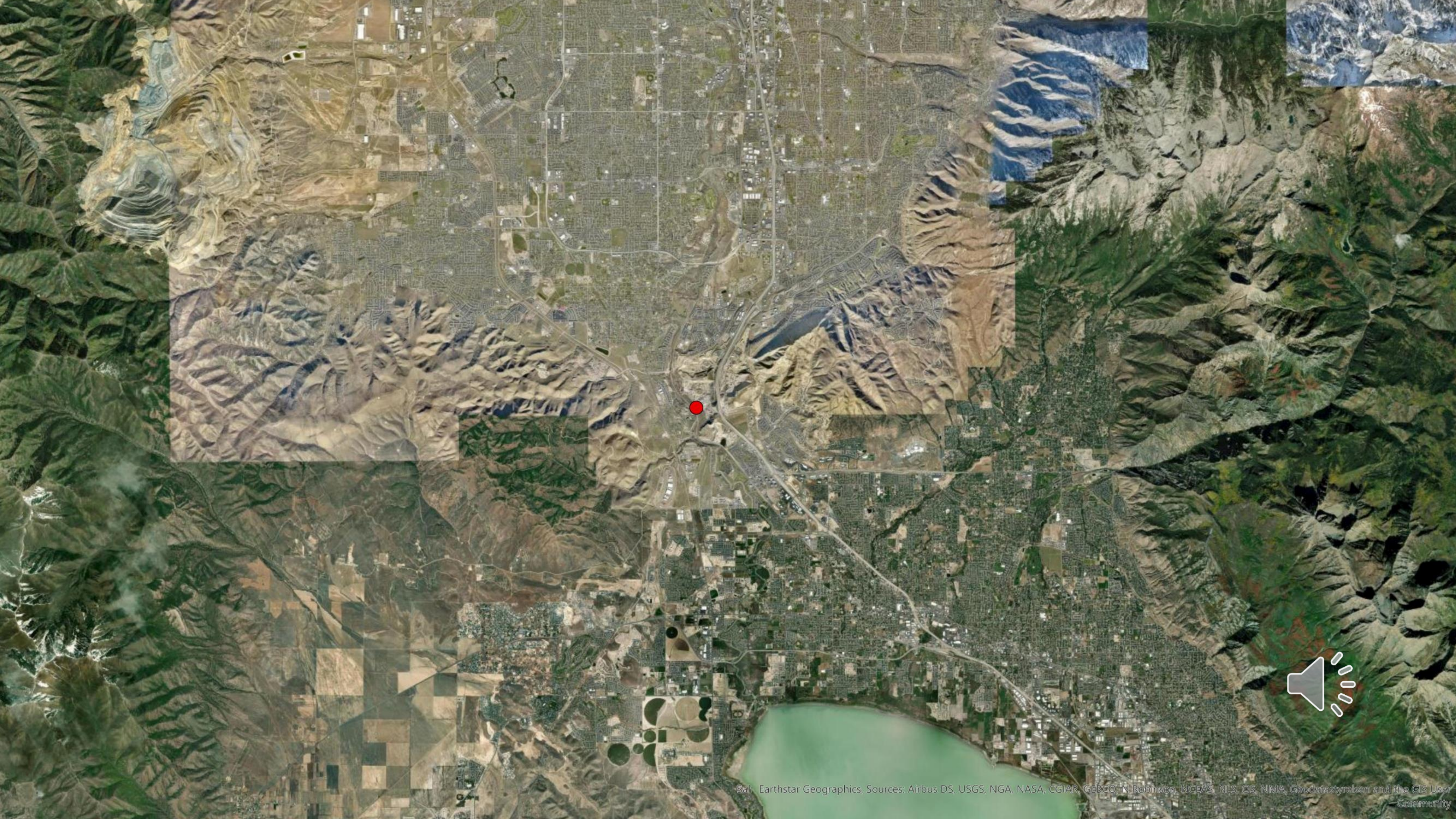
Quantifying Surface Water Influence on Hidden Valley Springs

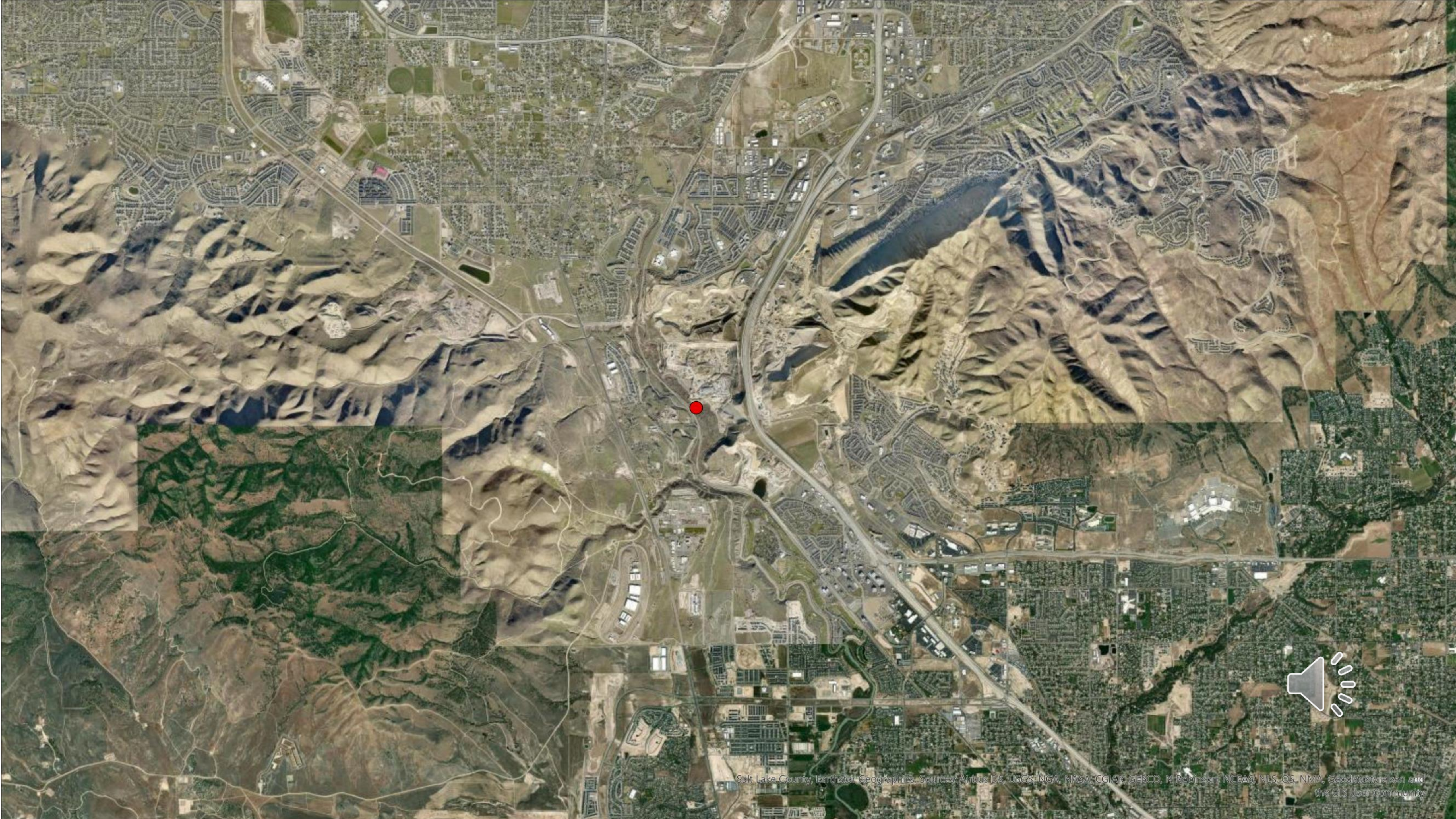
Bluffdale, Utah

Tyler Yoklavich

Undergraduate, University of Utah Department of Mines and Earth Sciences


Earthstar Geographics, Sources: Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community


Sal Earthstar Geographics, Sources: Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community

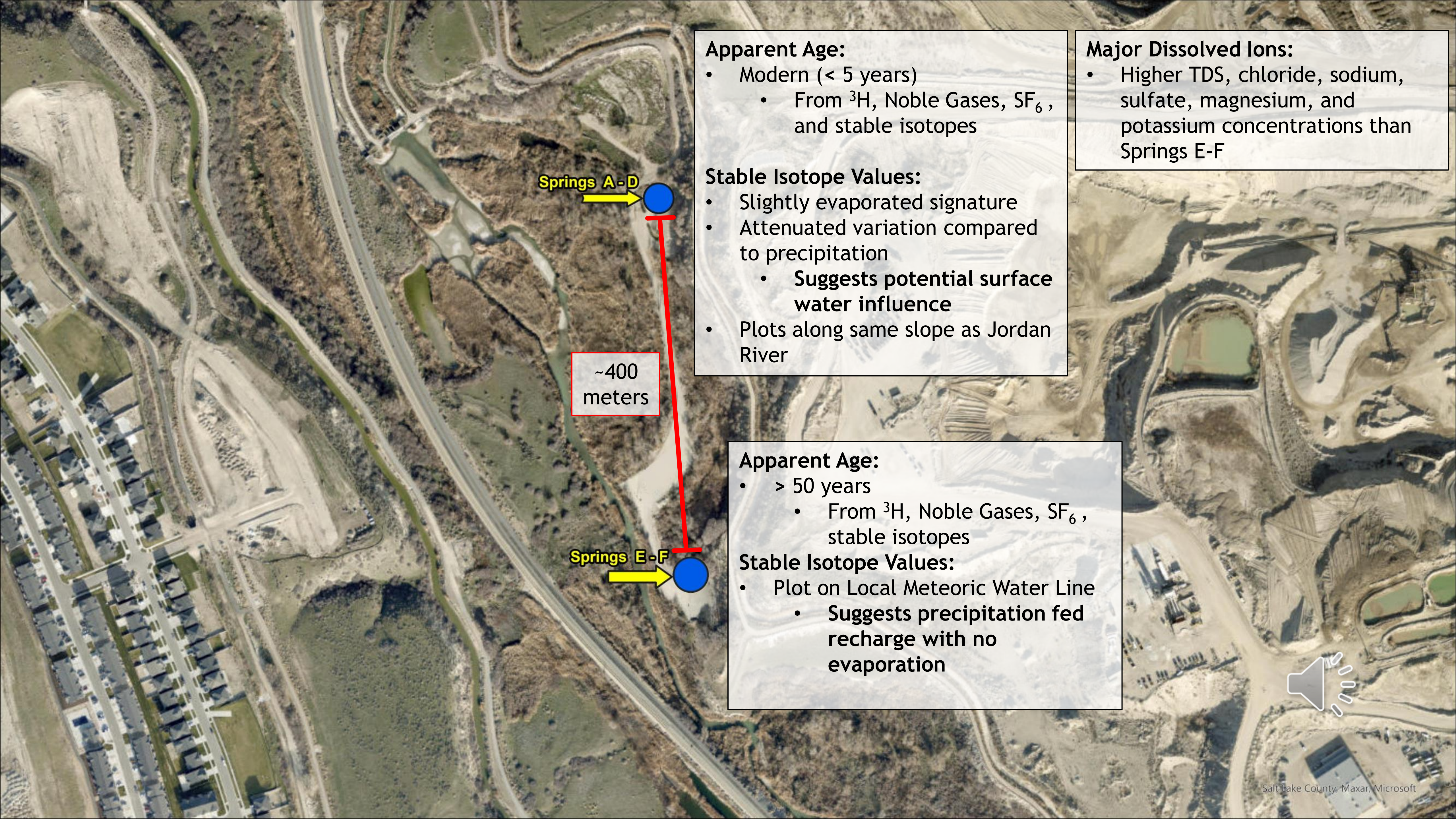

Salt Lake County, Earthstar Geographics. Sources: Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community


Sources: Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community, Salt Lake County, Maxar


Hidden Valley
Sources: Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community, Salt Lake County, Maxar


~400 meters
Sources: Airbus DS, USGS, NGA, NASA, CGIAR, GEBCO, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen and the GIS User Community, Salt Lake County, Maxar


Springs A - D
~400
meters
Springs E - F
Salt Lake County, Maxar, Microsoft



Apparent Age:

- Modern (< 5 years)
  - From ^3H, Noble Gases, SF_6, and stable isotopes

Stable Isotope Values:

- Slightly evaporated signature
- Attenuated variation compared to precipitation
  - **Suggests potential surface water influence**
- Plots along same slope as Jordan River

Major Dissolved Ions:

- Higher TDS, chloride, sodium, sulfate, magnesium, and potassium concentrations than Springs E-F

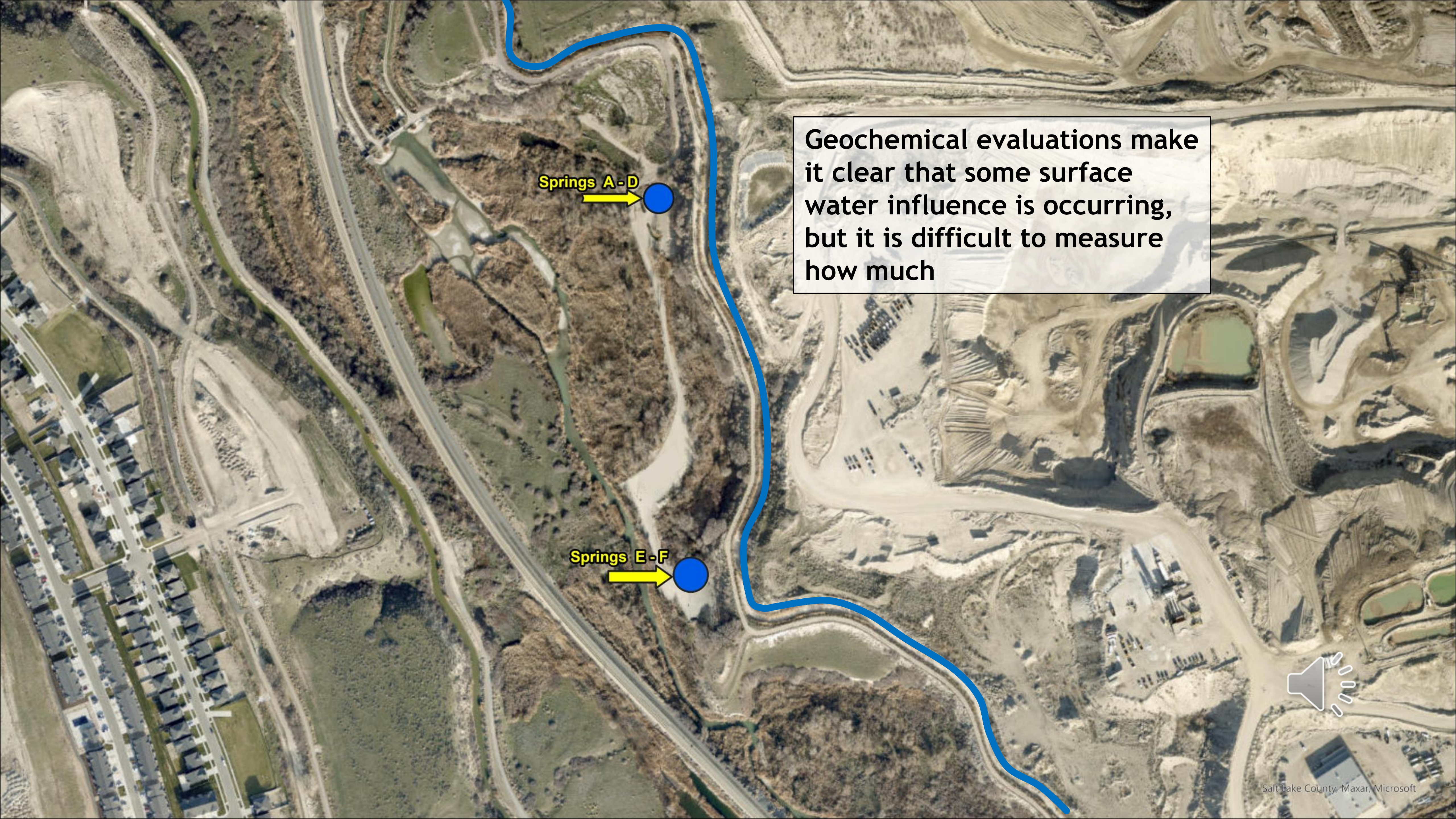
Apparent Age:

- > 50 years
  - From ^3H, Noble Gases, SF_6, stable isotopes

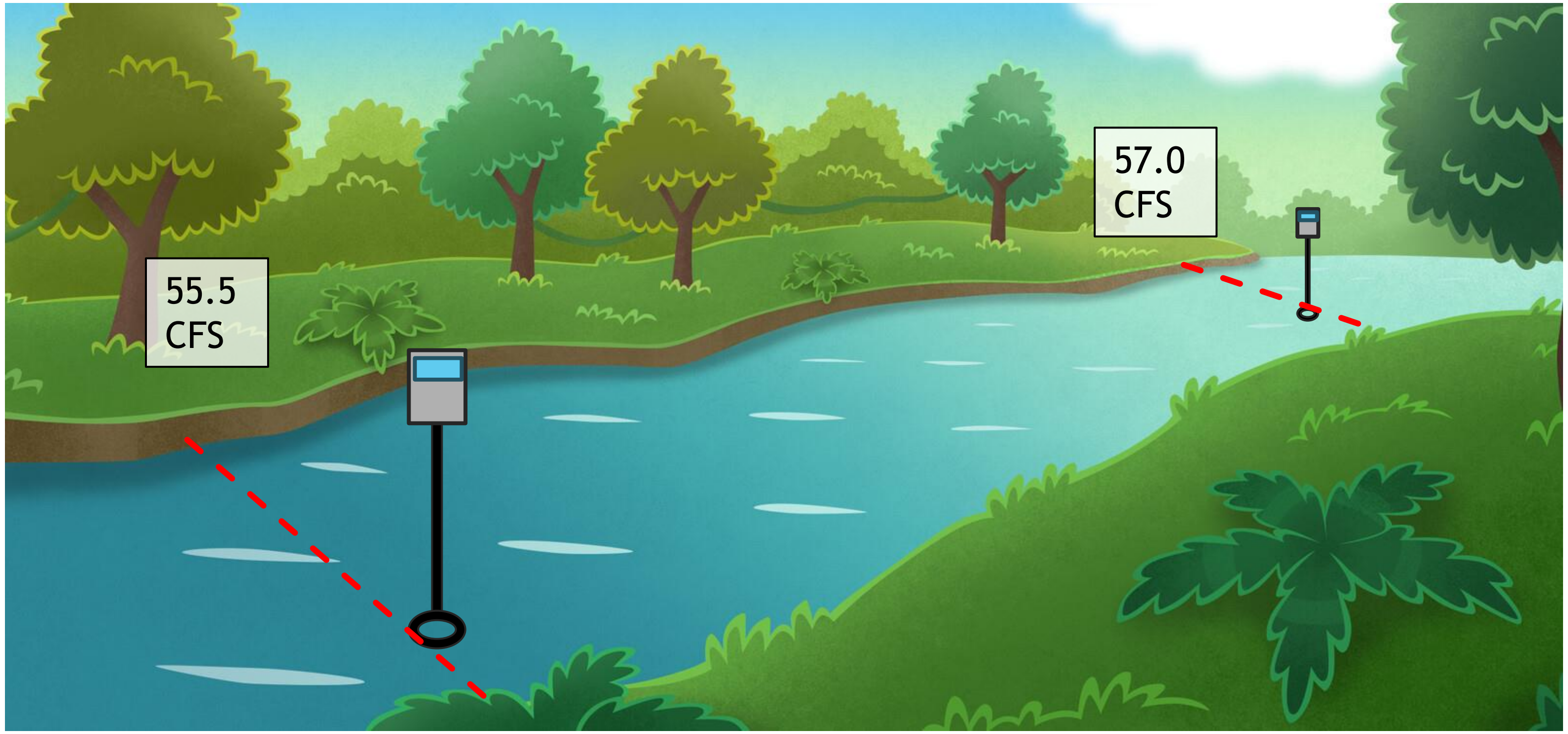
Stable Isotope Values:

- Plot on Local Meteoric Water Line
  - **Suggests precipitation fed recharge with no evaporation**

Geochemical evaluations make it clear that some surface water influence is occurring, but it is difficult to measure how much



Differential Flow Gauging (Seepage Run)

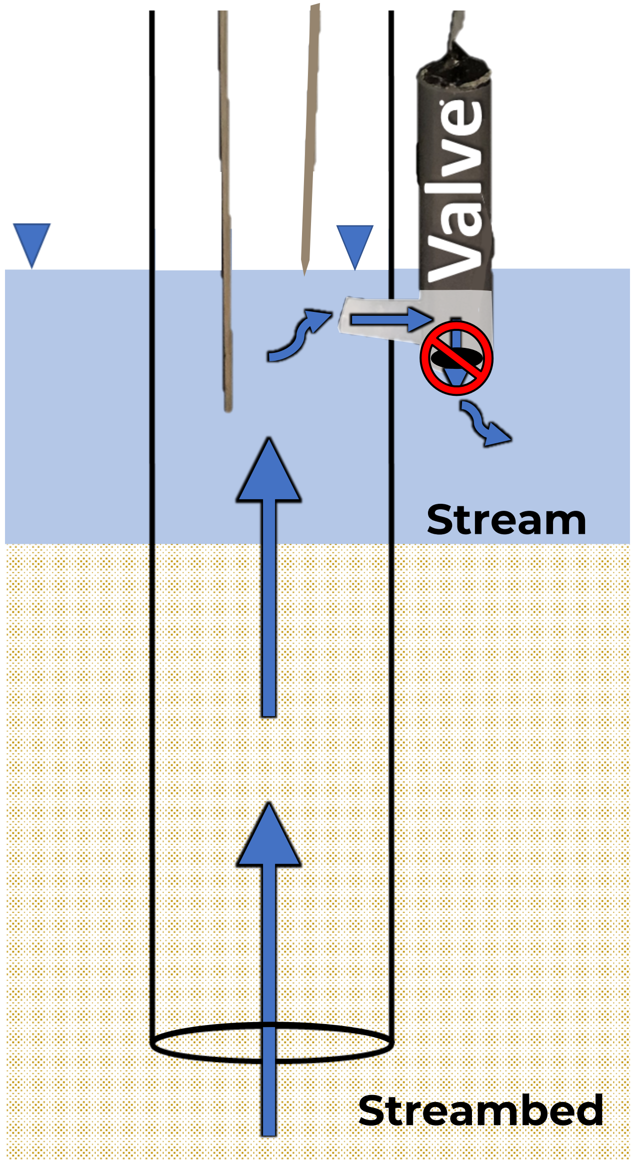


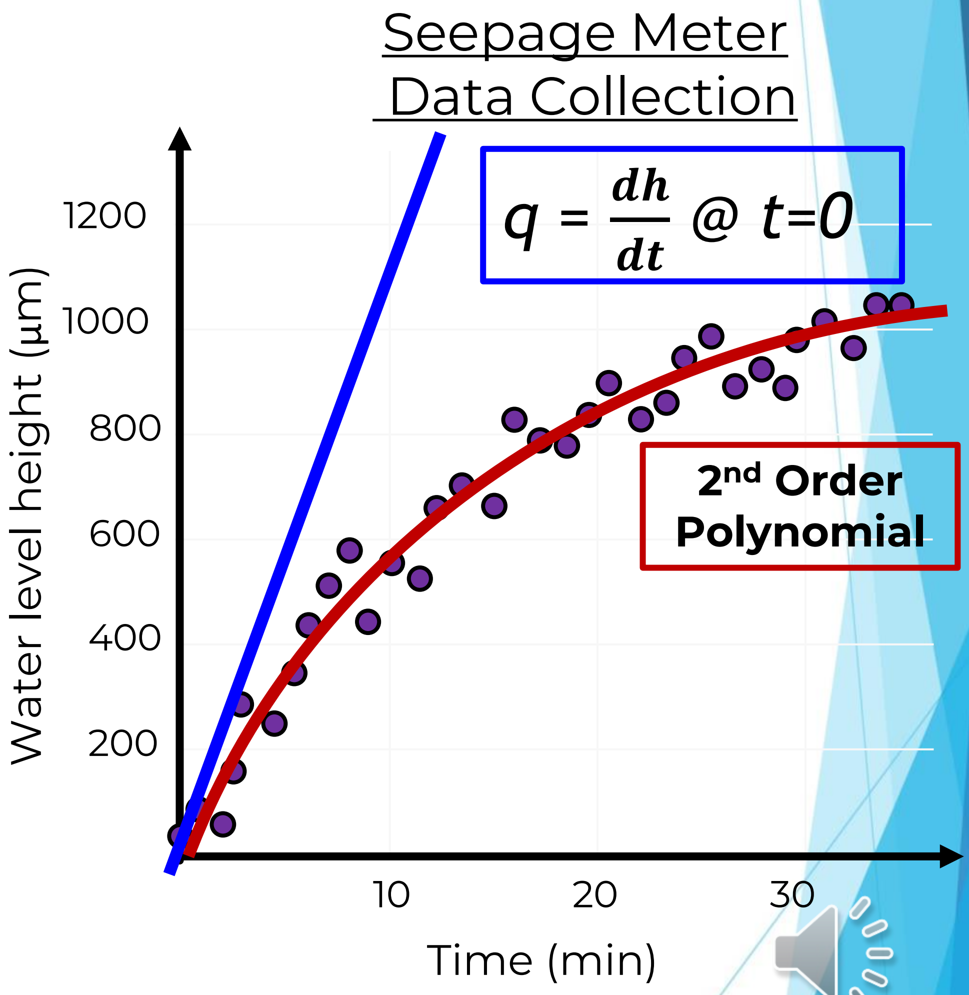
Applied to East Jordan Irrigation Canal:

- Reported 1.5 ±2.0 CFS differential
- Springs of interest have mean flow of .9 CFS
- Inconclusive, more precision necessary to constrain estimate

Automatic Seepage Meter

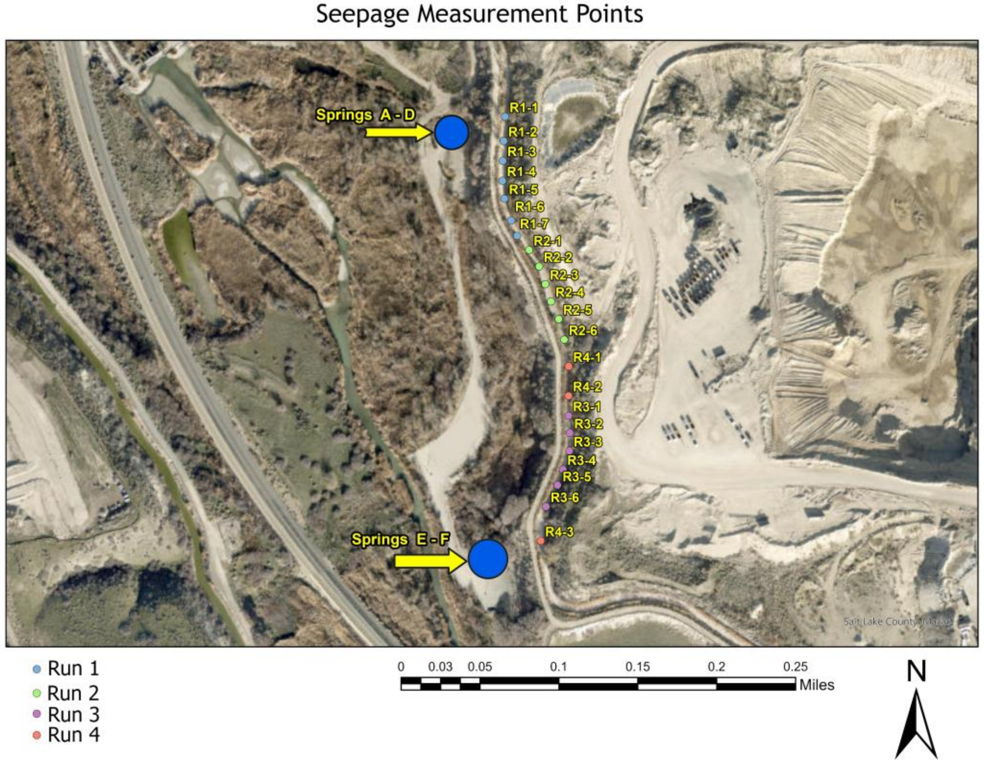
Solomon et al. (2020)





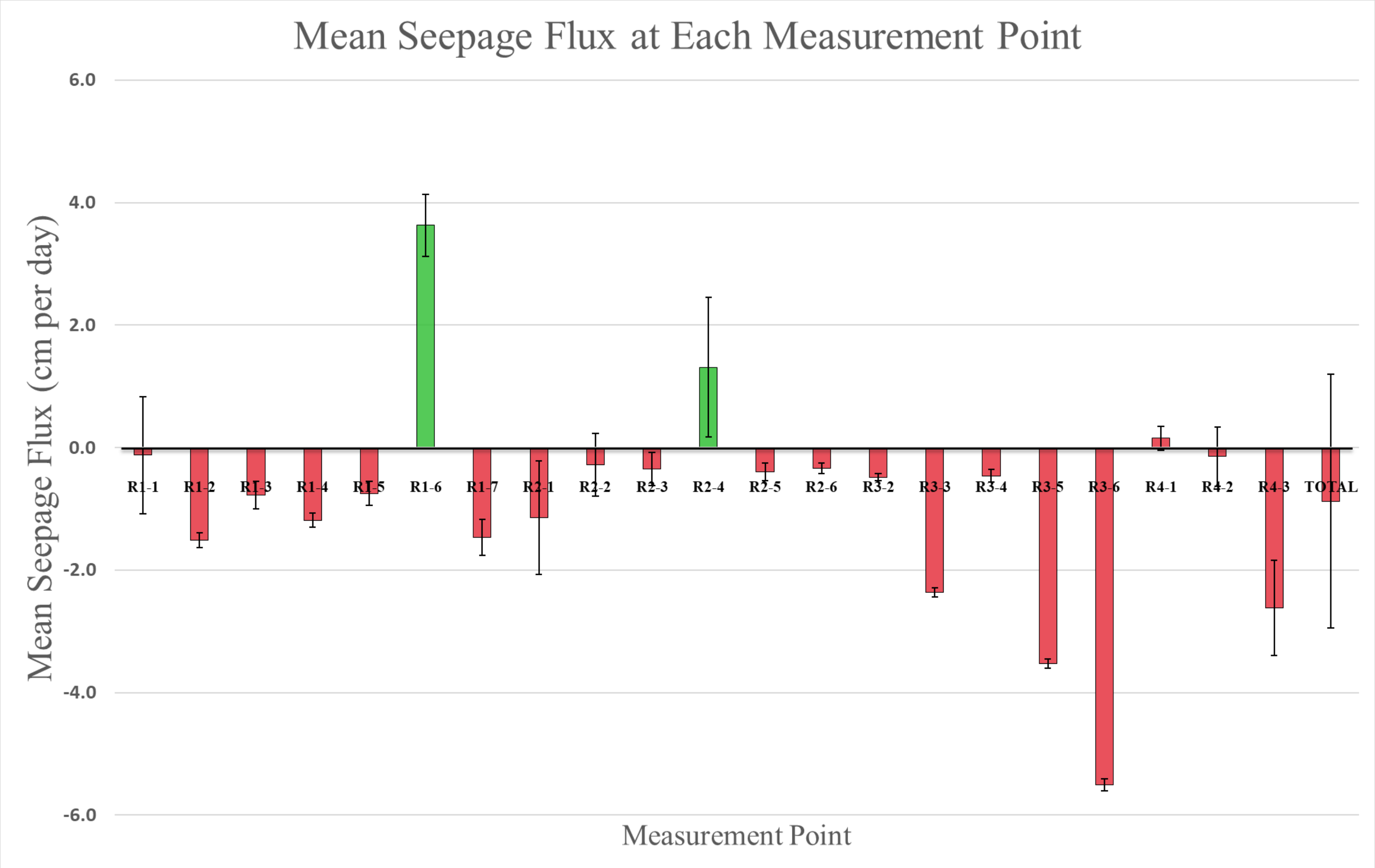
Animation Courtesy of
Dr. Eric Humphrey

Finding a Canal Representative q - Methods



- Meters placed at 15 m intervals along centerline of canal
- Measurements taken during 4 non-consecutive field outings
- Total of 255 individual measurements taken at 21 discrete measurement points
- Each measurement point produced a mean seepage flux (q) in cm/day

Results



- Most measurement points recorded a small amount of mean negative (downward) seepage
- Uncertainty is obtained by calculating the standard error of all flux values recorded at a given point
- Points with a positive flux may be due to hyporheic flow

Representative q

- To find a representative seepage flux (q), the average of all measurement point fluxes was calculated
  - Overall uncertainty is obtained by propagating the error associated with each measurement point flux through the averaging of fluxes
- The representative seepage flux (q) was identified to be **-.9 ±2.1 cm/day**

Meter/ Measurement Point	Mean Seepage Flux, q (cm/d)	Uncertainty +/- (Standard Error)
R1-1	-0.12	0.96
R1-2	-1.52	0.12
R1-3	-0.78	0.22
R1-4	-1.19	0.11
R1-5	-0.75	0.19
R1-6	3.63	0.51
R1-7	-1.47	0.29
R2-1	-1.15	0.93
R2-2	-0.28	0.51
R2-3	-0.35	0.27
R2-4	1.31	1.14
R2-5	-0.40	0.15
R2-6	-0.34	0.08
R3-2	-0.48	0.06
R3-3	-2.37	0.08
R3-4	-0.46	0.11
R3-5	-3.53	0.07
R3-6	-5.51	0.09
R4-1	0.15	0.19
R4-2	-0.15	0.48
R4-3	-2.62	0.77
Overall:	-0.87	2.08

Estimating a Volumetric Seepage Rate (Q) and Proportion of Spring Flow Due to Canal Seepage

The representative seepage flux (cm/day) was multiplied by the surface area of canal within the springs presumed recharge zone to produce a **volumetric seepage rate of 181 ± 444 m^3/day (0.07 ±.18 CFS)**

> Uncertainty is still high relative to the total seepage, but the precision is much greater than with differential flow gauging (2 CFS error vs .18)

This means that annually, $3.3x10^4$ m^3/year seeps from the canal into springs A-D

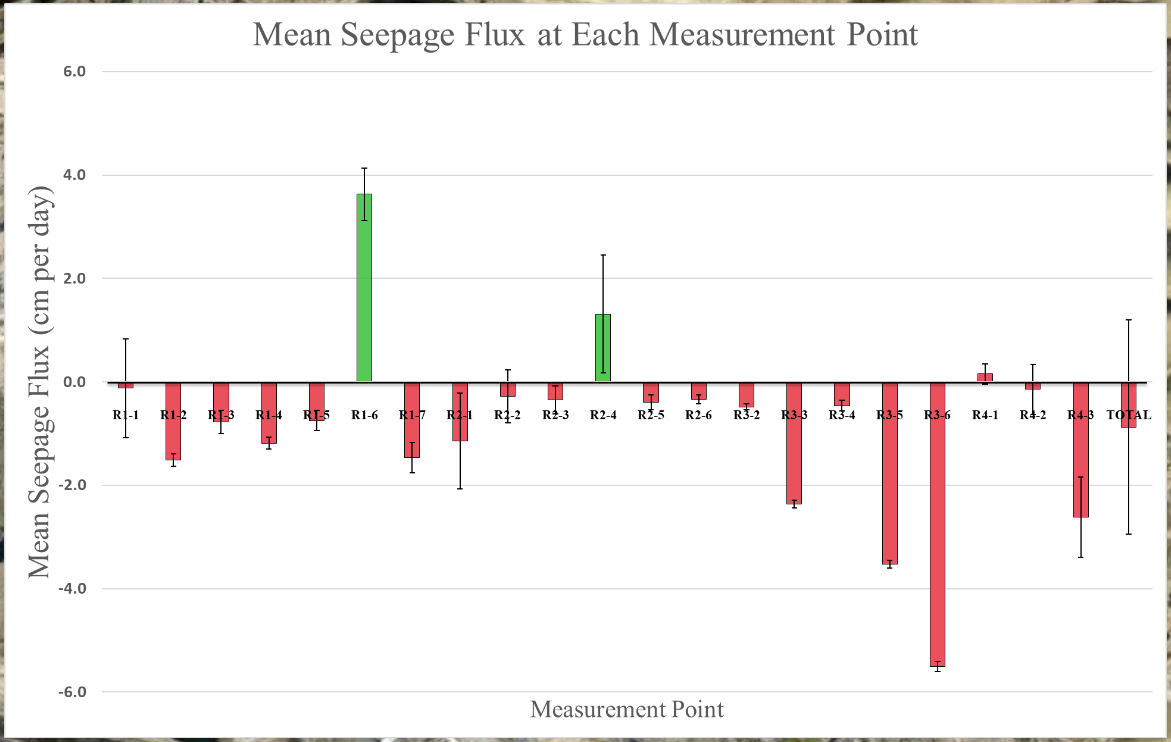
In 2021, springs A-D had a total flow of $6.4x10^5$ m^3

Dividing total flow by seepage input indicates that **at maximum, ~5% of spring flow may be attributed to seepage losses from the irrigation canal**

Limitations/Future Work

- Higher than typical uncertainty was recorded during this project
- Assumptions made regarding recharge zones and flow paths may not be accurate
- All seepage unlikely to discharge at springs
- High spatial variability –larger scope may capture more high seepage areas/reduce overall uncertainty
- Monitoring wells could establish more well constrained flow paths

- Due to these assumptions, we consider 5% to be the maximum possible contribution to spring flow



Summary and Conclusions

- 255 automatic seepage meter measurements were taken along a 400 meter transect of the East Jordan Irrigation Canal
- A representative seepage flux of -.9 ±2.1 cm/day was obtained
- Applying this flux to the area of canal within the springs presumed recharge zone results in a volumetric seepage rate of 181 ± 444 m^3/day (0.07 ±.18 CFS), or $3.3x10^4$ m^3/year
- A comparison of seepage inputs to total annual spring flow shows that a maximum of **5% of spring flow may be attributed to seepage losses**

- Due to these findings, **we conclude that the irrigation canal is not a primary source of recharge to Hidden Valley Springs**
- Further investigations including more seepage measurements, shallow monitoring well installation, and continued geochemical investigation will help to further constrain recharge sources to Hidden Valley

Acknowledgements

- Utah Army National Guard Environmental Resources Management
- Dr. Kip Solomon
- Will Mace
- Bert Stolp
- Alex Engstrom
- Dr. Eric Humphrey
- University of Utah SIRFER Lab
- Bowen Collins and Associates
- Loughlin Water Associates
- Horrocks Engineers