# Refining Groundwater & Transport Understanding at the Navy Red Hill Facility

*Presented to:*
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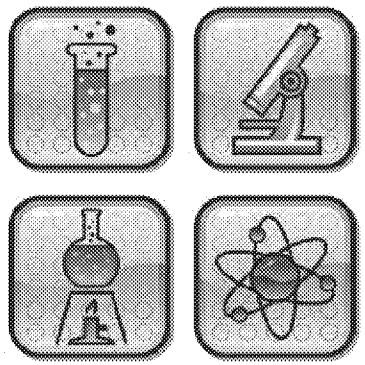
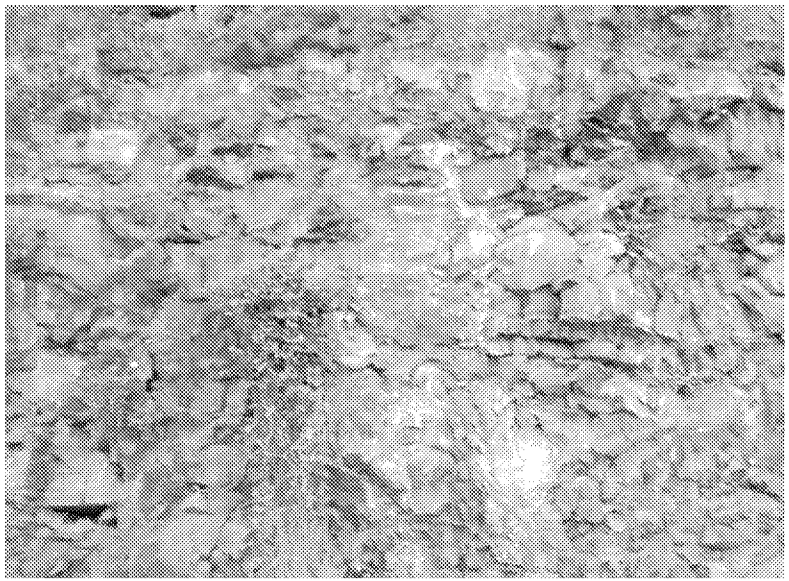
# Transport Observations by Others



- Pore scale processes are important
  - But won't often be seen at macro-scale
  - Homogenization can yield insights, but limited
- Heterogeneity ***cannot*** be modeled deterministically
  - Micro-scale phenomena appear semi-random
  - Stochastic approaches should be considered
    - *Abbreviated from Russell et al., NSF (2008)*
- Small volumes of LNAPL in fractures can produce significant LNAPL heads:
  - Significant depth of penetration into aquifer possible
  - Monitoring well observations are not straightforward
- The presence of potentially mobile LNAPL beneath historical groundwater surface lows should be considered
    - *Abbreviated from Hardisty et al., J. of Eng. Geo & Hydro 2003*

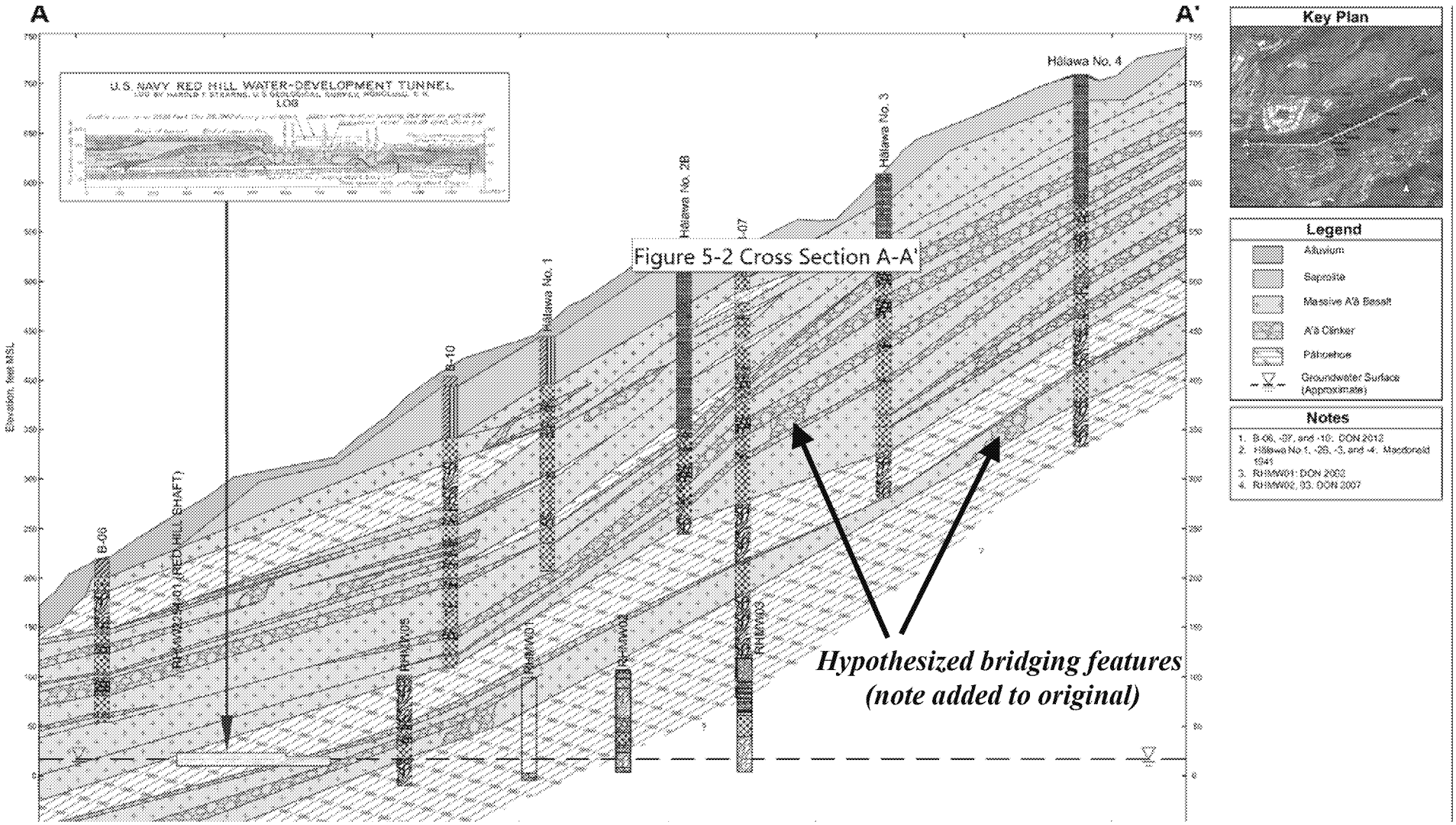
# The Hawaii Hard Rock Release Experience



***Source: Don Thomas, 2021***

- Fuel releases often move quickly
  - Typically in complex pathways
    - Primary & secondary transport
  - Often difficult to characterize
- Fast-track geologic features exist
  - Lava tubes, voids, clinkers, others
  - Often sparse distribution, large effect
- Weathering of rock is complex
  - Non-uniform in time & location
  - Adds to transport complexity
  - Bulk rock properties may not apply
- For Red Hill
  - How is the architecture arranged?
  - How will fuel behave within that?
  - Effects on capture/remediation?
  - All relates to g.w. protection goals
    - And sole source aquifer preservation

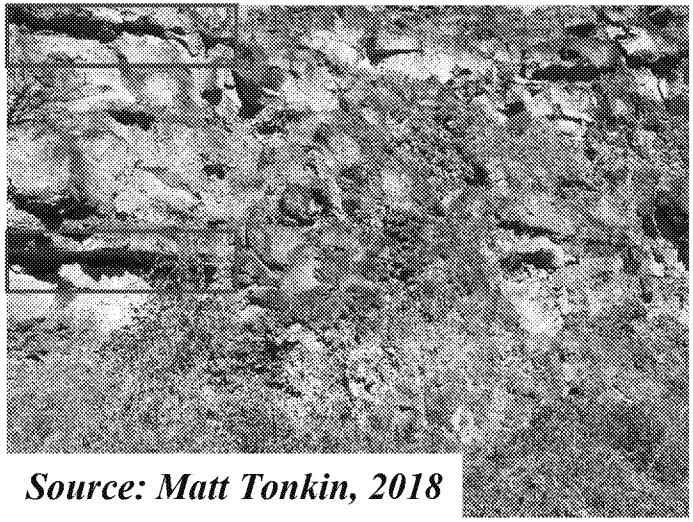
# Example Navy CSM Cross-Section



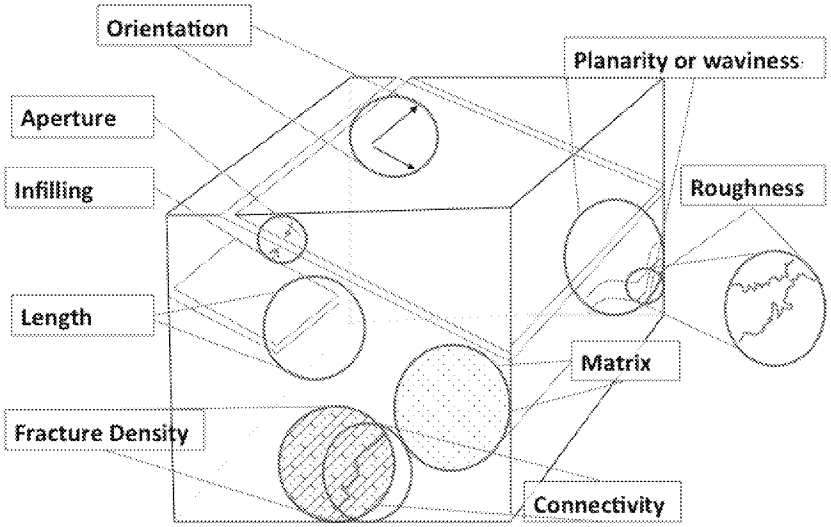

*Source: Red Hill Conceptual Site Model Report, Rev 01, June 2019*

# Example Factors Affecting Flow/Transport

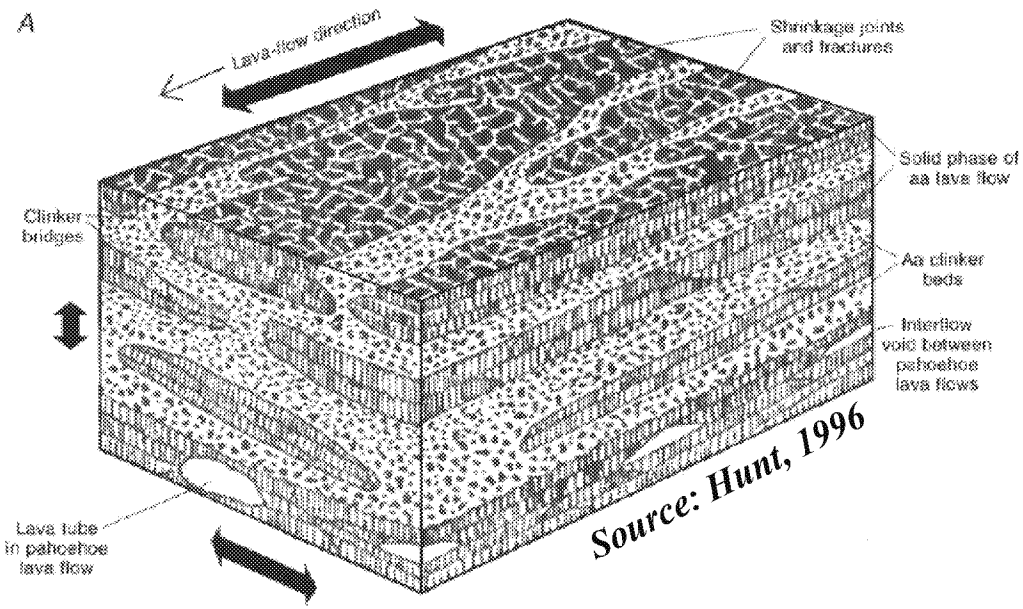
*Source: Don Thomas, 2021*



*Source: Matt Tonkin, 2018*

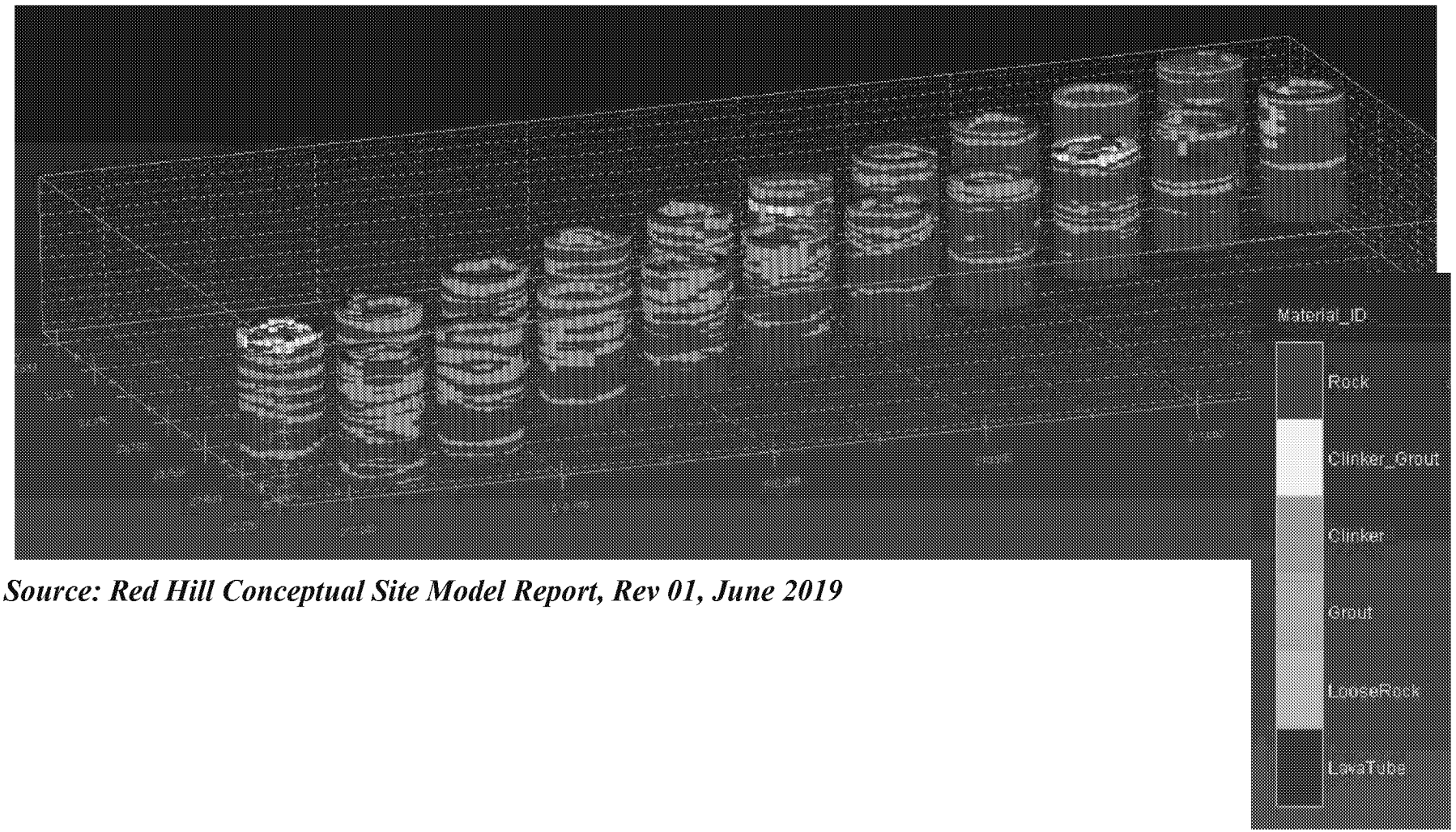



*Source: ITRC, 2017*



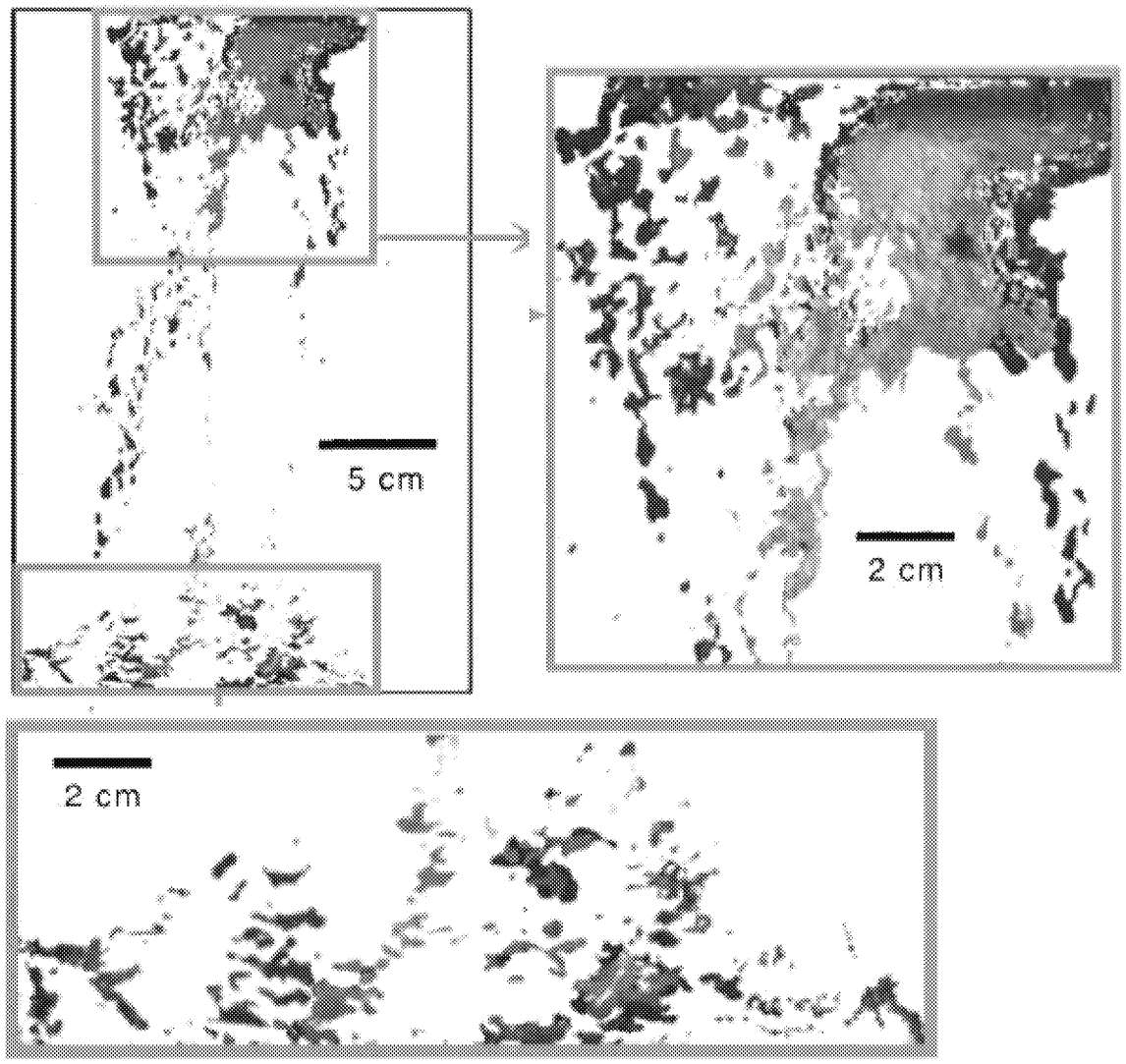

*Source: Hunt, 1996*

# Navy 3D Lithologic Model – Barrel Logs



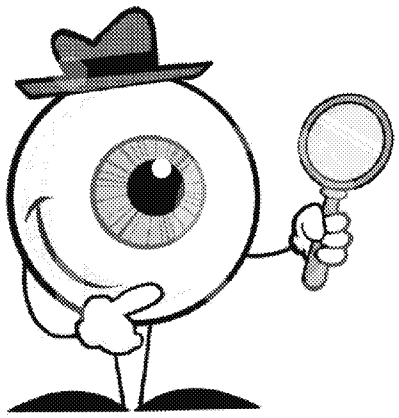

***Source: Red Hill Conceptual Site Model Report, Rev 01, June 2019***

# Complex NAPL Distribution in a Fracture




*Geller et al., 2000*

# The Basis for Further Investigations



- The DOH sees uncertainty in the CSM
  - With key complexities not characterized
  - Alignment of modeling approaches with data
    - Particularly NAPL/CF&T
    - And those effects on mitigation measures
- Key CSM elements need technical confirmation
  - Basics like g.w. flow directions and rates
  - Variance, if any, at the water table zone
  - Potential vertical dilution effects
  - Transport behavior elements
    - Dispersivity, compartmentalization
    - Potential dual-domain type responses
    - EPM scale dependency aspects
      - Particularly for NAPL transport
- Leading to sound approach to CF&T/risk
  - And aid in public communications