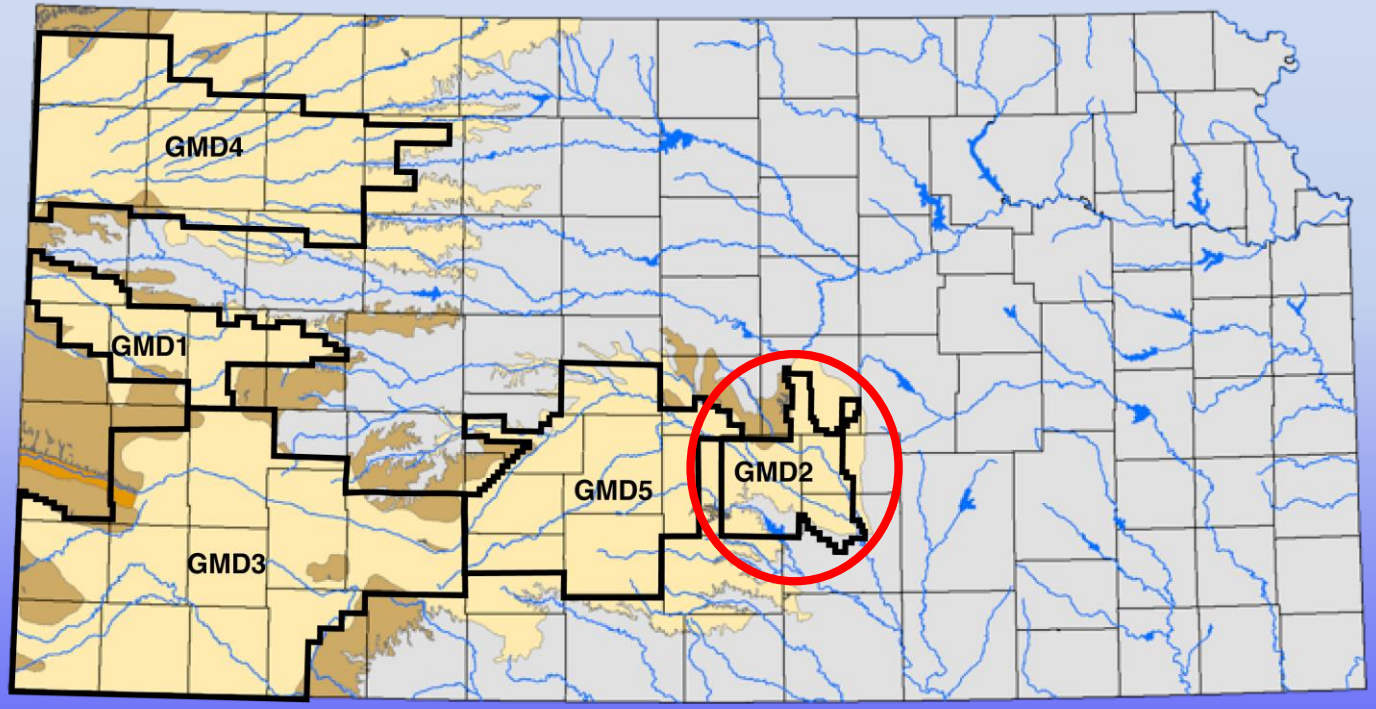
Sustainability Assessment for Equus Beds Groundwater Management District No. 2

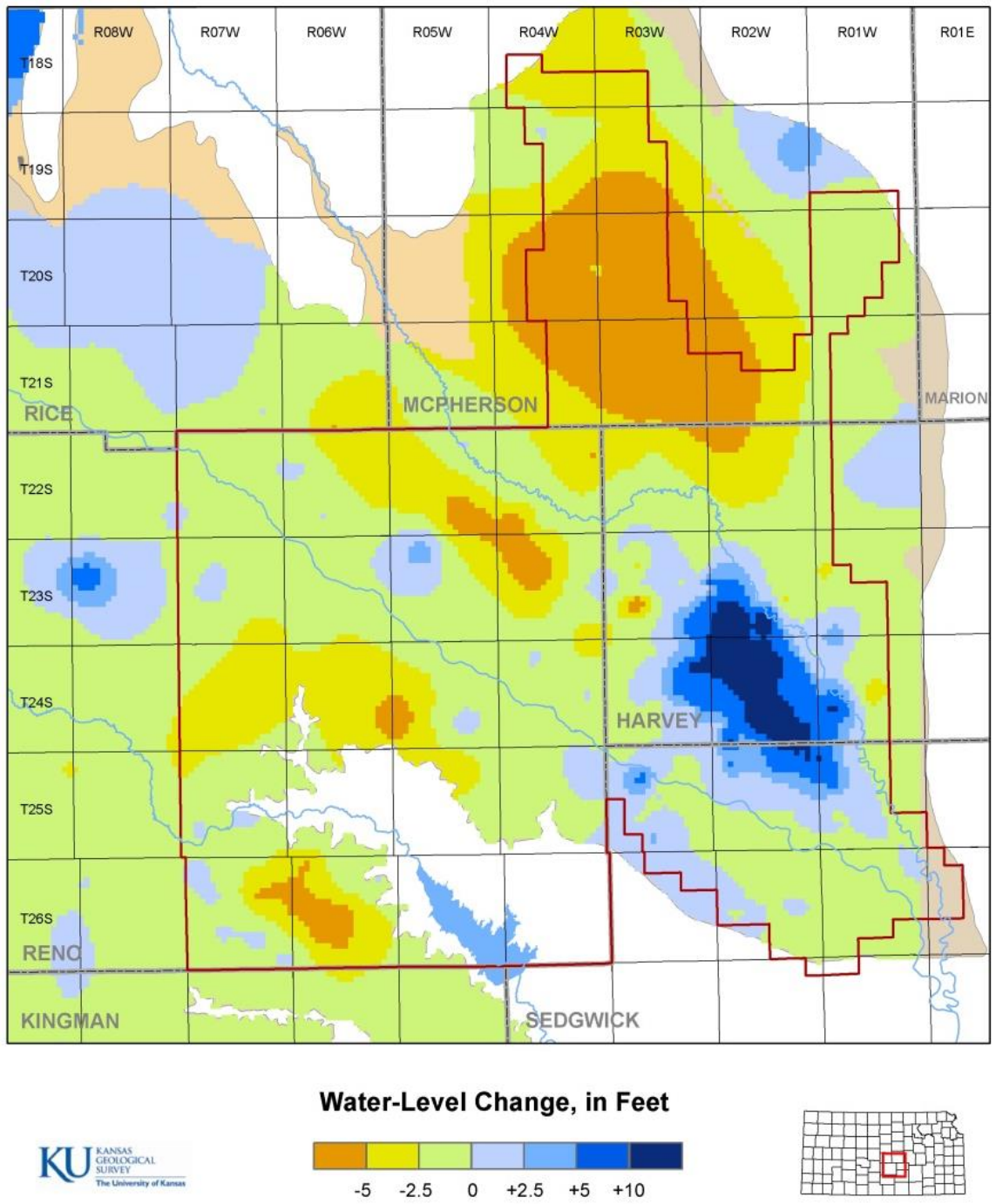
Don Whittemore, Jim Butler, and Brownie Wilson – KGS
Steve Flaherty and Tim Boese – GMD2



KANSAS GEOLOGICAL SURVEY
The University of Kansas

Governor's Conference
2017
Future of Water in Kansas

GMD2

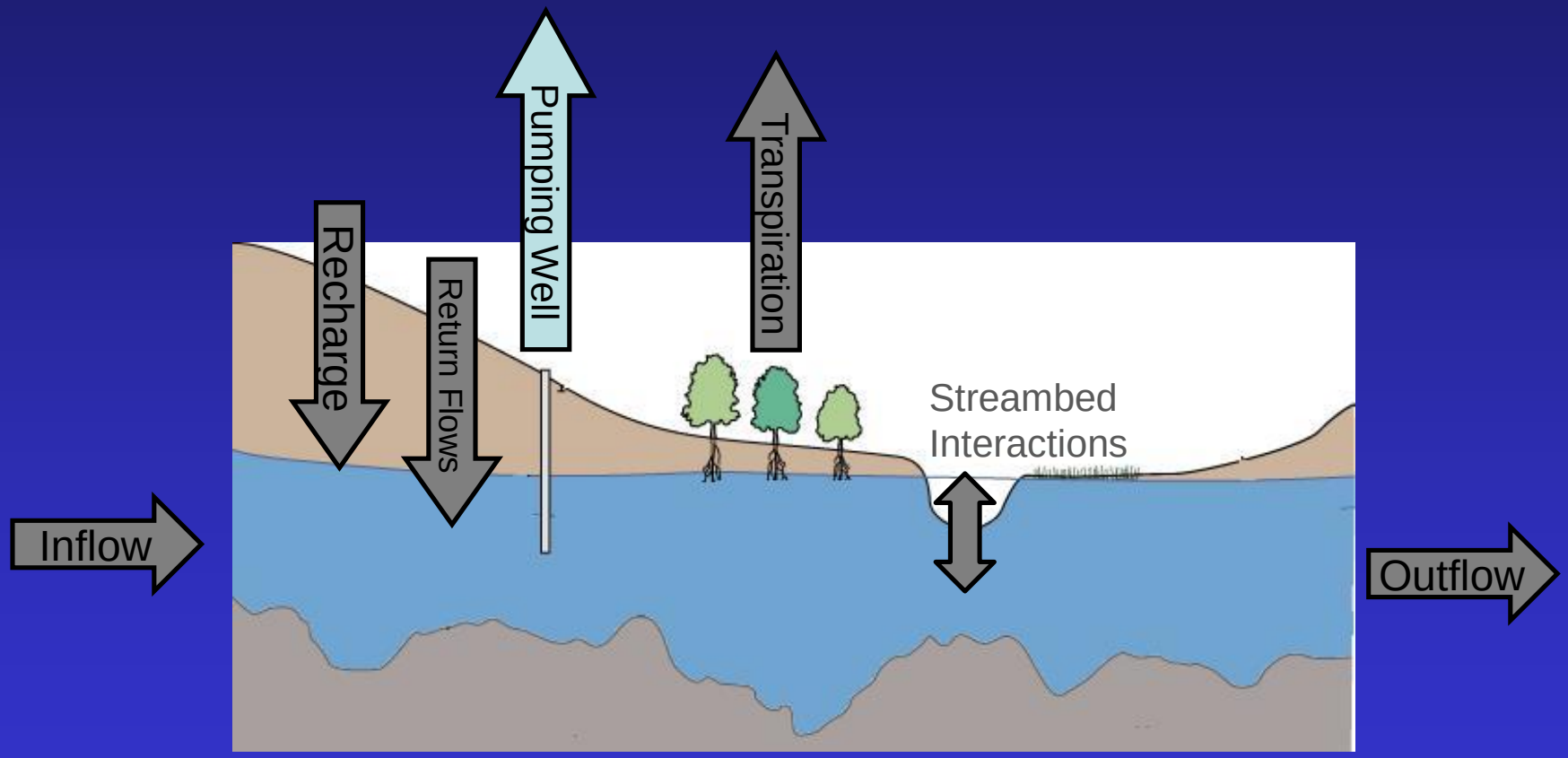


Water-level change in High Plains aquifer in GMD2 Area, average 1995-1997 to average 2014-2016

GMD2 Sustainability Assessment

Purpose: Apply new KGS data-driven water-balance approach to estimate Q_{stable}, the annual pumping that would produce stable water levels in an area.

Water Volume Change in Aquifer = Net Inflow – Pumping



GMD2 Sustainability Assessment

Purpose: Apply new KGS data-driven water-balance approach to estimate Q_{stable}, the annual pumping that would produce stable water levels in an area.

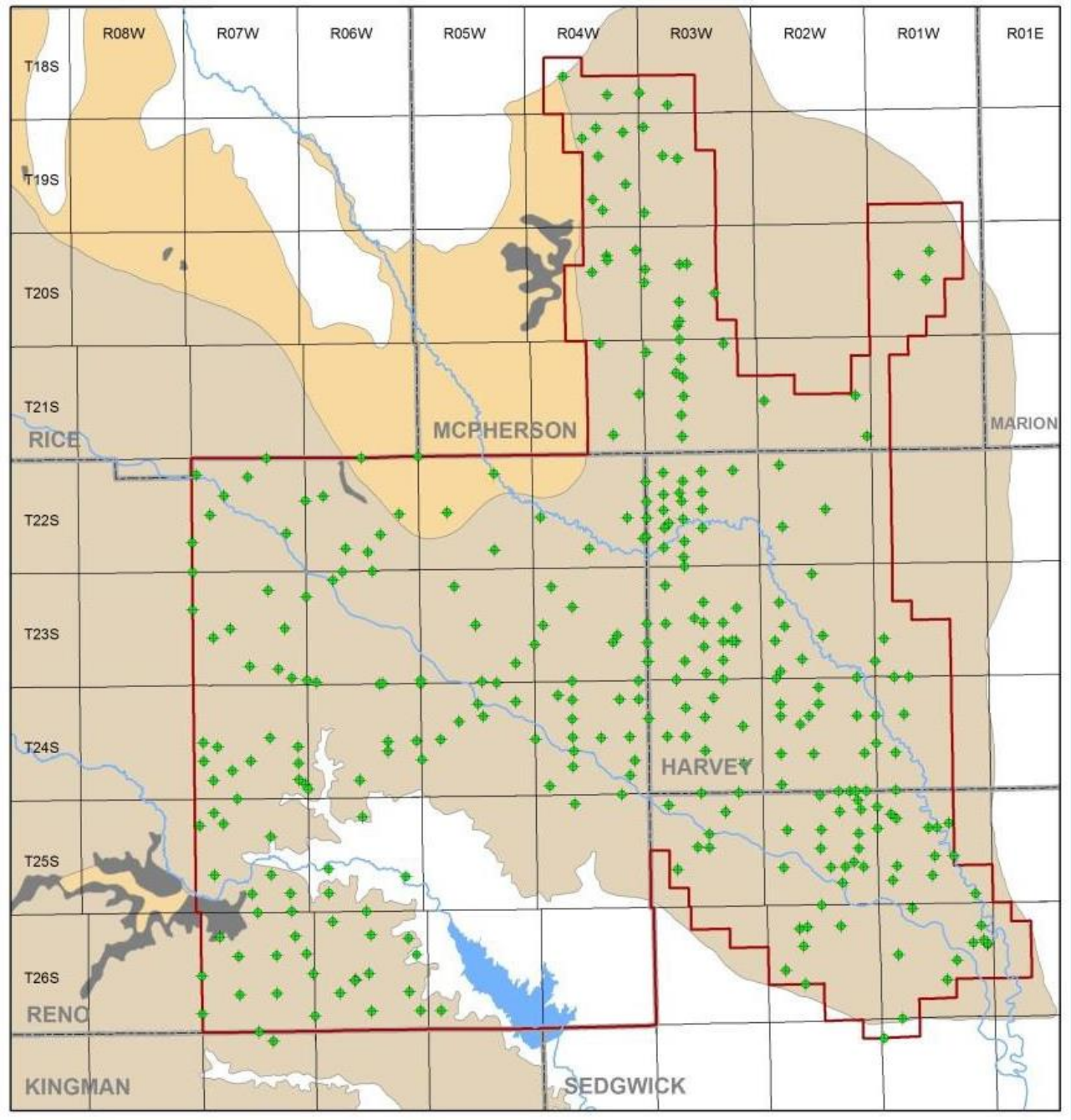
Q_{stable} is calculated using the <u>average annual water-level change</u> and the <u>annual water use</u> for an area.

Plot of ΔWL versus Q

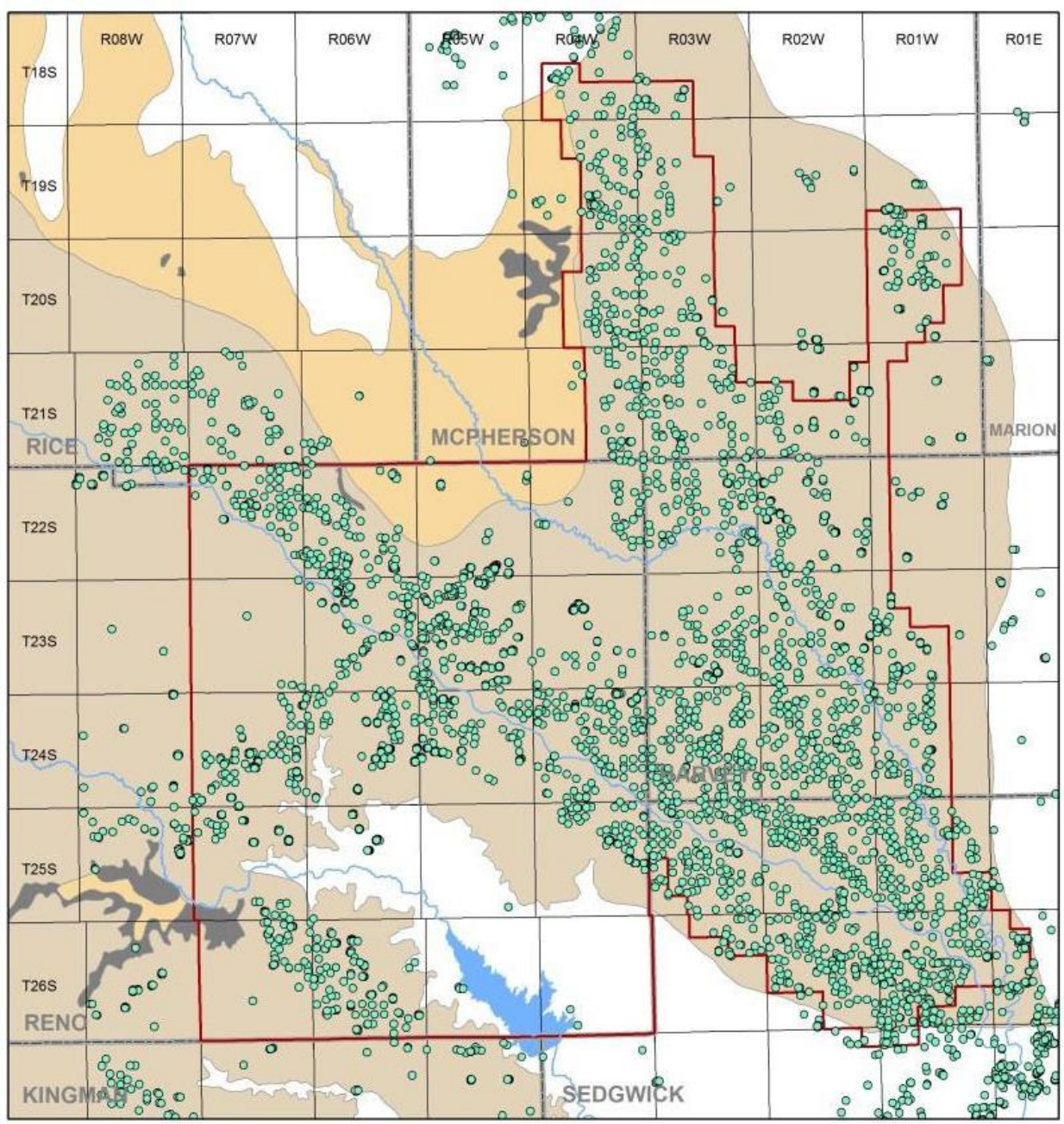
Equation for a line: $\Delta WL \approx b - aQ$

$$Q_{stable} = \frac{b}{a}$$

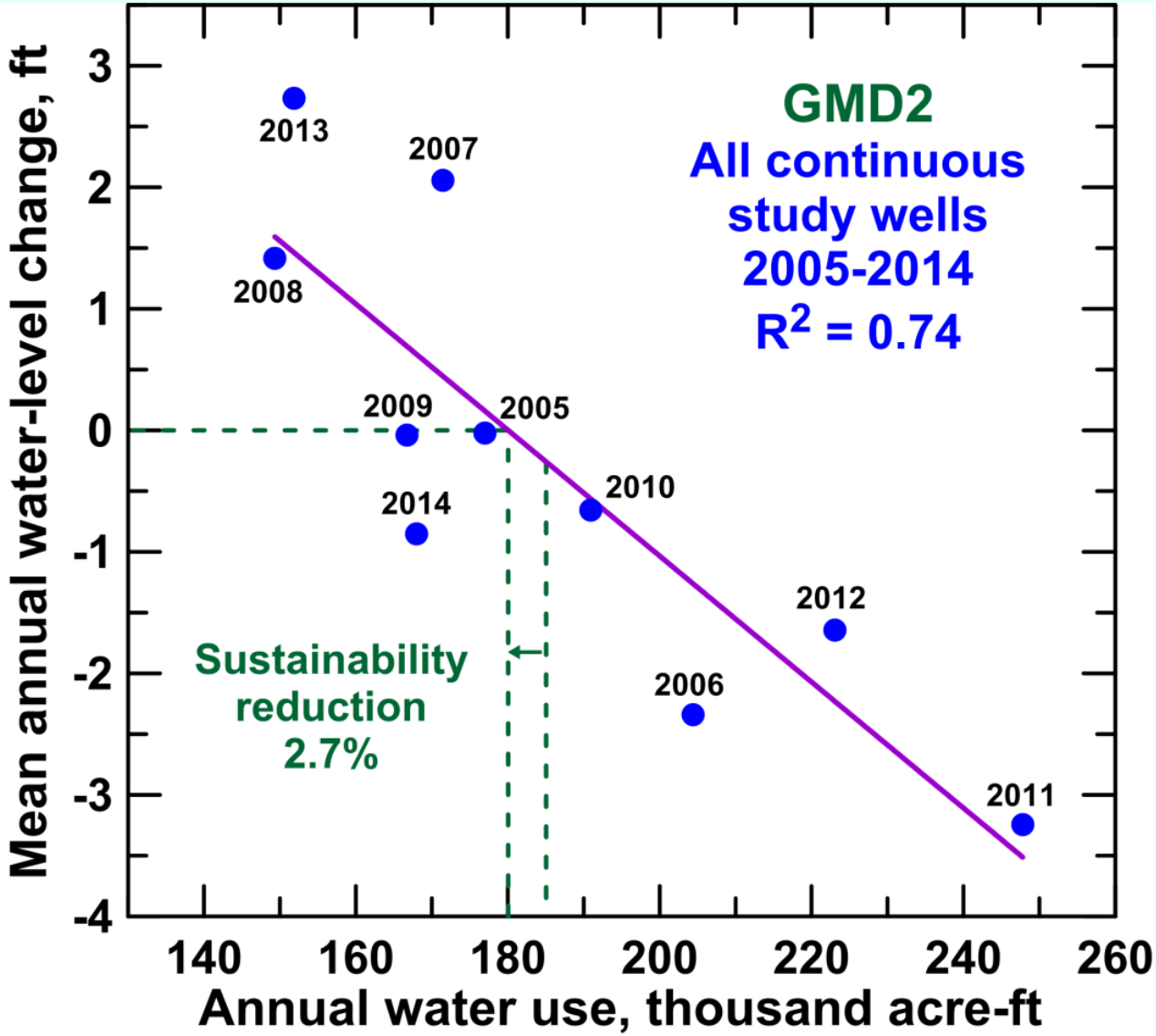
Compute Q_{stable} for <u>entire district</u>, <u>counties</u> within district, <u>townships</u> within district, and <u>areas defined by GMD2</u>.



Wells annually monitored for water level during 2005-2014 for GMD2 area

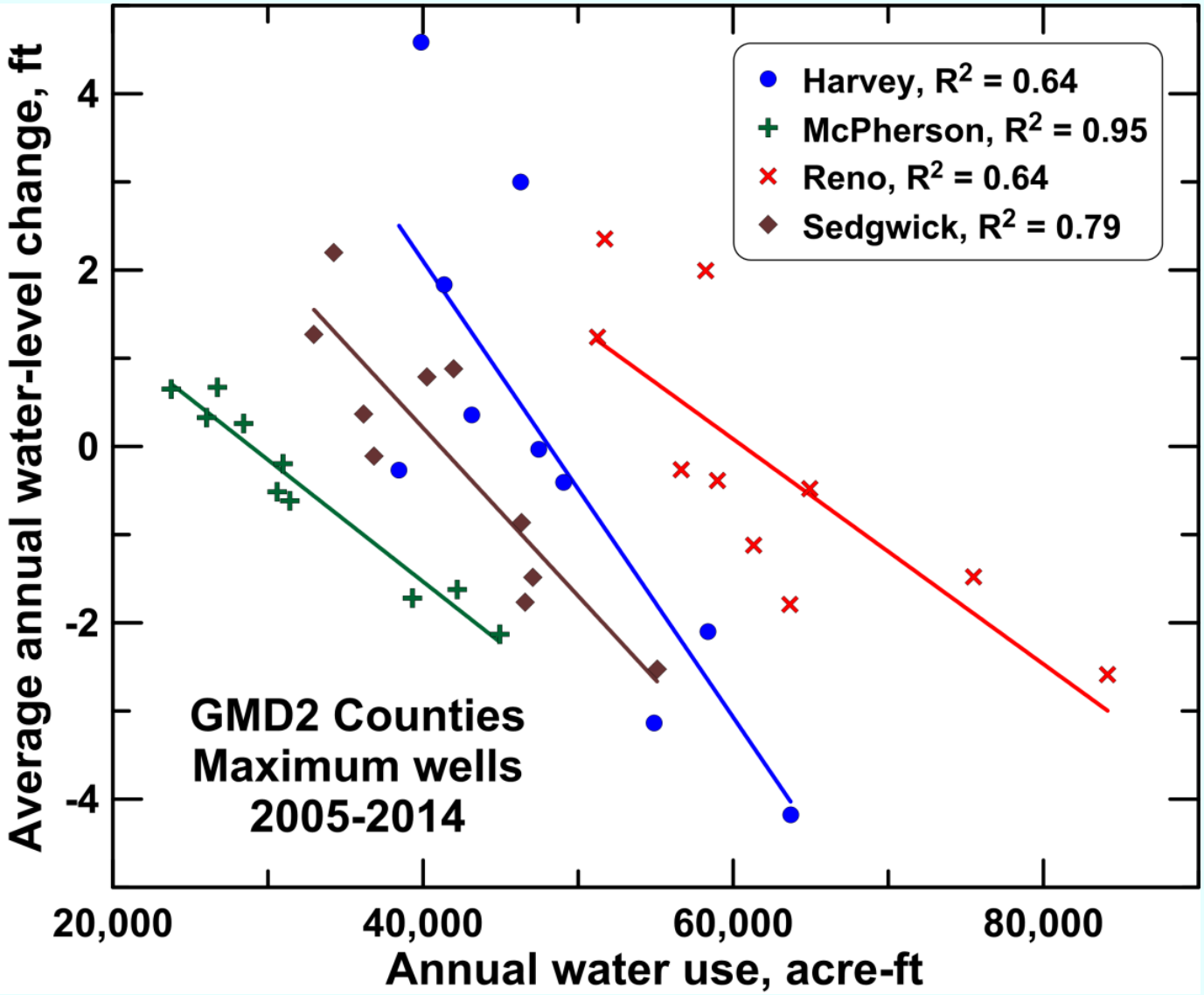


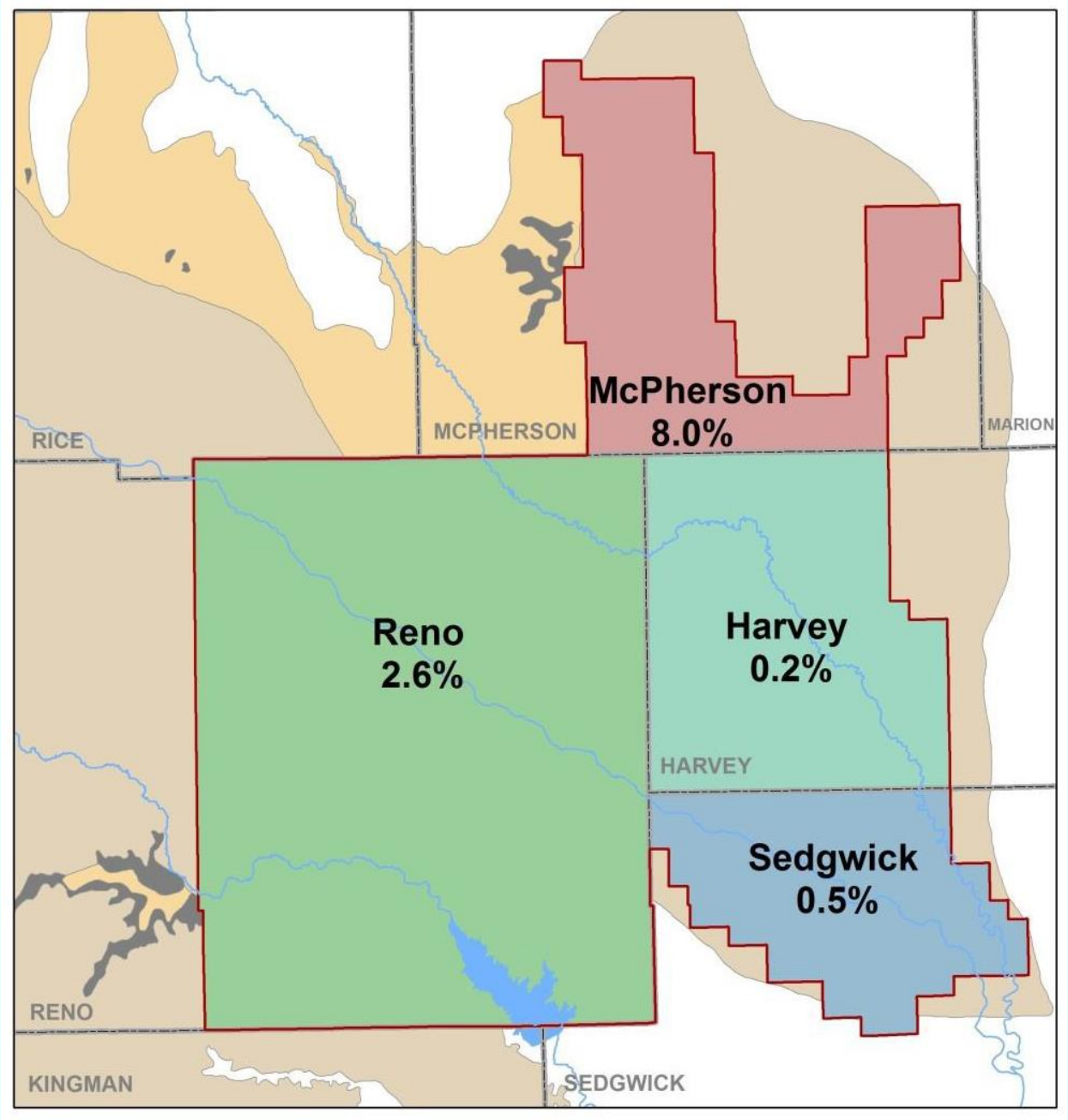
Points of diversion with water use reporting, groundwater right 1996-2014 for GMD2 region



Average water use minus Q_{stable} relative to the average use is the sustainability reduction percent.

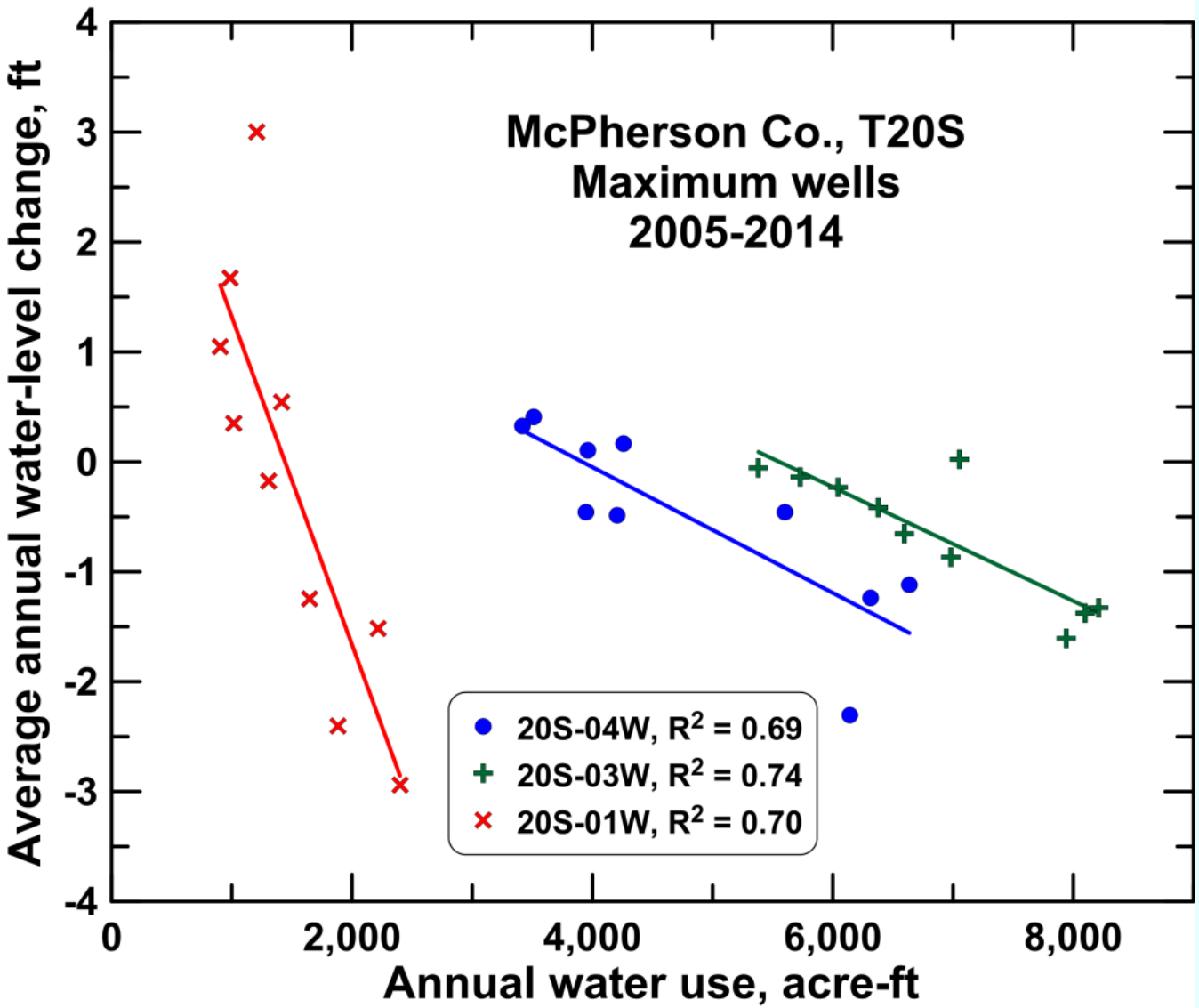
Water-level Change vs Water Use for Each County Area within GMD2





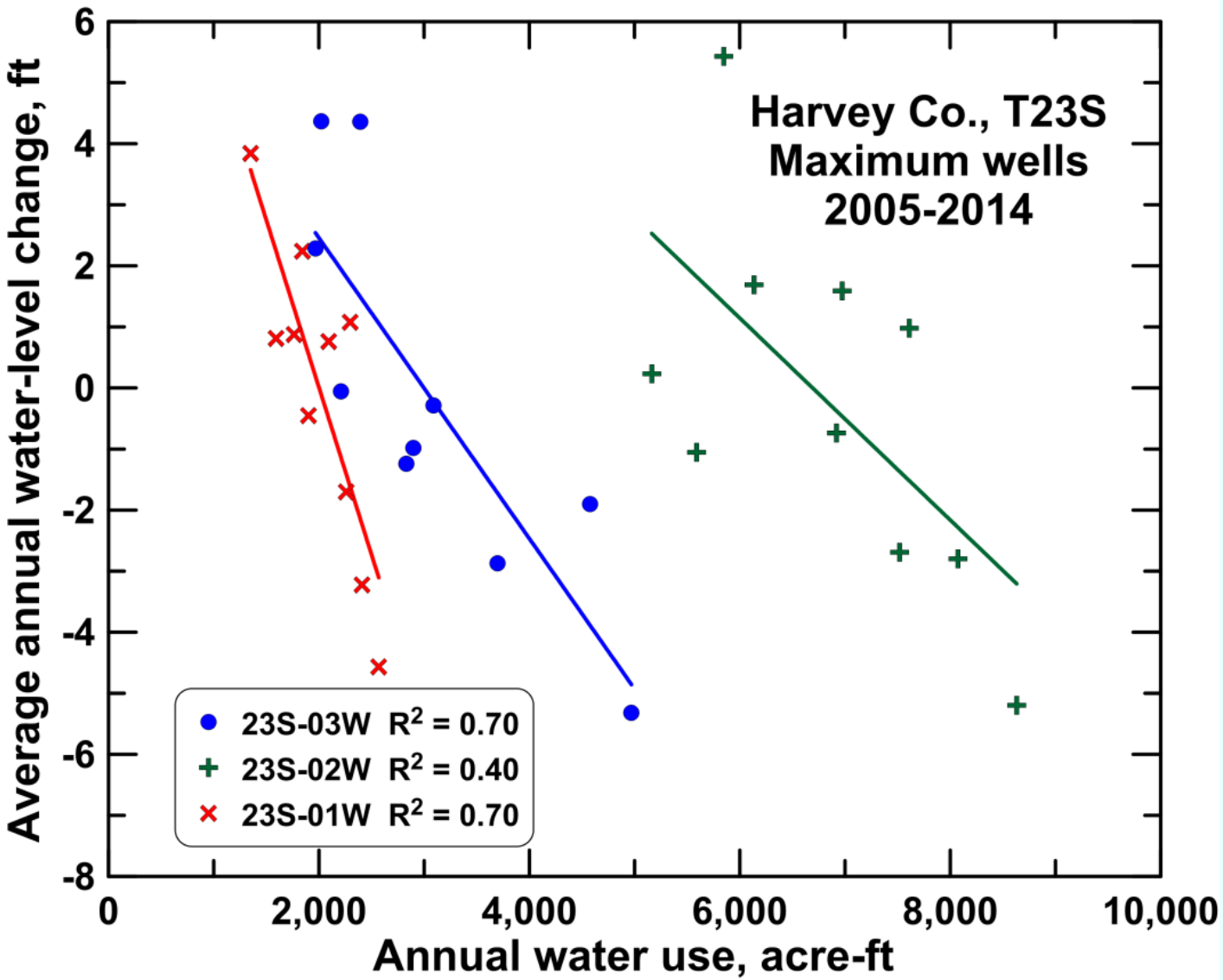
Average sustainability percentage (pumping reduction for Q_{stable}) for counties based on 1996-2014 and 2005-2014 data.

Township example: McPherson Co.
Sustainability percentages: 3.1, 18, 19

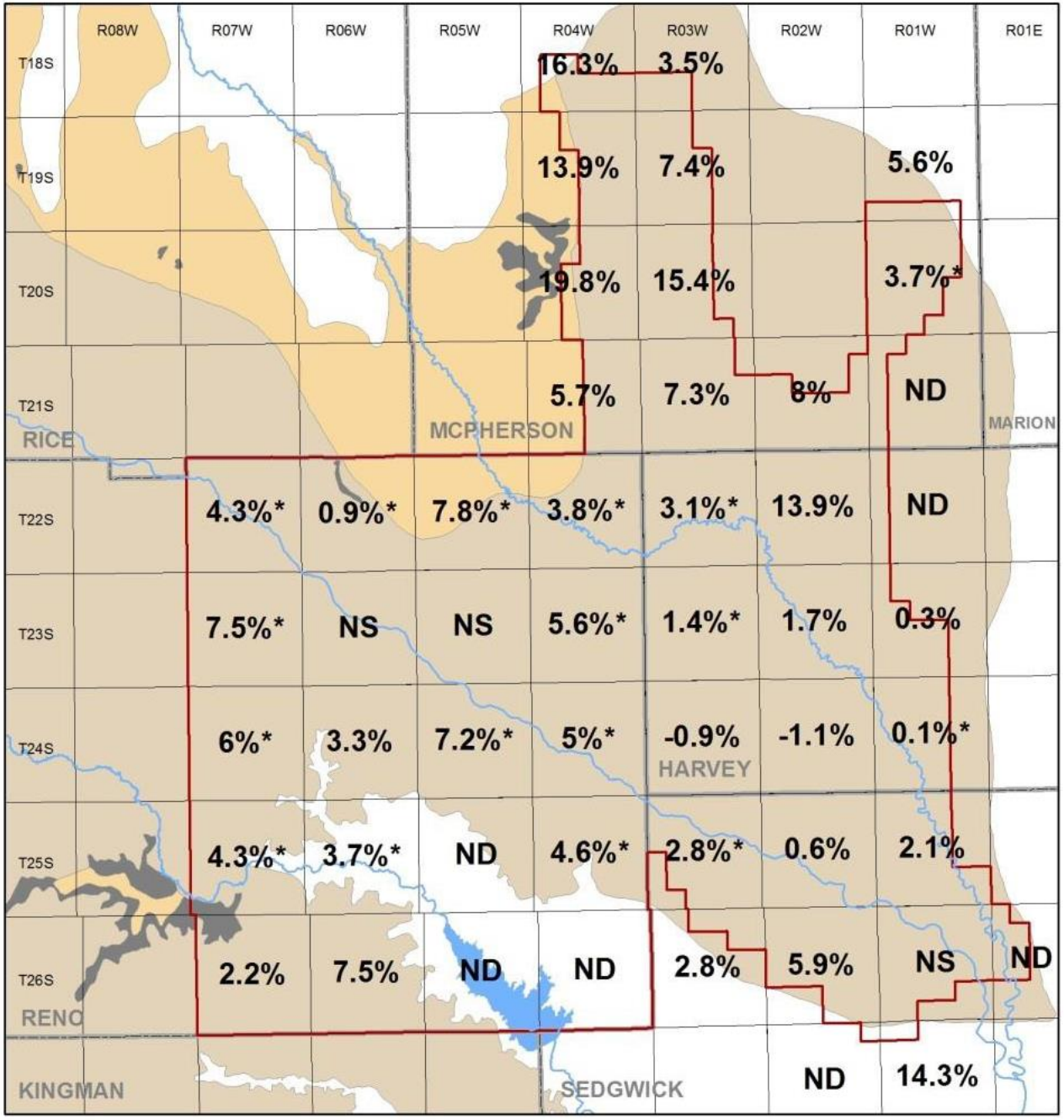


Sustainability percentages listed in order of regression lines from left to right.

Township example: Harvey Co.
Sustainability percentages: 0.3, 2.2, 2.3



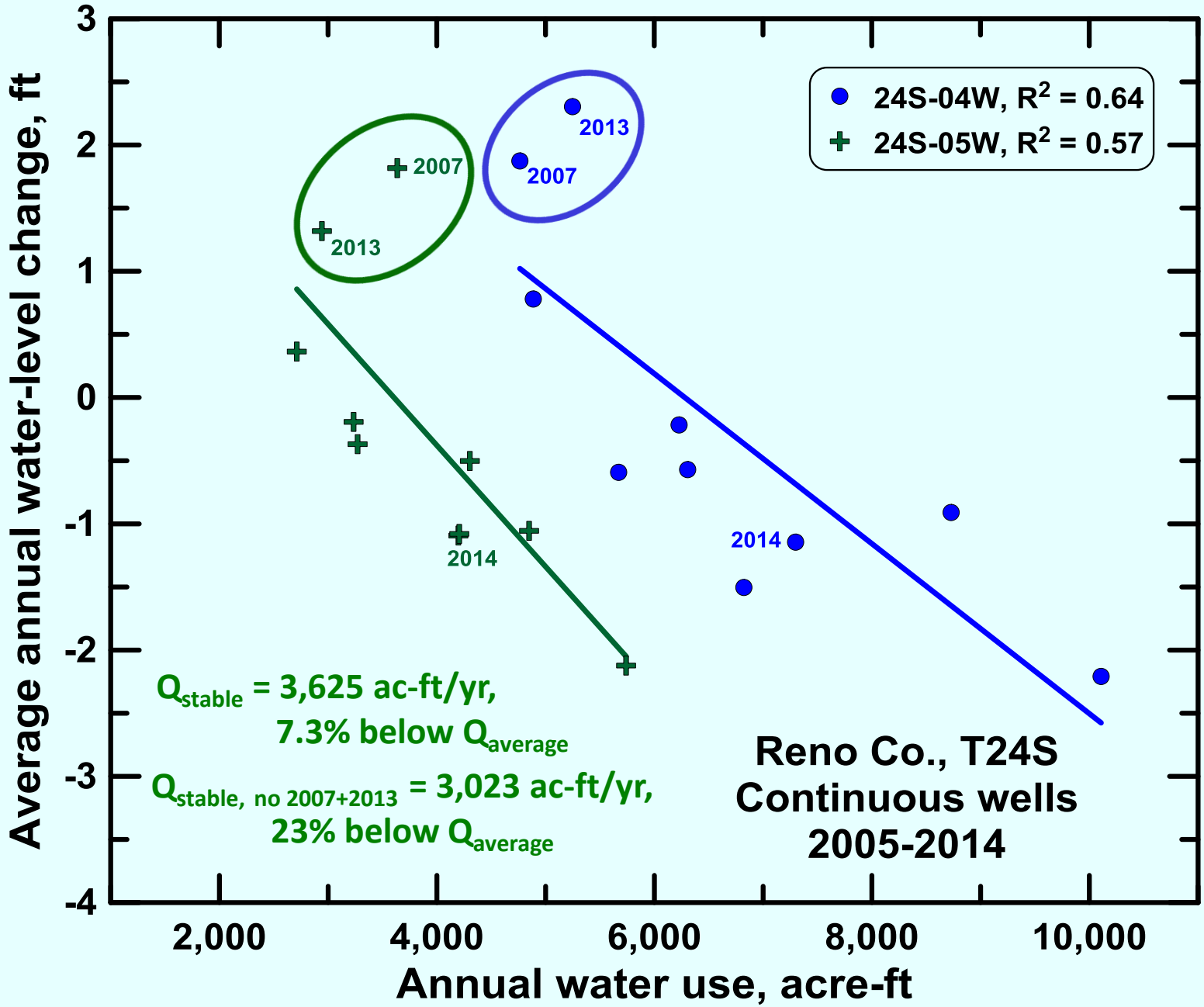
Sustainability percentages listed in order of regression lines from left to right.



Average sustainability percentage for the parts of townships within GMD2 (1996-2014 and 2005-2014 conditions)

Positive values = pumping reduction

Negative values = pumping increase


24S-04W, R^2 = 0.64
24S-05W, R^2 = 0.57
2013
2007
2007
2013
2014
2014
Q_{stable} = 3,625 ac-ft/yr,
7.3% below $Q_{average}$
$Q_{stable,\ no\ 2007+2013}$ = 3,023 ac-ft/yr,
23% below $Q_{average}$
Reno Co., T24S
Continuous wells
2005-2014
Average annual water-level change, ft
Annual water use, acre-ft
3
2
1
0
-1
-2
-3
-4
2,000
4,000
6,000
8,000
10,000

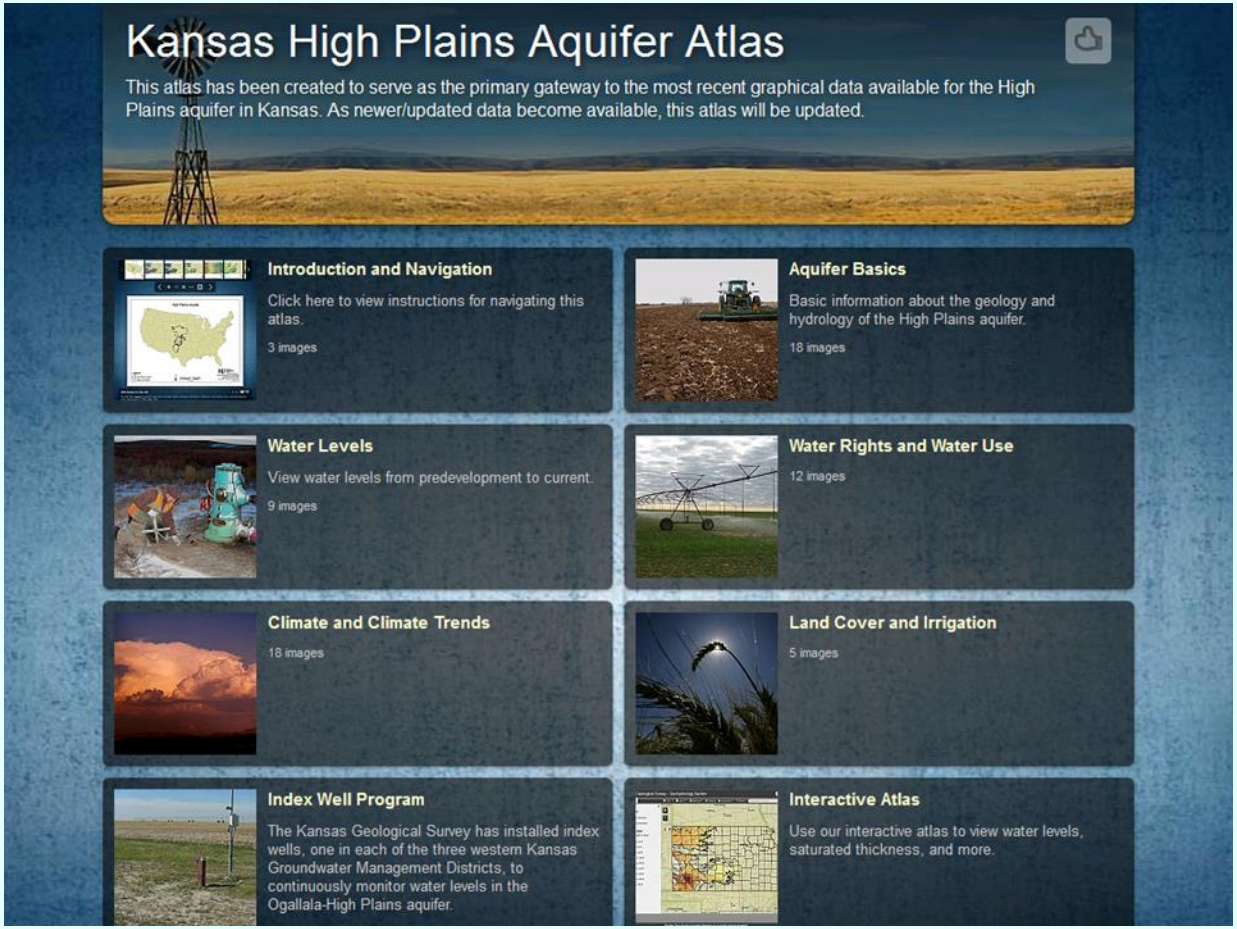
Conclusions

- **Data-driven approach considers complete picture of all aquifer inflows and outflows.**
- **Average annual water use over much of GMD2 was close to sustainable during 1996-2014.**
- **County sustainability assessment indicates McPherson County requires greatest pumping reductions (8%) to achieve stable water levels.**
- **Township sustainability percentage ranges are 0.6–2.8% in Sedgwick, 0.9-7.8% in Reno, -0.9–13.9% in Harvey, and 3.5-19.8% in McPherson County.**
- **Sustainability in township and defined areas is dependent on high inflows during wet years.**
- **Approach gives improved specific yield values for use in numerical model for GMD2 region.**

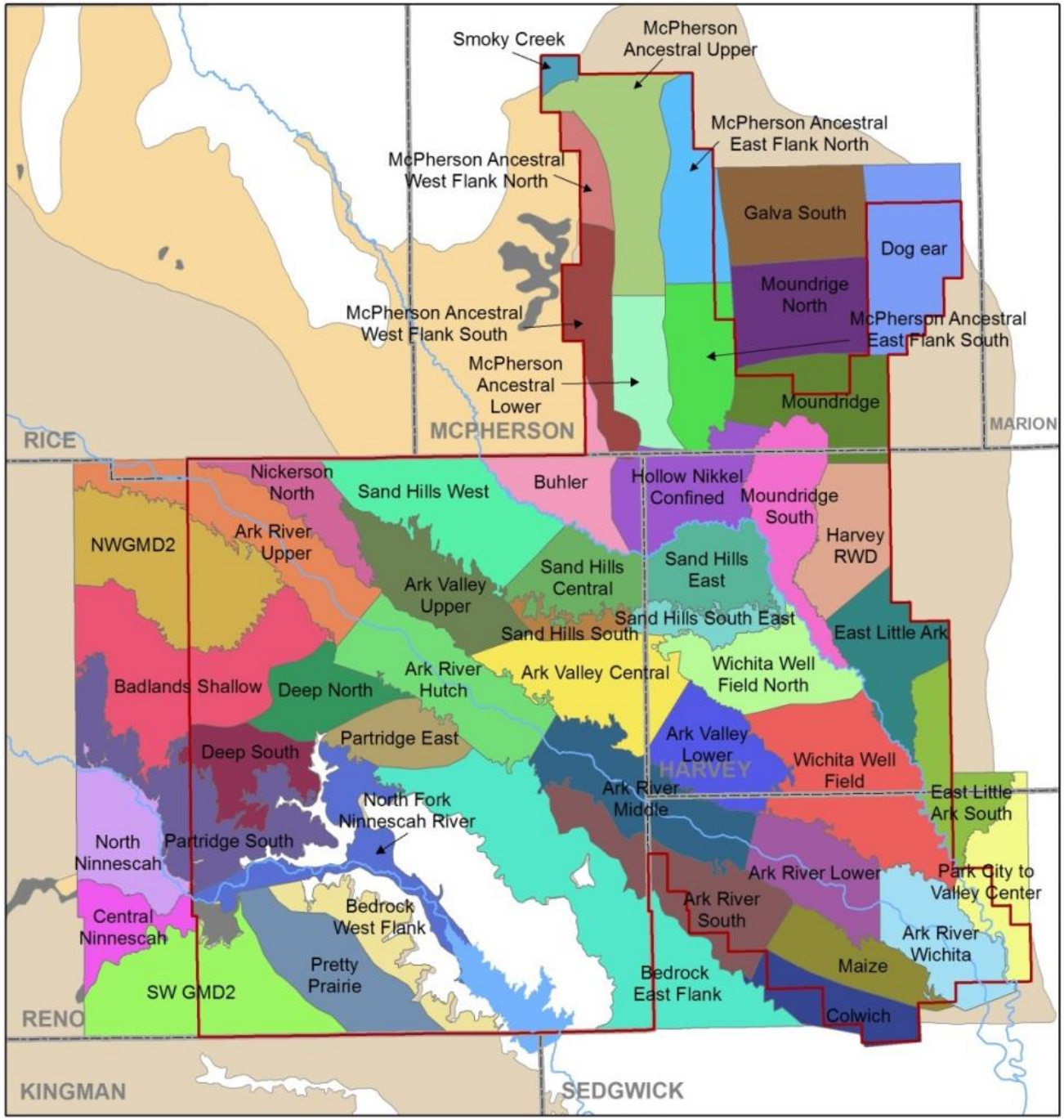
ACKNOWLEDGMENT

This work was supported by funding from Equus Beds Groundwater Management District No. 2 and the Kansas Water Plan.

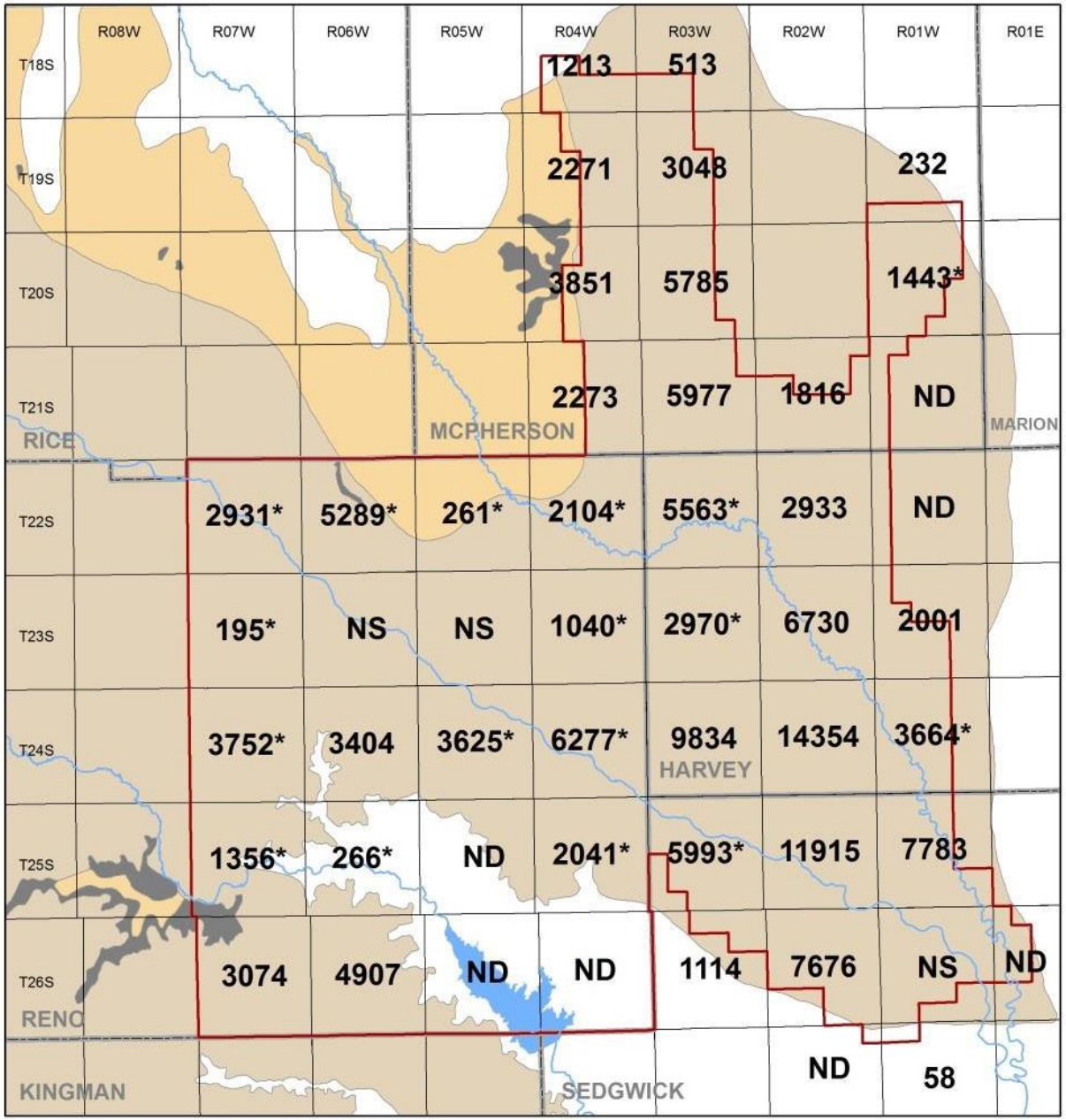
Paper with theoretical basis for approach:
Butler, Whittemore, Wilson, and Bohling, 2016, *Geophysical Research Letters*



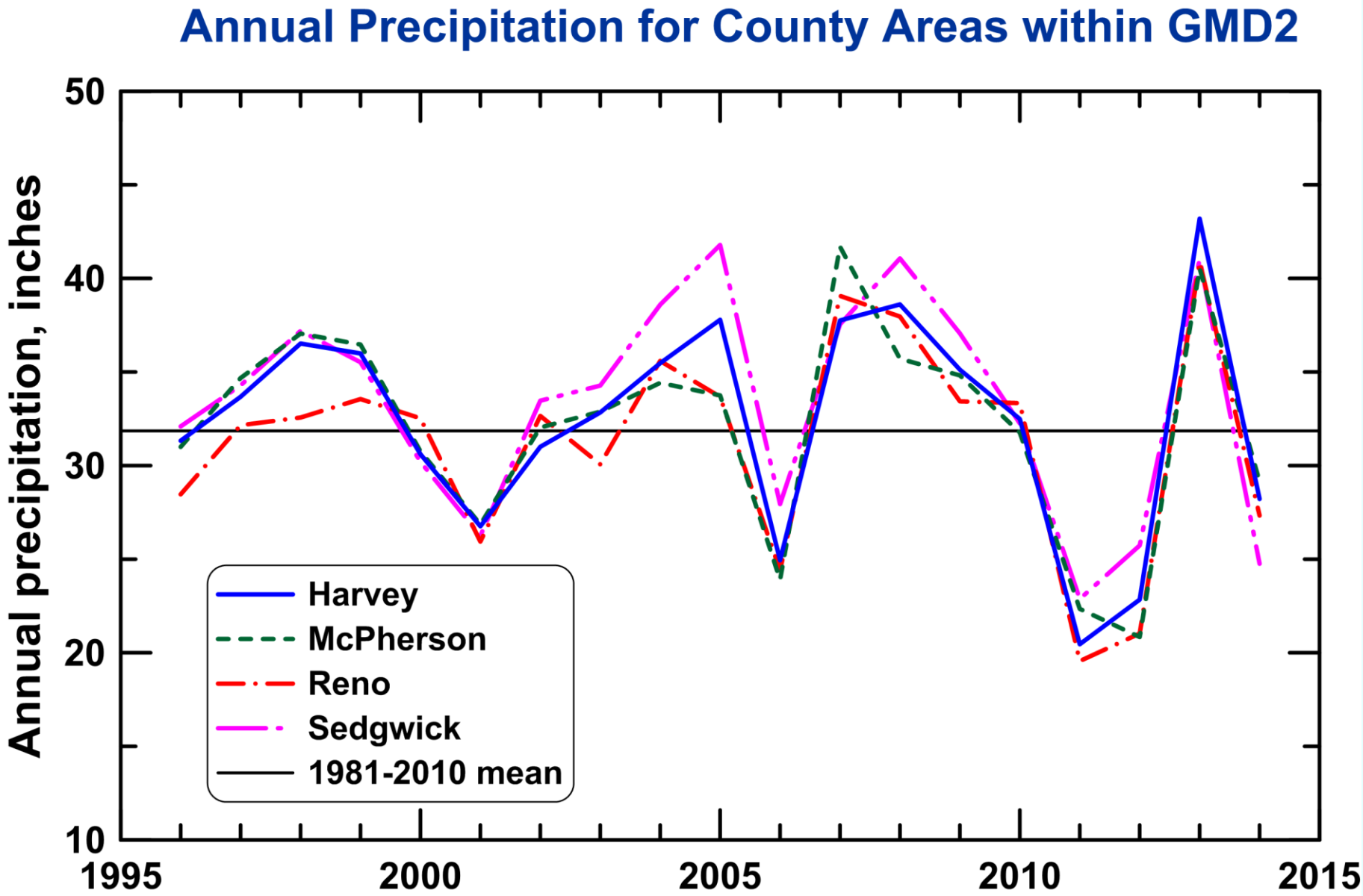
www.kgs.ku.edu/HighPlains/HPA_Atlas/index.html



GMD2 defined areas



Average sustainable water use, in acre-feet, for the parts of townships within GMD2


Annual Precipitation for County Areas within GMD2
Annual precipitation, inches
50
40
30
20
10
1995
2000
2005
2010
2015
Harvey
McPherson
Reno
Sedgwick
1981-2010 mean