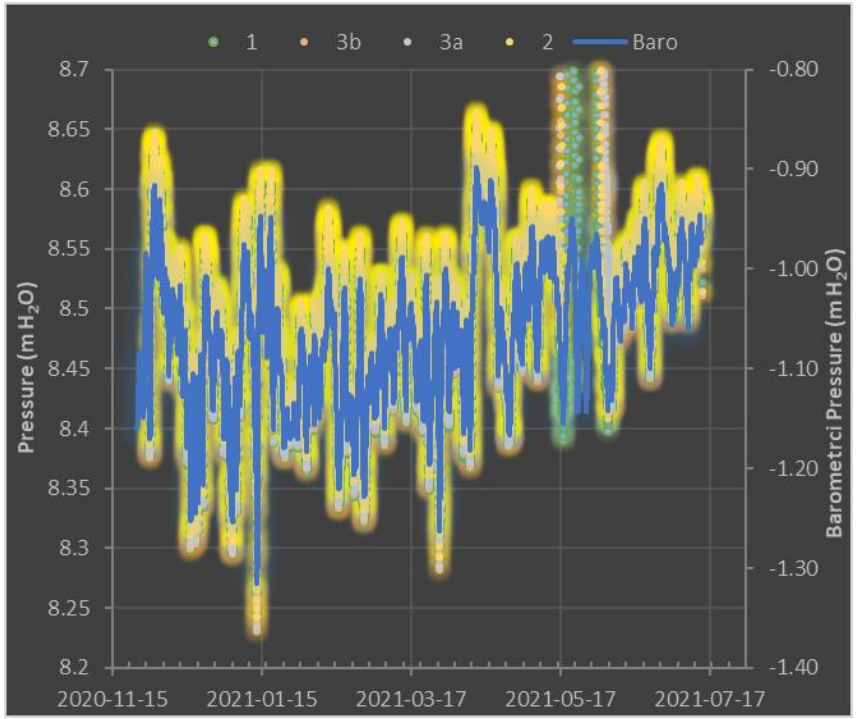
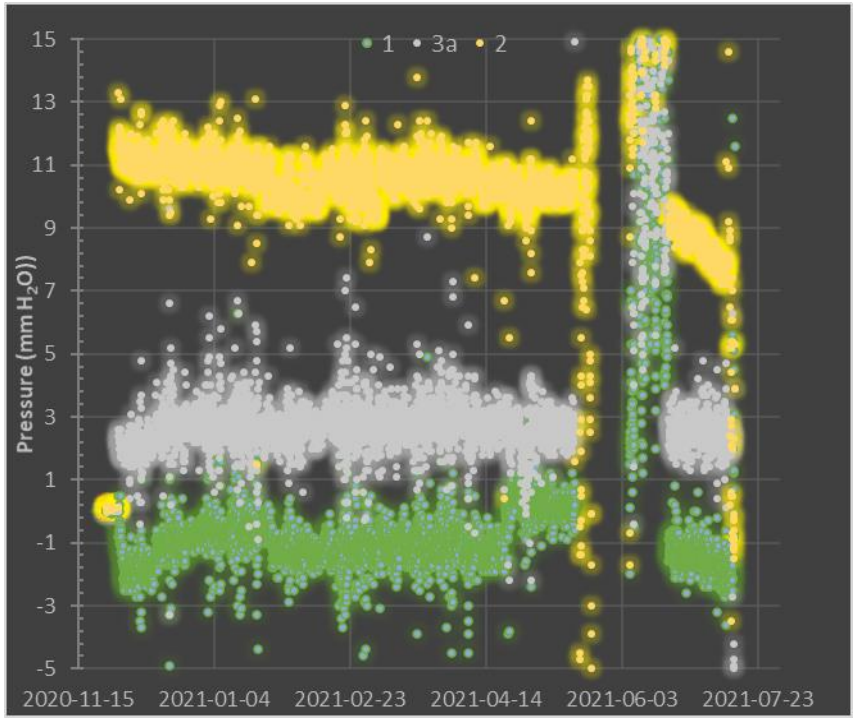
Pressure Comparison - Well Casing



Uncorrected



Corrected

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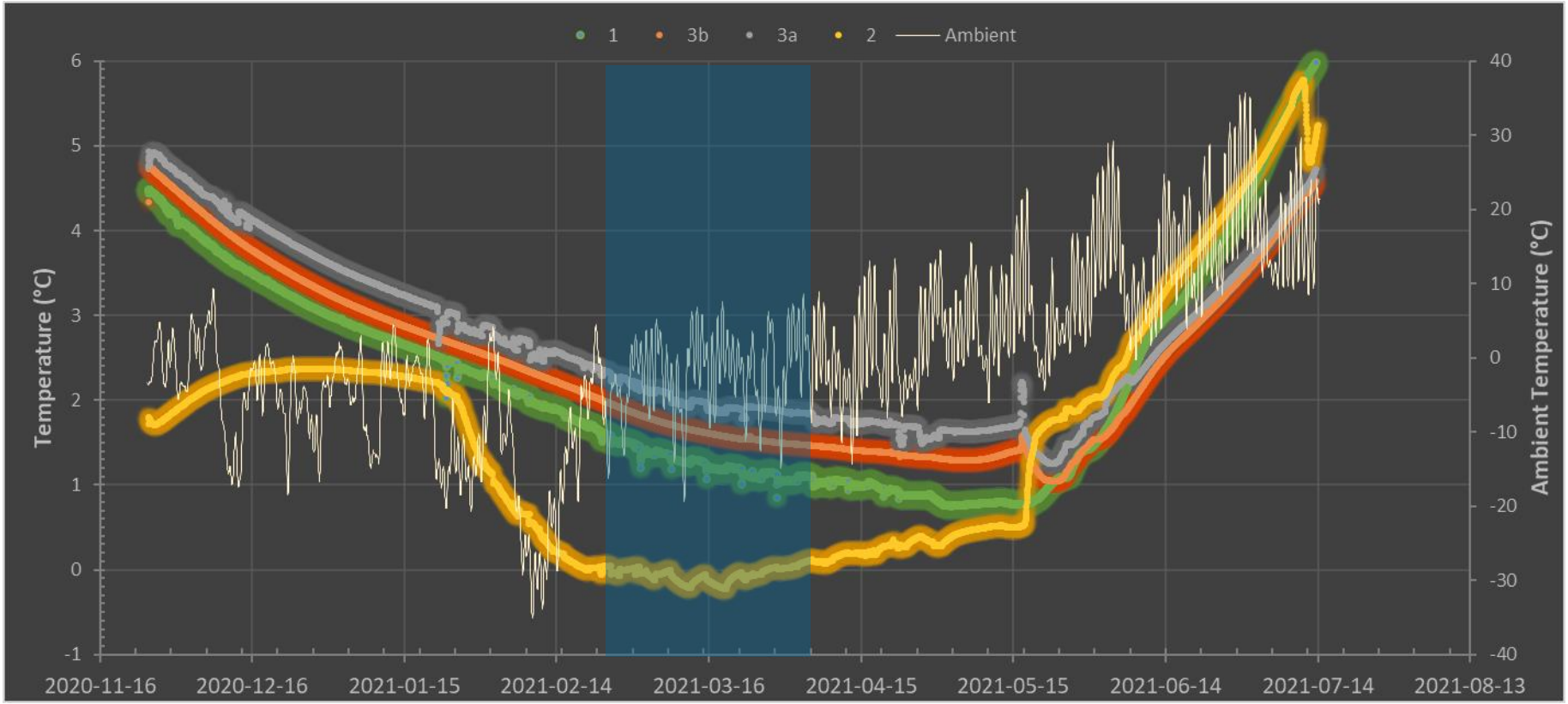
Temperature in Observation Well Casing



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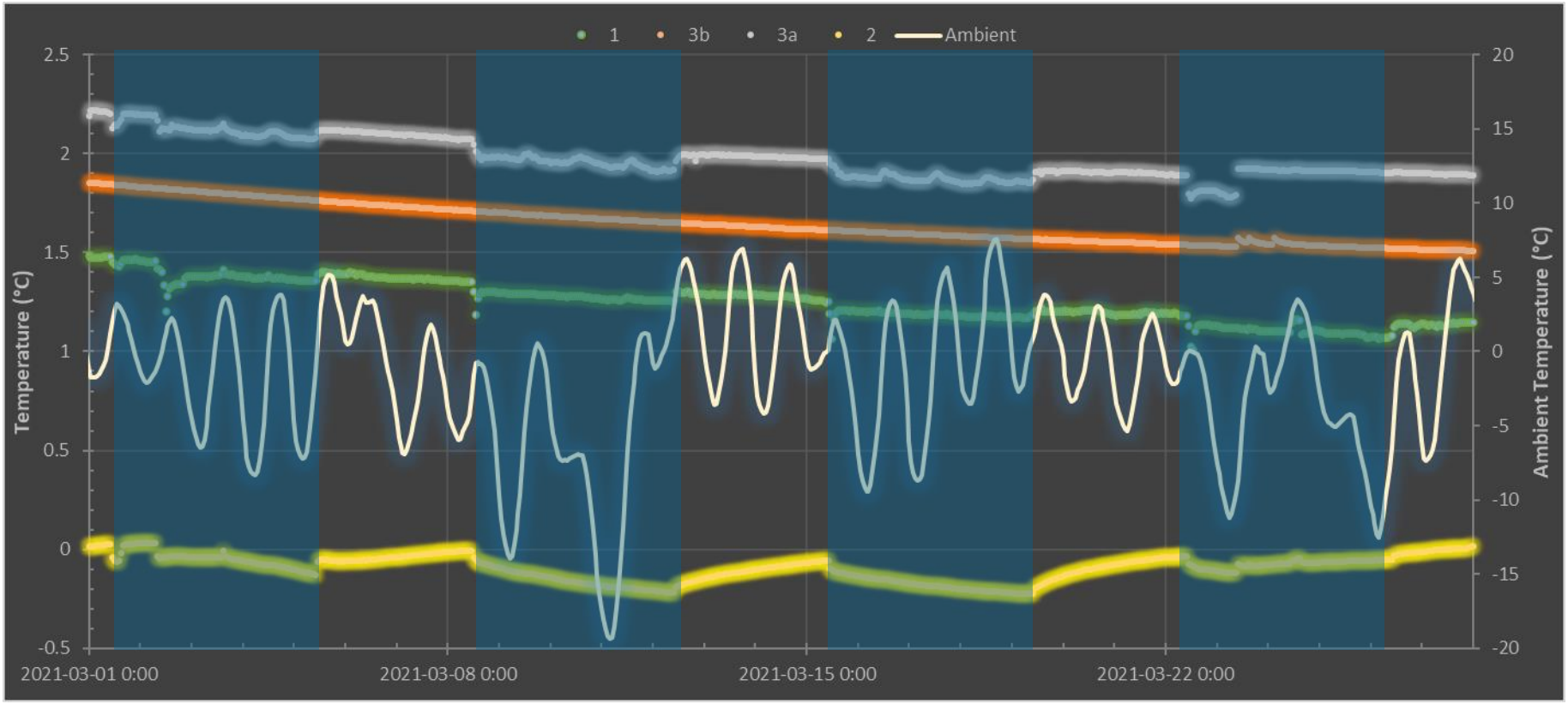
Temperature – March



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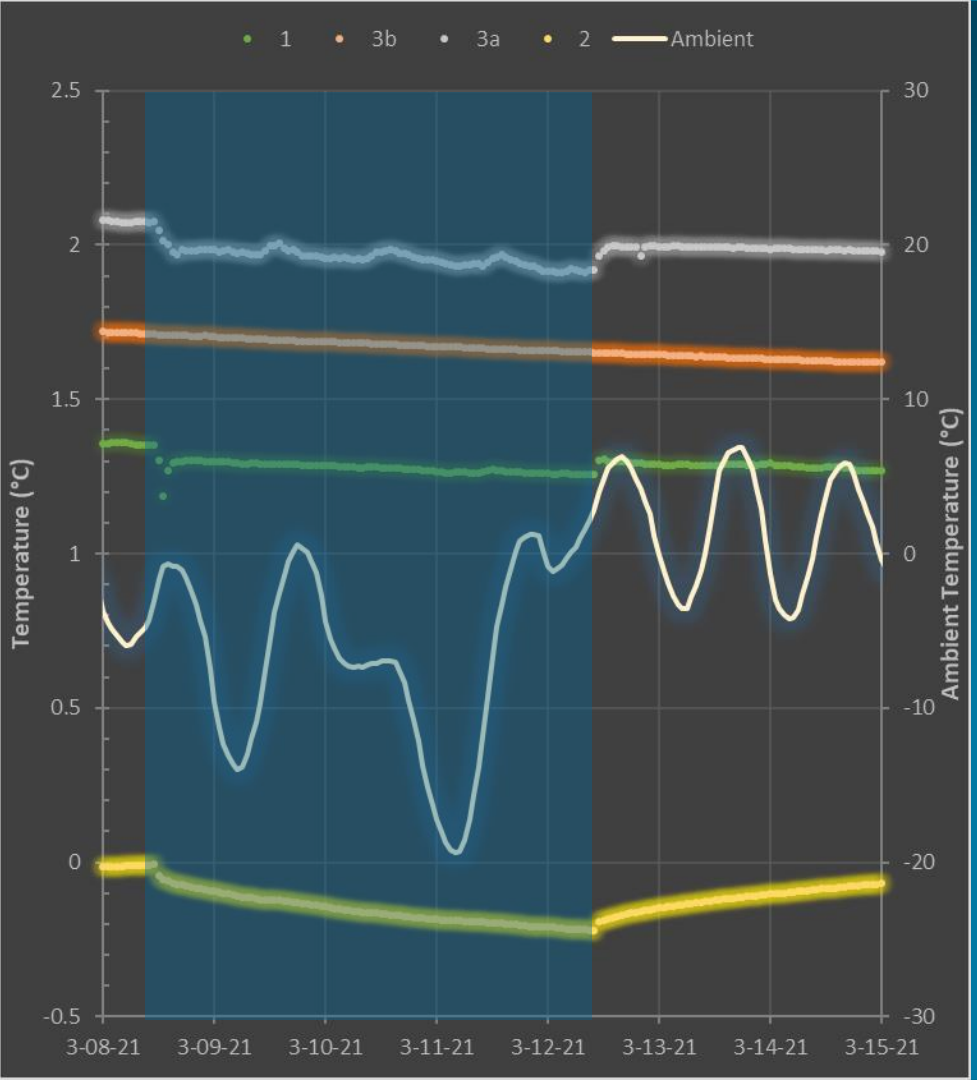
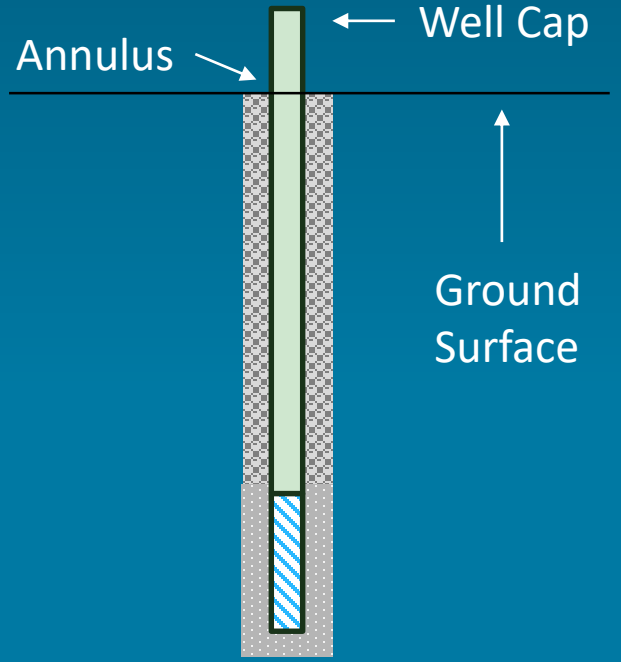


Areas of Potential Leakage



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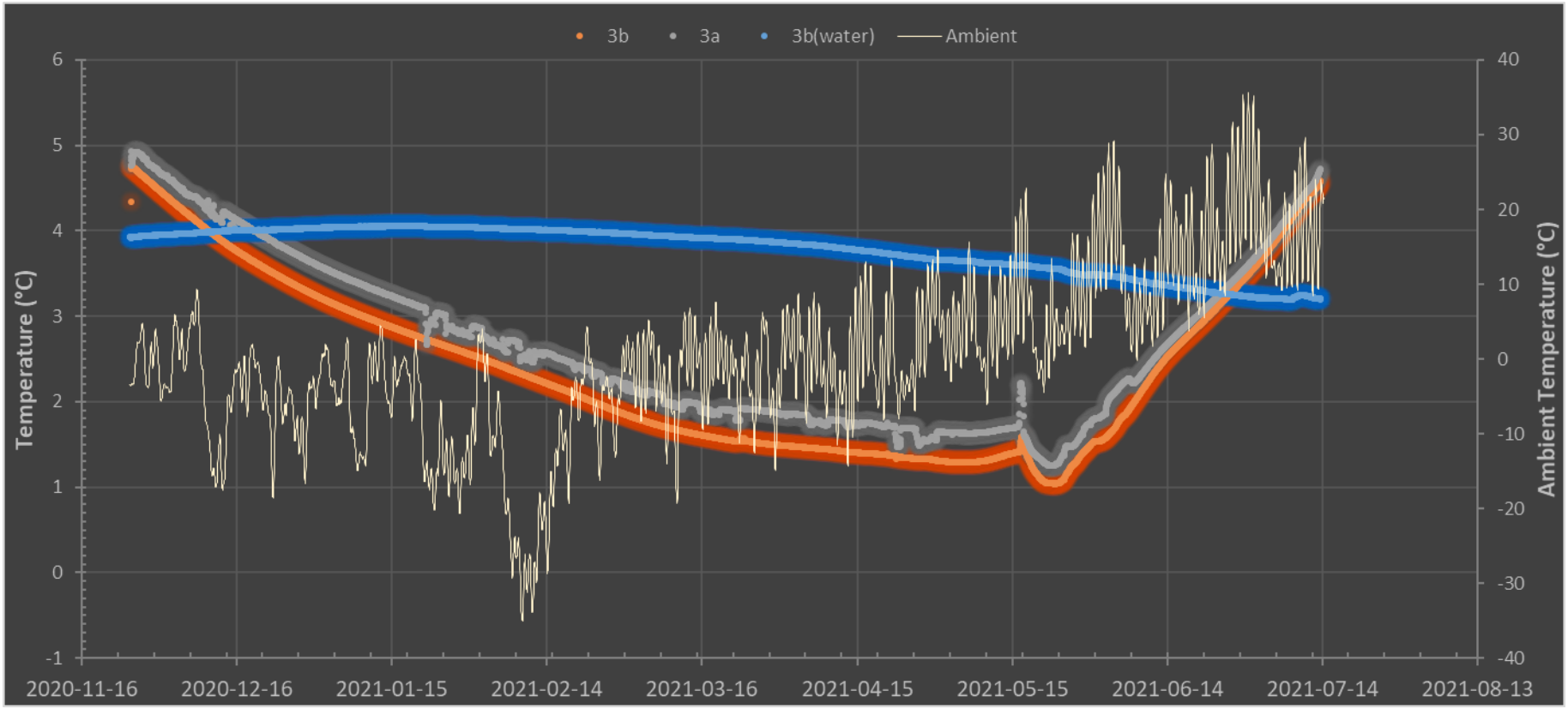
Casing Temperature vs Water Temperature



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Locations

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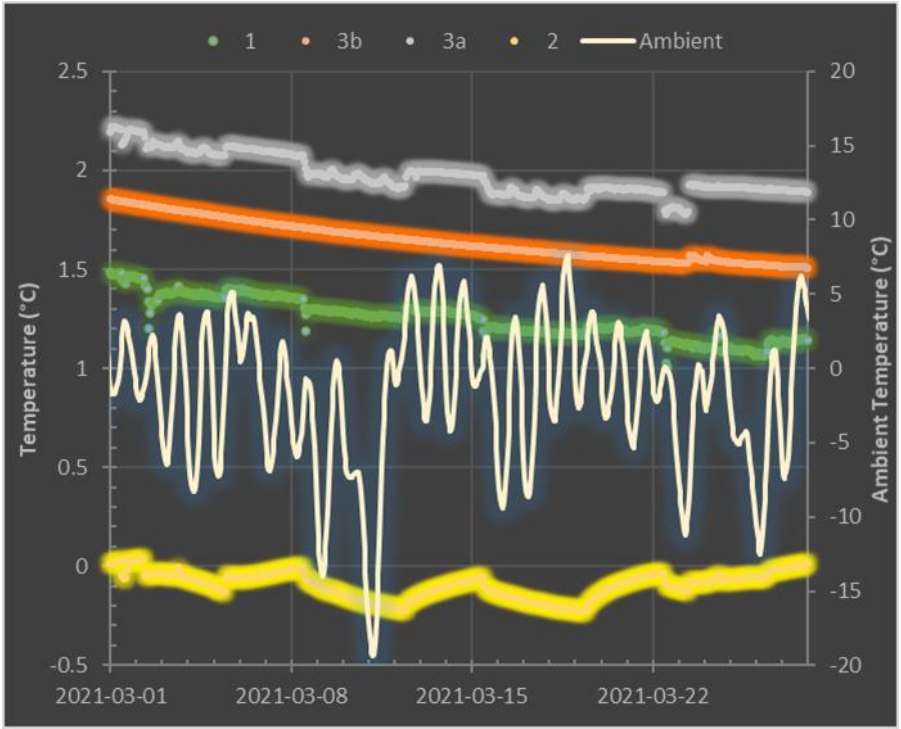
Temperature as an Indicator of Influence



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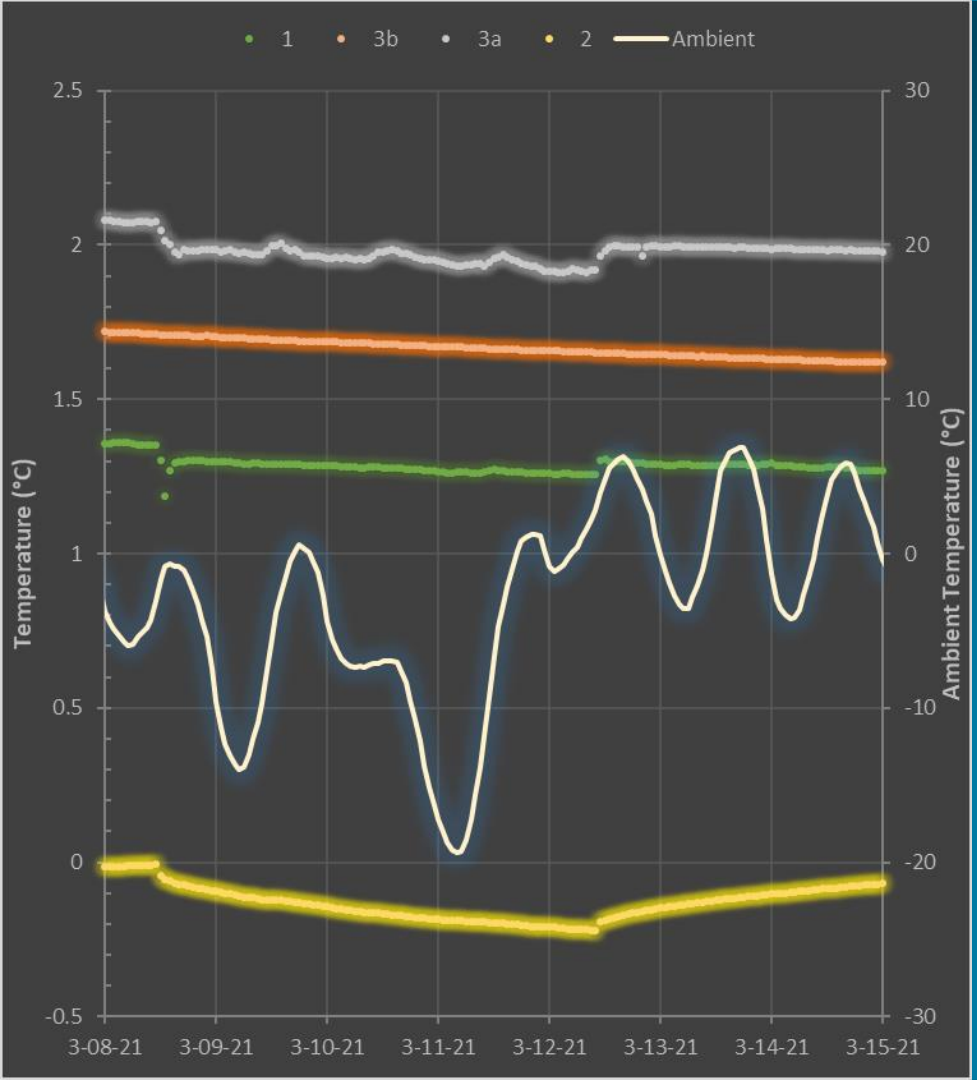

Formation Temperature - Recap

- Δ -0.1 to -0.3 °C is indicative of radius of influence on observation wells during operation
- Subsurface temperatures between 0 and 5 °C during seasonal SVE operation
- Diurnal effect in some wells
- Wells completed closer to surface have cooler subsurface temperatures
- System operation verification

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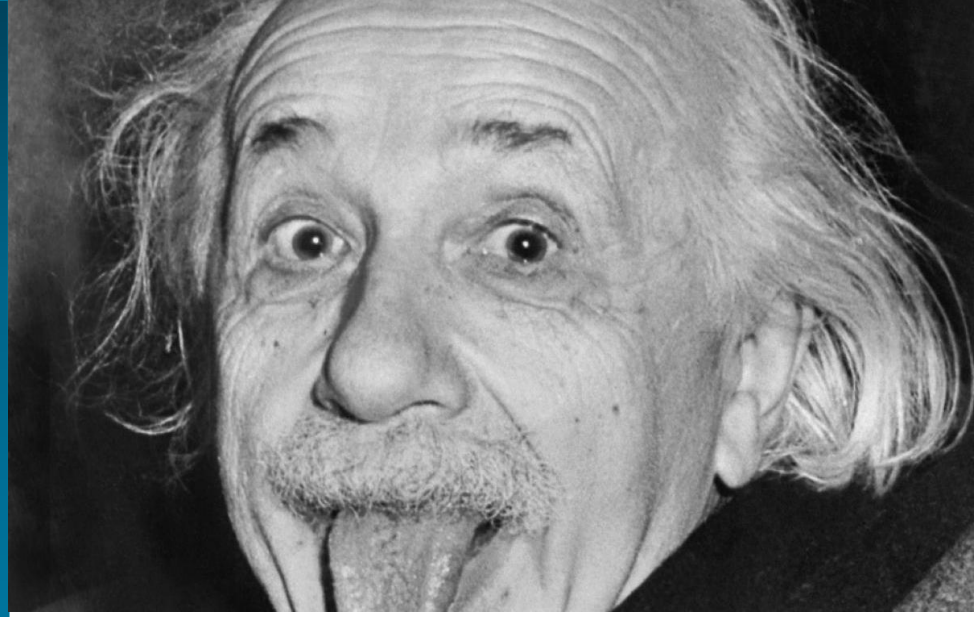
Key Learnings

Subsurface temperature changes can be a useful parameter to evaluate vacuum based remediation system performance at the well field

- Pressure measurements can be substituted or supported by temperature measurements at observation wells
- Temperature can verify effective system run-time and can validate operational status

Future Study Ideas

- Multi-level temp monitoring
- Quantify pressure from temp
- Other types of wells (horizontal)
- Bioventing and air injection
- In-situ chemical oxidation (exothermic reactions)



*We cannot solve our problems with the same thinking we used when we created them – **Albert Einstein***

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