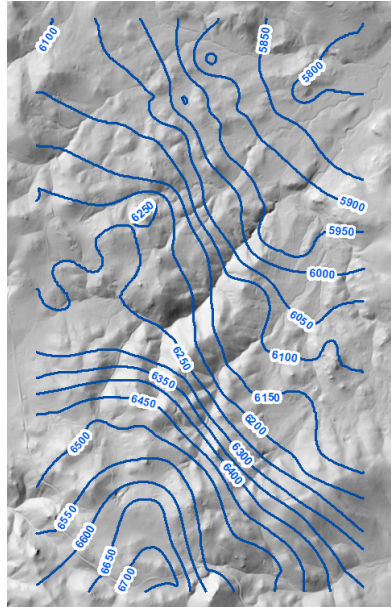


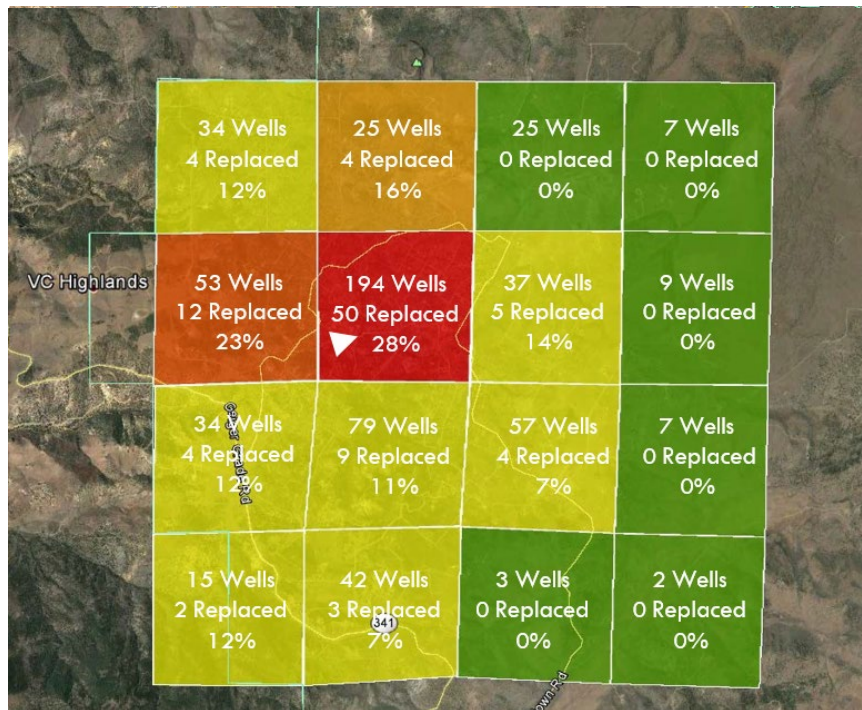
# Virginia City Highlands Groundwater Investigation: Year 2 Summary

Storey County Planning Commission Meeting 9/5/2019



# Problem

- **Discovered significant water-level declines in 2016.**
  - Two domestic well declined 50' and 165' since 1997.
  - 28% of wells in one section were deepened or replaced.
  - Storey County wants better understanding of groundwater situation in the VC Highlands.
- Started 5-year investigation in 2017 to better understand problem and inform decisions.



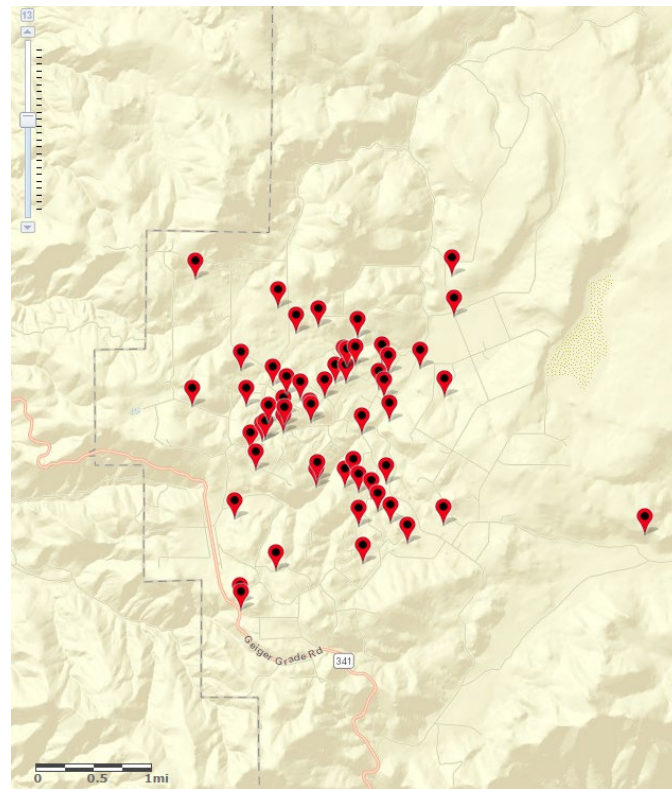
# Approach

- **Water-level Network established in 2017**
  - Quarterly and Annual Monitoring
  - GPS surveying and Lidar Data
  - Continuous Water-Levels
- **Precipitation network established in 2018**
  - 4 precipitation gages
- **Develop Informative Maps 2019**
  - Water table map for 2018 data.
  - Digitize 1984 UNR Thesis water table map
  - Compute Water-level change map
- **Aquifer Properties 2020-2021**
  - Aquifer tests (3-5)
  - Lousetown Creek Recharge to aquifer
  - Geophysics (EM, Gamma, and Resistivity)



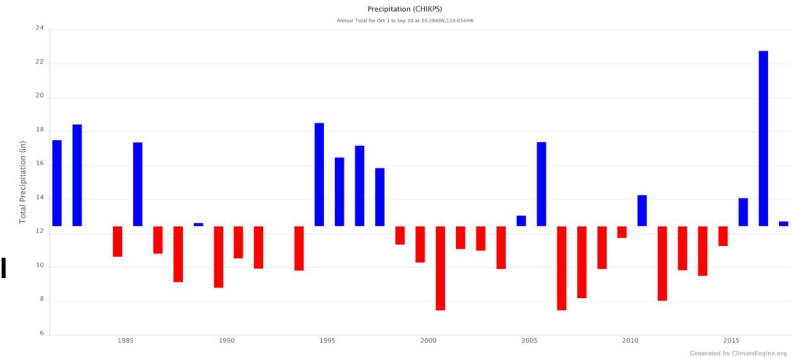
# Progress

- Year 2 Tasks
- Measured Groundwater Network of 60 Wells
  - (>200 measurements in WY19)
  - Quarterly measurements
  - Data is available online (below URL)
- Measured 4 precipitation gages
- Measured discrete flow of Lousetown Creek
- Preliminary 2018 water-table map and water-level change Map.
  - UNR Master's Thesis water-table map by Koltermann (1984) digitized.
  - Developed preliminary water-level change map.



# Significant Findings: Precipitation

- **Precipitation Comparison of Bulk and Satellite Data**
  - No long term record of precip available for VCH
- **Climateengine.org – Historical estimates 1981-2018**
  - **CHIRPS Satellite – Provides best relationship with current annual bulk precip. data (WATER YEAR Oct. to Sept.)**
- **VCH 30 year average from CHIRPS = ~12.0”**
- **2017 CHIRPS = 22.8”**
- **2018 USGS bulk = 13.2”**
- **2018 CHIRPS = 12.7”**
- **2019 USGS bulk = Oct. - June ~14.5”**



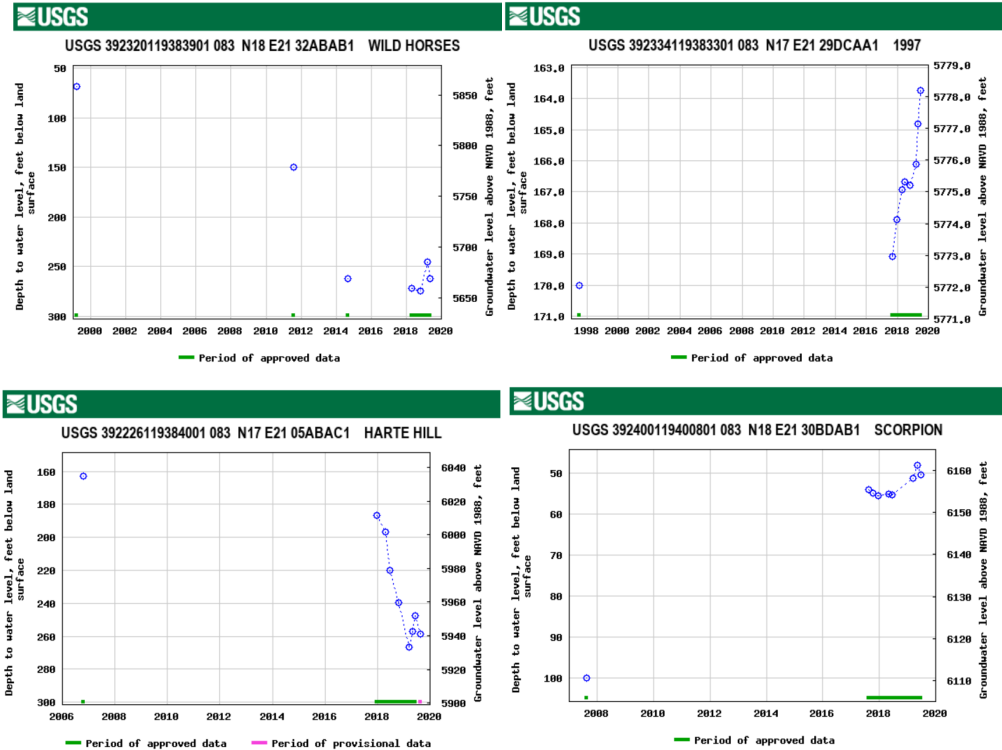
VCH annual departure from 12” average: 1981 - 2018



One of the USGS Bulk Precip field sites

# Significant Findings: 2019 Water Levels

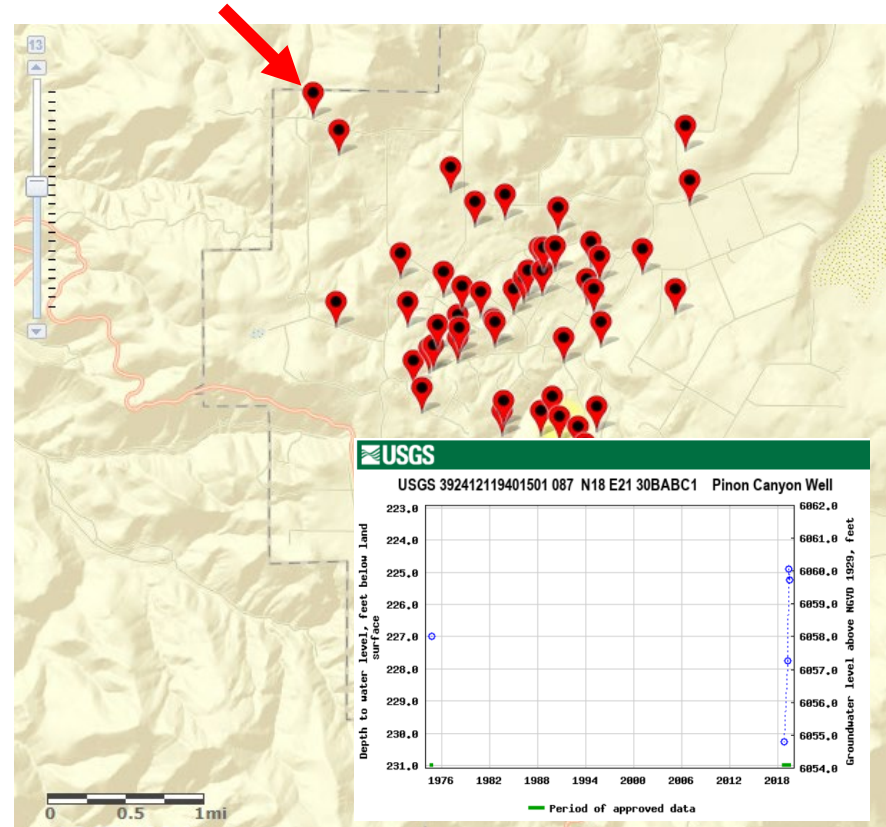
- Significant water-level increases in WY 2019, above average precip.
- ~85% of wells in network have increased within the past year from April, 2018 to June, 2019.
- 41 wells increased
  - average increase of 10.7 feet
  - Largest increase 71 feet
- 7 wells continued to decline
  - Average decline of 20 feet
  - Largest decline 60 feet



# Significant Findings

- 2 more wells were added in WY2019.
- 1 well in particular is worth mentioning. Well near Scorpion Lane was one of the original test wells for the VCH, originally drilled in 1974.
- Static water level was 227' in 1974.
- Most recent measurement was 227.9' – essentially unchanged.
- Suggests little change in aquifer water-levels in the Highland Ranches north of the VC Highlands.

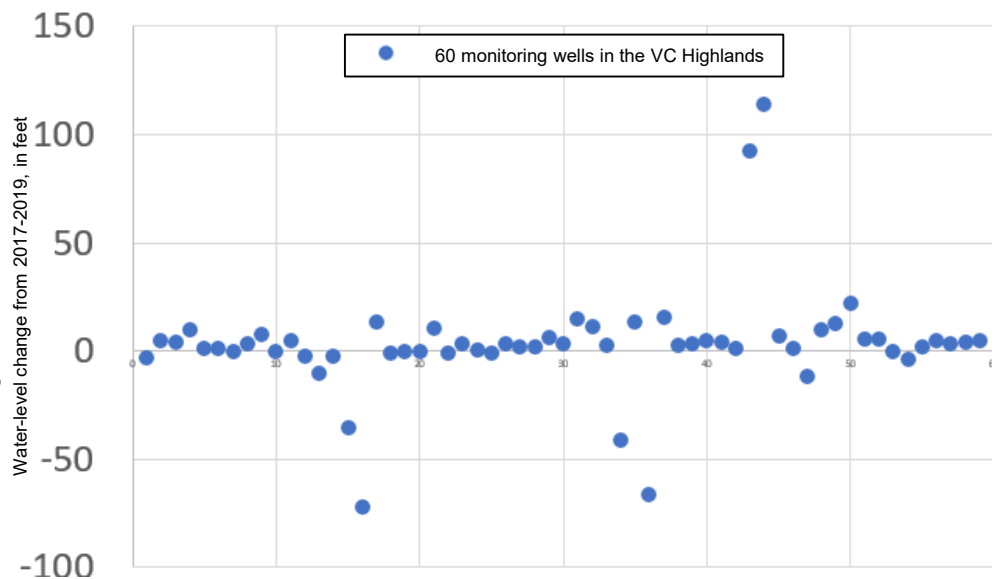
## 1974 VCH Test Well



# Significant Findings: USGS Monitoring Network

- **Monitoring began July 2017**
- **Water-level change from 2017-2019**
  - **Wetter conditions**
  - **60 total wells**
  - **41 increasing/stable trend**
  - **19 decreasing**
- **Monitoring Summary Statistics**
  - **Average increase 3 feet**
  - **Maximum increase 114 feet**
  - **Maximum decline 72 feet**

VCH Groundwater Network Water-Level Change 2017-2019



Each point represents the water-level change for a monitored well between 2017 and 2019. Negative values are declines, positive values are increases.

# Water-Level Change Map

- Constructed to help identify areas of water-level change.
- Requires accurate elevation data (LiDAR).
- Similar distribution of water-level measuring locations needed when comparing two maps.
- Compare snapshots of water-levels separated by 36 years (1982 and 2018).

## So what is a water-table map?

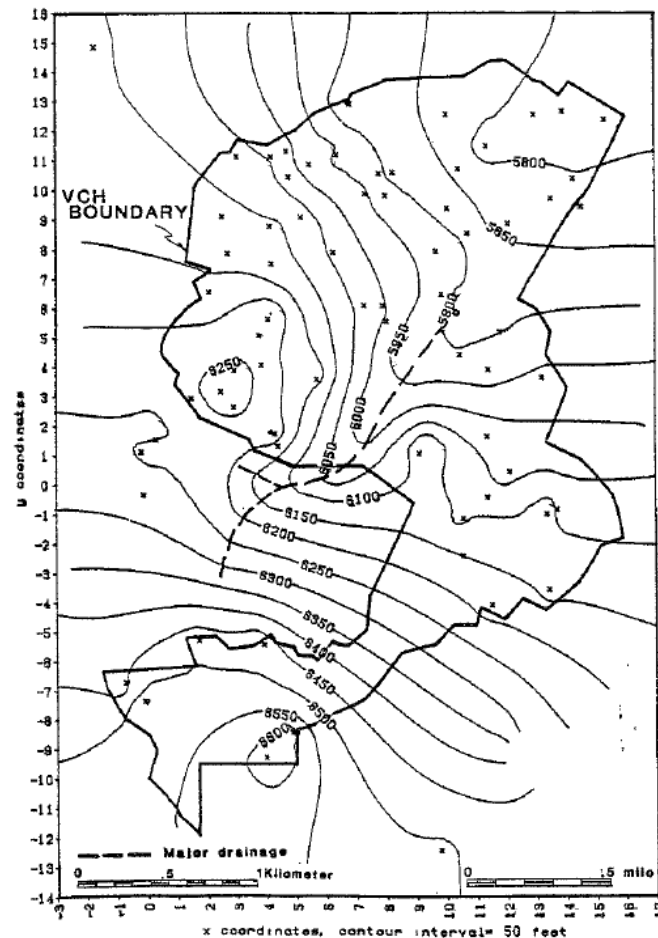
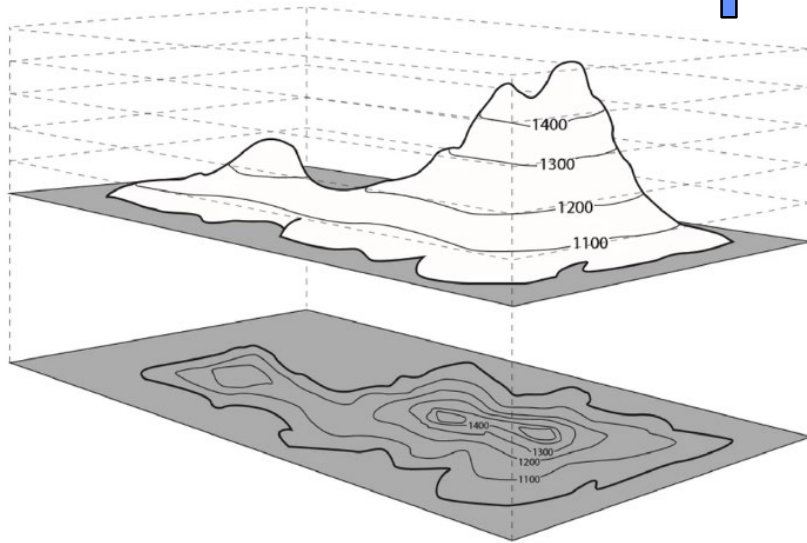


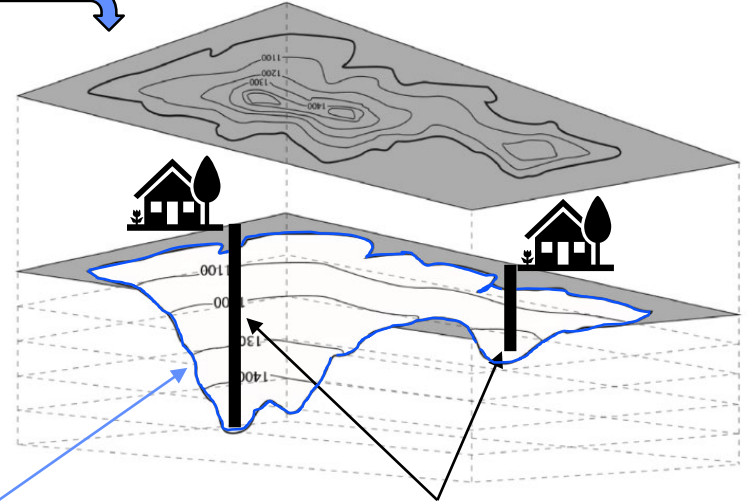
Figure 7. Piezometric Head Contour Map of the VCH area

Koltermann, 1984

# Topographic map



# Water-table map



Groundwater  
Level

Domestic Wells

# Water Table Maps are developed from measured water-level altitudes

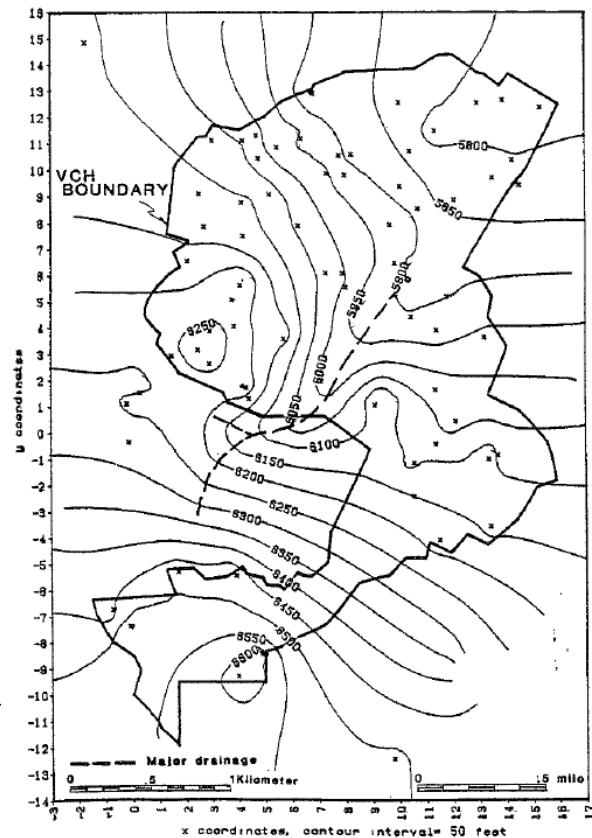
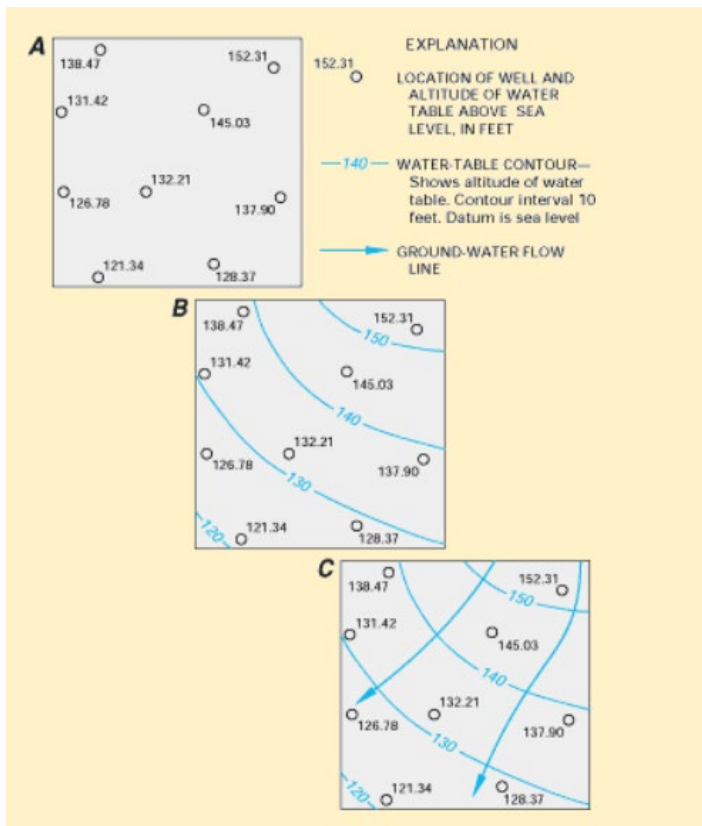
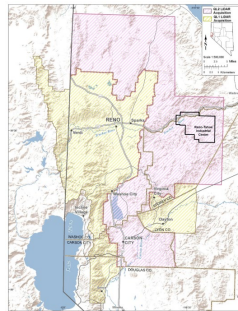


Figure 7. Piezometric Head Contour Map of the VCH area  
Koltermann, 1984

# New USGS LiDAR Dataset

- Collected by USGS and funded by Nevada Bureau of Mines and Geology and Storey County.
- Vertical Accuracy ~3 inches, 3 foot grid
- LiDAR data was used to obtain surface elevation and help confirm accuracy of the elevations used in the 1984 map.



[Below the Neon: Reno's Bare Earth \(ArcGIS 2018\)](#)



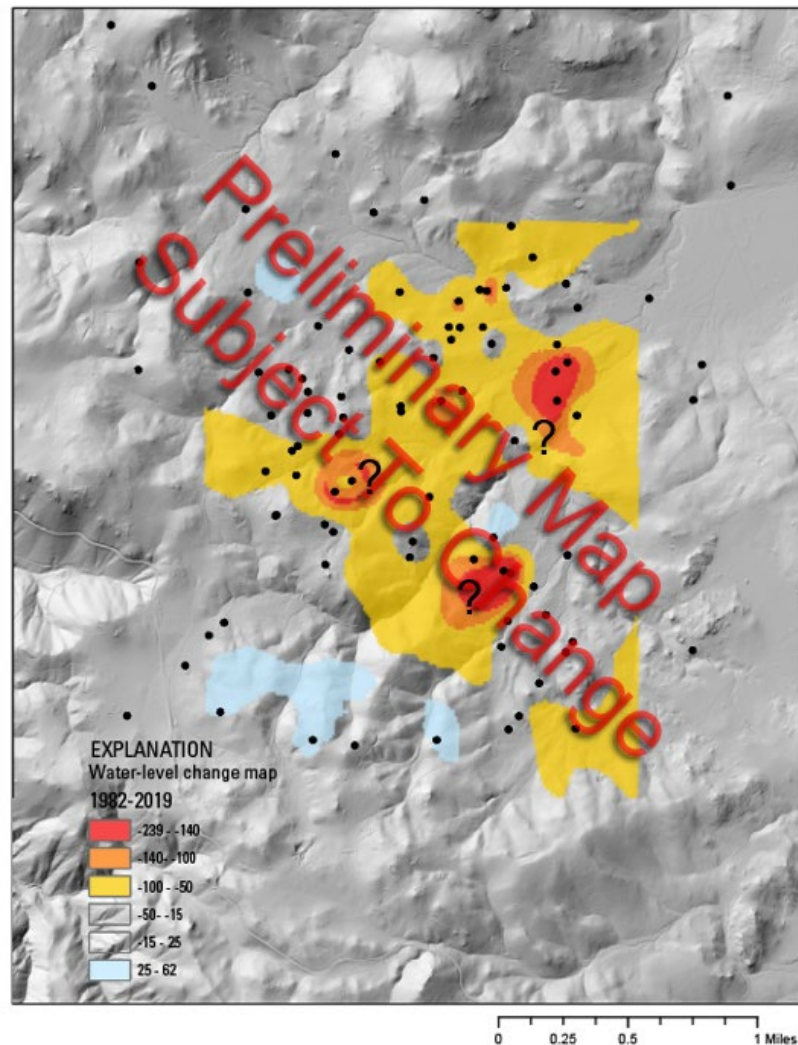
0 0.25 0.5 1 Miles



# Water-Level Change Map

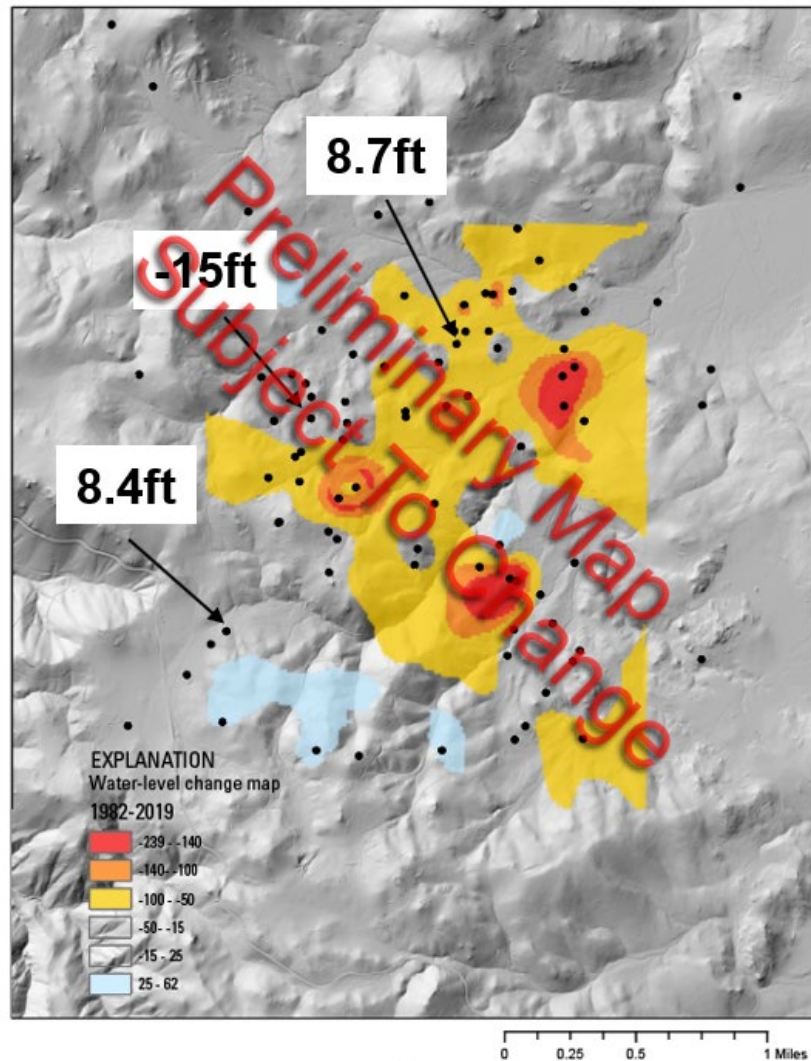
- Change Map = 2018 WLs – 1982 WLs.
- Map is “Preliminary” and will be refined as more data is collected.
- “?” - areas where water levels are needed.
- Water levels and hydraulic connection across fractured bedrock aquifers are highly variable. Contours are interpolated based on existing measurements. New measurements will help refine them.
- This is the current approximation of 1982 to 2018 change in water-levels for VC Highlands.

- Reds and yellows are declines. Light blue is rise. No color indicates only modest change.



# Vertical Elevation Accuracy

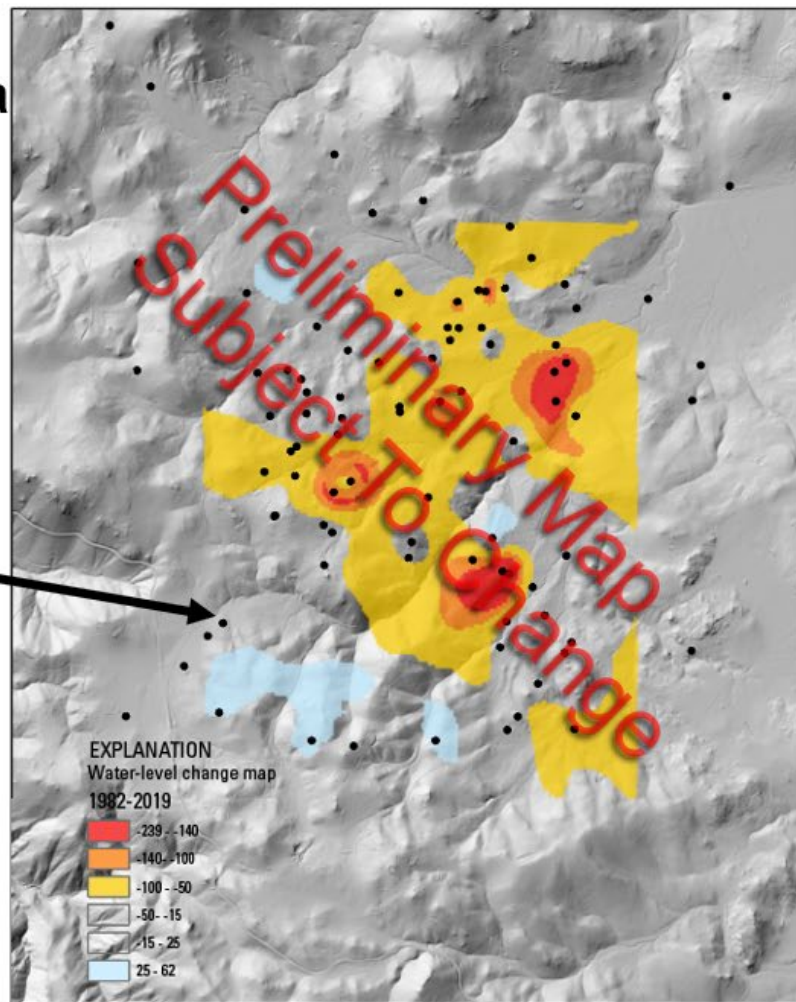
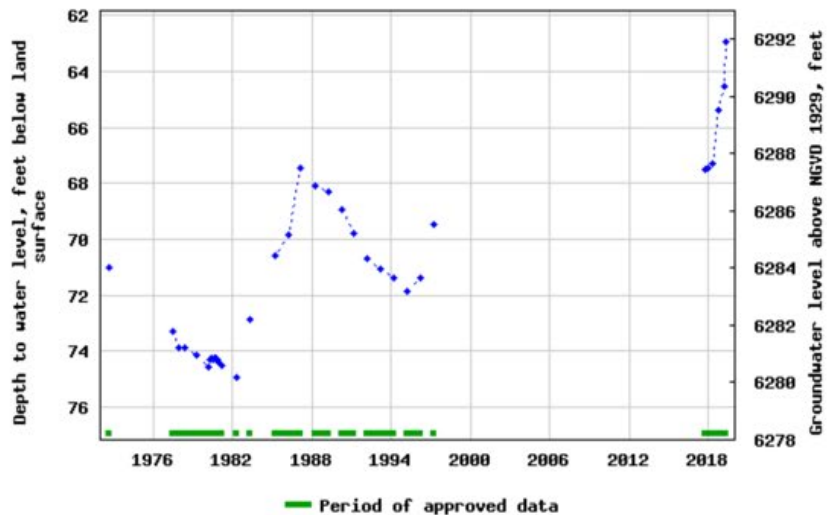
- Comparing two maps, made with different data is complicated...
- Contour surfaces made using altitude data from DGPS and LiDAR datasets.
- Raw water-level data not available from Koltermann, 1984.
- Compare accuracy of USGS monitoring 1982 locations to topo-map contours used by Kolterman 1984 (Map shows difference in elevation of 3 locations available for comparison).
- Continue to evaluate and adjust where applicable.



# Comparison with USGS water-level data



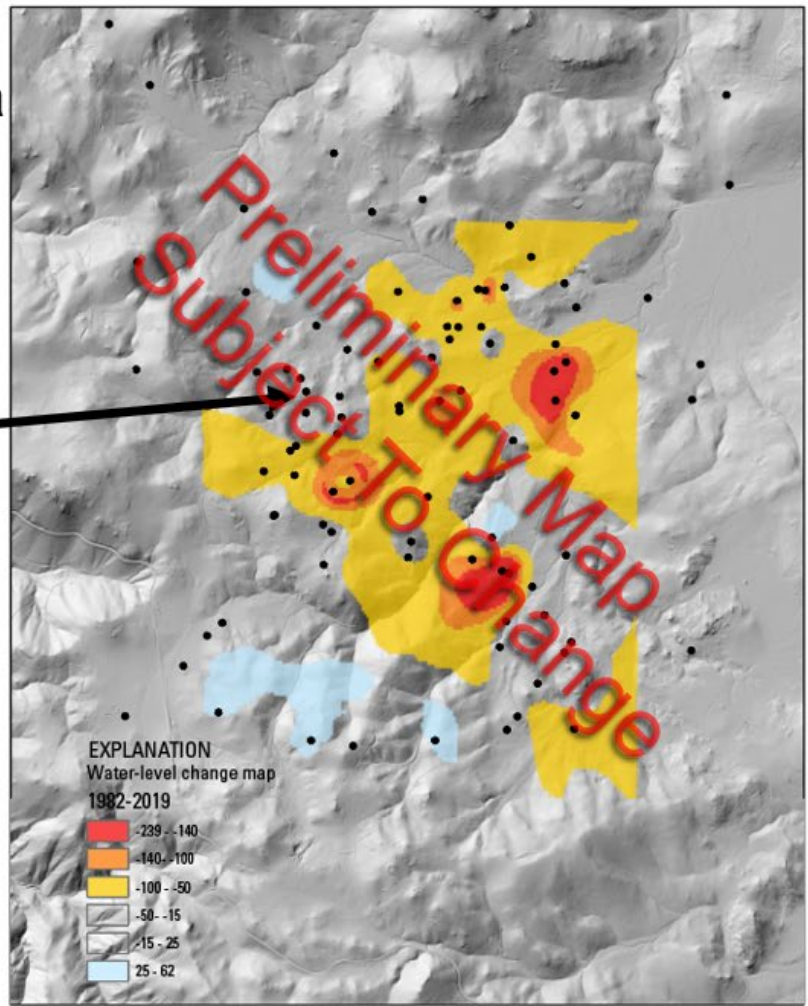
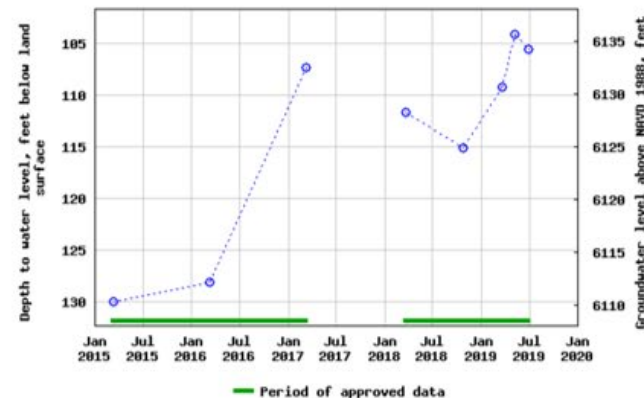
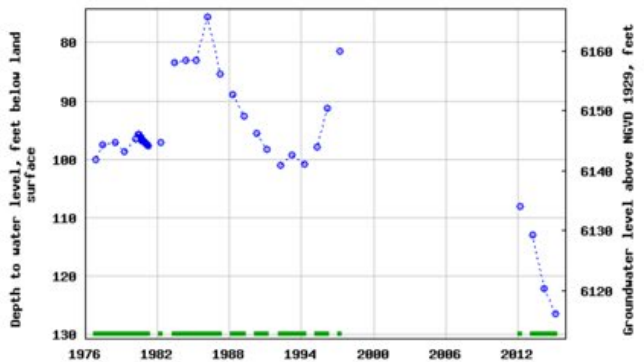
USGS 392212119394101 087 N17 E21 06ADCA1



# Comparison with USGS water-level data



USGS 392254119392001 083 N18 E21 32CBBD1

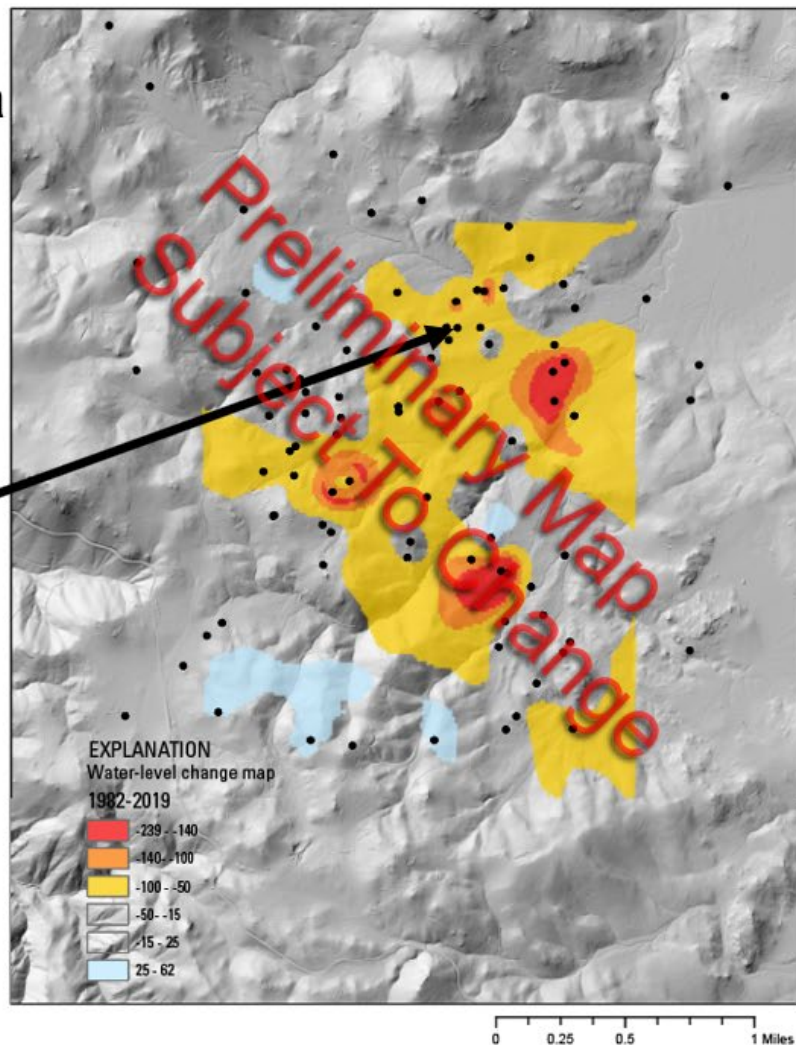
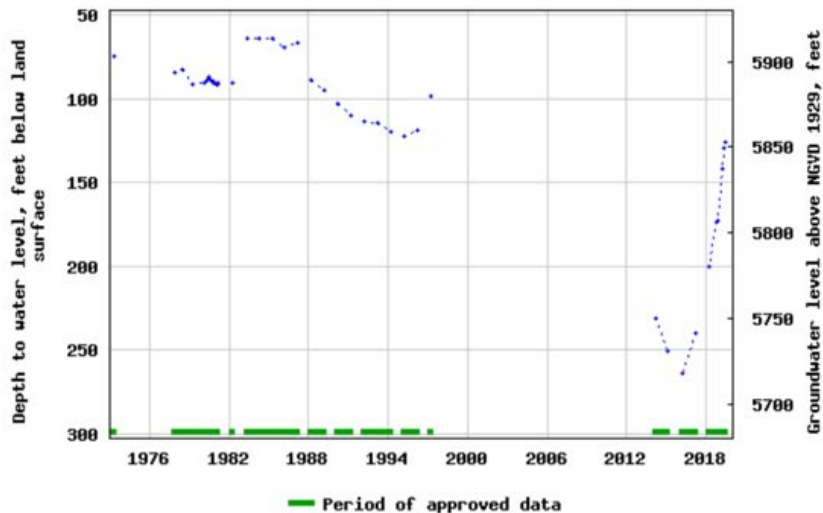


0 0.25 0.5 1 Miles

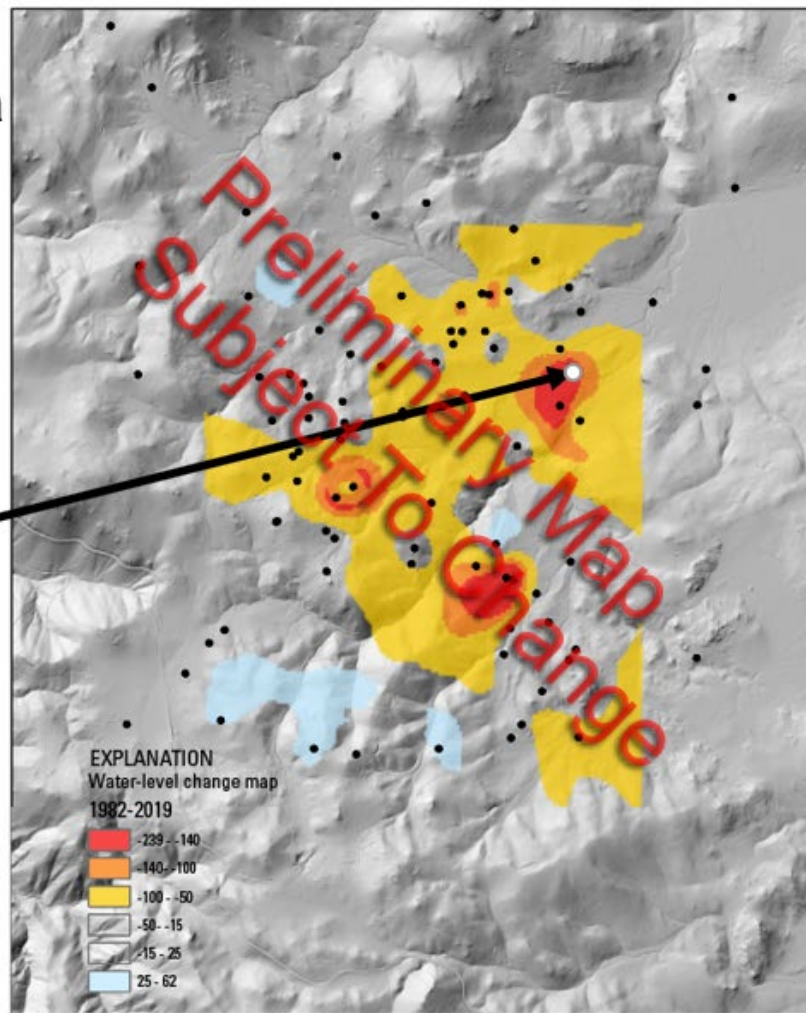
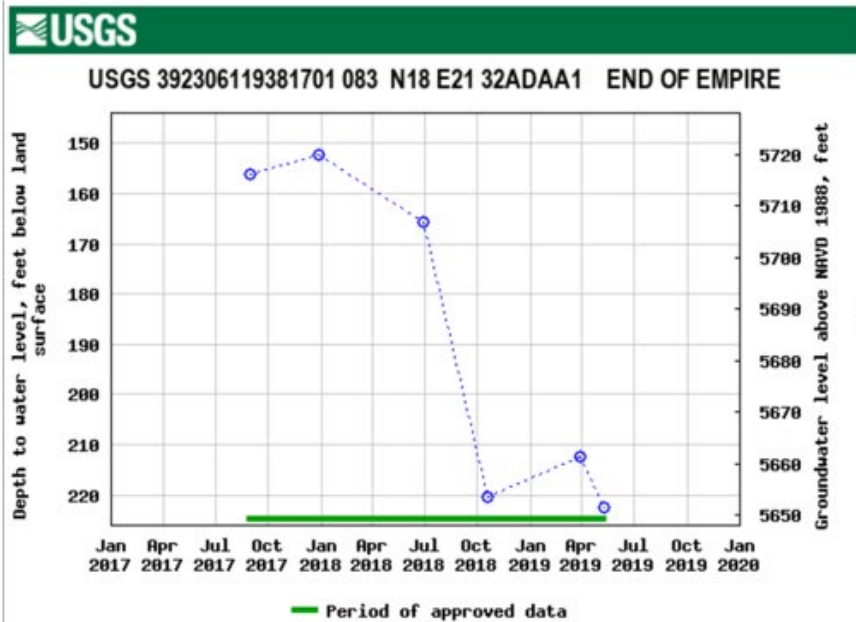
# Comparison with USGS water-level data



USGS 392313119384201 083 N18 E21 32ABCD1



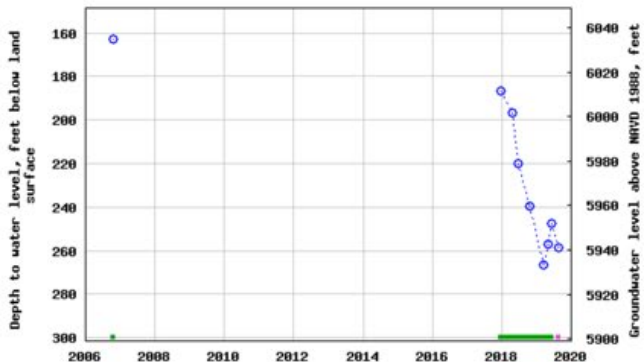
# Comparison with USGS water-level data



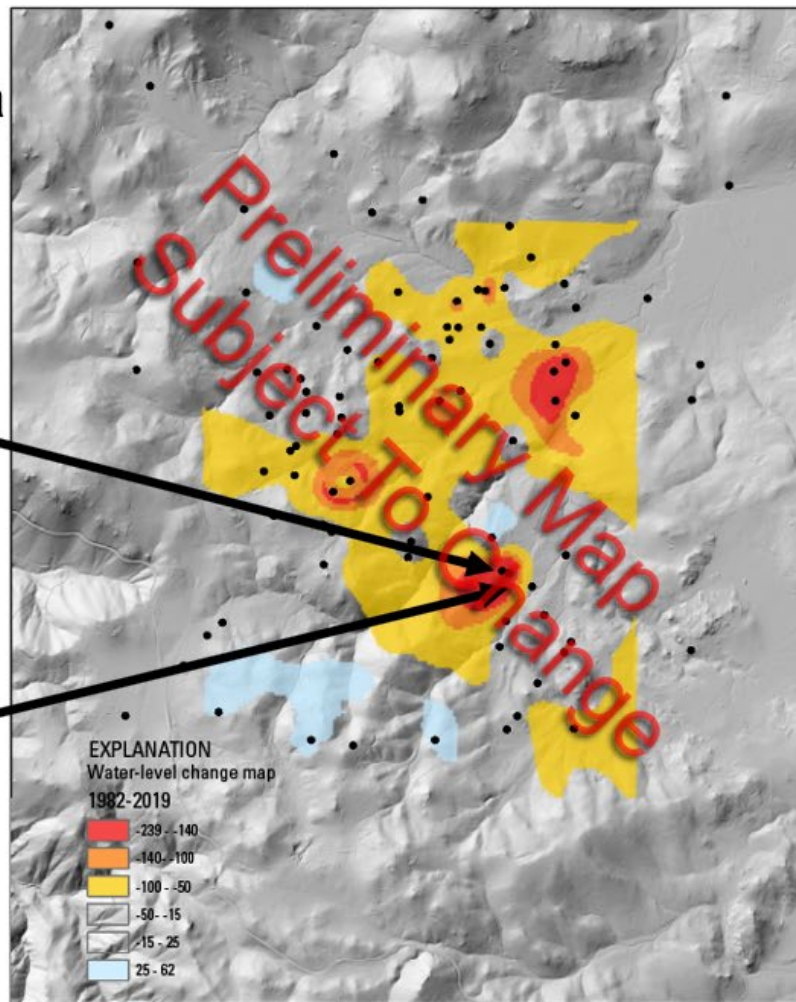
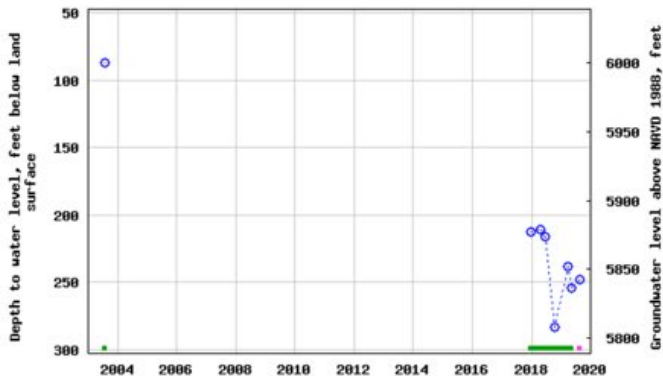
# Comparison with USGS water-level data



USGS 392226119384001 083 N17 E21 05ABAC1 HARTE HILL



USGS 392224119383201 083 N17 E21 05AACB1 END OF HARTE



# VC Highlands Parcels

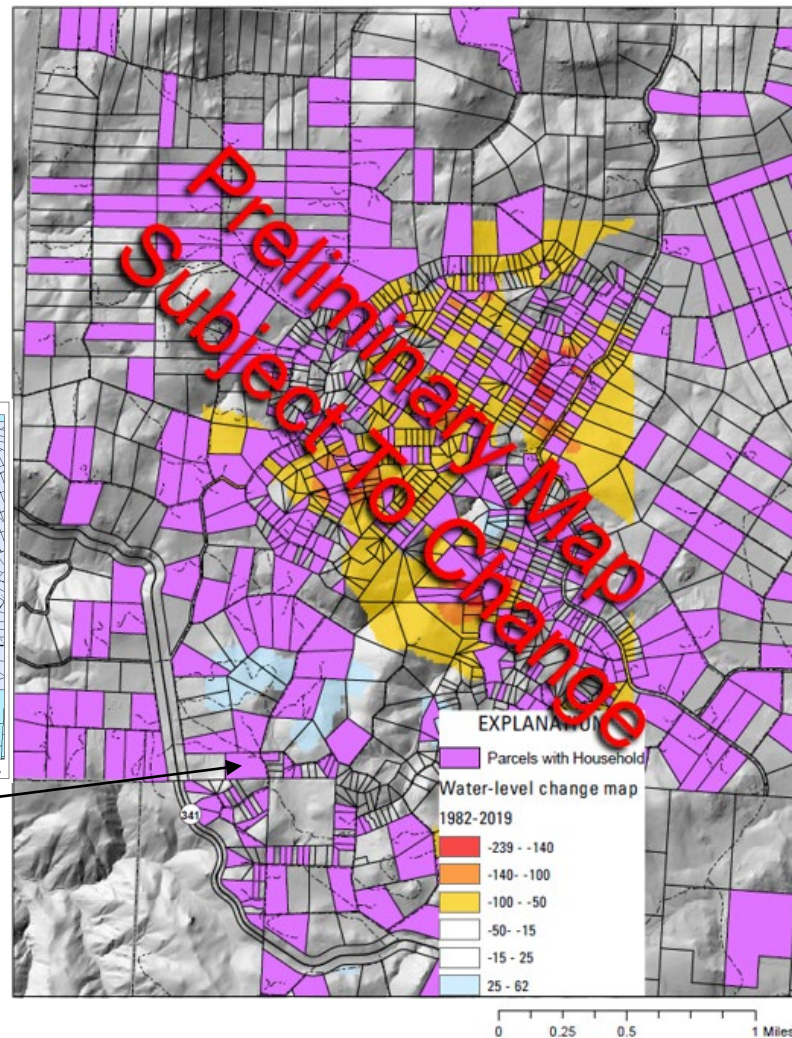
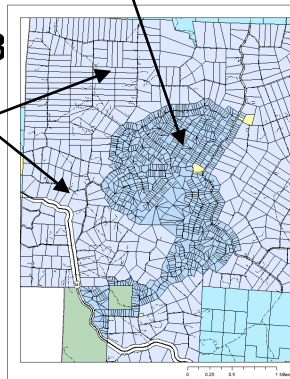
- **Virginia City Highlands** (*dark blue*)

- ~1 acre parcels
- Single Family Estates
- Current 330\* households out of ~913

- **Highland Ranches** (*light blue*)

- ~10 acre parcels
- Single Family Estates
- Current 170\* units out of ~505

- **Parcels that currently have homes**  
(Purple)



\*Values determined from 2018 data.

# 2020 USGS Project Tasks

- Refine and add data to improve water-level change map.
- Continue monitoring the groundwater network at a quarterly frequency.

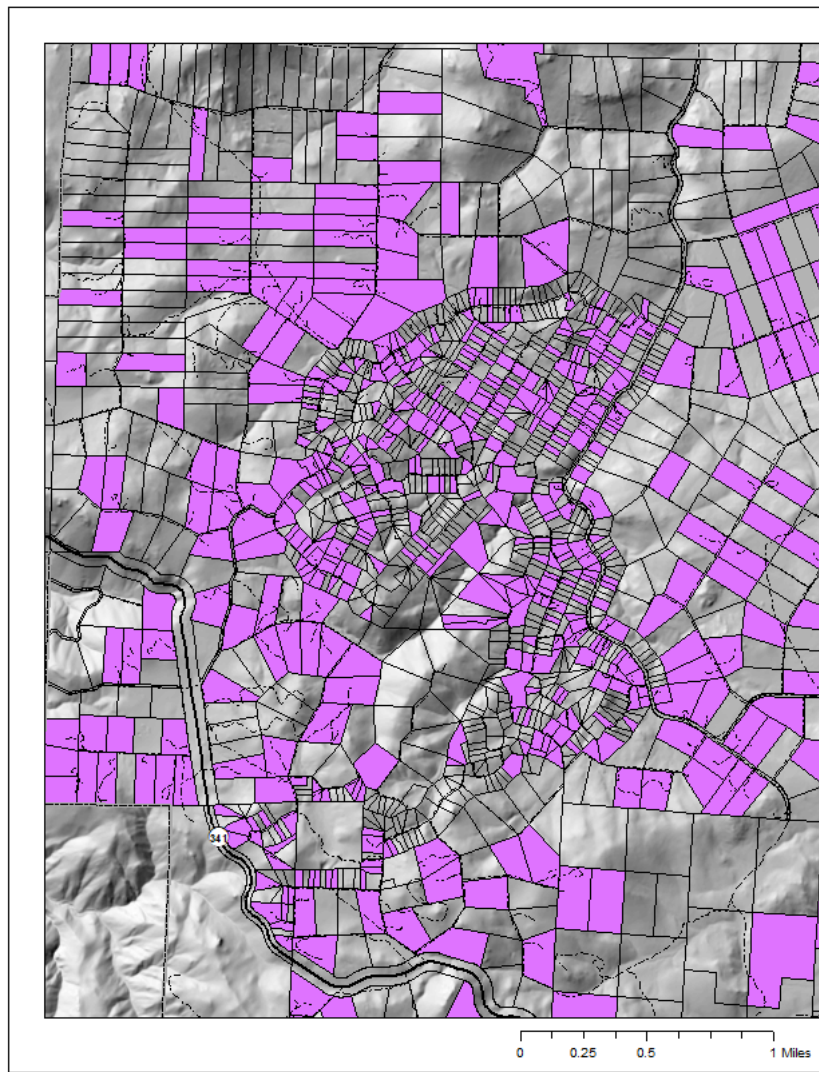
*Still accepting volunteers,  
especially in areas of limited data*

- Conduct aquifer tests to better understand hydraulic properties of the fractured volcanic-rock aquifer system.



Questions?

David W. Smith ([dwsmith@usgs.gov](mailto:dwsmith@usgs.gov))



# References

**Koltermann, Howard H.**, 1984, Hydrogeochemical and environmental isotope investigation of groundwater recharge mechanisms in the Virginia City Highlands, Nevada, University of Nevada-Reno, Masters Thesis, Geological Sciences and Engineering.

**Winter, Tom C., Harvey, J.W., Franke, O.L., Alley, W.M.**, 1998, Groundwater and Surface Water – A Single Resource: [U.S. Geological Survey Circular 1139](#), 79 p.