# An Overview of the Virginia City Groundwater Investigation

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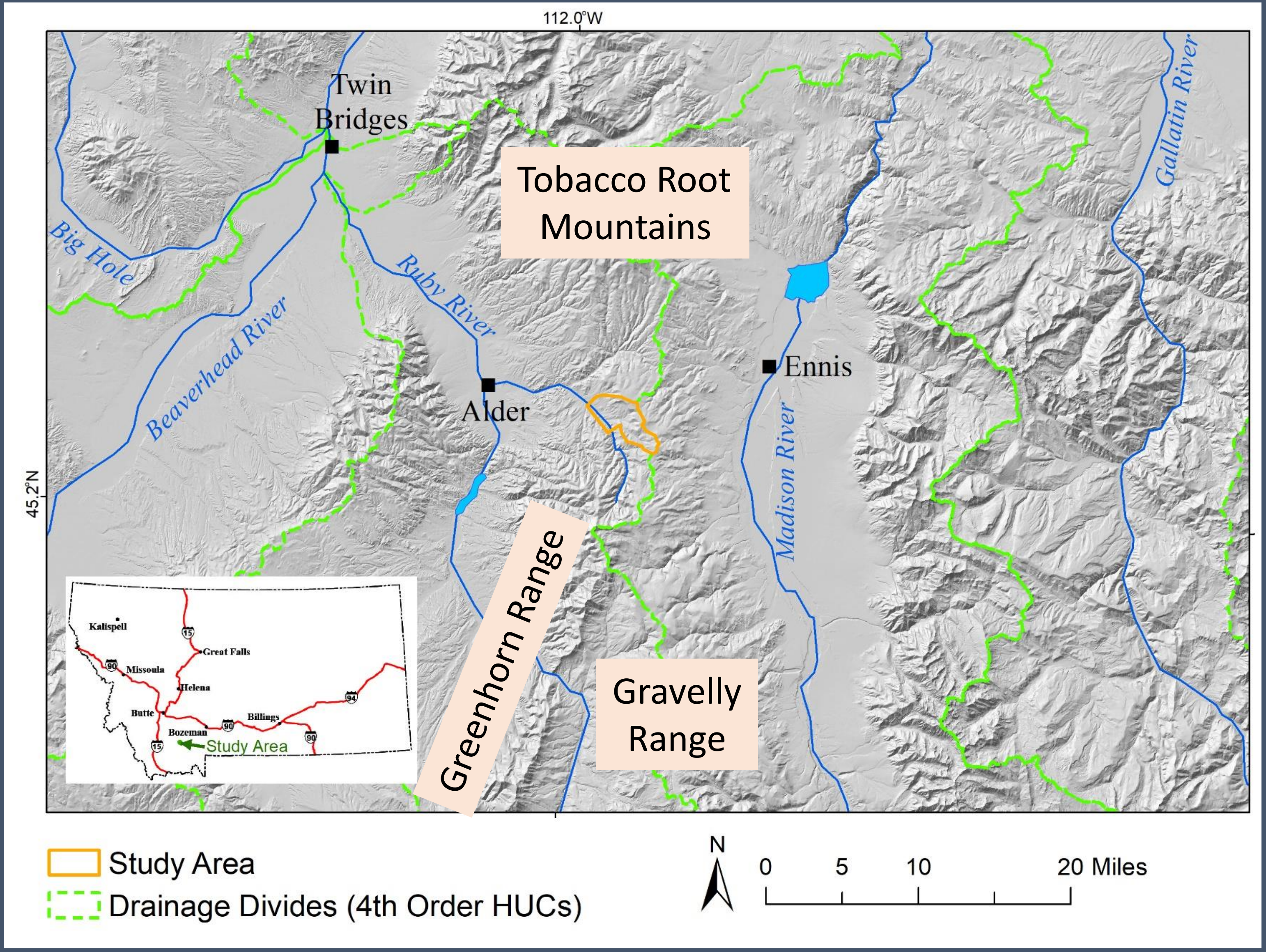
# Objectives

1. Evaluate the potential impacts of residential and commercial development on Virginia City's springs.

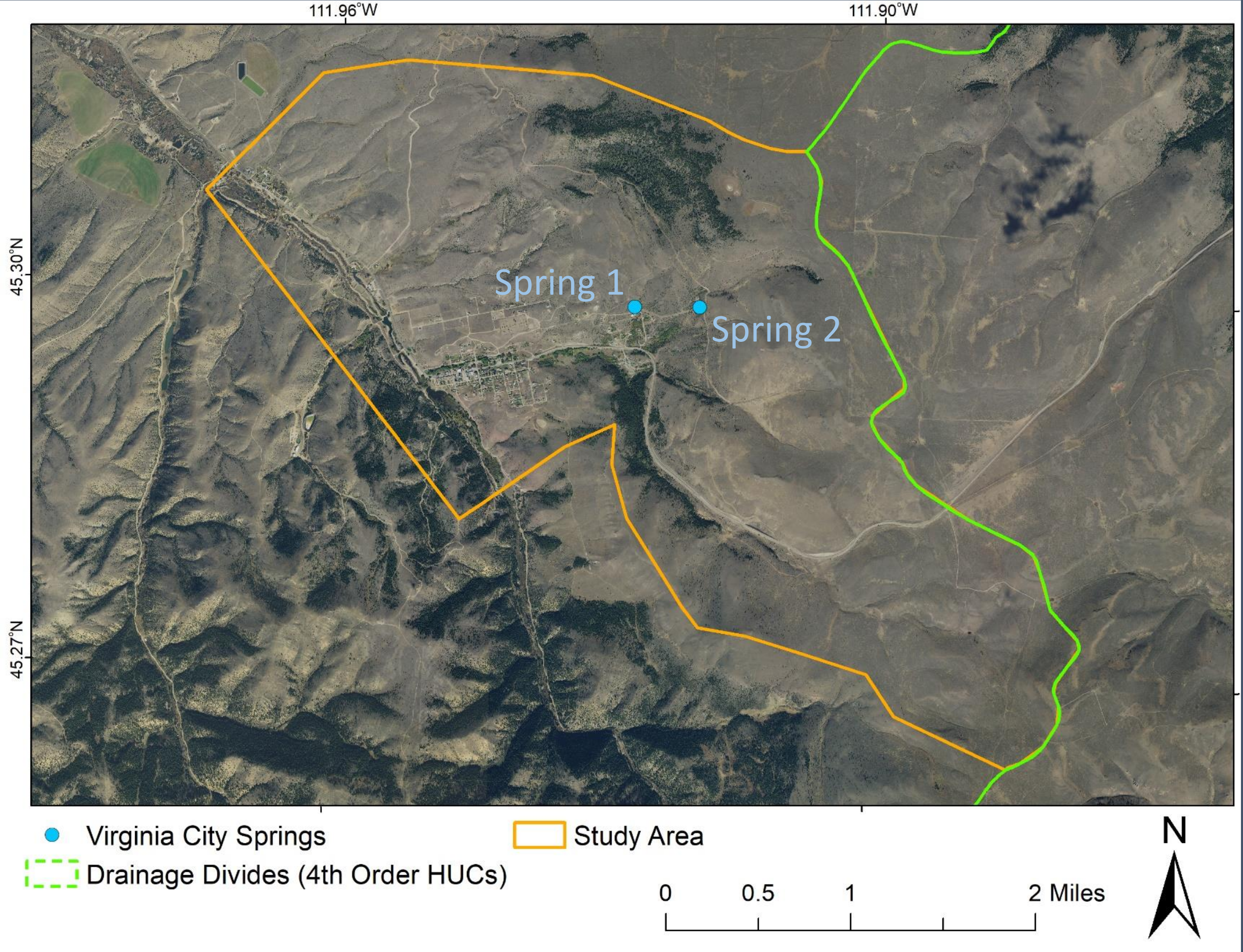
2. Understand the source of the springs.

3. Identify and evaluate potential backup water sources.

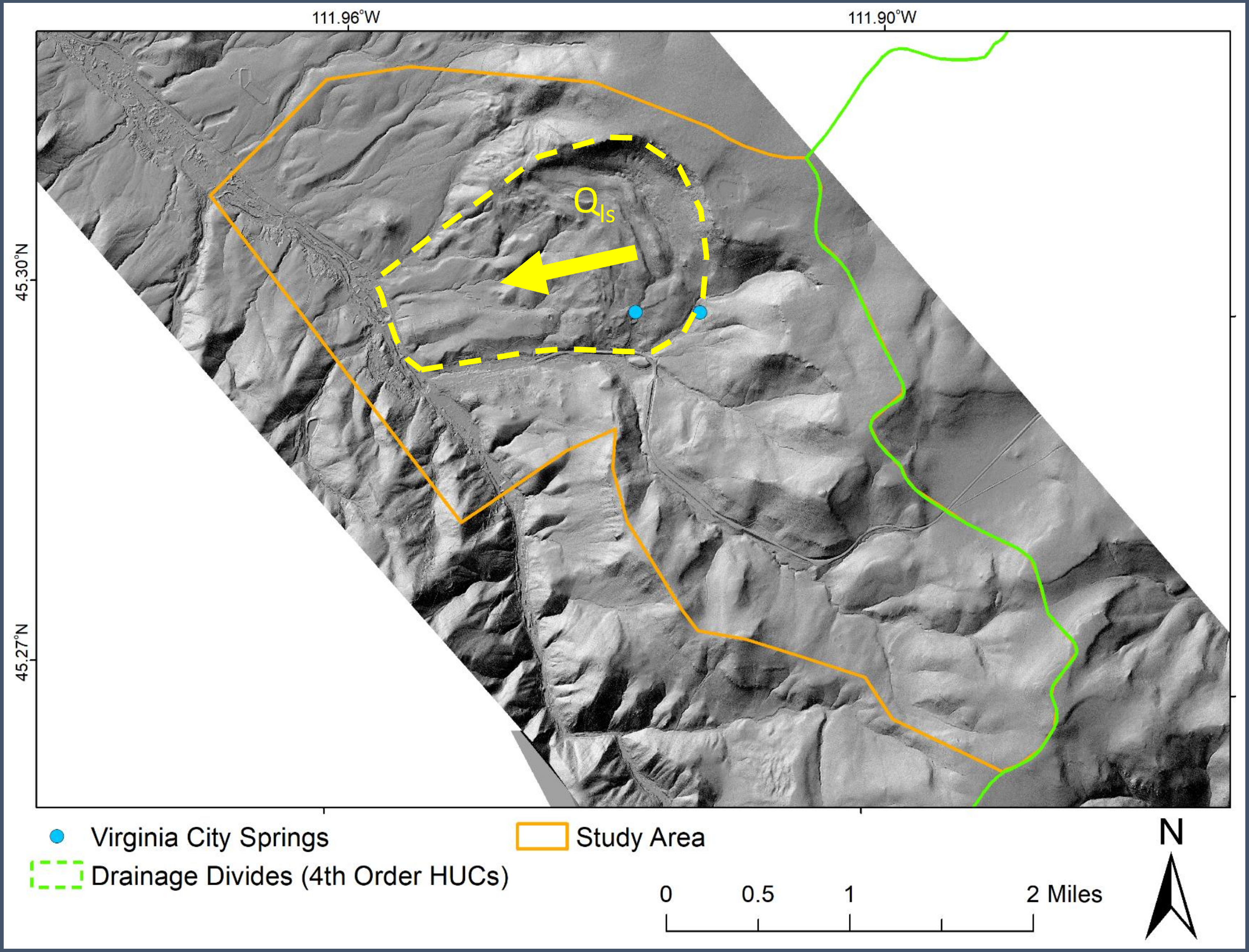
# Regional Setting



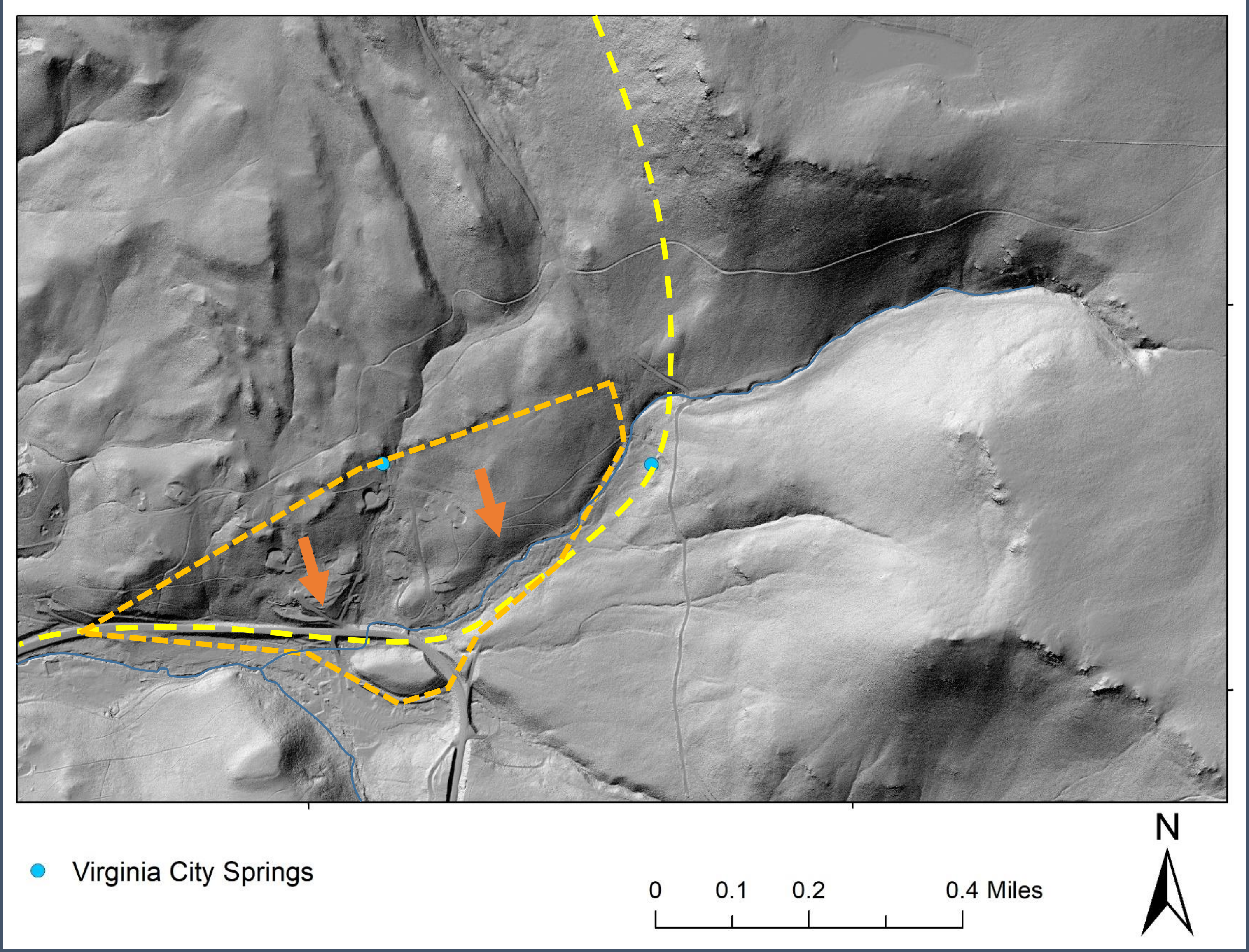
# Setting – Air Photo



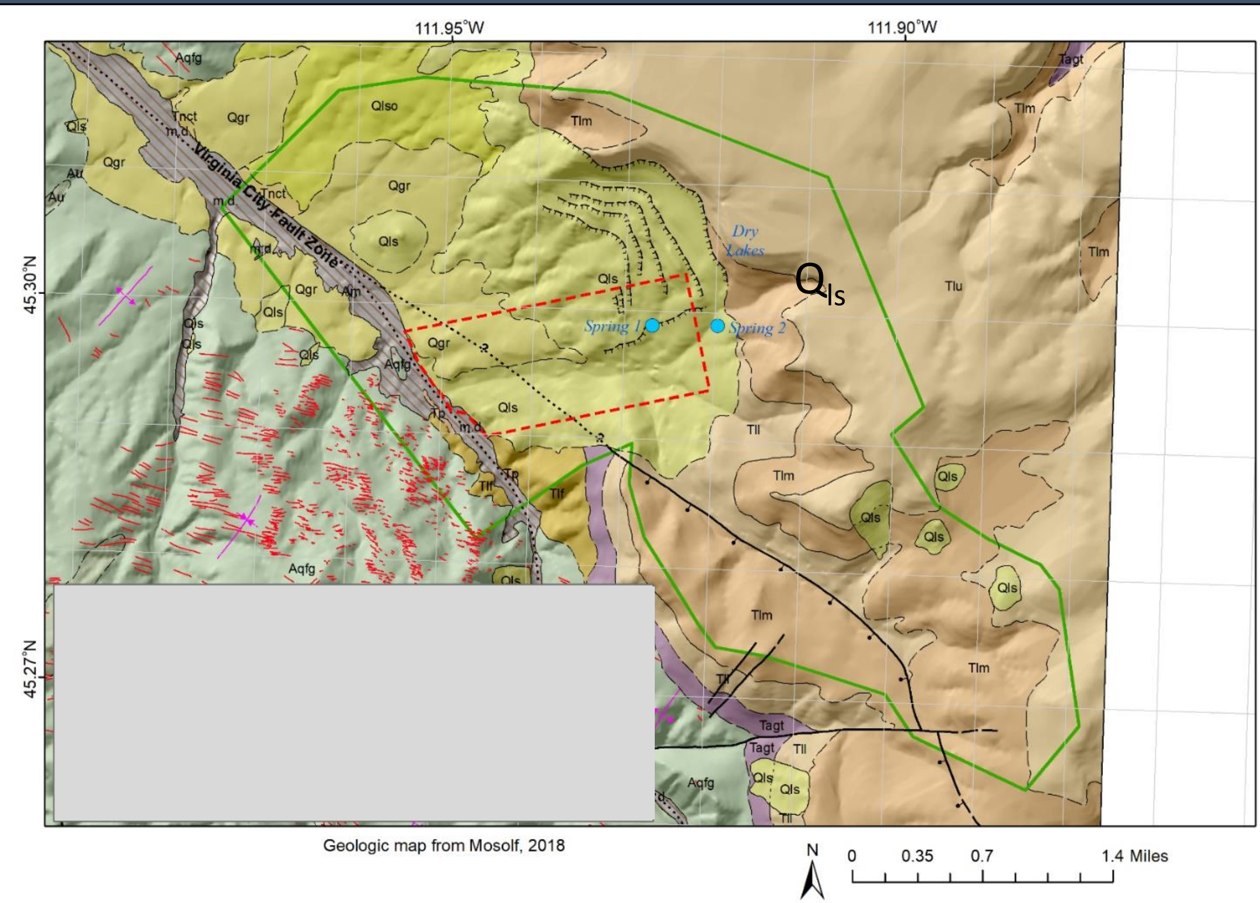
# LiDAR Hillshade



# LiDAR Hillshade



# Geologic Mapping (Mosolf in prep)

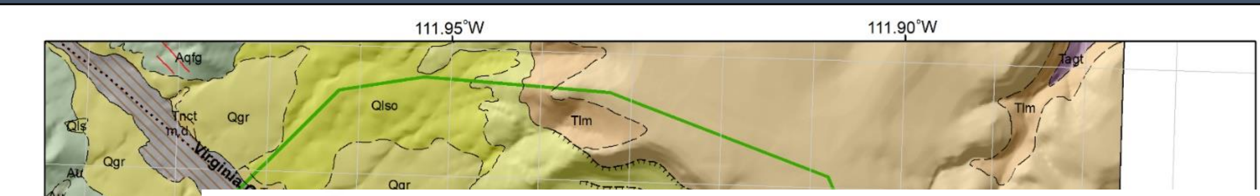


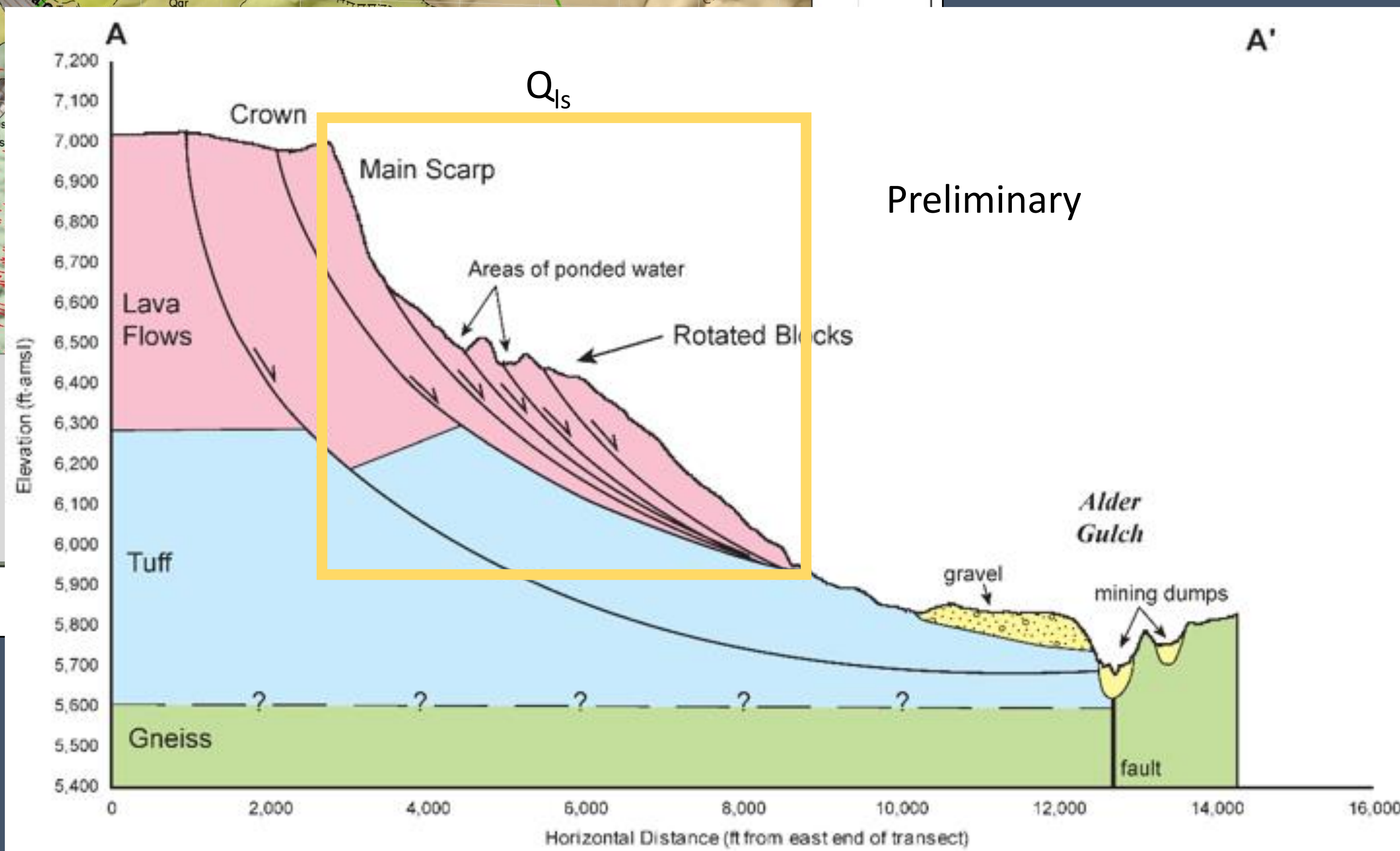

Geologic map from Mosolf, 2018

Schematic Stratigraphy (not to scale)

| | |
|---|---|
| Qls | Landslide |
| Tlu | Upper Lava Flows |
| Tlm | Middle Lava Flows |
| Tll | Lower Lava Flows |
| Tagt | Tuff |
| Aqfg | Gneiss |

# Geologic Mapping (Mosolf in prep)



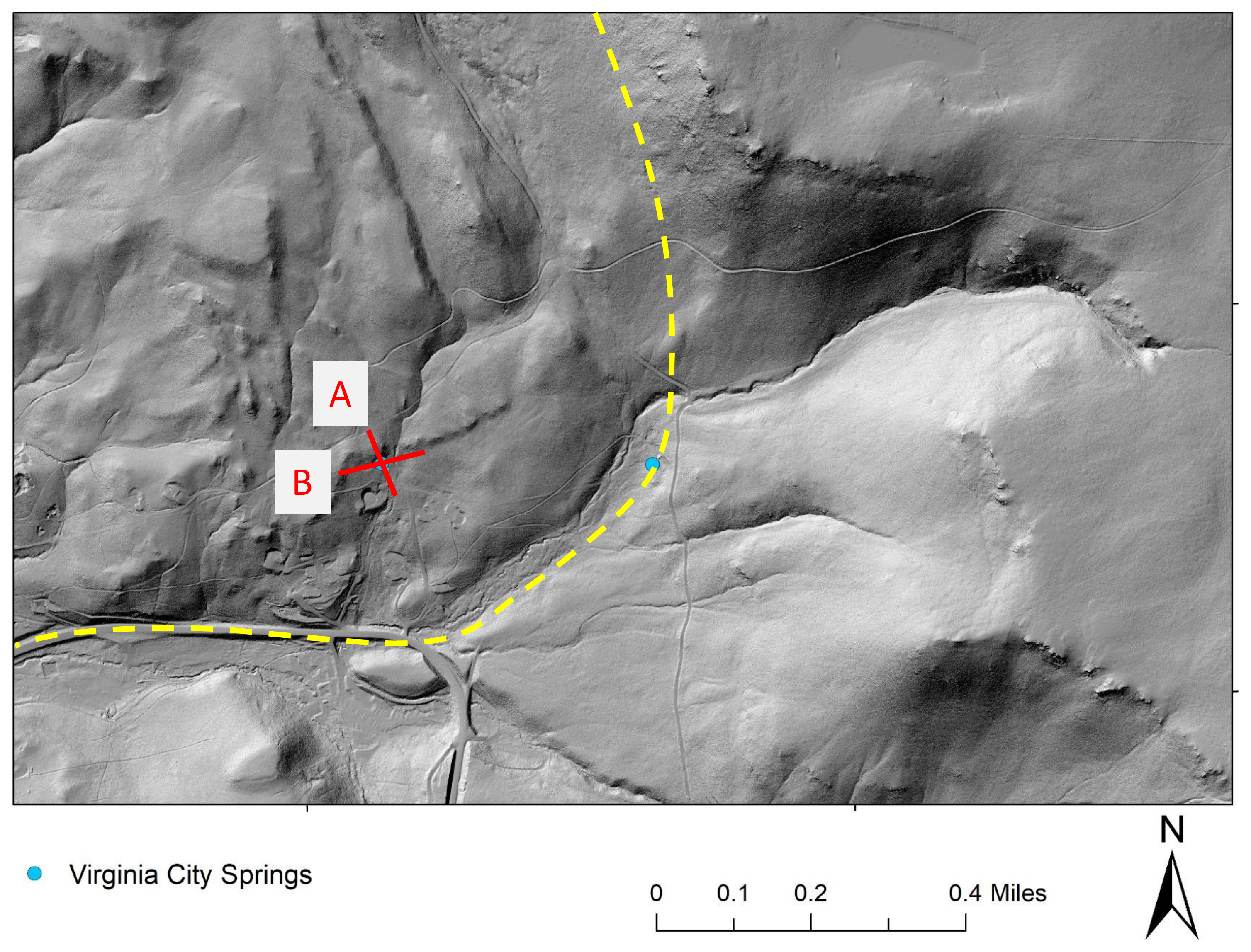

Schematic Stratigraphy
(not to scale)

ows

Flows

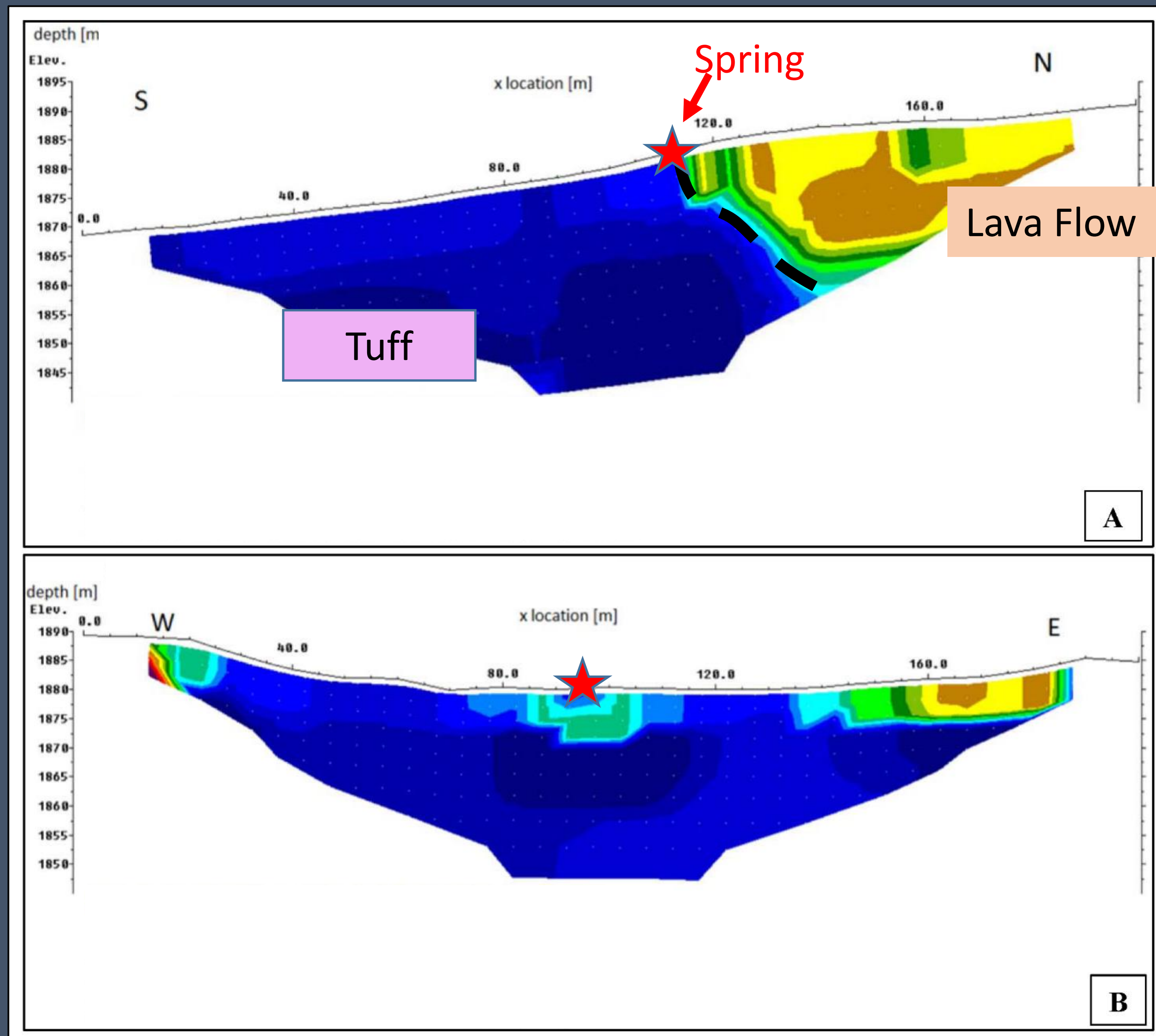
ows

# 2D Electrical Resistivity Tomography Surveys
# Montana Tech Geophysical Field Camp



# 2D Electrical Resistivity Tomography Surveys
# Montana Tech Geophysical Field Camp

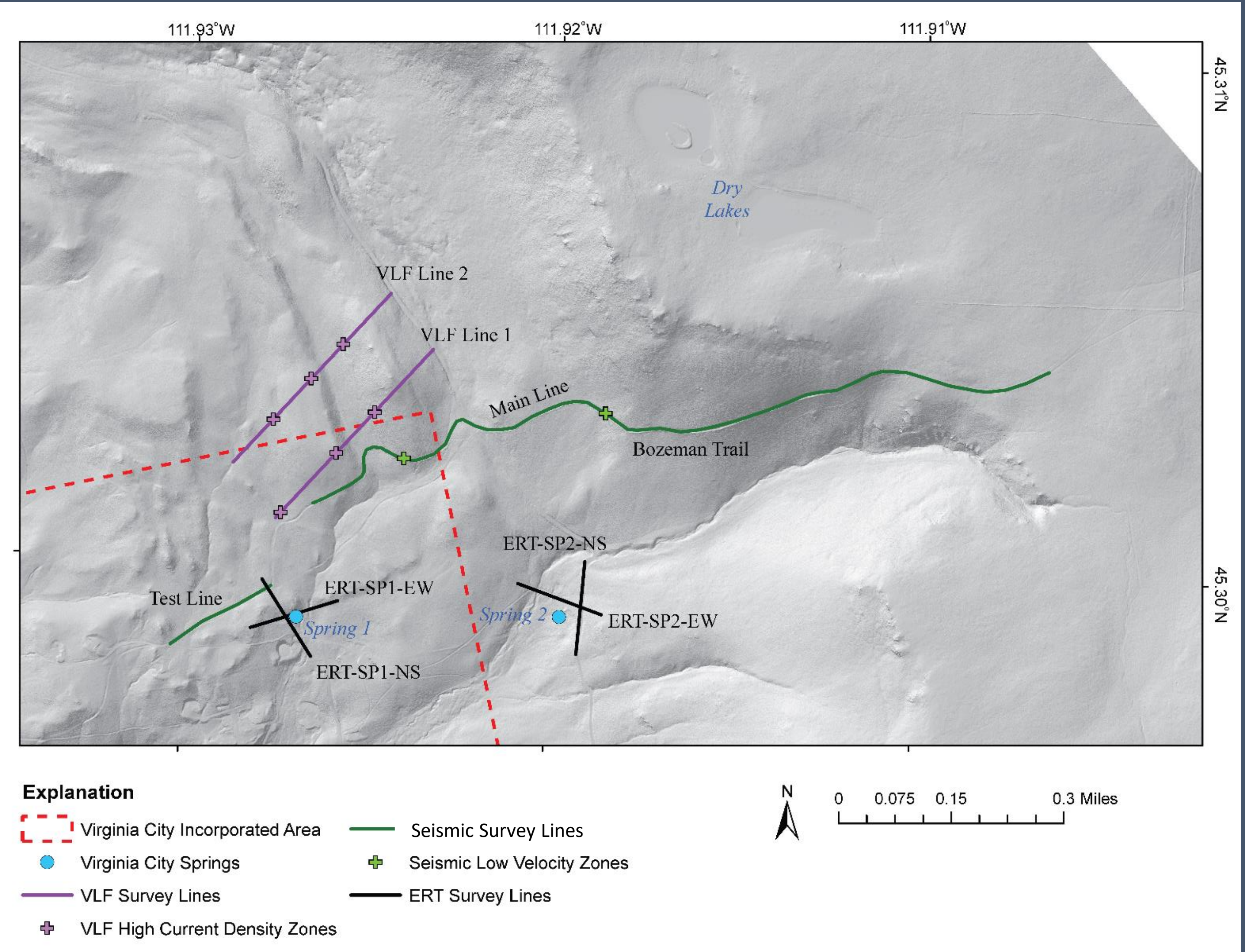
Spring 1
~Perpendicular to Contour




Spring 1
~ Parallel to Contour

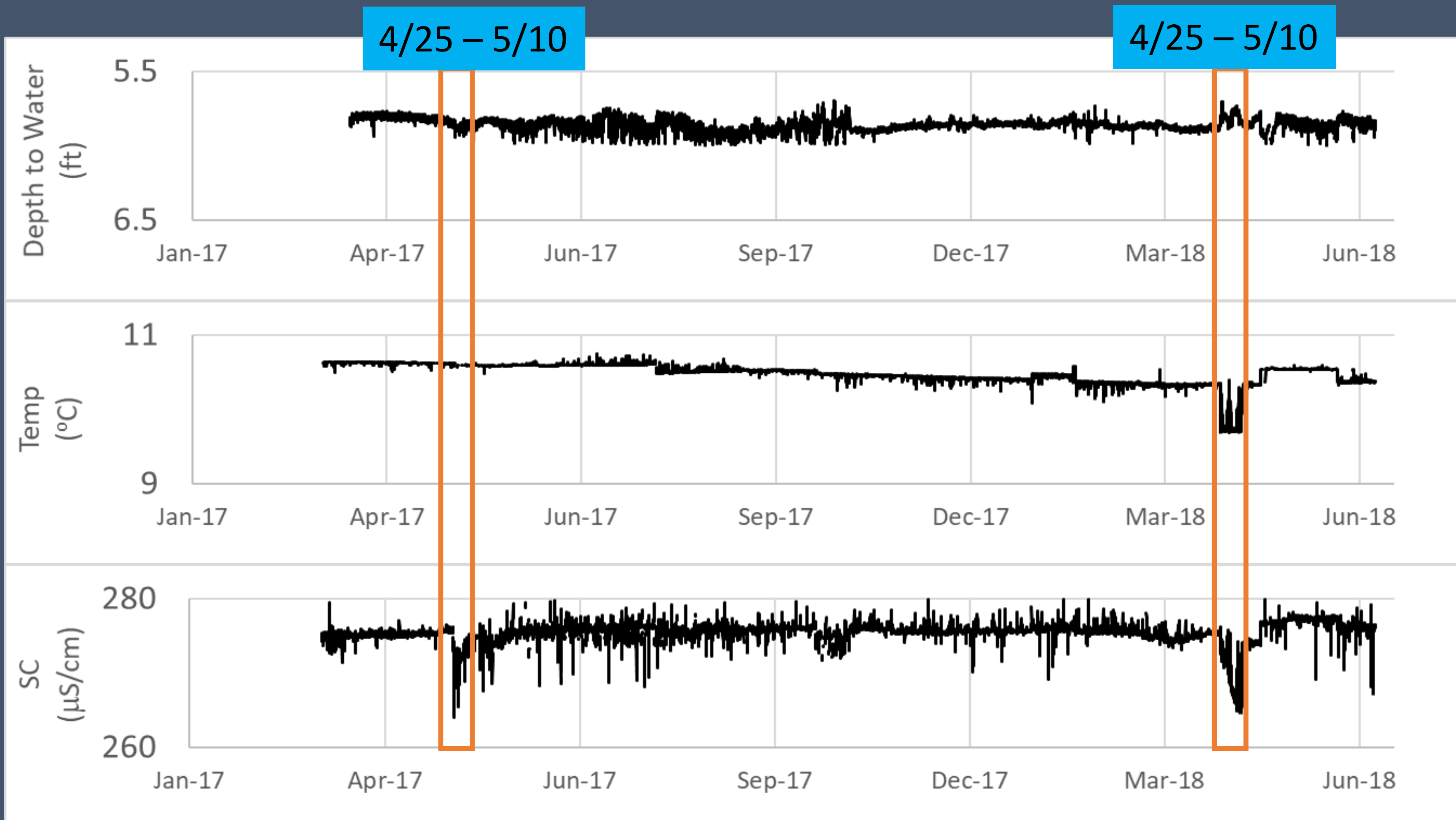
# Very Low Frequency (VLF) Electromagnetic, and Seismic Surveys

## Montana Tech Geophysical Field Camp



# Sonde in Spring 1

Preliminary data




Mean Spring Water Temp = 10.5ºC
Mean Annual Air Temp = 6.2ºC

# Age of Spring Water

## CFCs for Spring 1

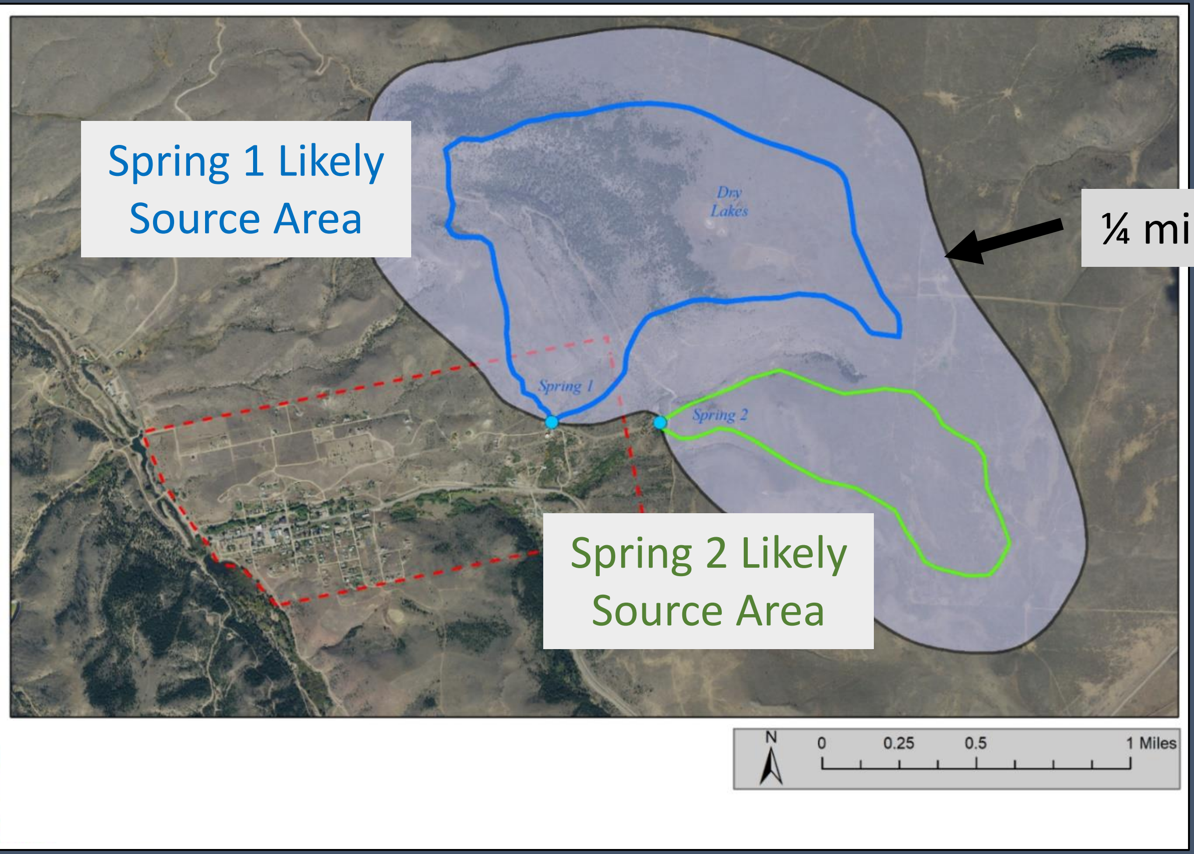
a) CFC-11 –> 33-40 years old; biodegradation may result in an older age
b) CFC-12 and CFC-113 –> 21-32 years old

CFCs => ~25 yrs since isolation
Spring water is well aerated

## Tritium

a) Low but detectable Tritium (<1 TU)
b) Indicative of a mixture of pre-1952 and younger water

# Spring Source Areas



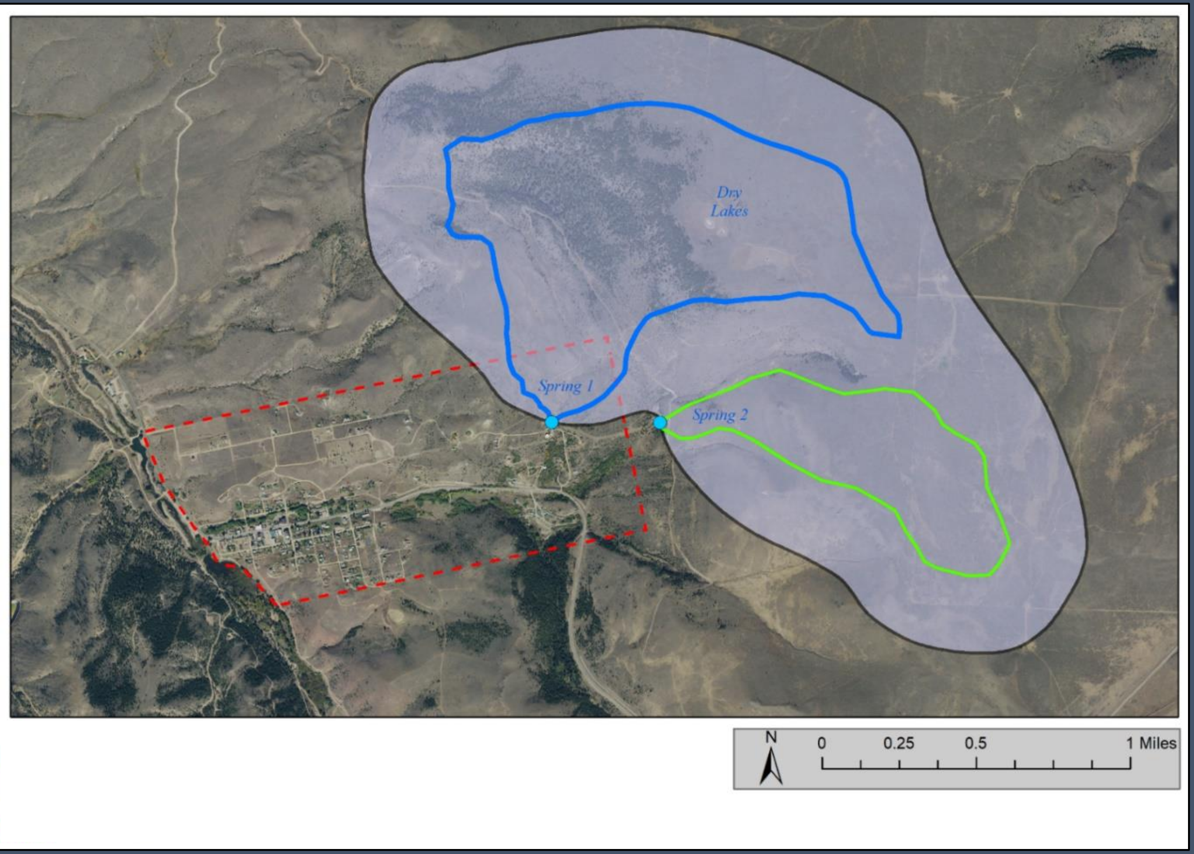

Preliminary Results

Based on geomorphology, geology, and locations of other springs

Spring 1
Source area = 548 acres
20" of precipitation per year
~44% of precipitation to get 250 gpm

Spring 2
Source area = 206 acres
20" of precipitation per year
~24% of precipitation to get 50 gpm

# Storage in Spring 1 Source Area

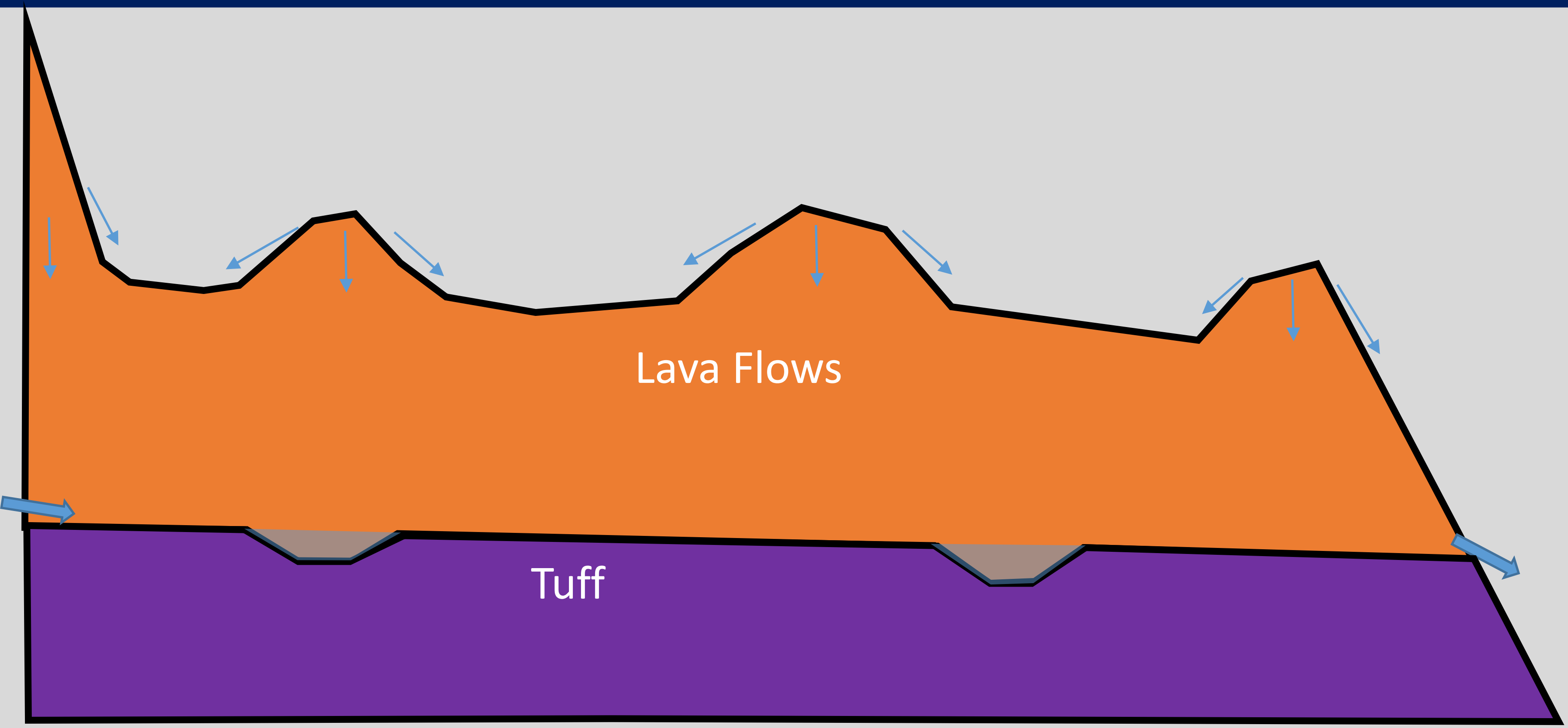



Preliminary Results

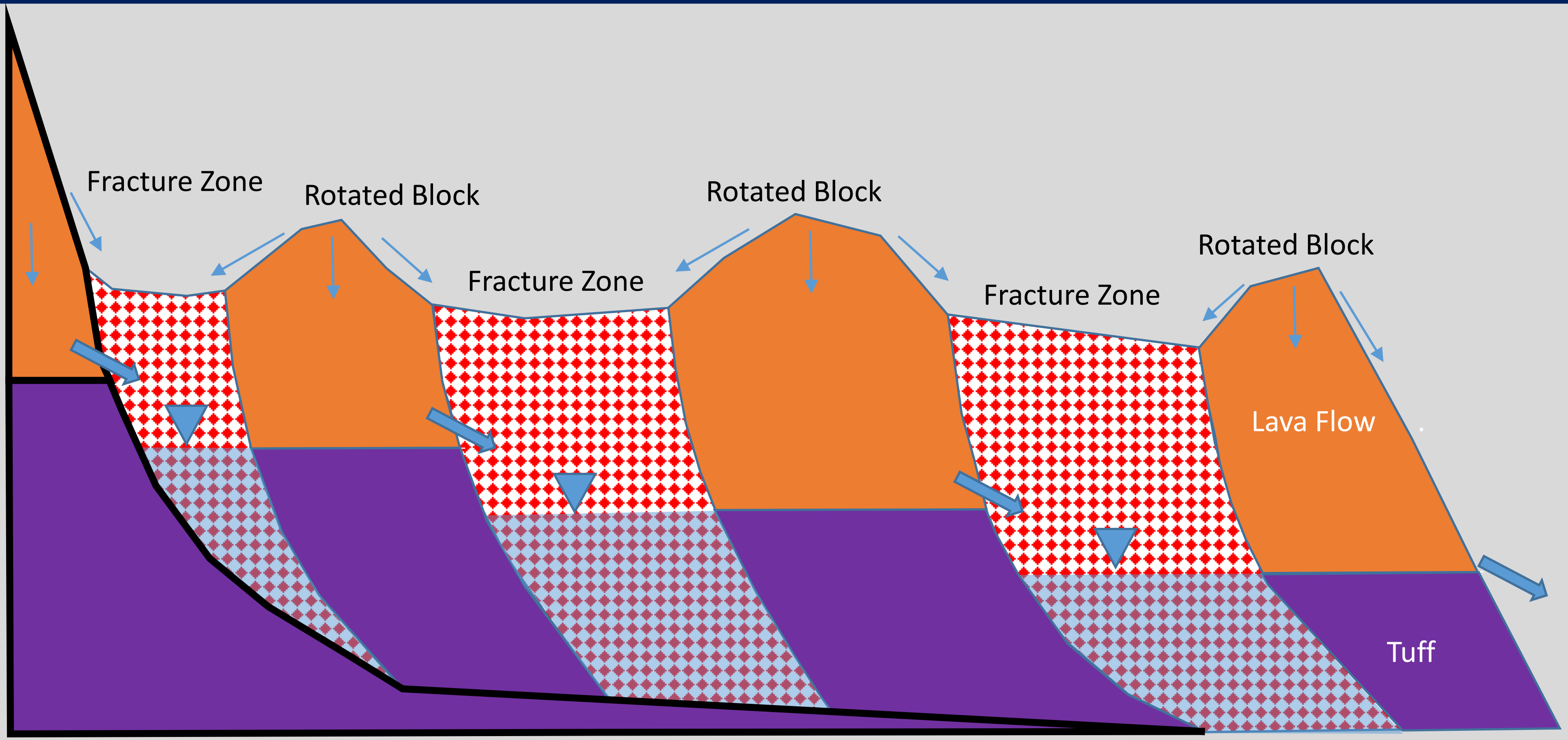
Using:
Porosity ~ 0.2
Spring discharge = 250 gpm
Residence time = 25 yr
Area = 548 acres

$$Residence\ Time = \frac{Area * Thickness * Porosity}{Q} \rightarrow Tk = \frac{RT*Q}{A*n}$$

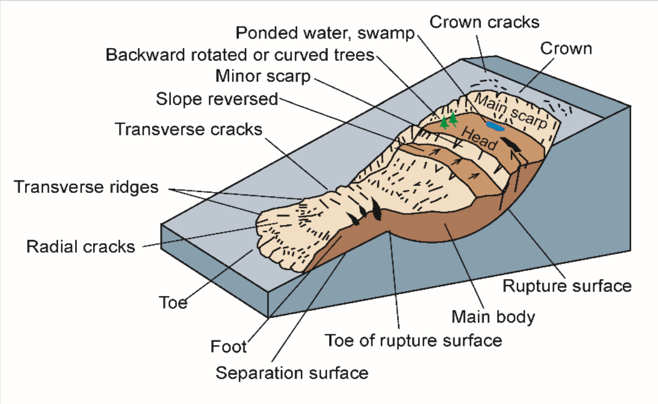
$$\frac{\left(9{,}131\ d * 48{,}128\ {ft^3}/{d}\right)}{\left(23{,}870{,}880\ ft^2 * 0.2\right)} \sim 92 \text{ ft, on average}$$




Conceptual Diagram of a Simple Contact Spring
Little Storage
(Spring 2?)




Preliminary Conceptual Diagram for a Spring from a Landslide Area
(Spring 1?)




From Vuke, 2013

# Conclusions

1. Spring 1 is a contact spring that emerges at the contact between overlying fractured lava flows and underlying tuff along the lateral edge of a large landslide.
   a) Substantial storage in the highly fractured landslide area
   b) Wells completed in the fracture zones may affect spring flows

2. Spring 2 is a contact spring that emerges at the contact between overlying fractured lava flows and underlying tuff along the main scarp of a large landslide.

3. High potential to be affected by surface activity/septic systems.
   a) Rapid Recharge; little denitrification
   b) Movement of bacteria and viruses in fractured rocks

# Questions?

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GoogleEarth, Looking NE; 2x vertical exaggeration