**Written testimony from Brownie Wilson, Kansas Geological Survey.**

**Submitted to Rhonda Hutton, Kansas Department of Agriculture, on July 21, 2020.**

**RE: Written testimony, proposed GMD1 Wichita County LEMA Hearing, August, 14, 2020**

My name is Brownie Wilson. I am the Geographic Information Systems (GIS) and Support Services Manager for the Geohydrology Section at the Kansas Geological Survey (KGS). The KGS is a research and service division under the University of Kansas and has been directed by the Kansas Water Plan to provide technical assistance to the three western Groundwater Management Districts, the Kansas Water Office, and the Kansas Department of Agriculture-Division of Water Resources (KDA-DWR) in the assessment, planning, and management of the groundwater resources of western Kansas.

At the request of Western Kansas GMD #1 in November of 2019, the KGS compared the relationship between observed water-level change and groundwater use in the Ogallala/High Plains aquifer (HPA) from 2009 to 2015 within Wichita County, KS. The comparison uses the water-balance approach described in Butler et al. (2016), to calculate the reduction in the average annual amount of water use needed to produce, on average, stable water levels over a given. The approach is data-driven, utilizing only annually collected water-level measurements and annually reported water use estimates.

The focus of this study is on Wichita County in west-central Kansas. The HPA is the source of water supply for over 99% of the wells, most of which are along and north of highway 96 (fig. 1). The aquifer here generally has greater vertical thicknesses and greater amounts of water in storage relative to southern portions of the county where, because of bedrock highs that are close to the land surface, the aquifer thins and large-scale groundwater development is limited (Wilson et al., 2015)

Groundwater declines in Wichita County have been significant. The aquifer thickness has declined, on average, by 68% from predevelopment conditions to a 3-year 2018-2020 average of 24 feet across the county (Fross et al., 2012). The largest of these declines, 75 to 100 feet, have occurred in the northern portions of the county, generally in the same areas that have the highest concentration of groundwater pumping each year. However, annual groundwater use, 95% of which is typically for irrigation use, has shown declining trends in both Wichita County and GMD1. This is caused by a combination of reduced well yields from the reduction in aquifer thickness and an improvement in the accuracy of reporting water usage with the increasing adoptions of totalizing flow meters (Whittemore et al., 2018).

<u>Water Levels</u>

Each year, the KGS and the KDA-DWR measure the depth-to-water in a network of approximately 1,400 water wells, across the HPA, as part of the state's Cooperative Water Level Program. The network attempts to have a well every 16 square miles and is used to provide regional- to sub-county- scale characterizations of the aquifer.

Customized software developed by the KGS, coupled with Global Positioning System (GPS) data, is used to make sure the same wells are visited each year. The majority of water-level measurements are taken in late December and early January using steel or electric tapes with precisions down to the hundredths of a foot. Measurements are field checked on site at the time of the visit to ensure locational accuracy and that the current measurement is within the historical trend of past measurements. Additional statistical and GIS reviews are conducted later to identify abnormal or anomalous measurements. If deemed necessary, well sites will be re-measured the same day or within a month, depending on the circumstances.

Collected water levels from the Cooperative Water Level Program, along with additional measurements from other local, state, and federal sources, are stored and served online through the KGS' Water Information Storage and Retrieval Database (WIZARD). WIZARD evolved from the U.S. Geological Survey's Ground Water Site Inventory in the mid- 1990s, and today represents the largest repository of depth-to-water measurements in Kansas.

Well site locations in the HPA and their associated water-level measurements were downloaded from WIZARD to estimate the water-table elevations each year from calendar years 2009 to 2016. The well site locations, based on their listed geographic coordinates, were spatially mapped into the ArcGIS software platform, a GIS mapping software. Within GMD1, all of the measured well locations used in this project have been surveyed with hand-held GPS units, which typically have horizontal accuracy ranges of 12 to 40 feet (fig. 1).

The WIZARD database contains codes indicating the status of the site at the time the water level was measured. Most water level measurements across GMD1 are taken in the first week of January and contain blank or null status codes indicating static or near static water level conditions. Past water level measurements that were coded to be "anomalous" from previous statistical and geostatistical reviews were not included in this project along with measurements taken from locations where the well was obstructed, was pumping at the time of the measurement, had recently been pumped, or had nearby sites that were being pumping at the time of the measurements.

The water-level measurements were used to calculate 1-year average winter depth to water for each well site, centered on each calendar year from 2009 to 2016. For example, a well's 1-year average, winter depth to water for 2009 are based on measurements taken in the months of December 2008, January 2009, February 2009, and March, 2009. Given most of the wells are only measured once a year (over 90% of the time in the month of January), the winter averages are typically only composed of a single measurement. However, some wells could be measured 2 or 3 times in a single winter period.

For this project, only wells containing computed 1-year, winter average water levels centered on the calendar years of 2009, 2010, 2011, 2012, 2013, 2014, 2015, and 2016 were considered. If a well site was missing a winter average value for one of these target years, it was removed from the data set. Under these selection criteria, 33 well sites were identified within Wichita County with 31 of them located within the proposed LEMA boundaries of GMD1 (fig. 2). The annual change in the water table occurring each year from 2009 to 2015, was computed for each well site.

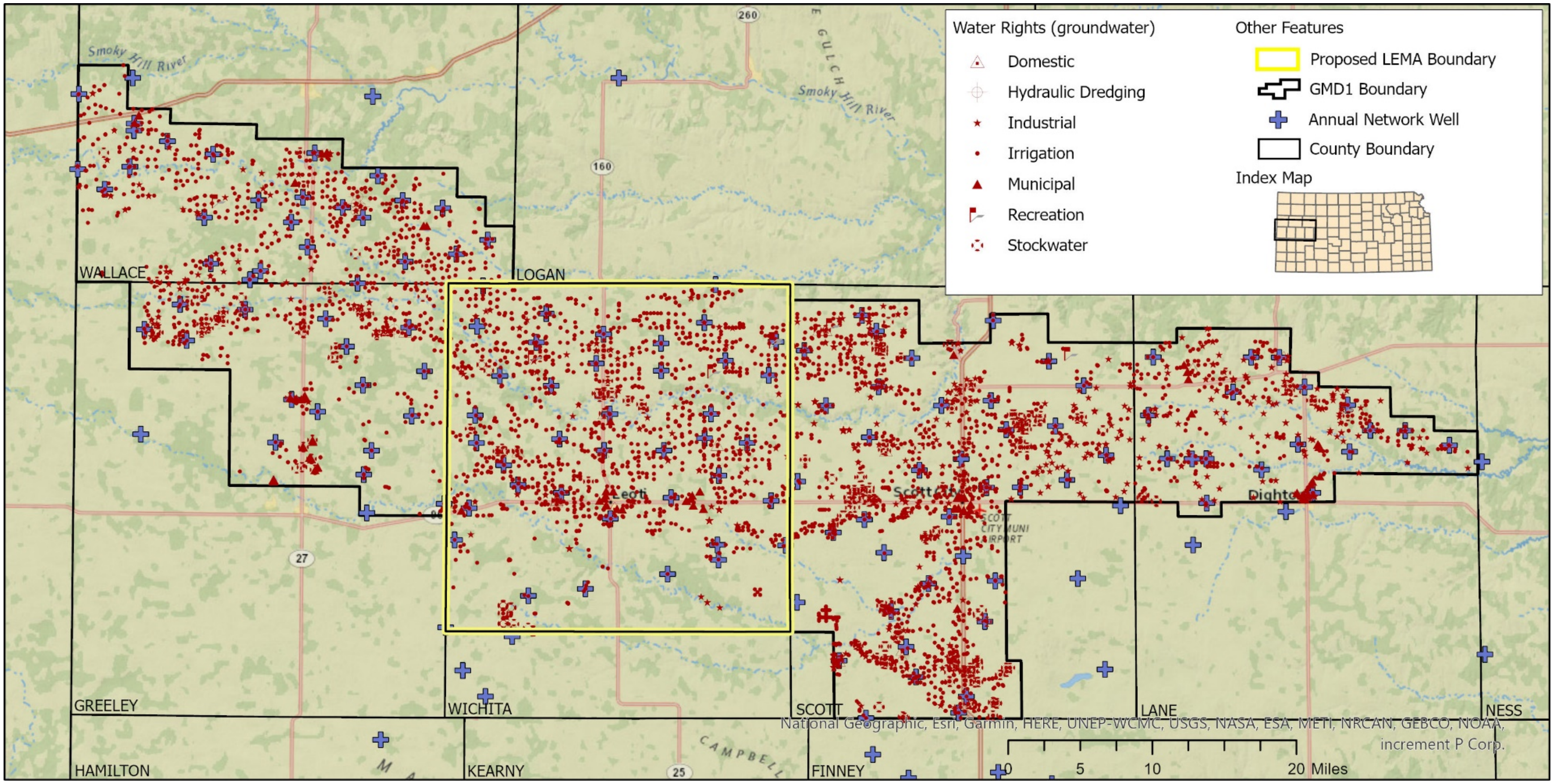


**Figure 1.** Western Kansas GMD1, annual network wells, and groundwater-based water right wells.

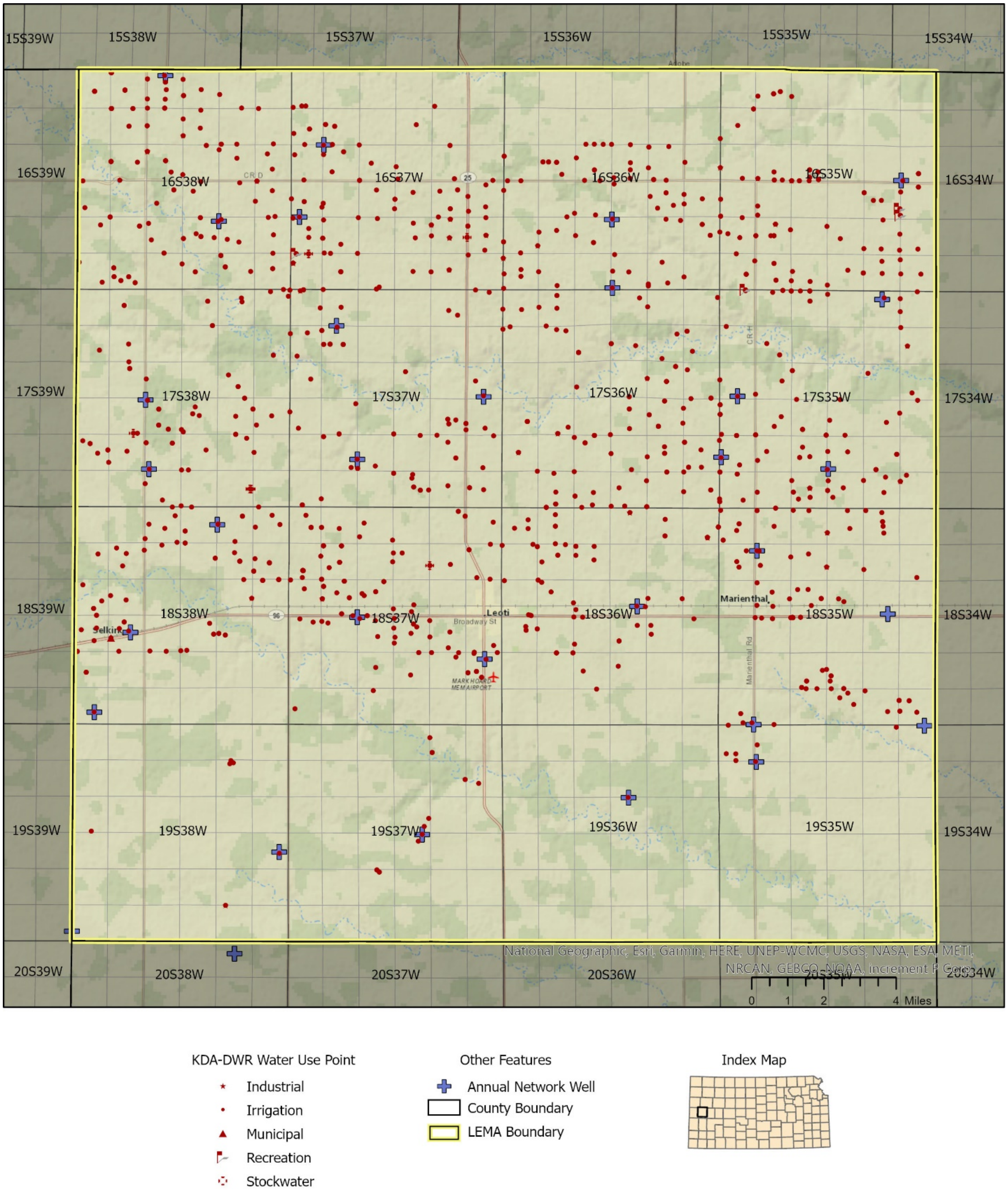


**Figure 2.** Proposed GMD1 Wichita County LEMA Area. The red points represent the PDs used in the KDA-DWR water use assessment and the blue pluses are the wells in which annual water levels were measured every year from 2009 to 2016.

Groundwater Use

Water use reports can be downloaded from the online Water Information Storage and Retrieval Database (WIMAS) database. These reports are required by law to be submitted annually by water right holders, or their designee, to the KDA-DWR and penalties exist for non-submission or knowingly falsifying them. A quality control program has been in place since 1990 to review the reports and follow up when necessary with the water right holders to correct missing or questionable information.

The KDA-DWR compared historical water use in relation to annual allocations for all water rights in Wichita County in order to determine new LEMA annual allocations based on the proposed 25% reduction in average use. This process consolidates or groups water rights into units based on overlapping point(s) of diversions and or place(s) of use. Reported water use for each point of diversion was based on active years of pumping from 2009 to 2015 and was adjusted where overpumping may have occurred. Water right information and the summarized water use from the KDA-DWR review was exported and spatially mapped into GIS, based on listed geographic coordinates for the points of diversion (fig. 2).

Groundwater Use and Water-Level Relationships, Wichita County

In Butler et al. (2016), the authors demonstrates how to apply the fundamental concepts of a water balance approach to seasonally pumped aquifers extending over county-scale areas in order to produce linear relationships between annual water use and annual water-level change. From these relationships, the reduction in the average annual water use needed to stabilize areally averaged water levels, defined as Q stable, can be readily calculated.

Figure 3 shows this relationship for the proposed LEMA area in Wichita County. Each dot on the plot represents the total amount of groundwater reported used in relation to the average annual water-level change for each year from 2009 to 2015. Over this time period, total reported water use ranges from a low of 40,050 acre-feet in 2015 to a high of 63,300 acre-feet in 2012, with an average of 54,600 acre-feet. Likewise, average water-level change computed from the 33 observation wells show the same pattern. Water levels rose slightly (0.02 ft) in 2015 (change from 2015 to 2016), had the largest decline (-1.3 ft) in 2012 (change from 2012 to 2013), and had an average annual water level decline of -0.59 feet over the period.

The relationship between water use and water level change is statistically significant with an R-squared value of 0.78. This indicates 78 percent of the variation shown in the average water-level change can be explain statistically by variations in the total annual reported water use. Based on this correlation of conditions from 2009 to 2015, a 20.02% reduction in average annual reported use would allow for stabilized water levels, defined here as a zero change in water levels.

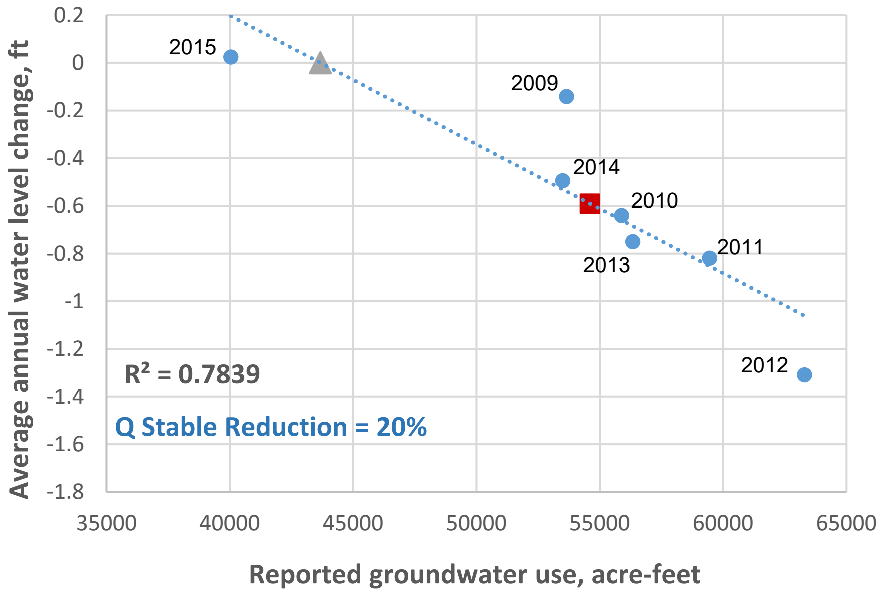


**Figure 3.** Average annual water-level change versus annual water use from 2009 to 2015 for the proposed Wichita County LEMA. Dashed line is the best-fit straight line to the plot. Overall average conditions for both water use and water-level change is represented by the maroon square. Water use, under stable water-level conditions, is shown by the olive-colored triangle.

Given the relative lack of water right development in the thinner portions of the HPA in the southern areas of Wichita County, the analysis was repeated using data only from townships along and north of highway 96- specifically, townships 16 to 18 south and ranges 35 to 38 west. During this review, it was found that the observation well in section 28 of Township 17S, Range 38W had an abnormally deep water level reading in 2009. This resulted in a computed 2009 to 2010 water level rise of 3.5 feet, a change that is out of trend relative to other wells in the area. The one change from 2009 to 2010 for this particular well was removed from consideration and the analysis for the northern portions of Wichita County repeated.

Figure 4 shows the relationship between water use and water-level change in the northern portions of Wichita County has an even stronger statically significant relationship (R-squared of 0.85) although the overall reduction in average use is relatively unchanged at 21.3 percent. The improved statistical relationship is a reflection of using data that is a better representation of the conditions of where water is actually used in the county.

Water-level trends from continuously recording observations wells across the Kansas HPA suggest these conditions and the computed Q stable values should hold for at least the next decade or two. However, the analysis should be repeated over time as the components that make up the water balance (aquifer inflows and outflows) slowly adjust to new pumping allocations determined by proposed management plans.

Thank you for your time today and I would be glad to answer questions or provide additional information.

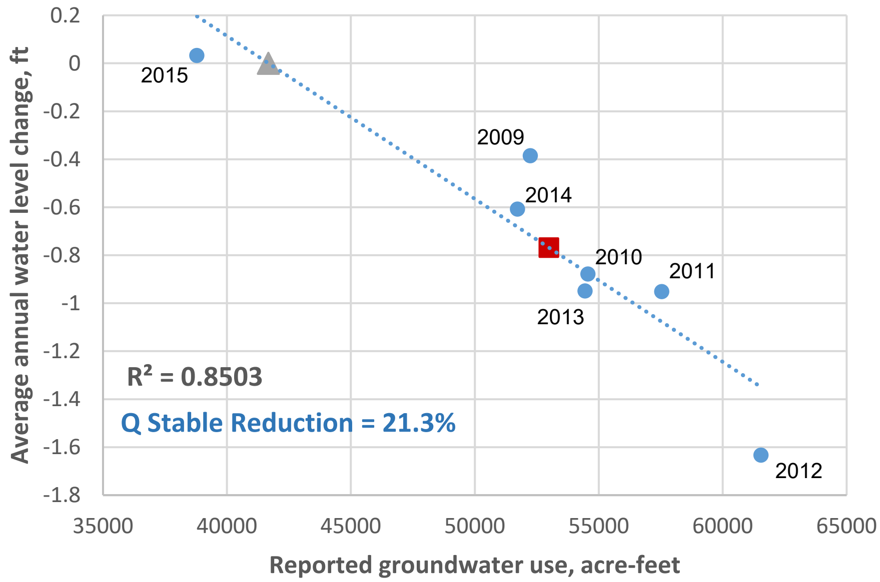


**Figure 4.** Average annual water-level change versus annual water use from 2009 to 2015 for the proposed Wichita County LEMA and areas along and north of highway 96. Dashed line is the best-fit straight line to the plot. Overall average conditions for both water use and water-level change is represented by the maroon square. Water use, under stable water-level conditions, is shown by the olive-colored triangle.

References:

Butler, J.J., Jr., D.O. Whittemore, B.B. Wilson, and G.C. Bohling, 2016, A new approach for assessing the future of aquifers supporting irrigated agriculture, Geophys. Res. Lett., v. 43, no. 5, pp. 2004-2010.

Fross, D., M. Sophocleous, B. B. Wilson, and J. J. Butler Jr., 2012, Kansas High Plains Aquifer Atlas, Kansas Geological Survey. [Available at http://www.kgs.ku.edu/HighPlains/HPA_Atlas/index.html, accessed May, 2020].

Whittemore, D. O., Butler, J.J., and Wilson, B. B., 2018, Status of the High Plains Aquifer in Kansas: Kansas Geological Survey, Technical Series 22, 14 p.

Wilson, B. B., Liu, G., Bohling, G. C., Whittemore, D. O., and Butler, J. J., Jr., 2015, West Central Kansas GMD1 Model: Kansas Geological Survey, Open-File Report 2015-33, 137 p.