Welcome!

Navy Red Hill Groundwater Model Webinar

Our presentation will begin at 5:00pm

Webinar Instructions

Please share your questions that are relevant to the presentation topic through the Q&A feature.

Questions will be reviewed before they are shared at the end of the presentation. Please update your name as you log in and submit questions.

Agenda

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- Welcome
- Introductions
- Background and Orientation
- Introduction to Groundwater Flow
- Groundwater Flow Modeling
- Navy Red Hill Groundwater Flow Model
- Q&A
- Upcoming Events

Welcome and Introductions

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Deputy for Environment & Remediation, Navy Closure Task Force-Red Hill

CDR Ben Dunn
Honolulu, HI

Key Speaker Hydrogeologist

Bianca Mintz, PG
Honolulu, HI

Moderator & Community Liaison, Navy Closure Task Force-Red Hill

Lila Castellano
Honolulu, HI

Navy Closure Task Force-Red Hill

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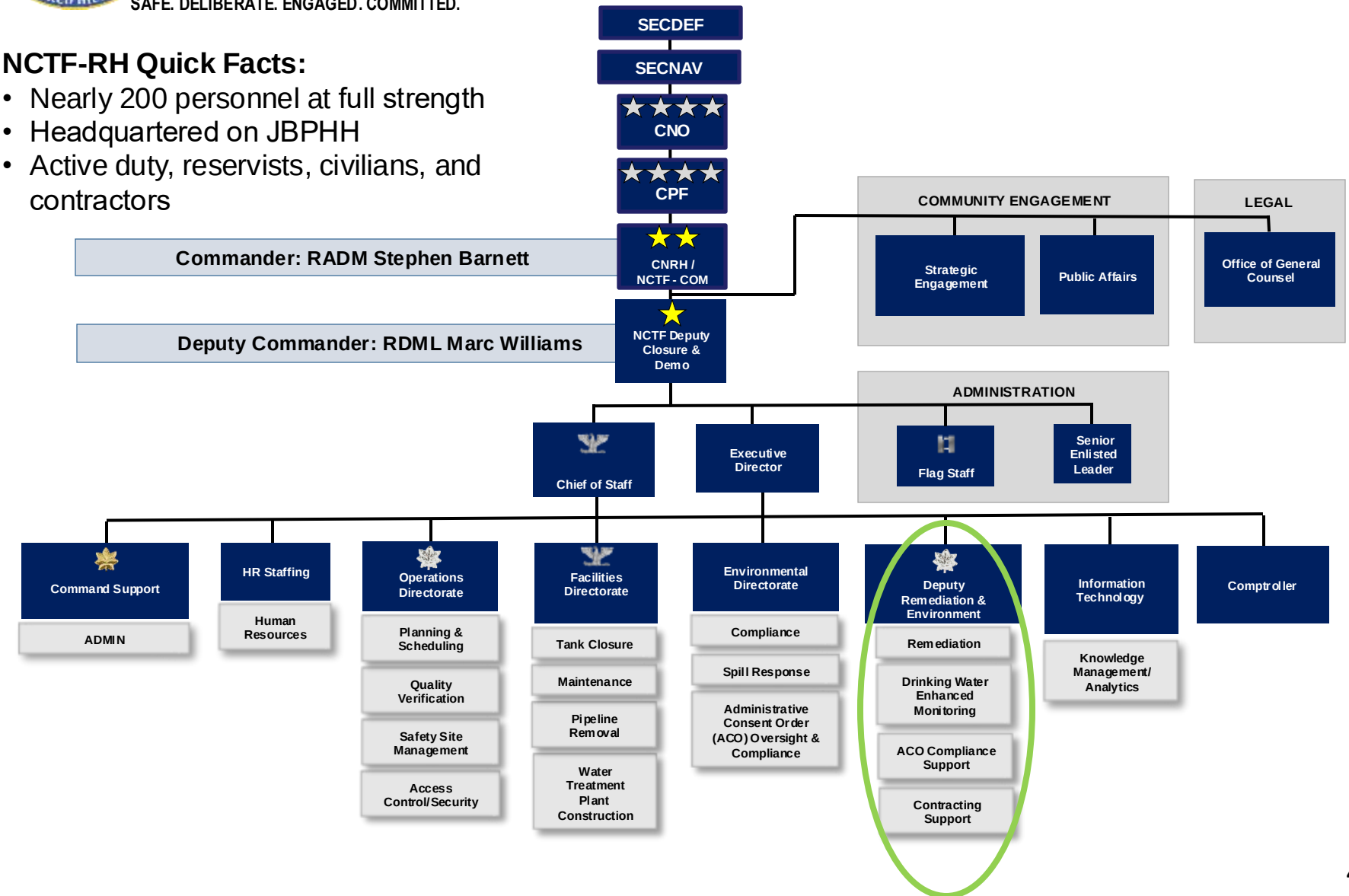
NCTF-RH Quick Facts:

- Nearly 200 personnel at full strength
- Headquartered on JBPHH
- Active duty, reservists, civilians, and contractors



Background and Orientation

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MEDIA INTERVIEWS

Navy Groundwater Flow Model

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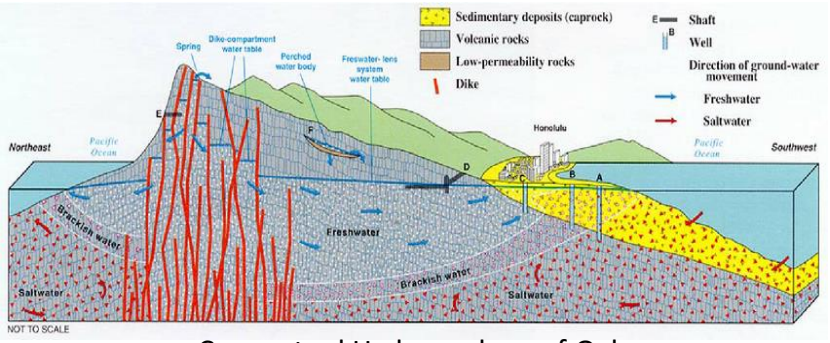
Navy Groundwater Model:

- Advance understanding of subsurface conditions
- Informs environmental remediation
- Assess potential fuel release migration



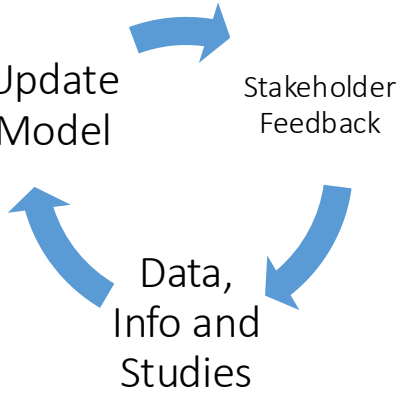
Conceptual Hydrogeology of Oahu

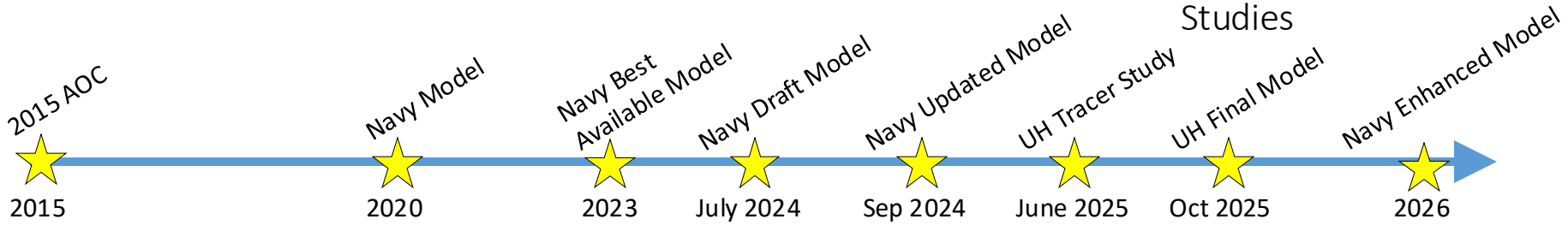
Composite model:

- Geological Conceptual Site Model
  - Estimation of the geologic material distribution
- Groundwater Flow Model
  - Estimates flow direction and flow rates of groundwater
- Vadose Zone Model
  - Studies processes that occur in the geology between the land surface and groundwater table
- Contaminant Fate and Transport Model
  - Estimates migration pathways of contaminants
  - Estimates how natural processes affect concentrations

Iterative Approach:

Informed by data, studies and feedback





Introduction to Groundwater Flow

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What is a Groundwater Flow Model?

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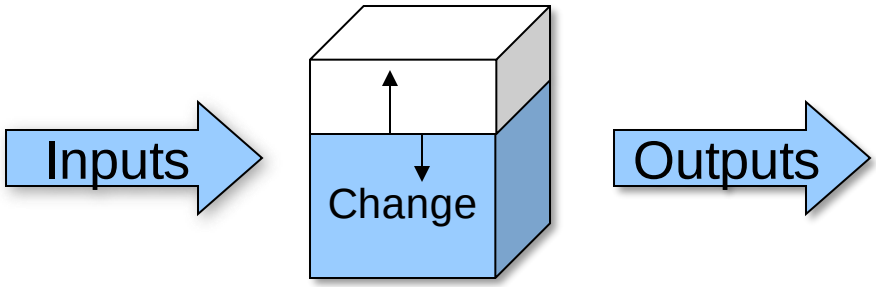
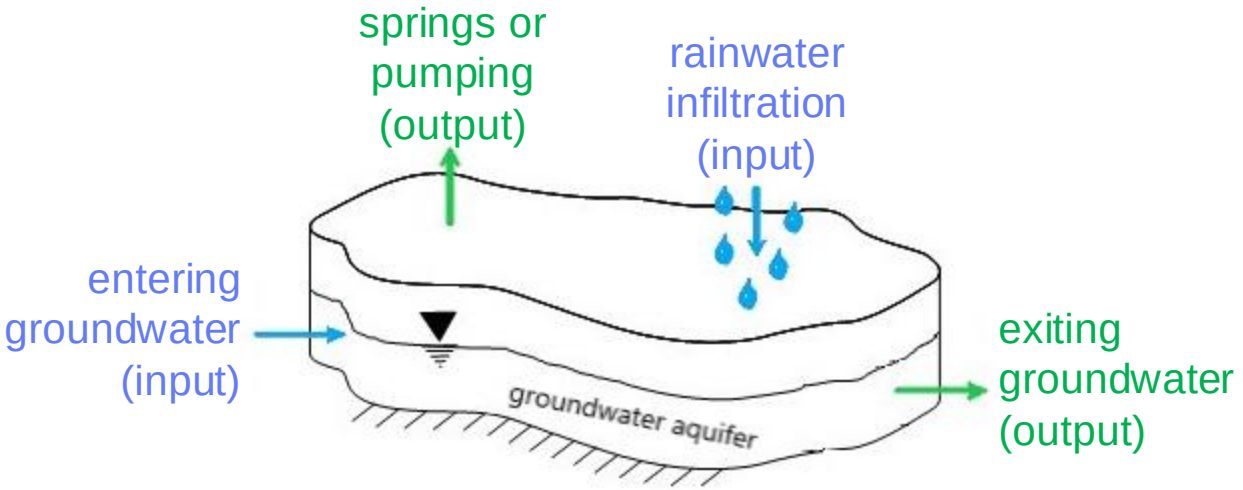
- Groundwater Flow Model is a computer model that simulates and predicts flow and direction in an aquifer (body of rock/soil that holds groundwater)
  - Can be used to support groundwater investigations
- It uses **physics** and **mathematics** to represent the physical processes of groundwater movement
- Models are **based on balances**:

  (Inputs) - (Outputs) = (Changes)



Groundwater Flow: Inputs and Outputs

- Groundwater models are based on an accounting of all the inputs and outputs to the groundwater aquifer.
  - Inputs add water include rainwater seeping into the ground
  - Outputs withdraw water include natural springs, groundwater discharge into a body of water, supply wells
- Inputs and outputs affect groundwater flow and direction.



Inputs and outputs are like deposits and withdrawals in a bank account

Groundwater Modeling

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1) Groundwater Flow Models (**GWFM**):
   - Estimate speed and direction of groundwater flow
2) Vadose Zone Model (**VZM**):
   - Estimate the movement of fluids to the water table
3) Contaminant Fate and Transport (**CF&T**) Models:
   - Estimate future or past concentrations of chemicals in groundwater at particular locations
     - Fate: how the chemicals undergo natural biodegradation
     - Transport: where the chemicals move
   - Generally, petroleum-related chemicals interact with the soil or rock and don't flow as fast or as far as groundwater does

Today we focus on two core models: GWFM and CF&T

Computer Modeling

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Simple	Detailed	Highly Detailed
One dimension	Two dimensions	Three dimensions
Uniform geology	Variable geology	Highly variable geology
Steady over time	Few changes over time	Frequent changes over time

The Navy's model is complex and advanced.

Groundwater Model Parameters

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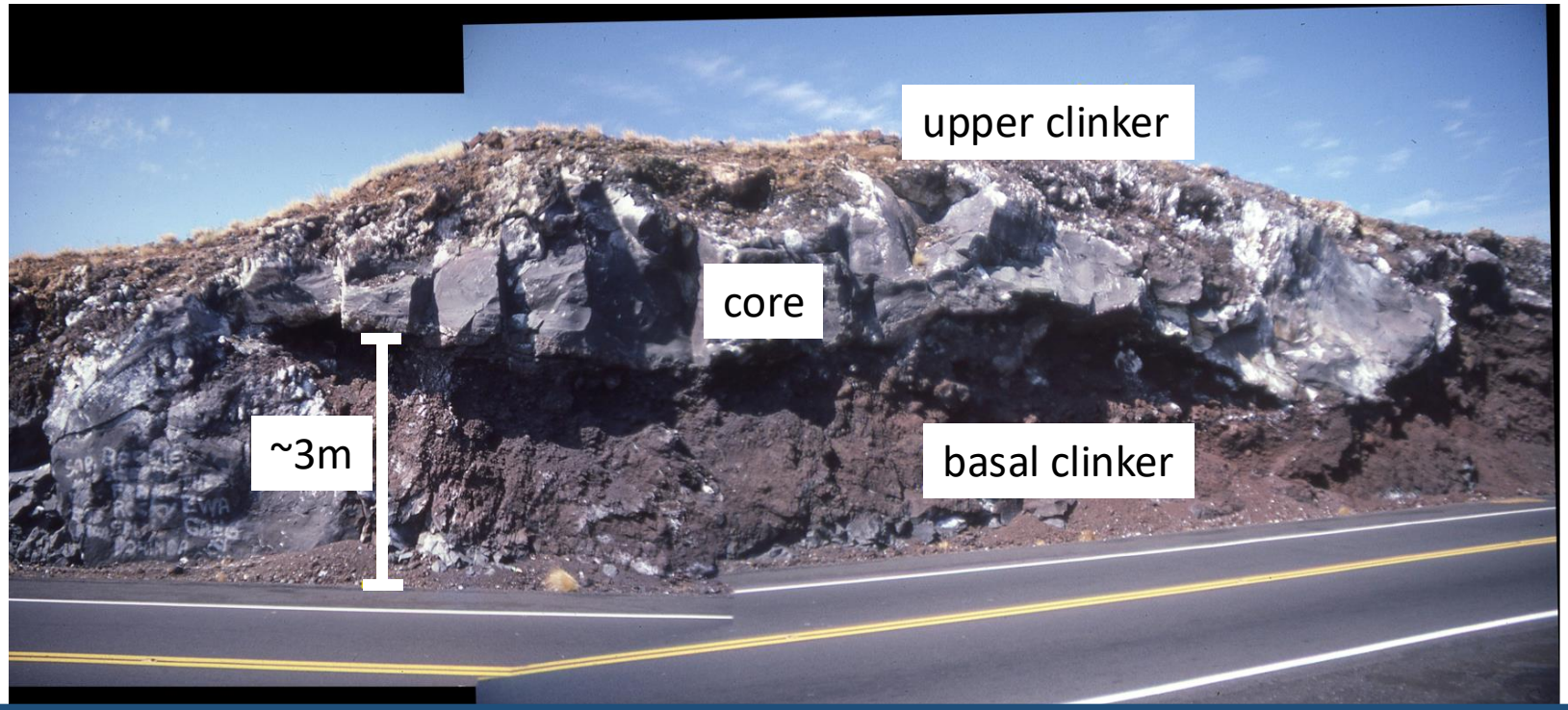
Properties of the aquifer materials affect modeling results:

- Properties of soil, rock and groundwater
- Chemical Properties



A lot of information is needed to account for site conditions.

Groundwater Flow Through Volcanic Rock

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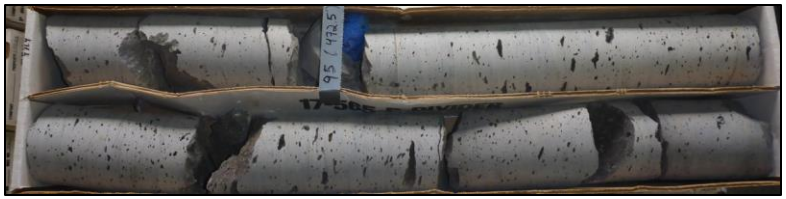
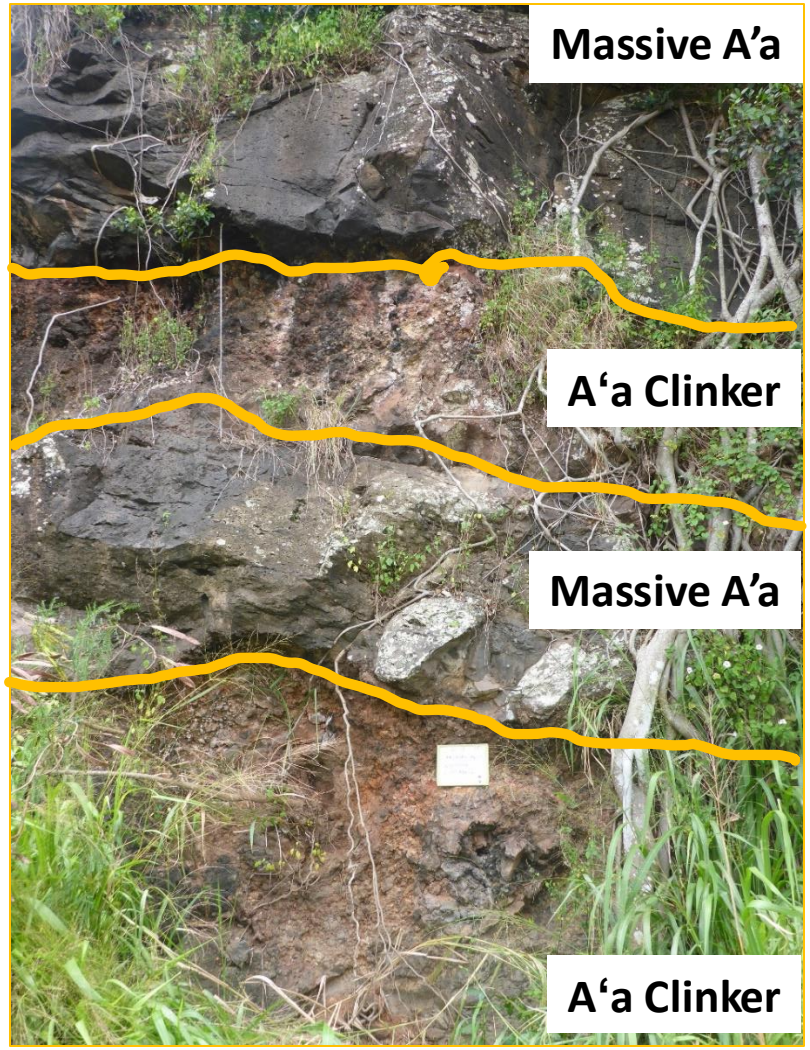
- There is extreme variability in volcanic rock (a‘a clinker, pahoehoe).
- Volcanic rock properties can vary greatly over short distances.
- Geologic data can be gathered from rock cores.





Groundwater Flow Through Volcanic Rock

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- Groundwater flow in basalt can be very fast through a'a clinkers and lava tubes, and very slow in massive a'a. Groundwater flow in pahoehoe can be in between.

Photos of pahoehoe lava and pahoehoe rock cores (medium to high permeability due to interflow zones and fractures)

Groundwater Flow Through Volcanic Rock

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- Saprolite is highly weathered rock, that retains rock-like appearance. It is weathered in place.
- Groundwater flow in saprolite is generally through soil grains as opposed to through conduits in basalt.
- Groundwater flow is slower in saprolite than in basalt.

Saprolite Situated on Red Hill Ridge

Red Hill Model Development

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Improve the understanding of the direction and rate of groundwater flow within the aquifer around the Facility.

Data Collection/Evaluation

↓

Model Development

↓

Simulations

Thousands of data points: water levels, chemical concentrations, geologic properties.

Navy's model is based on a model originally developed by the United States Geological Survey.

Simulations based on field measurements, scientific literature, values, and previous modeling efforts. Many scenarios were evaluated.

Red Hill Groundwater Flow Model Area

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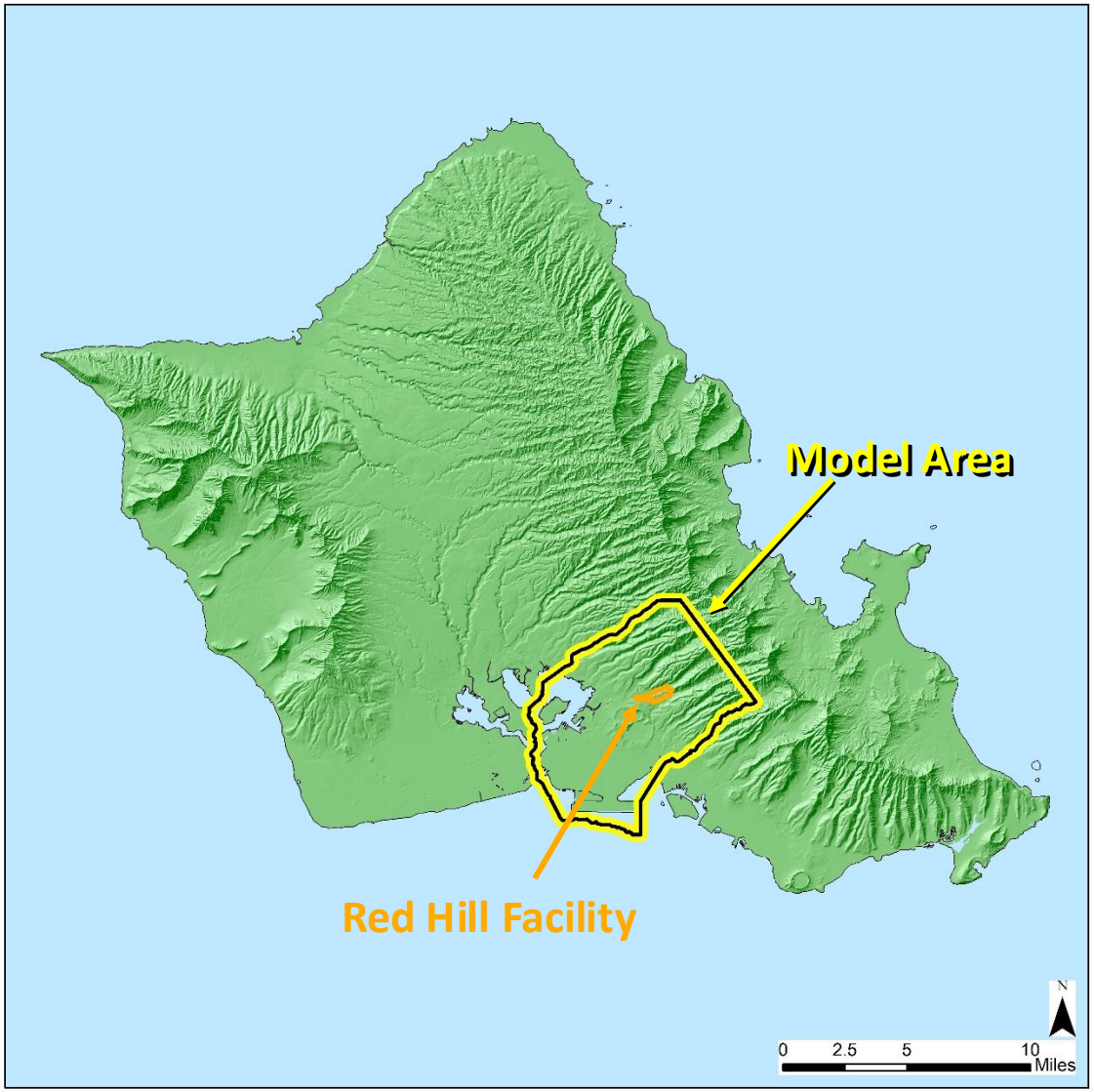
- Model boundaries are generally pushed back well away from the area of concern to edges of the shorelines and drainage divides.



Island Groundwater Flow

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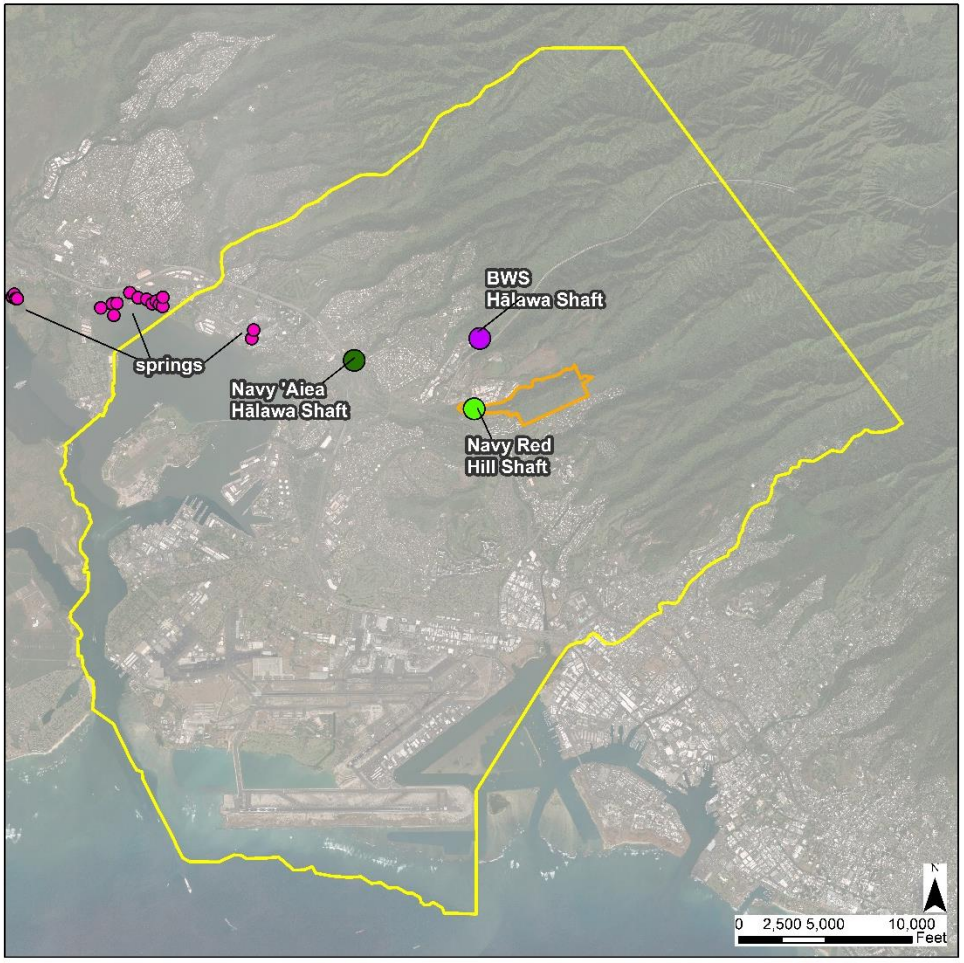

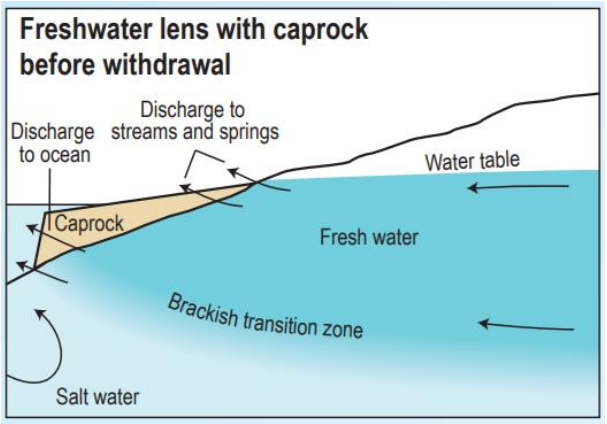

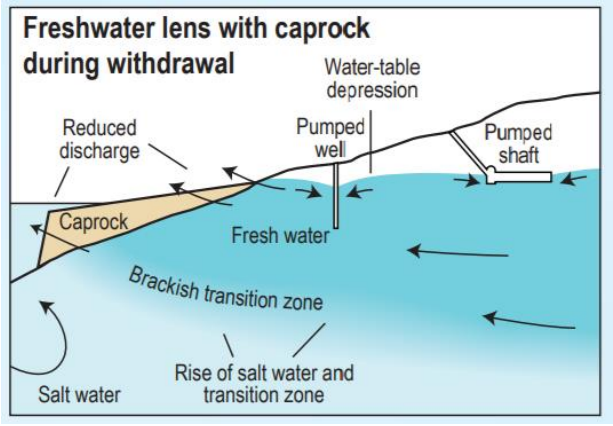

Groundwater in Hawaii typically flows mauka to makai, but there can be localized variations from this overall regional flow.

Red Hill Modeling Scenarios

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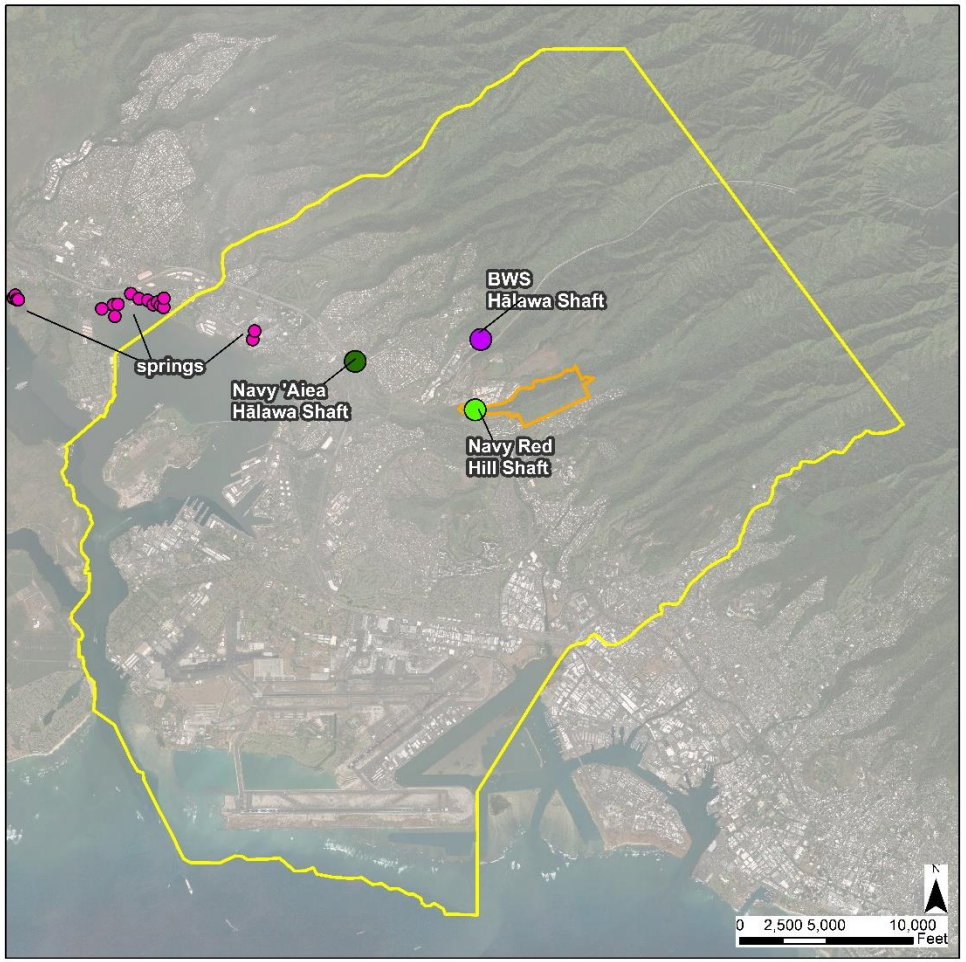
- Different combinations of water supply wells pumping at different rates were modeled, including:
  - Red Hill Shaft
    - Off
    - 1.8 million gallons per day (MGD) (current condition)
    - 4.3 MGD (after November 2021)
  - BWS Halawa Shaft:
    - Off
    - 12 MGD
  - Navy ‘Aiea Halawa Shaft:
    - Off
    - 0.8 MGD



Modeled Groundwater Flow
RHS Pumping at 4.3 MGD, Halawa Shaft Off

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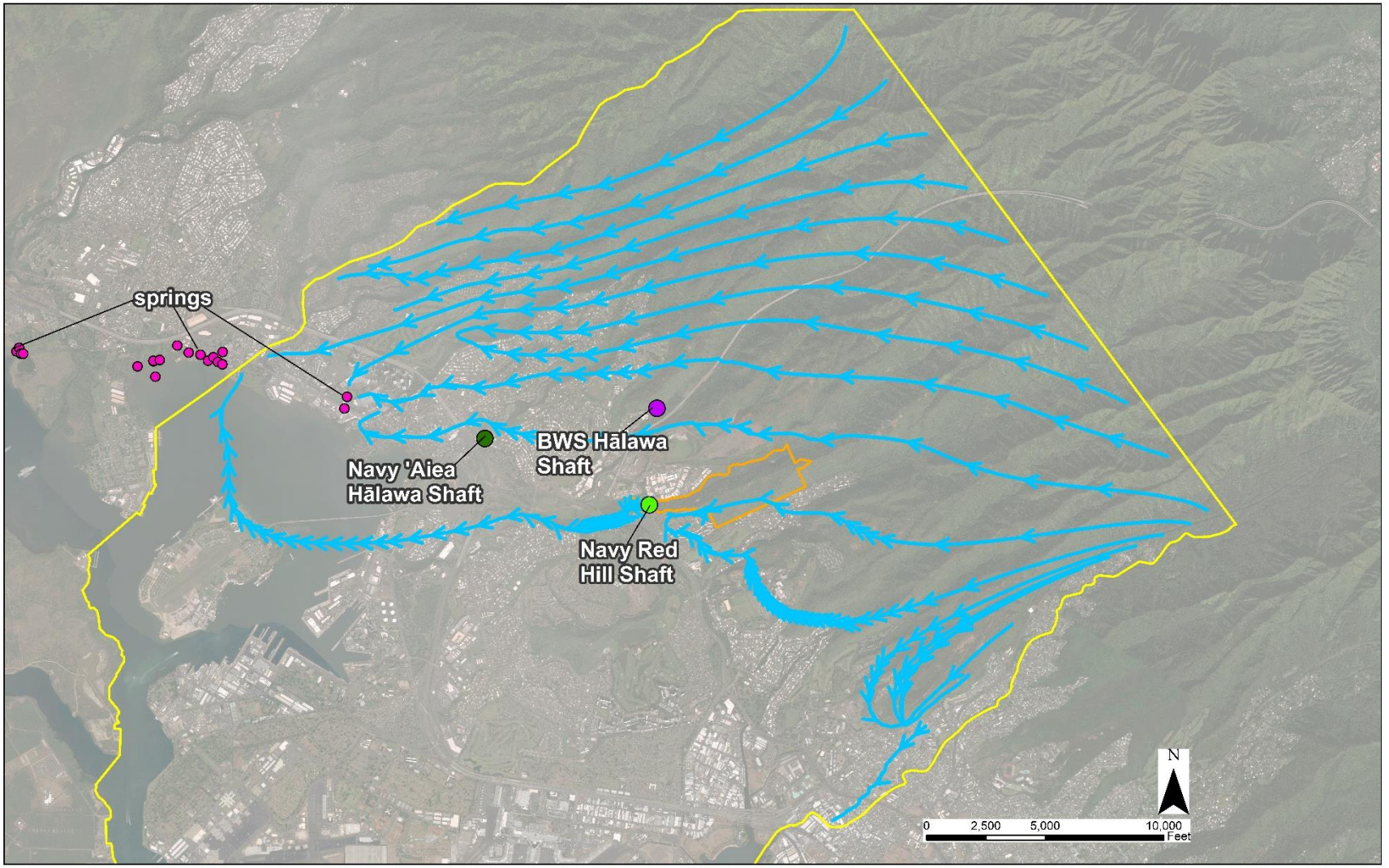

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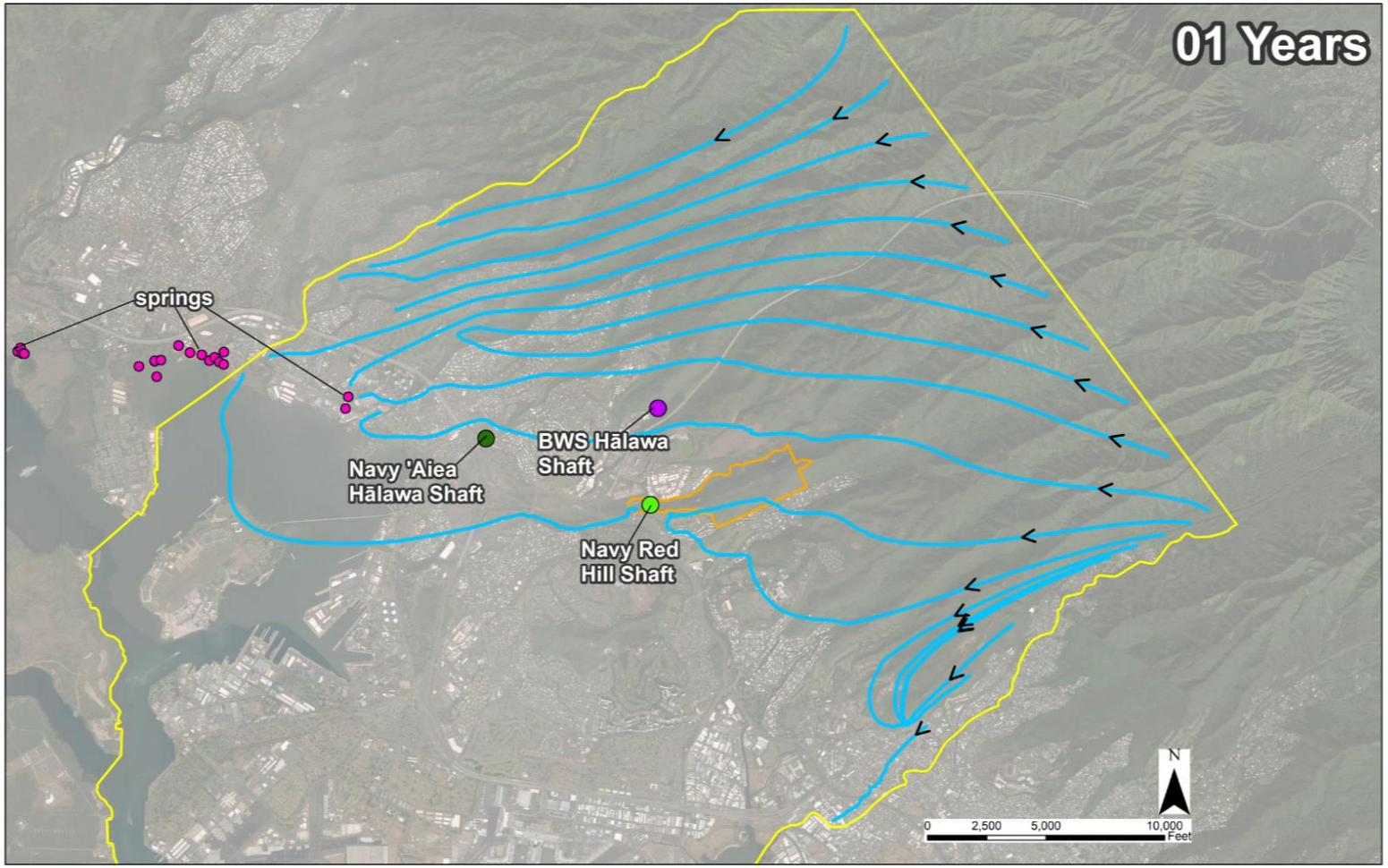

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RHS Off, Halawa Shaft Off

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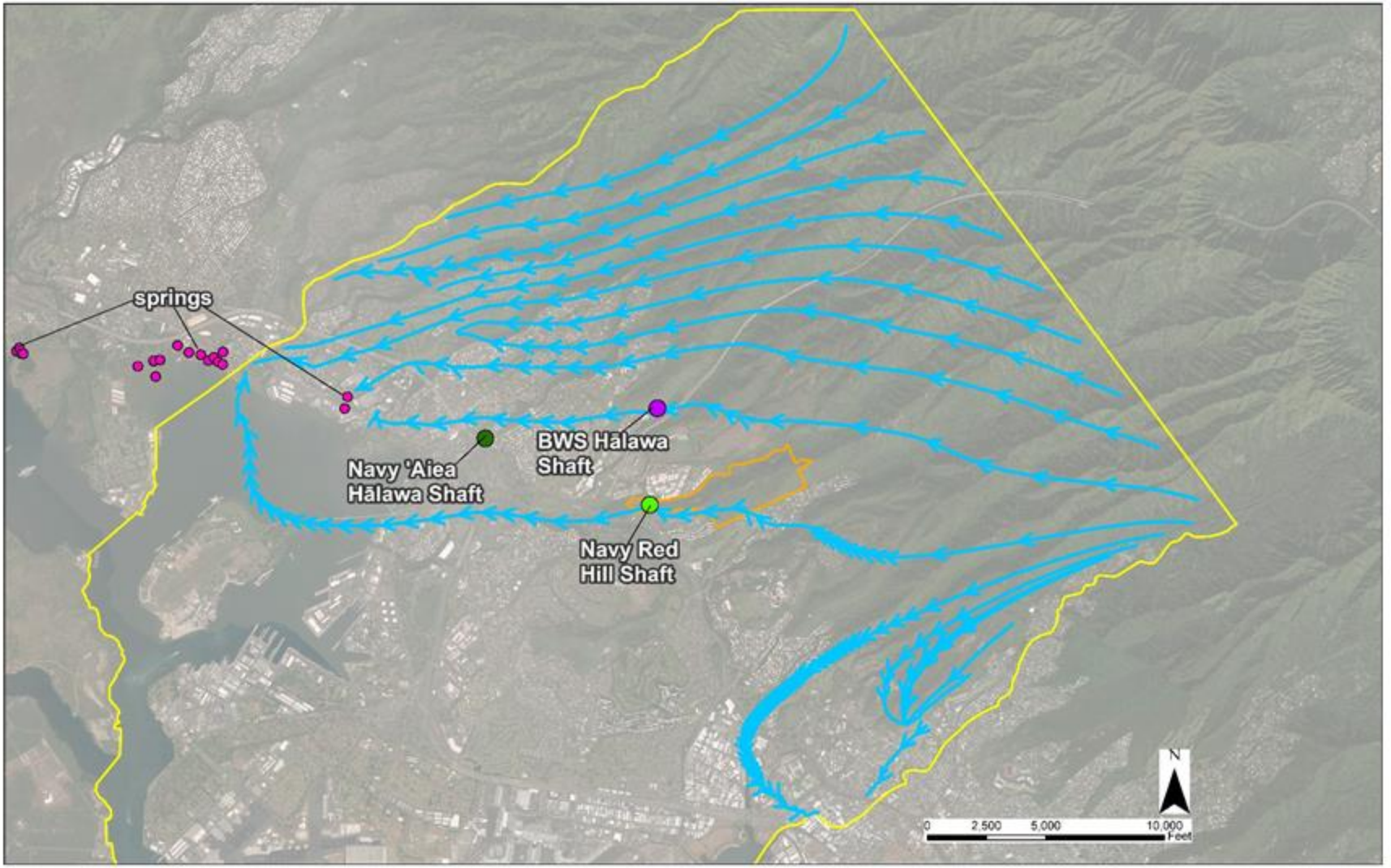

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RHS Off, Halawa Shaft Off

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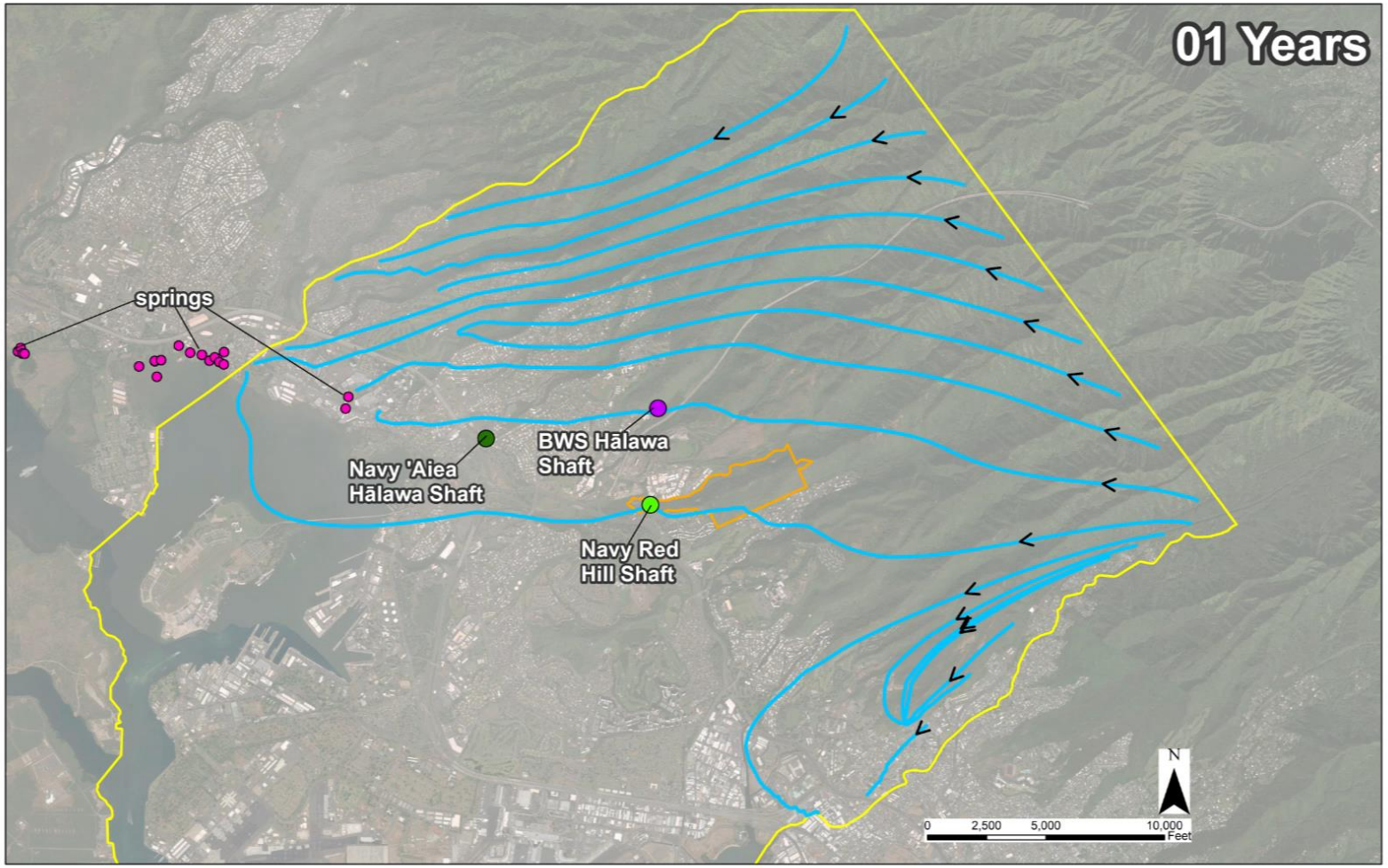

Modeled Groundwater Flow from the Tank Farm RHS Pumping at 4.3 MGD, Halawa Shaft Off

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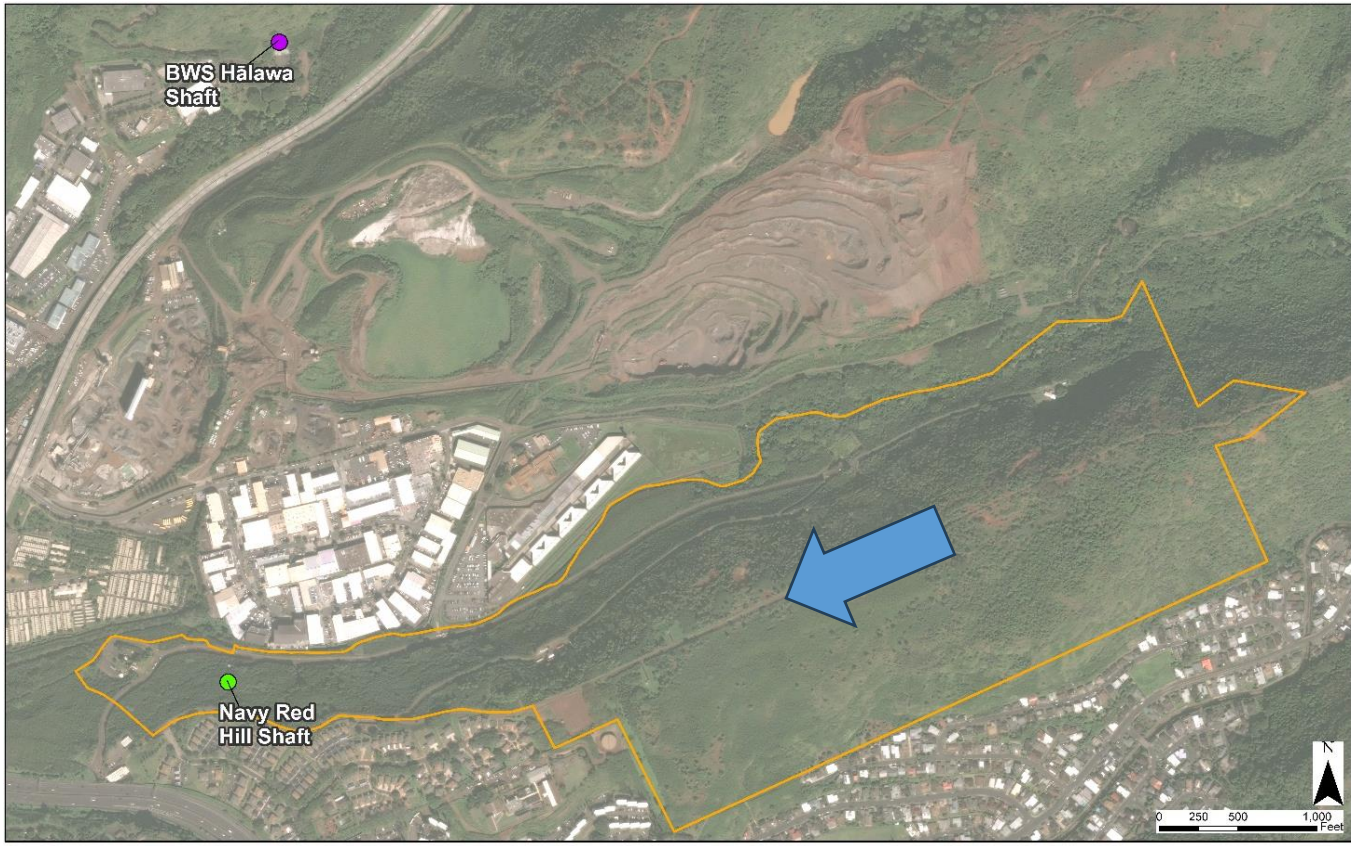

The model predicts groundwater under the tank farm will be captured by pumping at Red Hill Shaft.

Groundwater Conveyance

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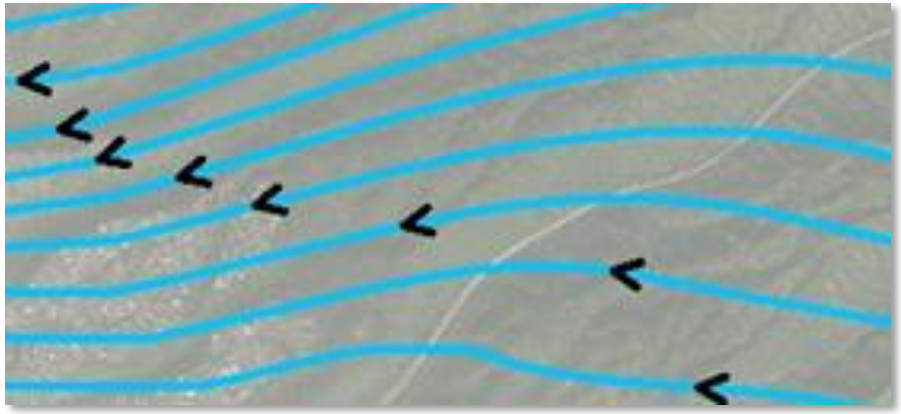
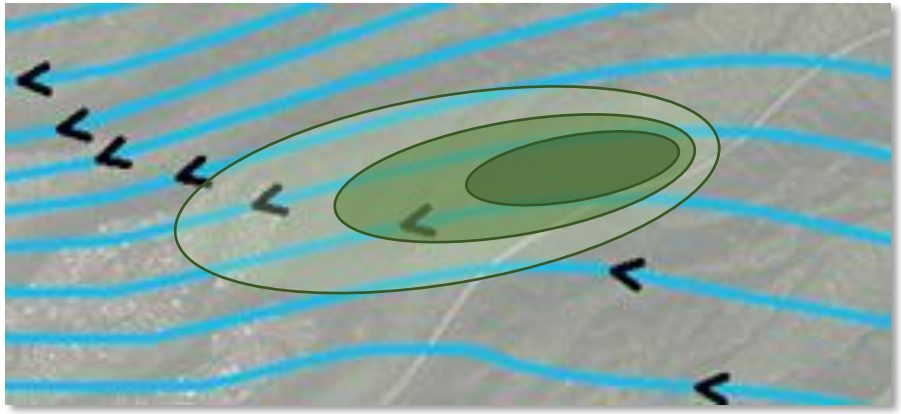
Flow model: how groundwater moves



Transport model: how chemicals move in groundwater



Generally, petroleum-related chemicals do not travel as fast or as far as groundwater

Chemical Transport Processes

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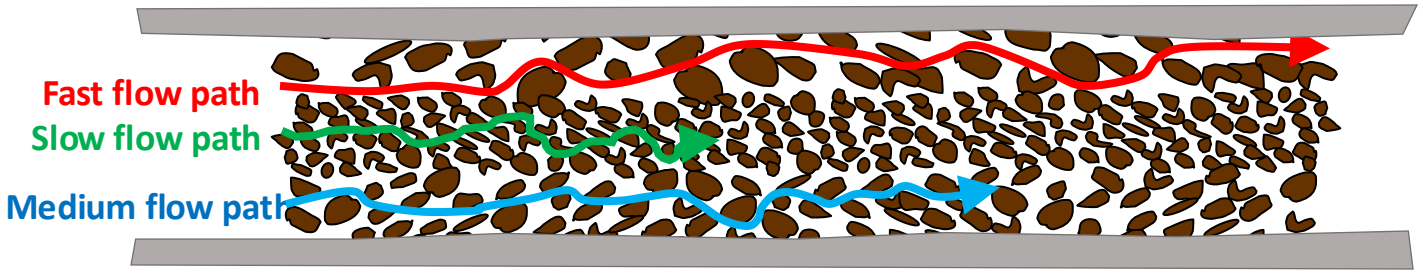
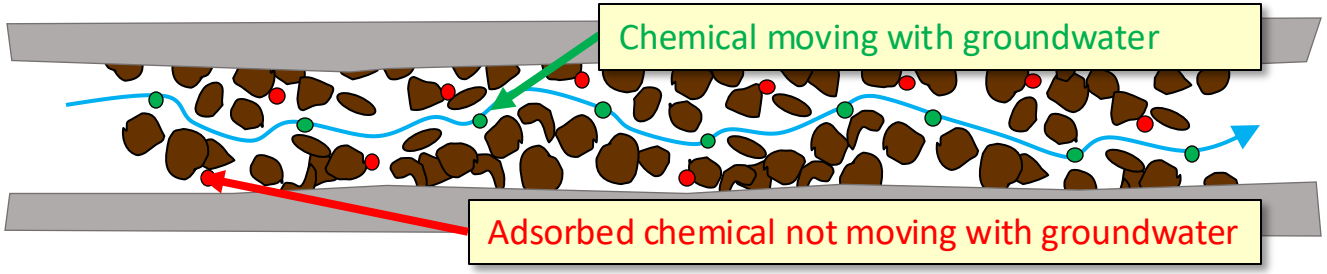
Groundwater flow paths based on soil or rock properties



Interaction between chemicals and soil/rock



Generally, petroleum-related chemicals move more slowly and not as far as groundwater

Contaminant Fate & Transport Modeling

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- To be protective and account for uncertainties the following conservative conditions were simulated:
  - The source of chemicals was modeled larger than the monitoring data indicate
  - The chemicals were modeled as if they do not degrade
- Compared to the actual groundwater data, the Navy's models are cautious overestimates of chemical migration and extent.

The model does not predict groundwater quality impacts to municipal water supplies.

Navy Groundwater Flow Model

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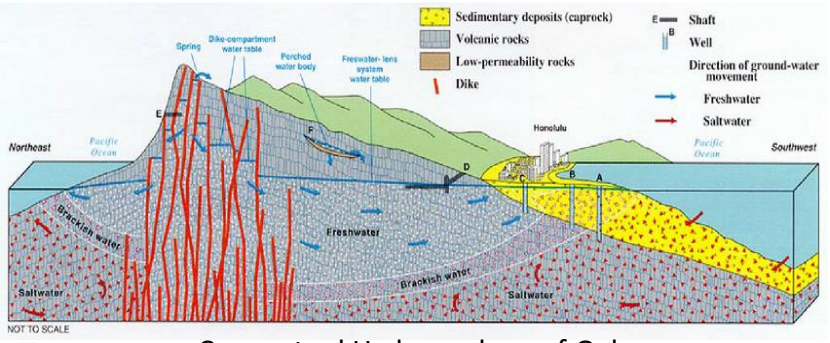

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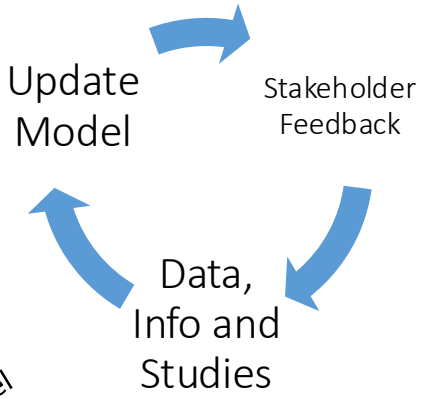

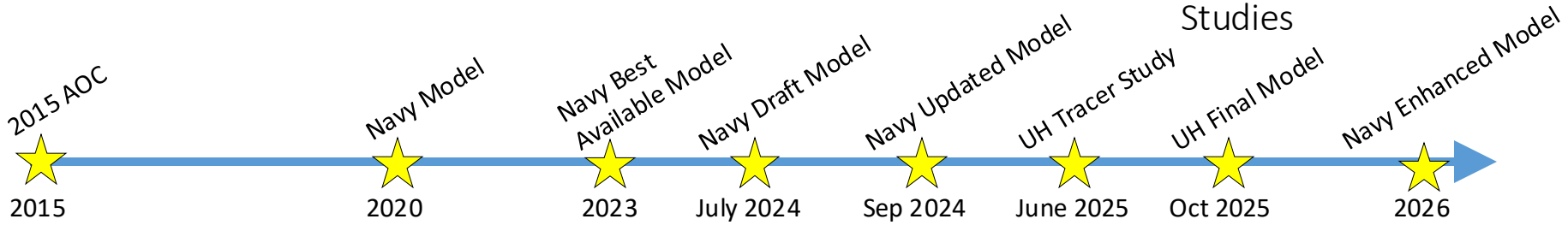

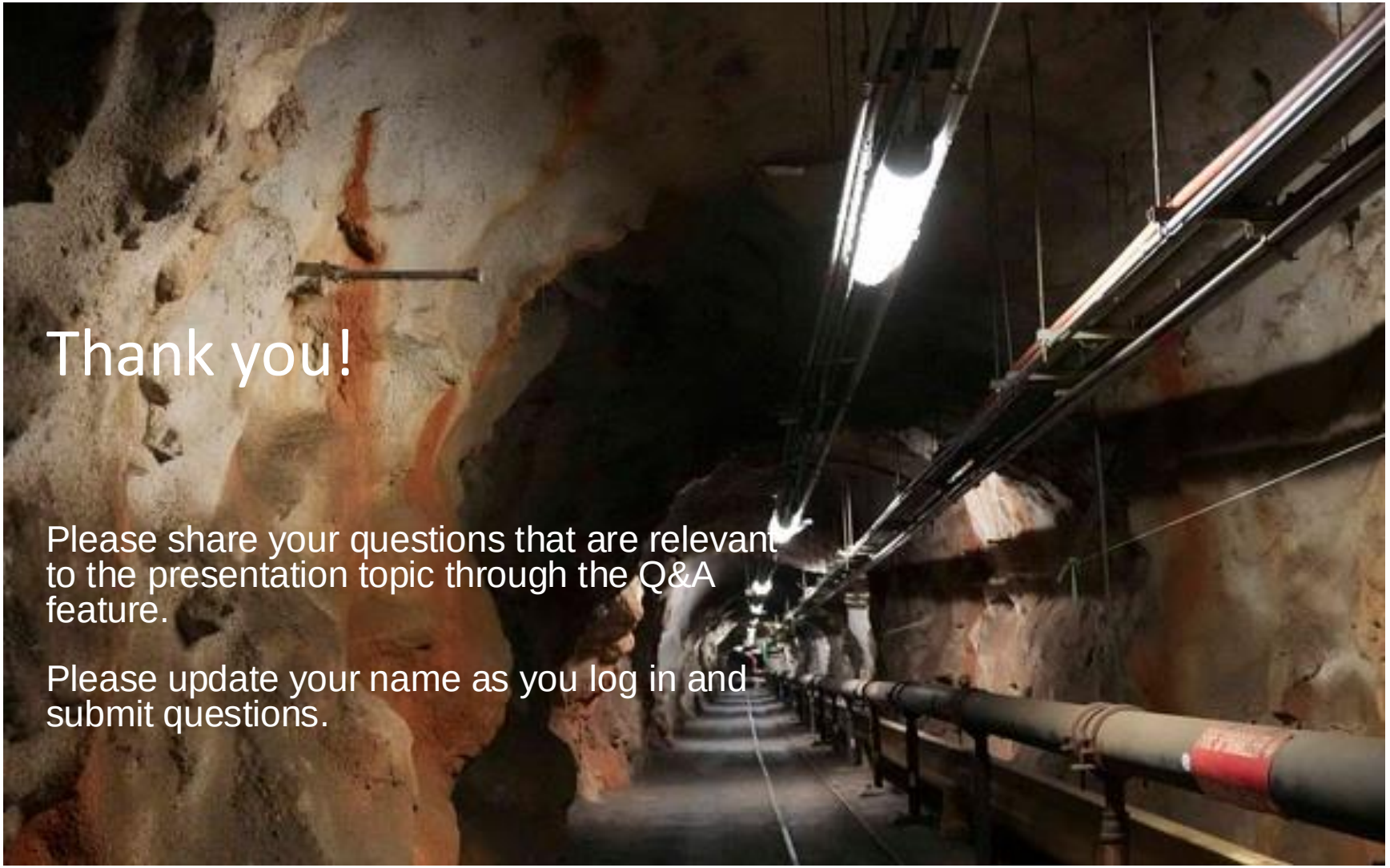

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RED HILL

References

- Informational video: Texas Water Development Board
- Slide 12 photograph: Dr. Scott Rowland, UH
- Slide 18 diagrams: USGS, 2011