An Overview of the Virginia City Groundwater Investigation

Andy Bobst, Tom Michalek and Jessie Mosolf

AWRA 10/8/2020

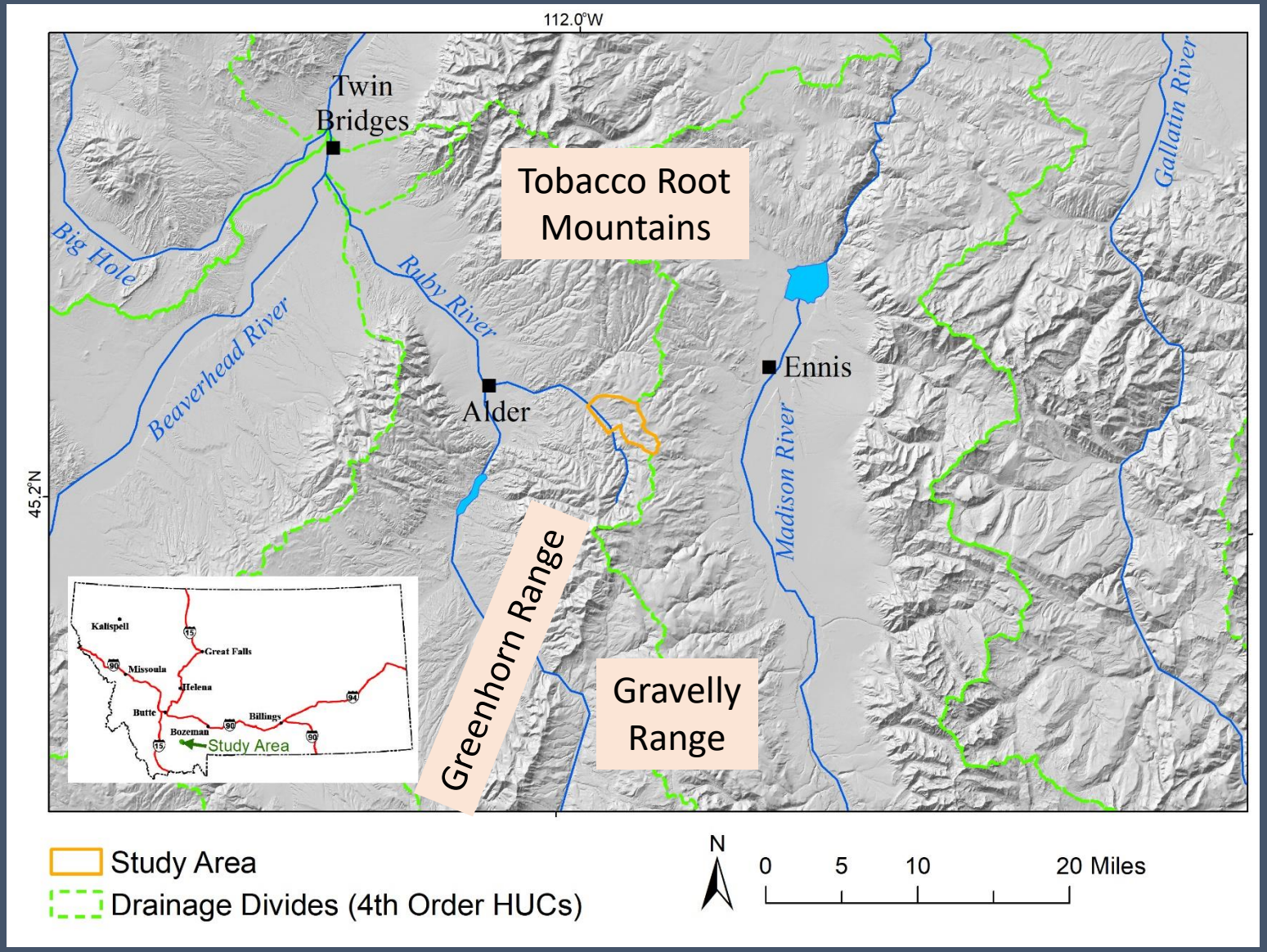
Objectives

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

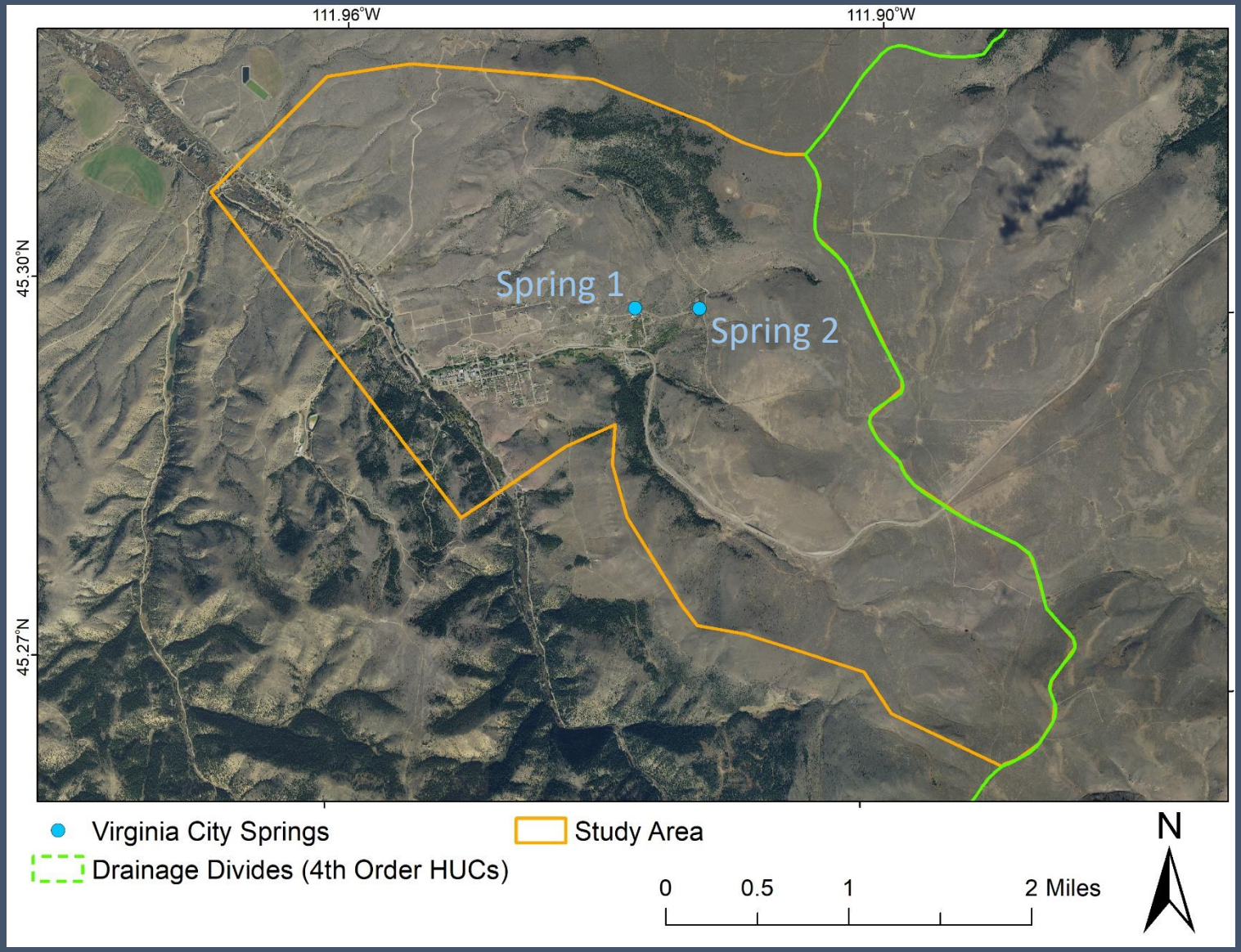
2. Understand the source of the springs.

3. Identify and evaluate potential backup water sources.

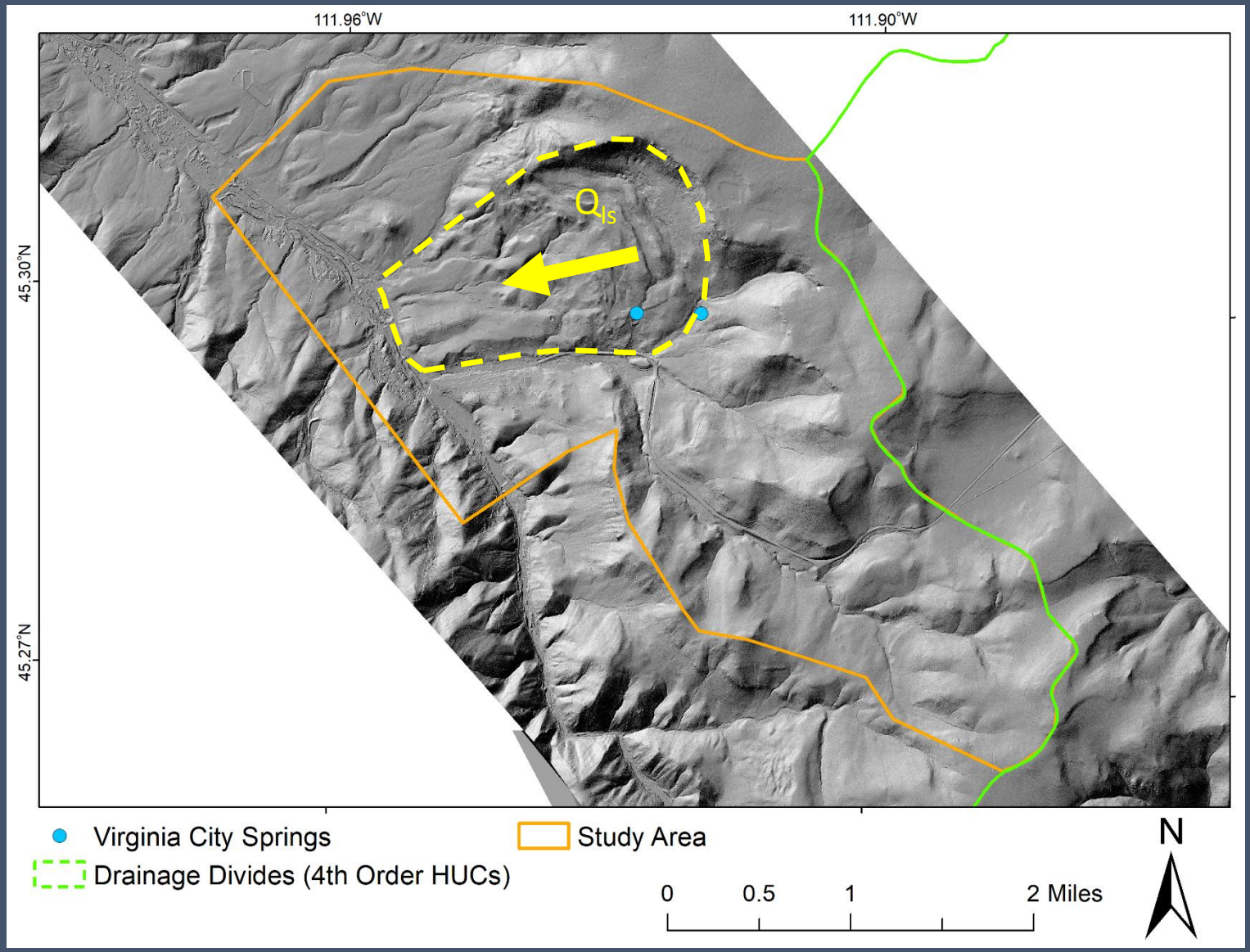
Regional Setting



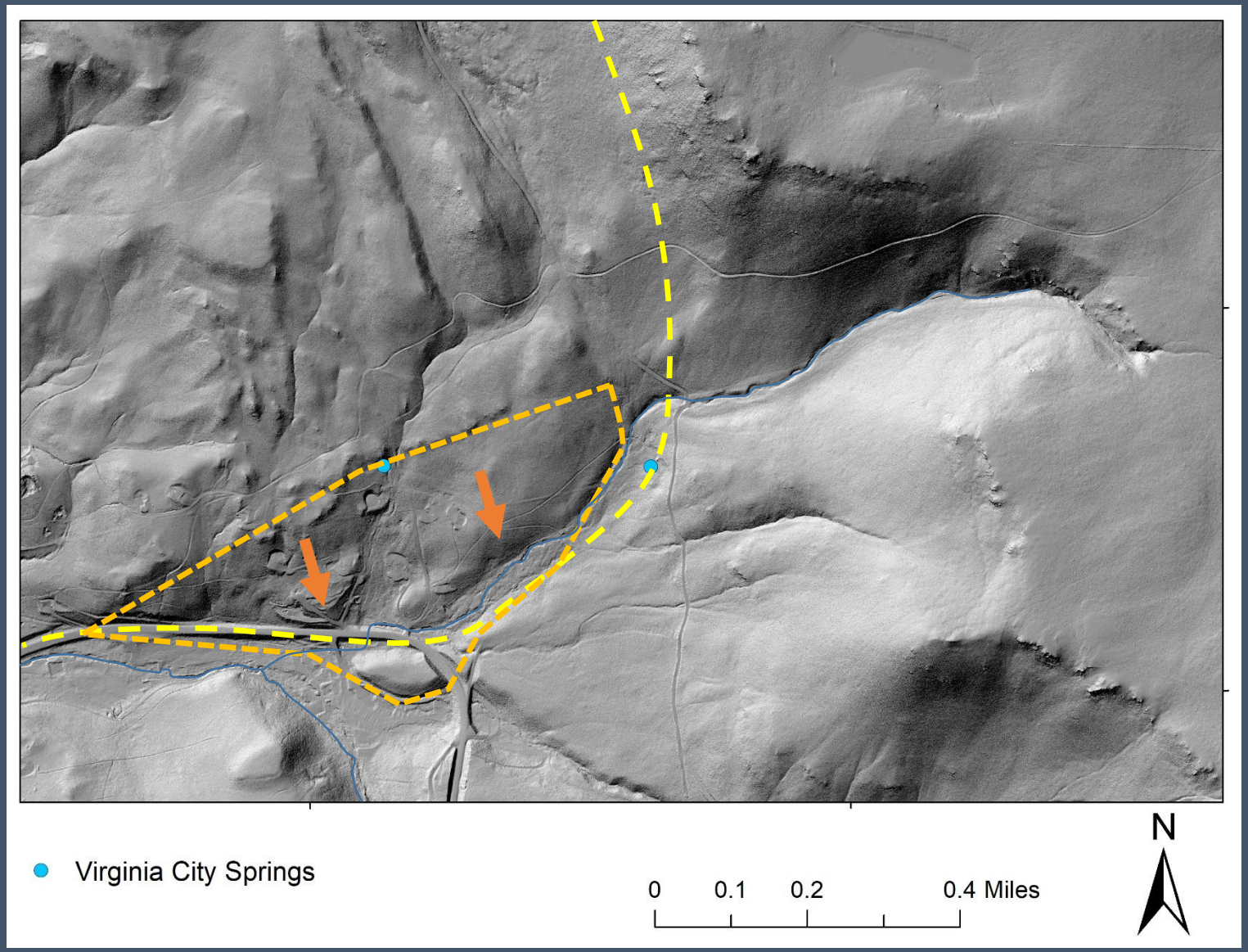
Setting – Air Photo



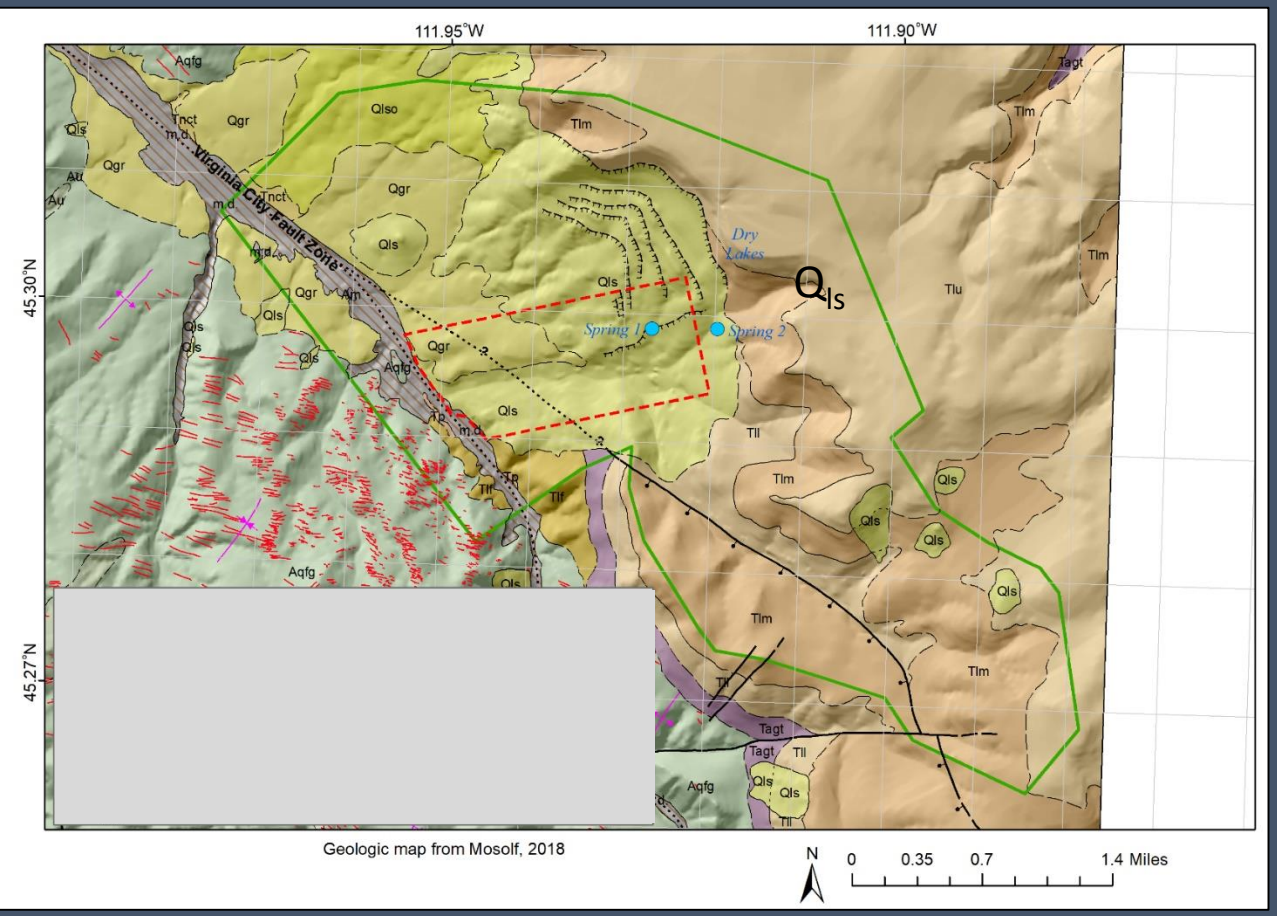
LiDAR Hillshade



LiDAR Hillshade



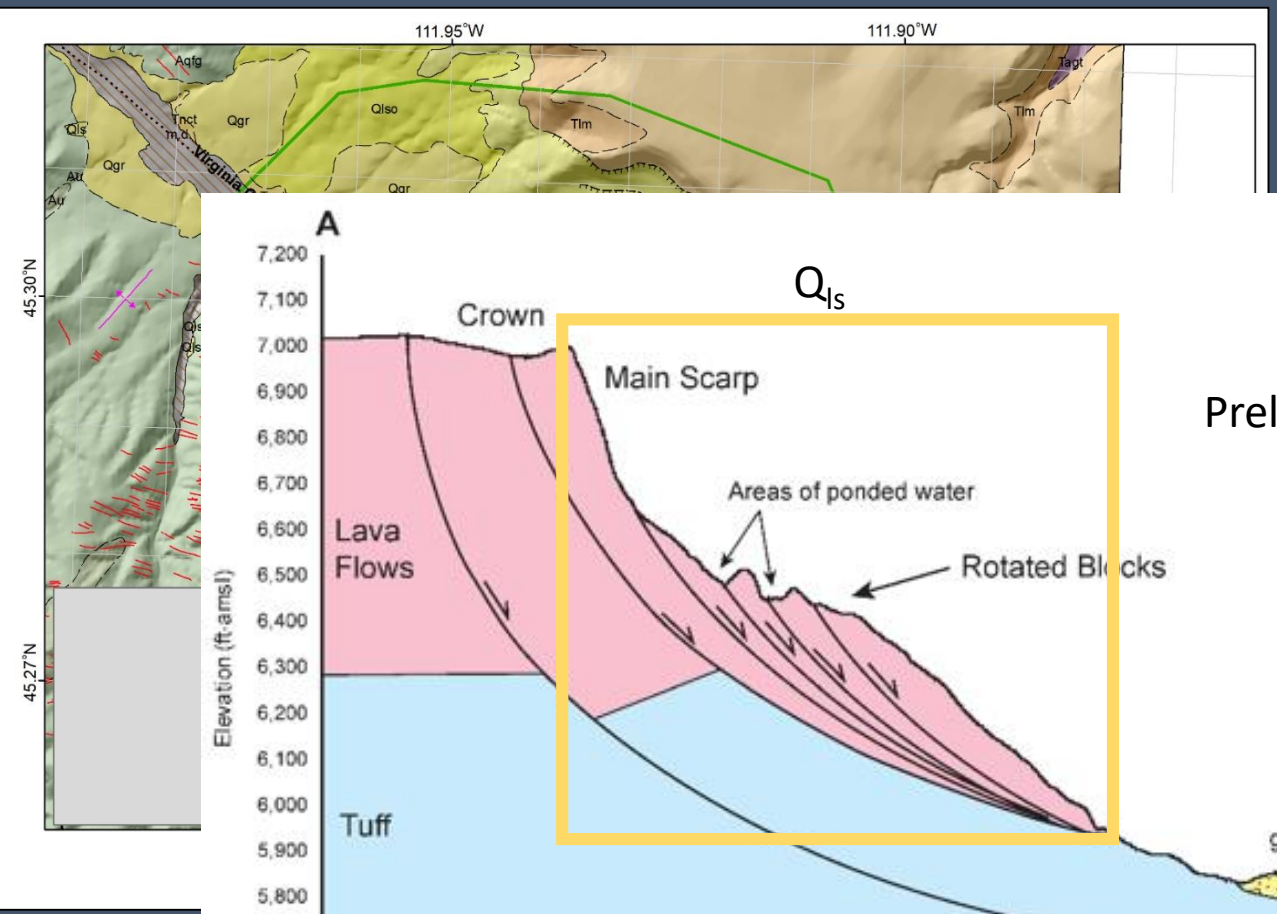
Geologic Mapping (Mosolf in prep)



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)

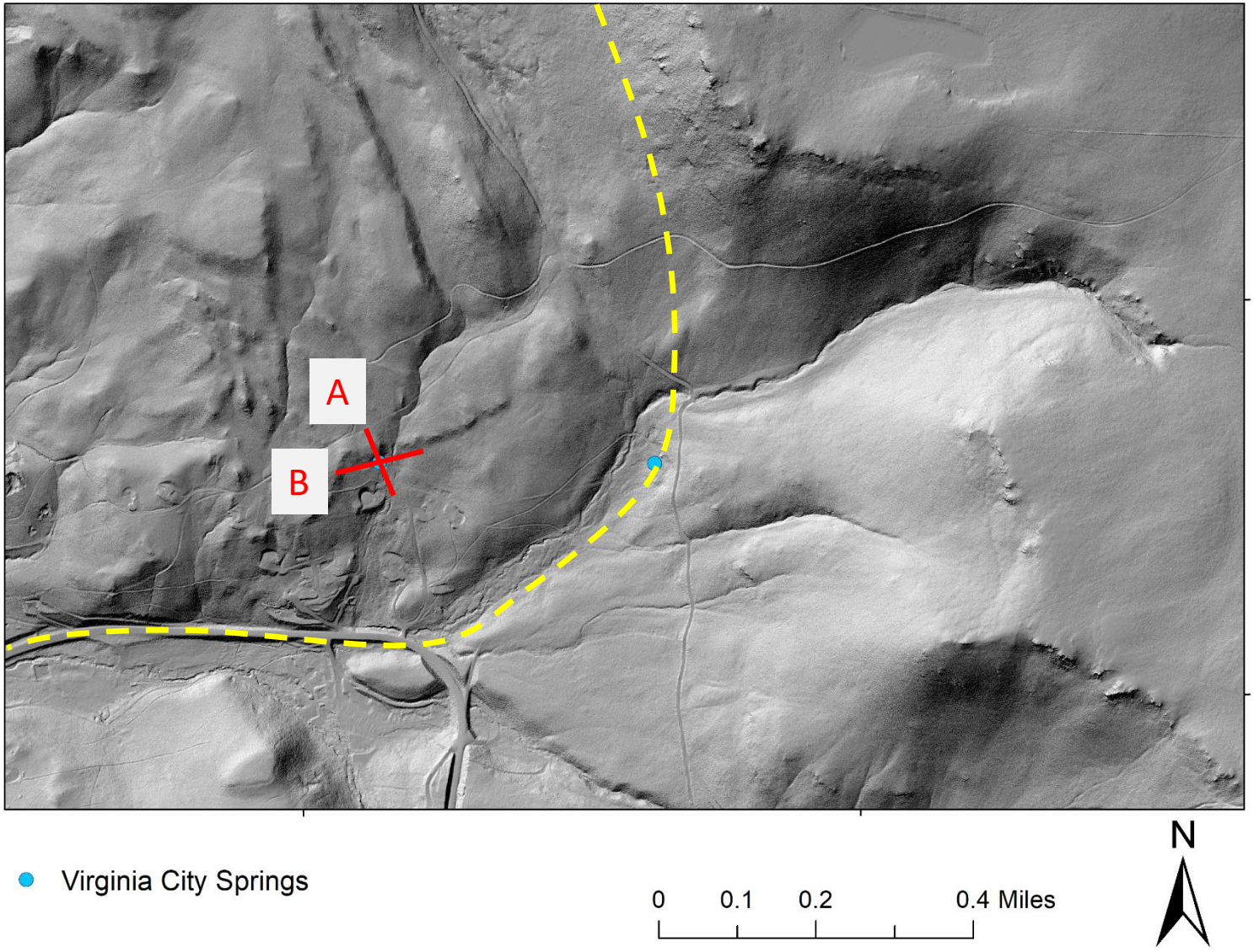
Preliminary

ows

lows

ows

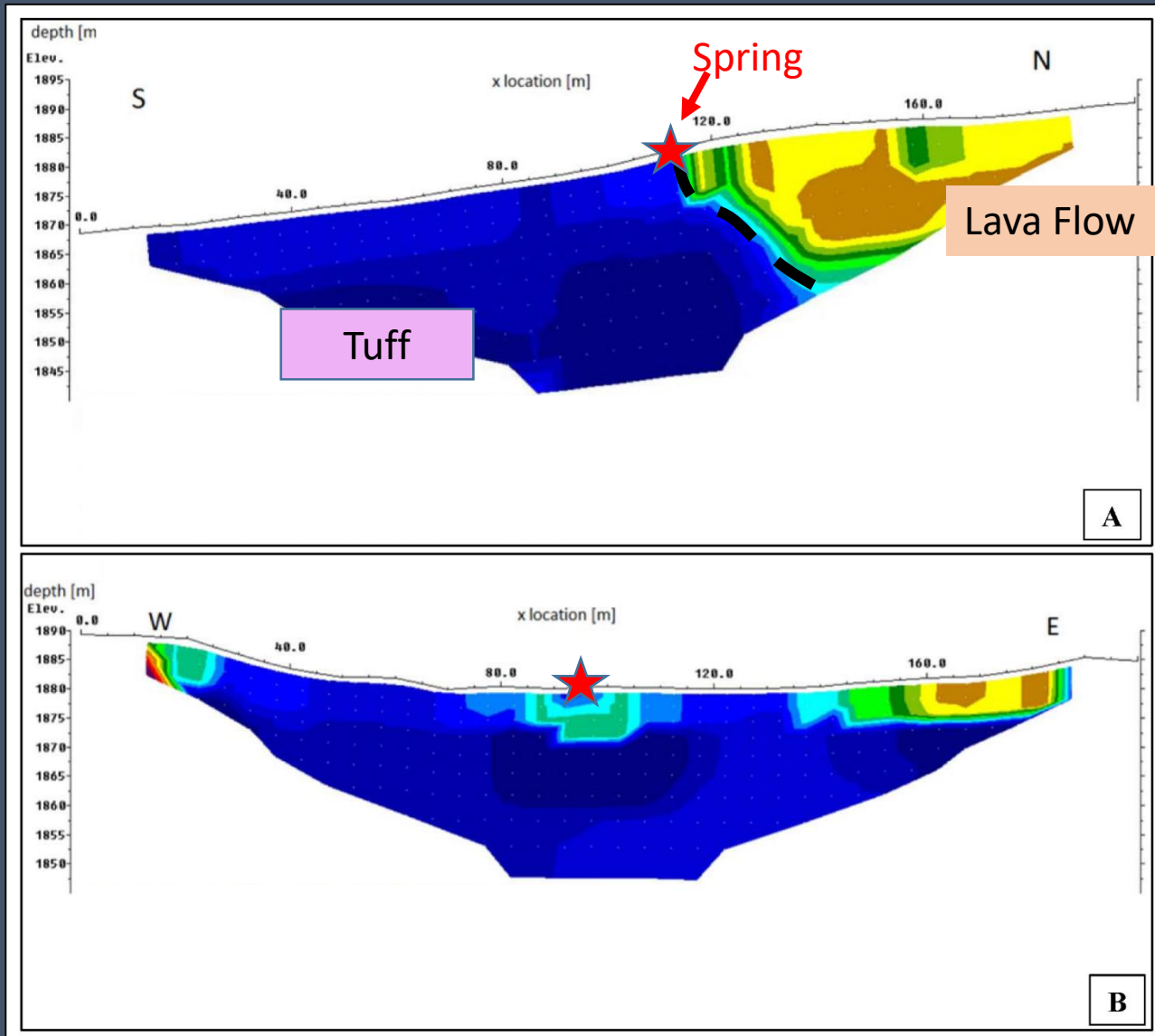
2D Electrical Resistivity Tomography Surveys
Montana Tech Geophysical Field Camp



2D Electrical Resistivity Tomography Surveys
Montana Tech Geophysical Field Camp

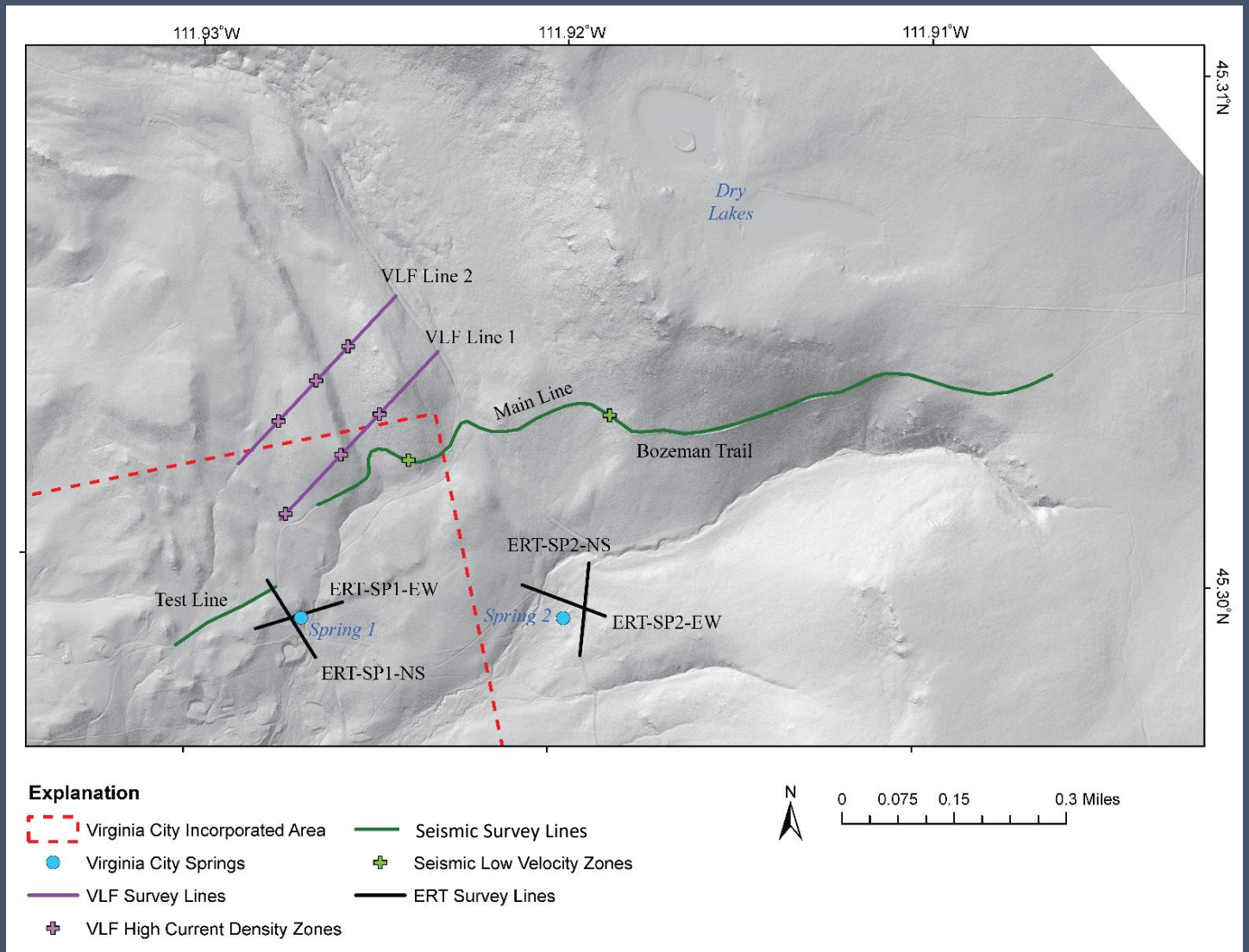
Spring 1
~Perpendicular to Contour

Spring 1
~ Parallel to Contour



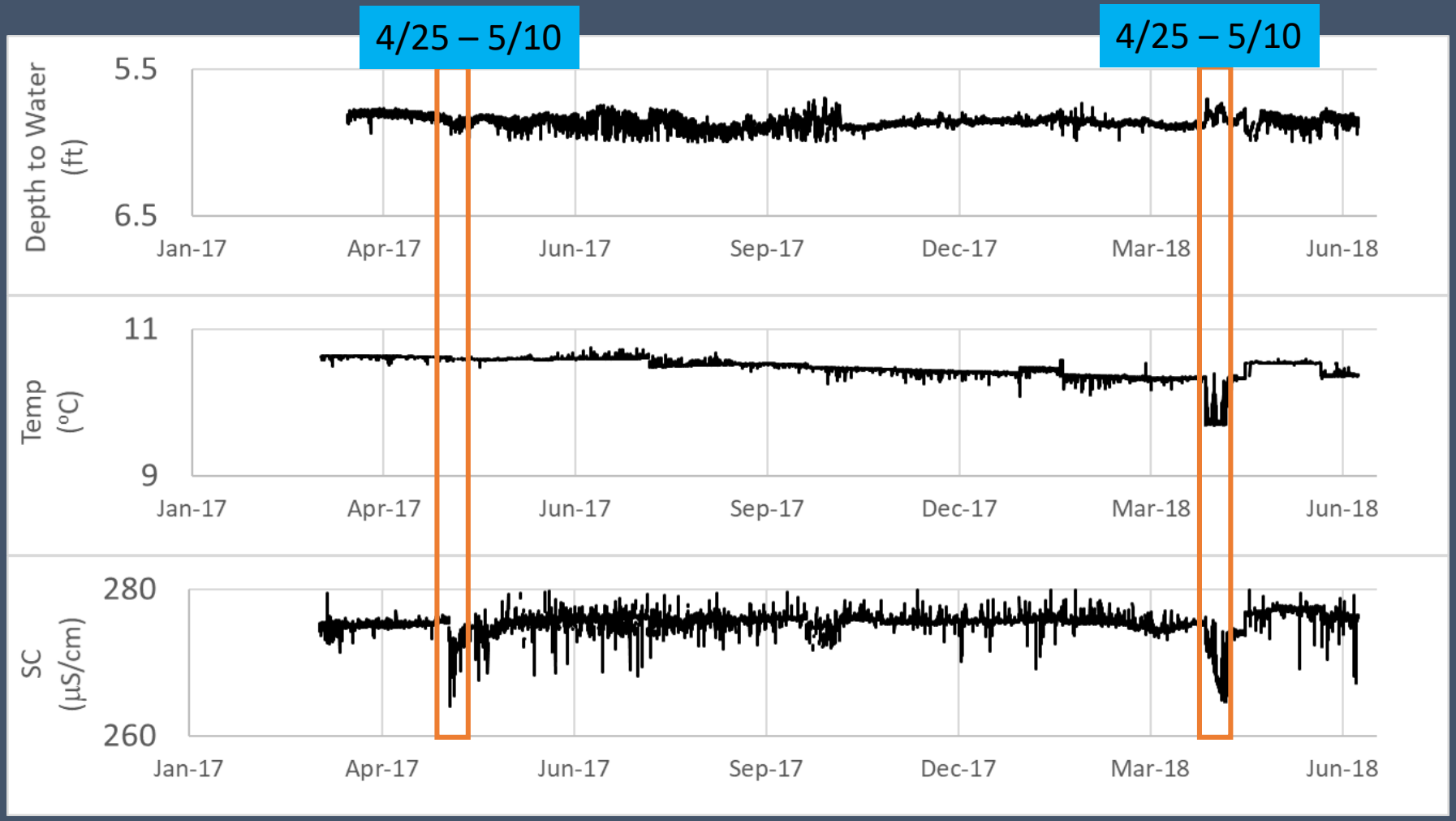
Very Low Frequency (VLF) Electromagnetic, and Seismic Surveys

Montana Tech Geophysical Field Camp



Sonde in Spring 1

Preliminary data



Mean Spring Water Temp = 10.5°C
Mean Annual Air Temp = 6.2°C

Age of Spring Water

CFCs for Spring 1

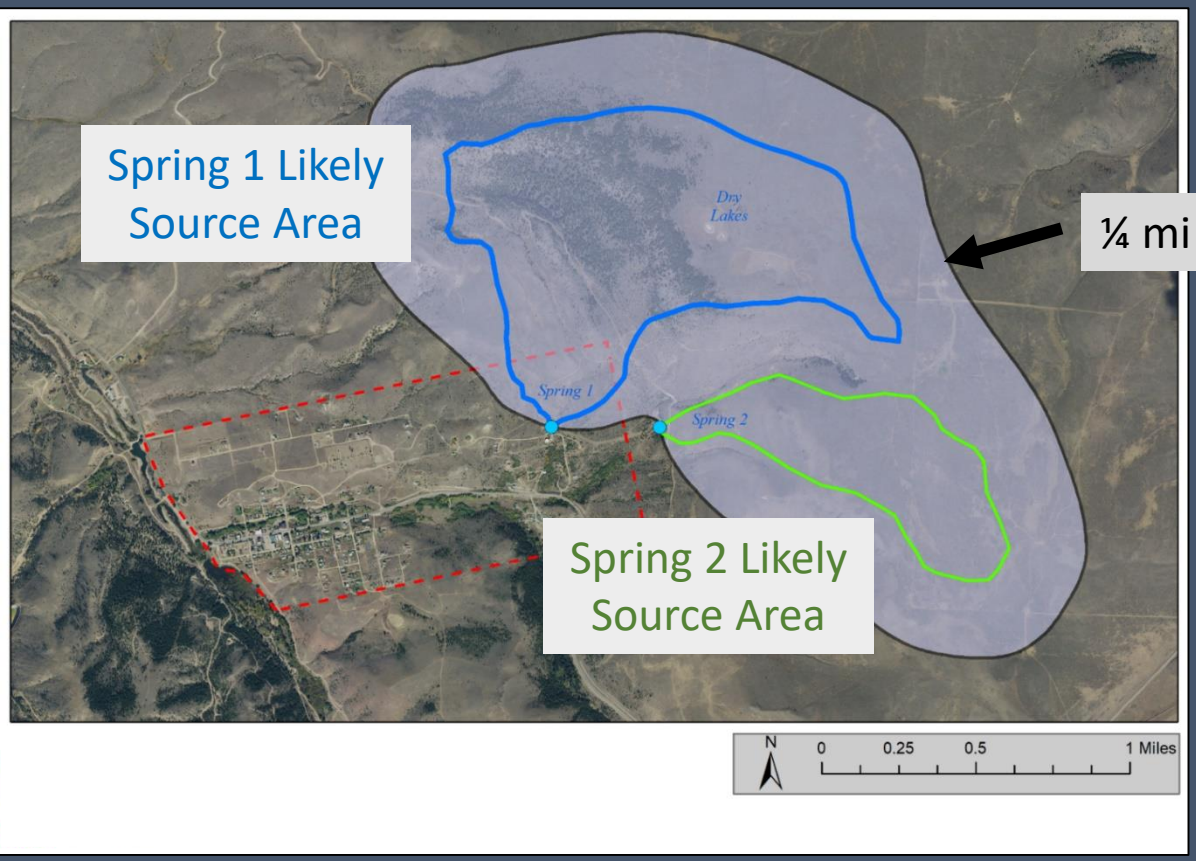
a) CFC-11 –> 33-40 years old; biodegradation may result in an older age
b) CFC-12 and CFC-113 –> 21-32 years old

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



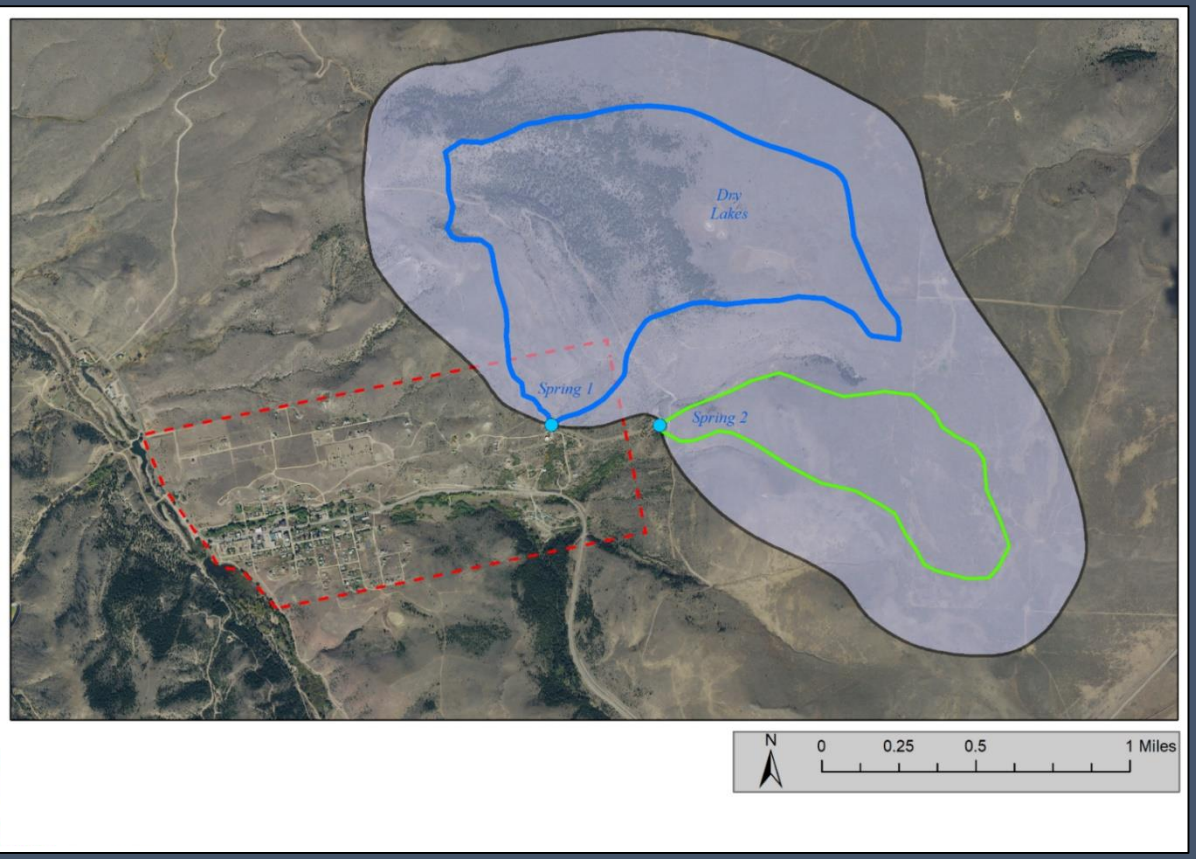
Preliminary Results

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

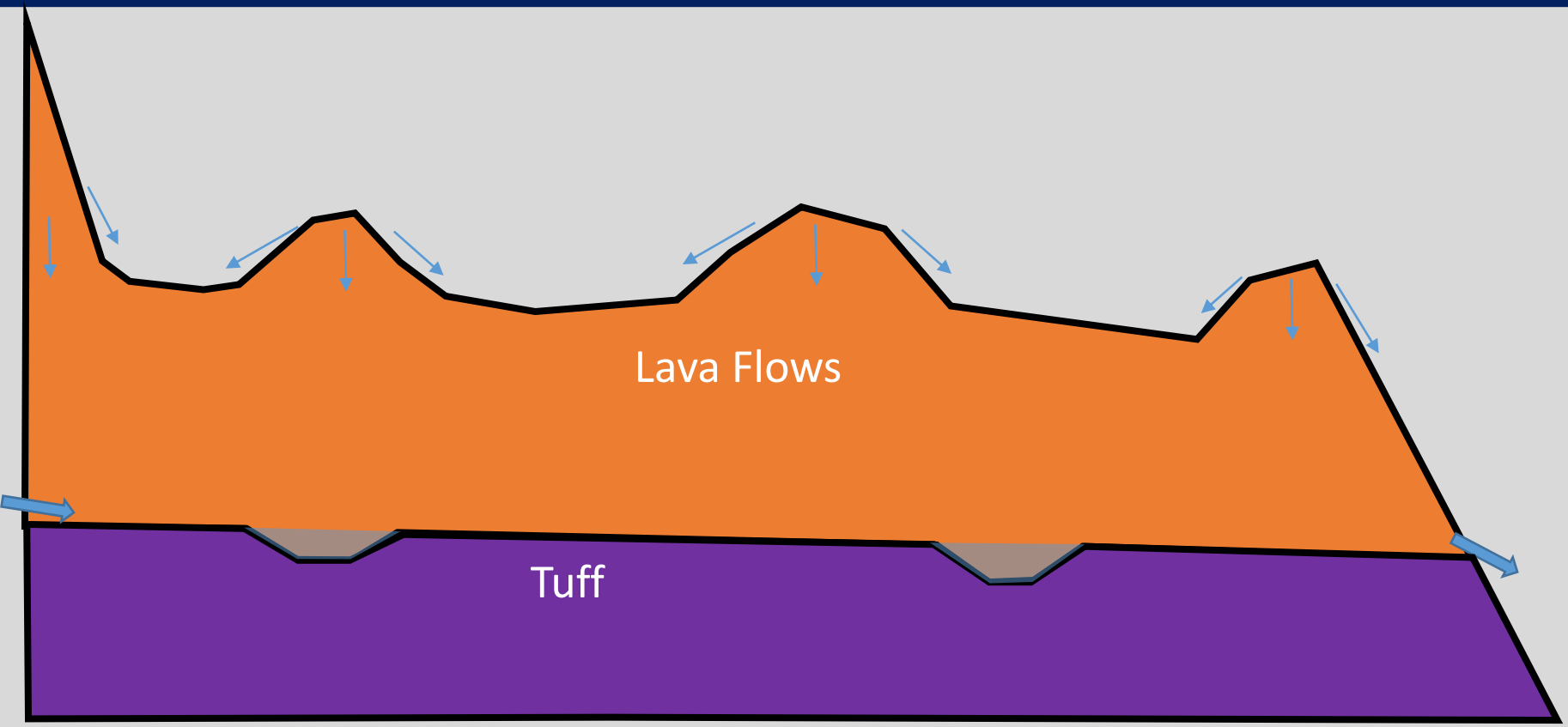


Preliminary Results

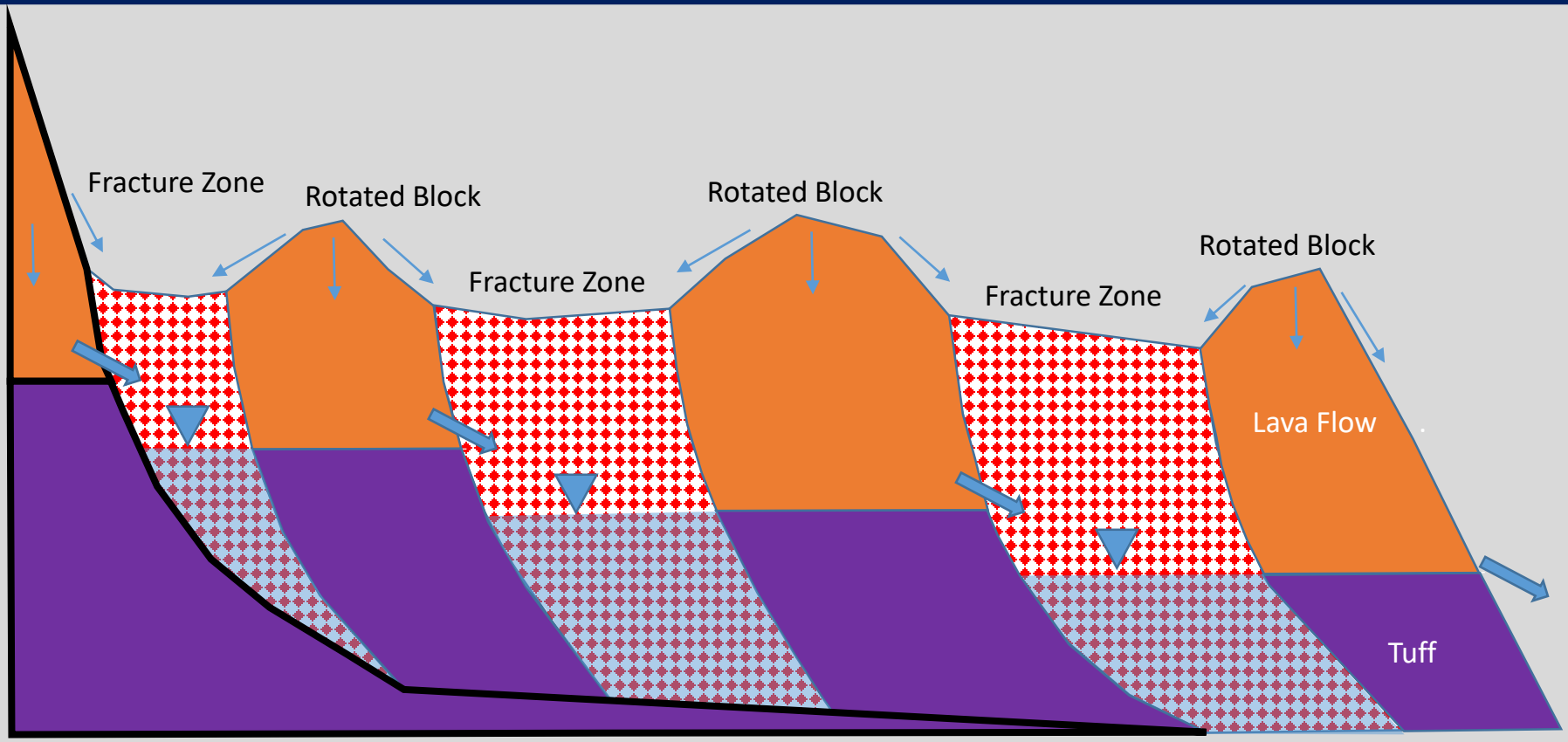
Using:
Porosity ~ 0.2
Spring discharge = 250 gpm
Residence time = 25 yr
Area = 548 acres

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

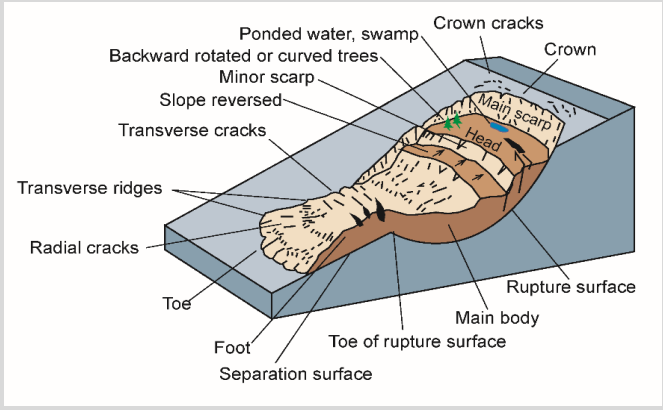
$$\frac{\left(9{,}131\ d * 48{,}128\ {ft^3}/{d}\right)}{(23{,}870{,}880\ ft^2 * 0.2)} \sim 92 \text{ ft, on average}$$



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?

abobst@mtech.edu 406-496-4409

GoogleEarth, Looking NE; 2x vertical exaggeration