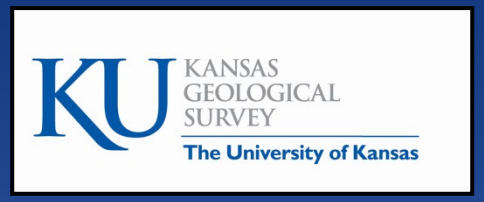
Introduction to Q-Stable

OAP- 2025 Research Planning Workshop
February 27, 2025



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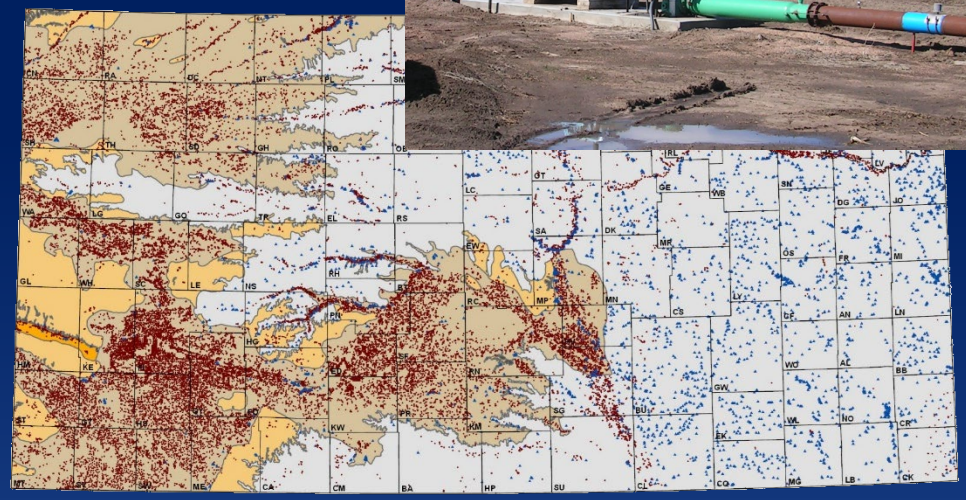
KGS Water Balance / Q-Stable Analysis

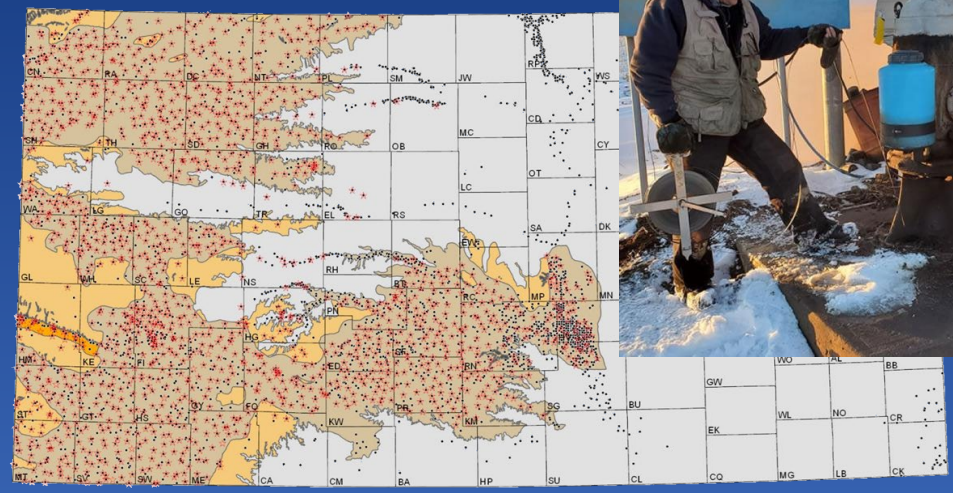
- A simple approach to assess the relationship between groundwater usage and water-level change

- Well suited for Ogallala/High Plains aquifer
  - Seasonally pumped
  - Water is at depth
  - Semi-arid region
- Data driven with no conceptualizations
  - Water use
  - Water levels

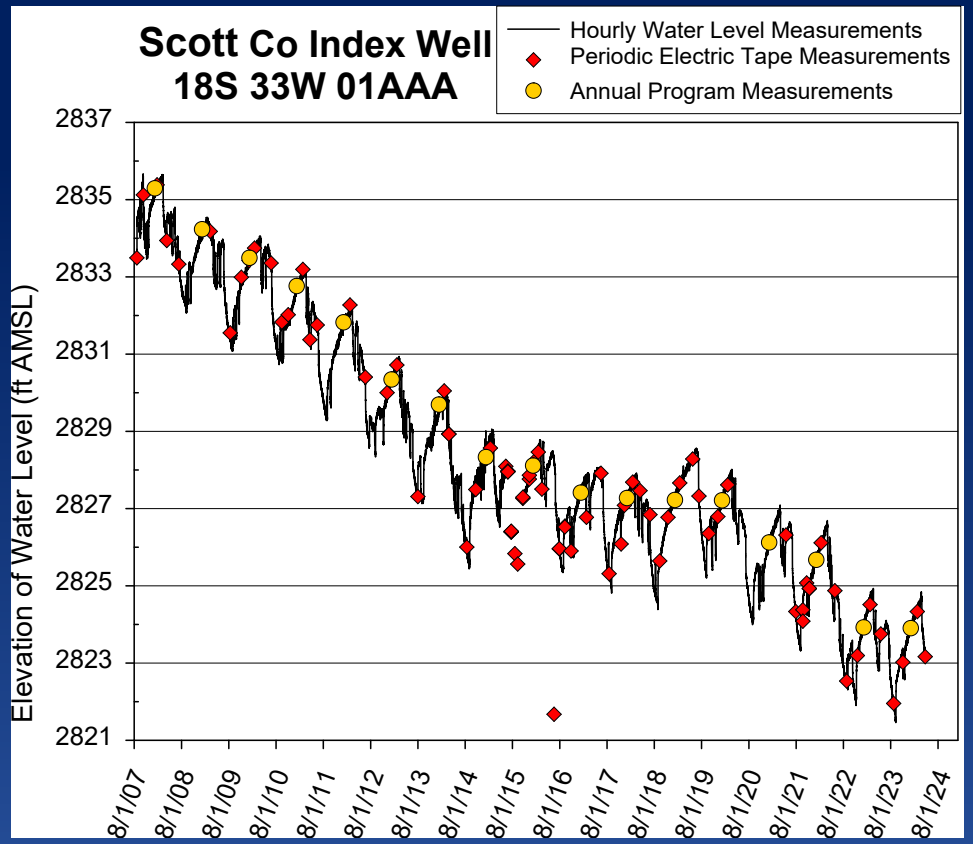


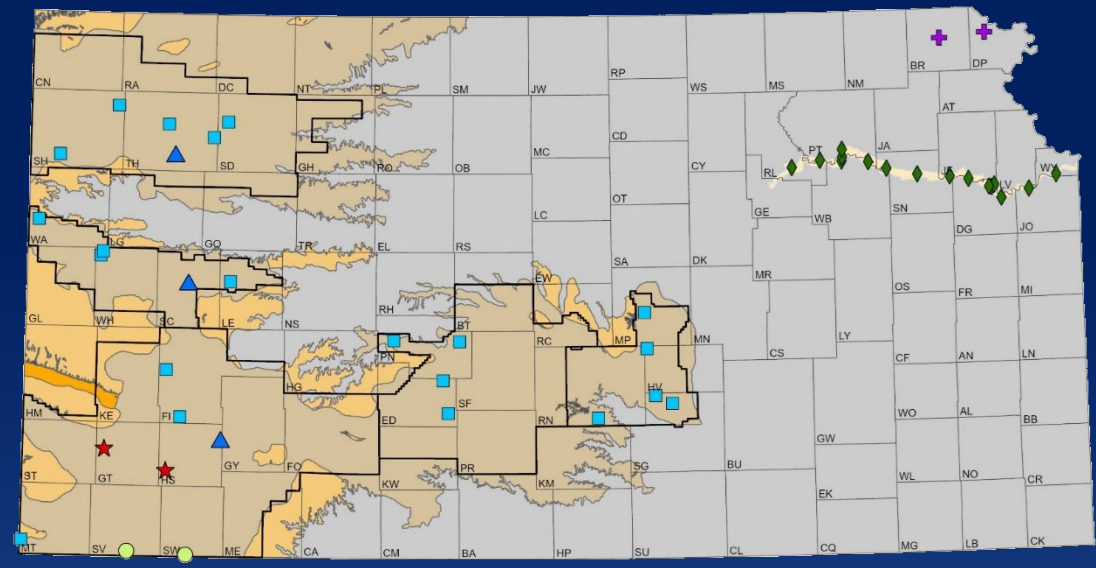
- Butler, J. J., Jr., Whittemore, D. O., Wilson, B. B., & Bohling, G. C. (2016). A new approach for assessing the future of aquifers supporting irrigated agriculture. Geophys Researcher Letters, 43 (5), p. 2004–2010.

- Butler, J. J., Jr., Whittemore, D. O., Wilson, B. B., and Bohling, G. C., 2018, Sustainability of aquifers supporting irrigated agriculture: A case study of the High Plains aquifer in Kansas: Water International, v. 43, no. 6, p. 815–828.



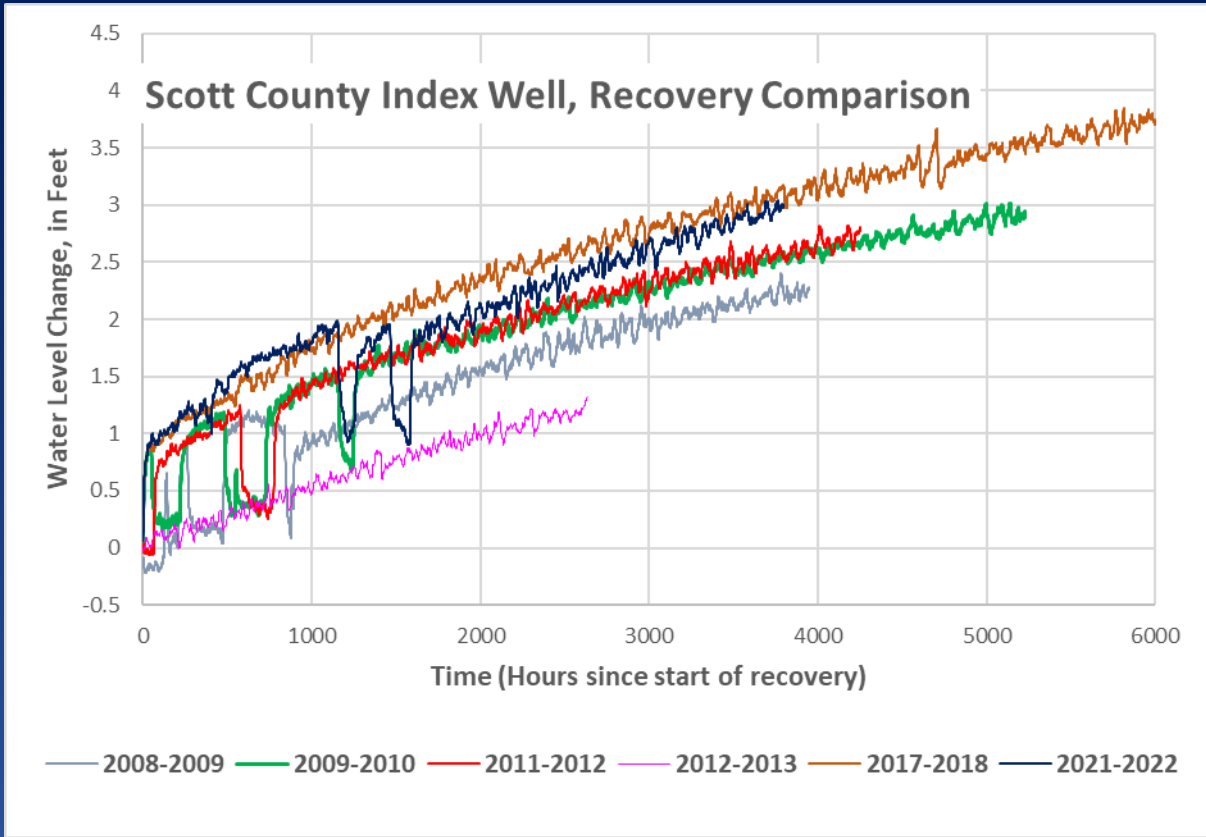
Kansas Index Well- Recovery Curves



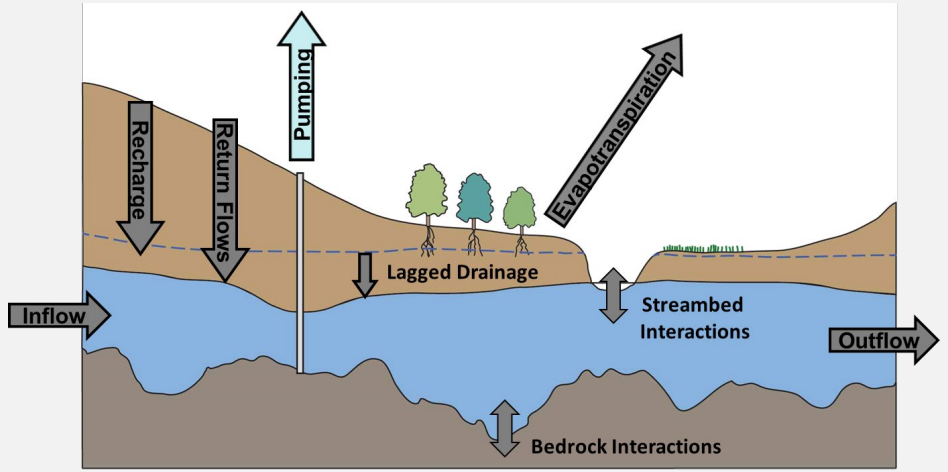


Over the last decade, end-of-season recovery is similar regardless of past pumping or climatic conditions

Index Wells Recovery Curves, Scott County

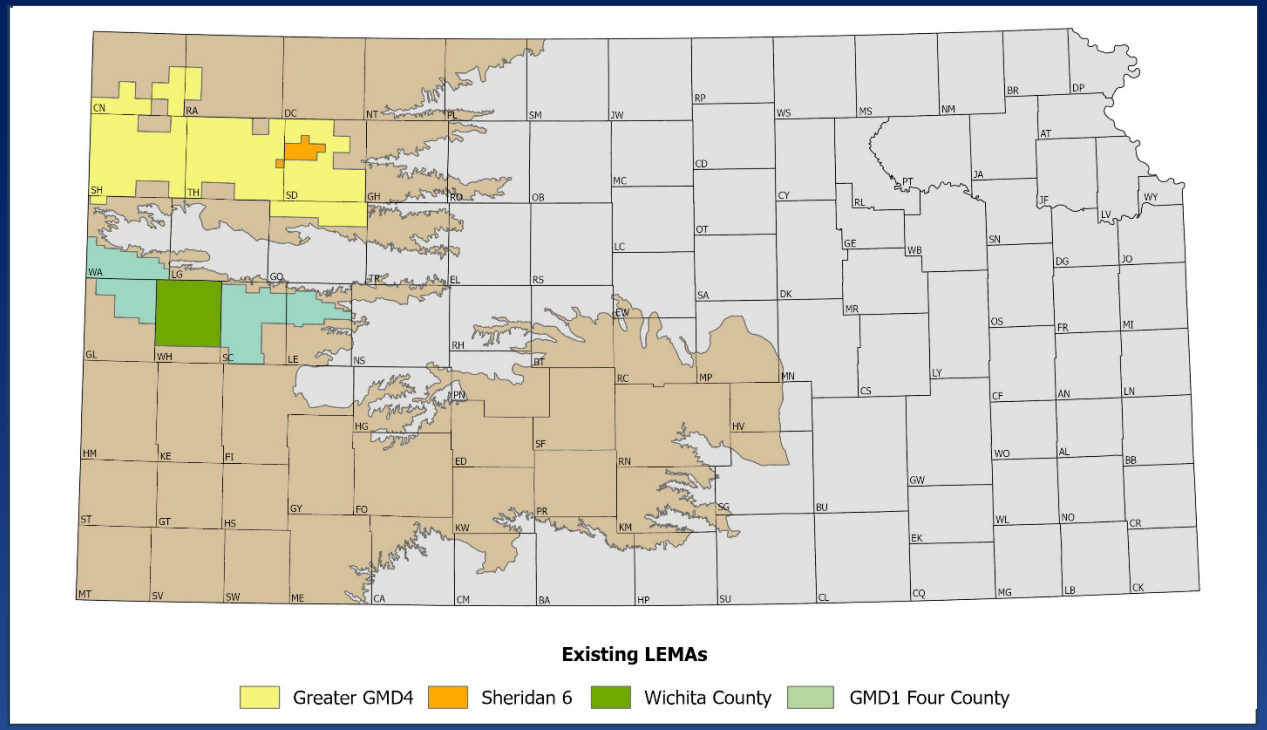


- Water level change starting at the end-of-season pumping (September to April~June)
- Recovery is similar each year
- "Net Inflow"
  Everything flowing in and out of the aquifer except pumping

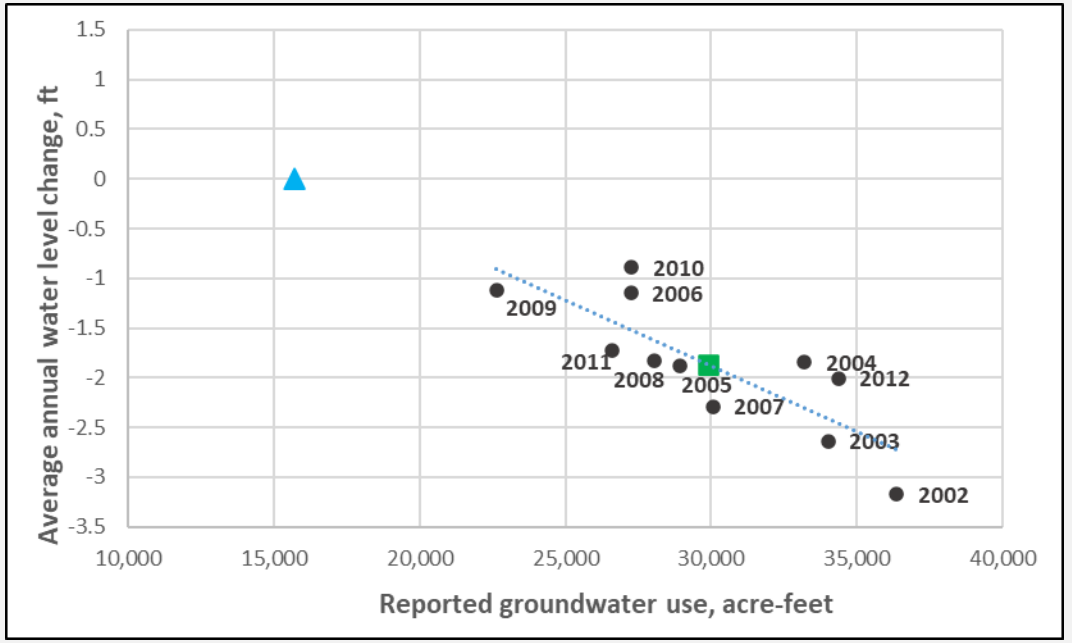


Water Use vs Water-Level Change, pre-Sheridan 6 LEMA

Reported water use and measured water levels, 2002 to 2012

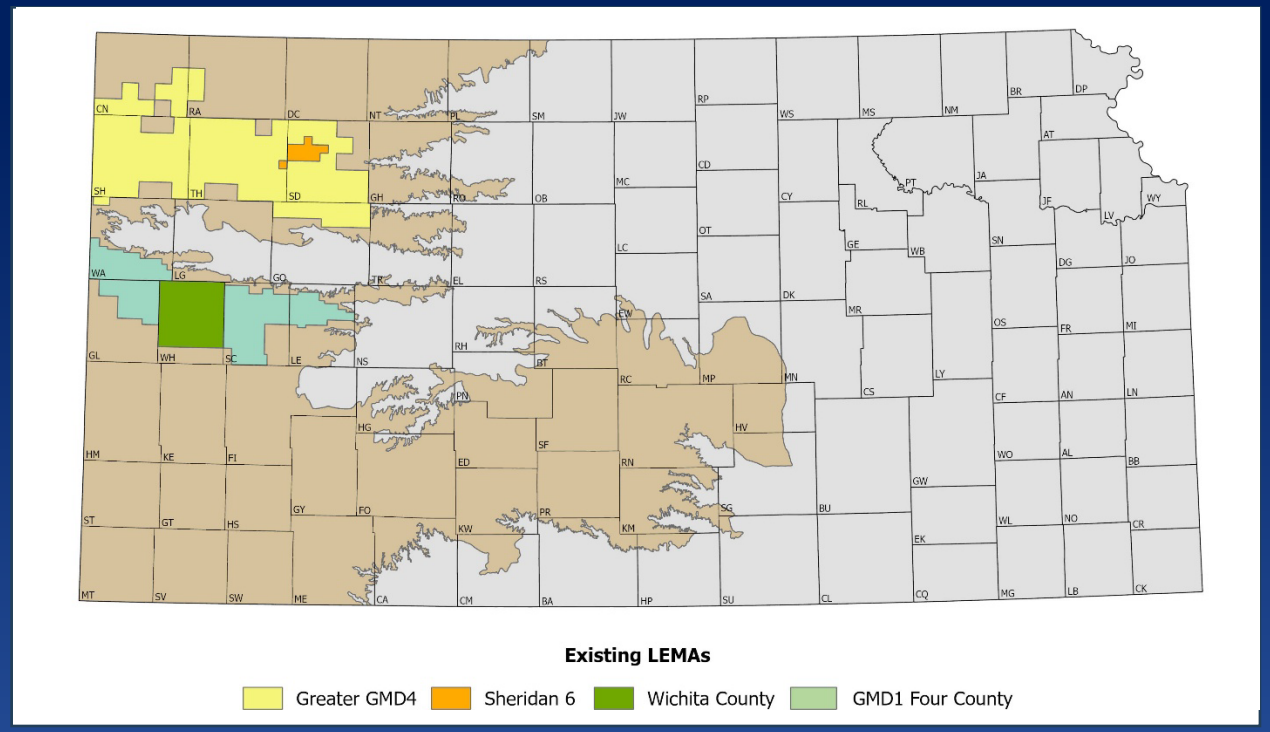


- R-squared = 0.66, P < 0.0025
- Average water level change = -1.87 ft
- Average total reported use = 29,880 AF
- Net Inflows = 15,727 AF (2.99 inches)
- Percent reduction for stable water levels:
  - Average conditions = 47%

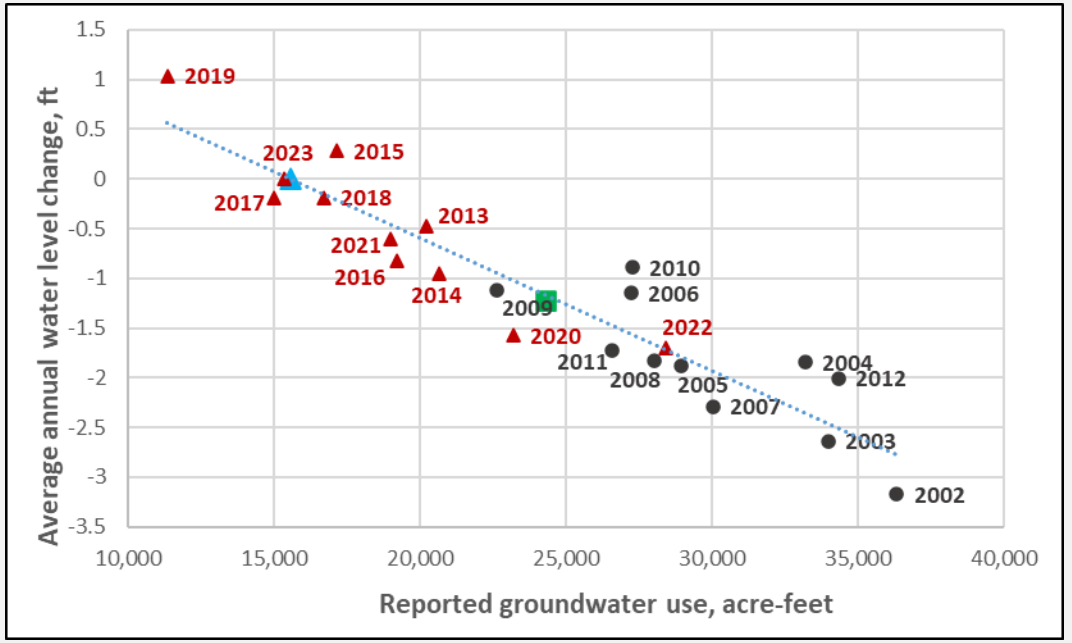


Water Use vs Water-Level Change, post-Sheridan 6 LEMA

Reported water use and measured water levels, 2002 to 2023



- R-squared = 0.88, P < 0.00000000015
- Average water level change = -0.47 ft
- Average total reported use = 18,749 AF
- Net Inflows = 15,585 AF (2.97 inches)
- Percent reduction for stable water levels:
  - Average conditions = 15%



- **Reduction in water use: 37%**
- **Reduction in rate of decline: 75%**

Conclusions and Observations

- Q Stable is scalable, depending on data.
- Modest reductions in pumping, 10 to 15%, will reduce decline rates.
- Benefits to water conservation efforts stay local.
- Conditions will likely hold for the next decade or two but will need to be revisited