SmartPLAN

Prioritize, Learn, Actuate, Navigate

Phase I: Report to the Chief Engineer Identifying all priority areas of concern within GMD3 and setting reasonable boundaries.

Southwest Kansas Groundwater Management District Number 3 (GMD3)
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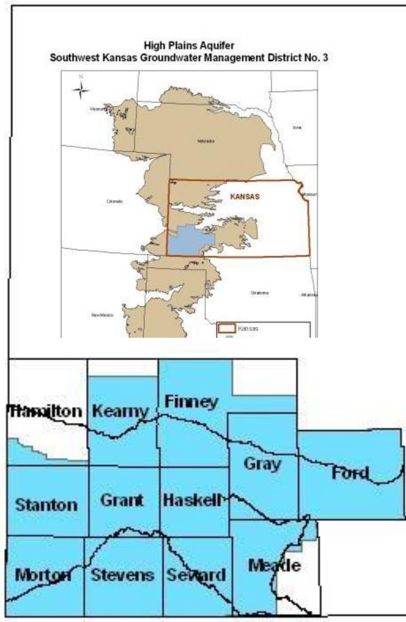

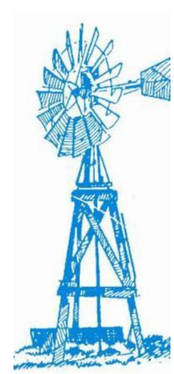

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Executive Summary

In 2023, the Kansas Legislature passed HB 2279 into law. A portion of that bill became K.S.A. 82a-1044, requiring all Kansas Groundwater Management Districts (GMDs) to identify all priority areas of concern within their boundaries by July 1, 2024, and then to develop action plans that reasonably address those concerns by July 1, 2026. The necessary work for the project is already underway. GMD3 has been tasked with identifying all priority areas by July 1, 2024, which it has completed with input from member water users and landowners in six public meetings held for that purpose.

Positive activities in place include:

- Robust aquifer data collection and analysis.
- I-CARE data and information to District Irrigators annually.
- District Groundwater Model updated May 1st, 2024.
- Many local water conservation successes.
- National Water Quality Initiative (NWQI) funding to address water quality in the Ark River basin.

Concerns in no order include:

- Continued groundwater depletion and declining well yields.
- Groundwater Quality decline in the upper Ark River basin and GMD3 Chloride Control areas.
- Loss of 176,000 irrigated acres in the District since 1989.

Priority Groundwater Areas

The existing boundary of the official GMD3 Management Program is the GMD3 Board reasoned priority area boundary with the Upper Arkansas River Intensive Groundwater Use Control Area as a priority area identified by statute (See Figure 1). The strengths of this decision as discussed with members in public meetings include the following:

- All areas in GMD3 meet one or more eligible priority concerns listed in statute.

- Assures members that all concerns are included in local planning.
- Consistent with other western district-wide priority areas adopted in statute.
- Recognizes that some of the thickest aquifer areas contain relatively short estimated usable remaining lifetime measures to be included by statute.
- Assures full eligibility for voluntary incentive-based conservation programs.
- Allows all 17 evaluation regions and 56 sub-regions of the I-CARE program to inform members and the Board in developing reasoned relevant local strategies.
- Allows locally relevant mitigation strategies in the known water quality areas.

The project area covers over 8,400 square miles, with 10,721 active wells having documented Kansas water rights. The existing I-CARE program linked HERE informs members and the work of the GMD3 Board in developing priority area boundaries. The I-CARE activity will continue to inform the GMD3 SmartPLAN process of action planning with member water users and landowners. The GMD3 interactive map layers, including wells, estimated usable life, water right information and the available map data layers are linked HERE and accessible at gmd3.org.

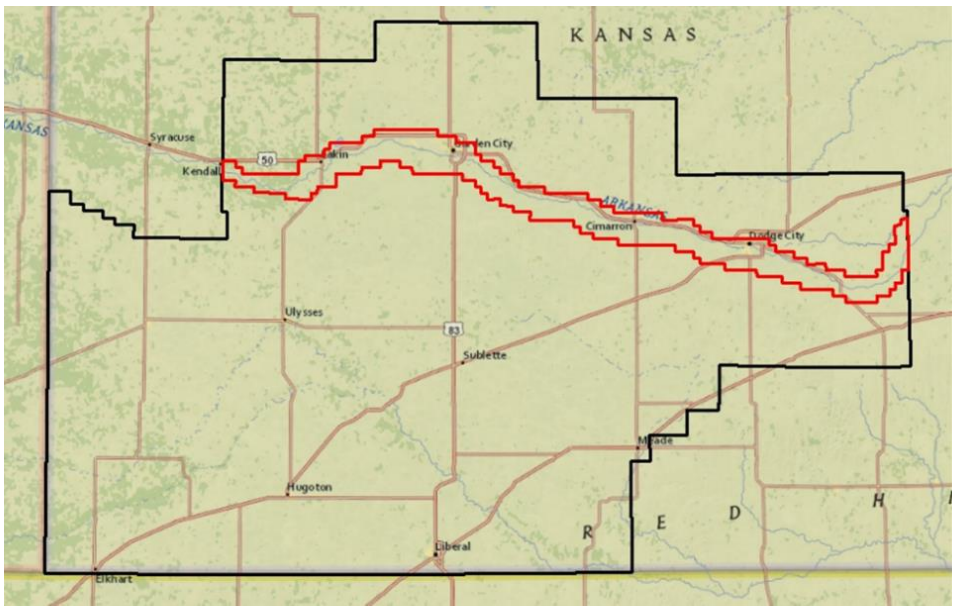


Figure 1. The 2024 GMD3 priority groundwater areas.

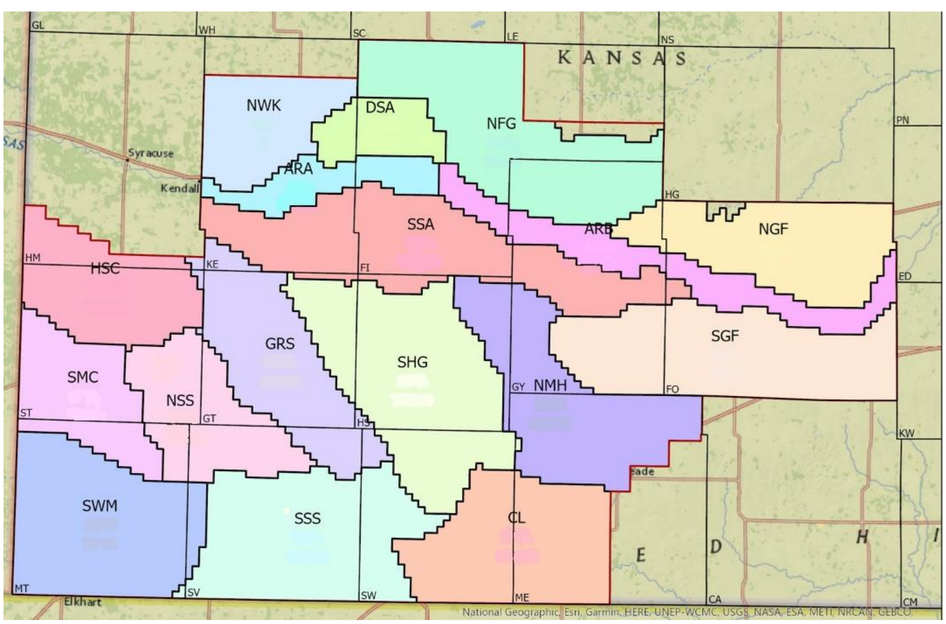


Figure 2. Current GMD3 I-CARE Regions. This information is available online at https://storymaps.arcgis.com/stories/f422d10893f8419395f0f095c11219e3.

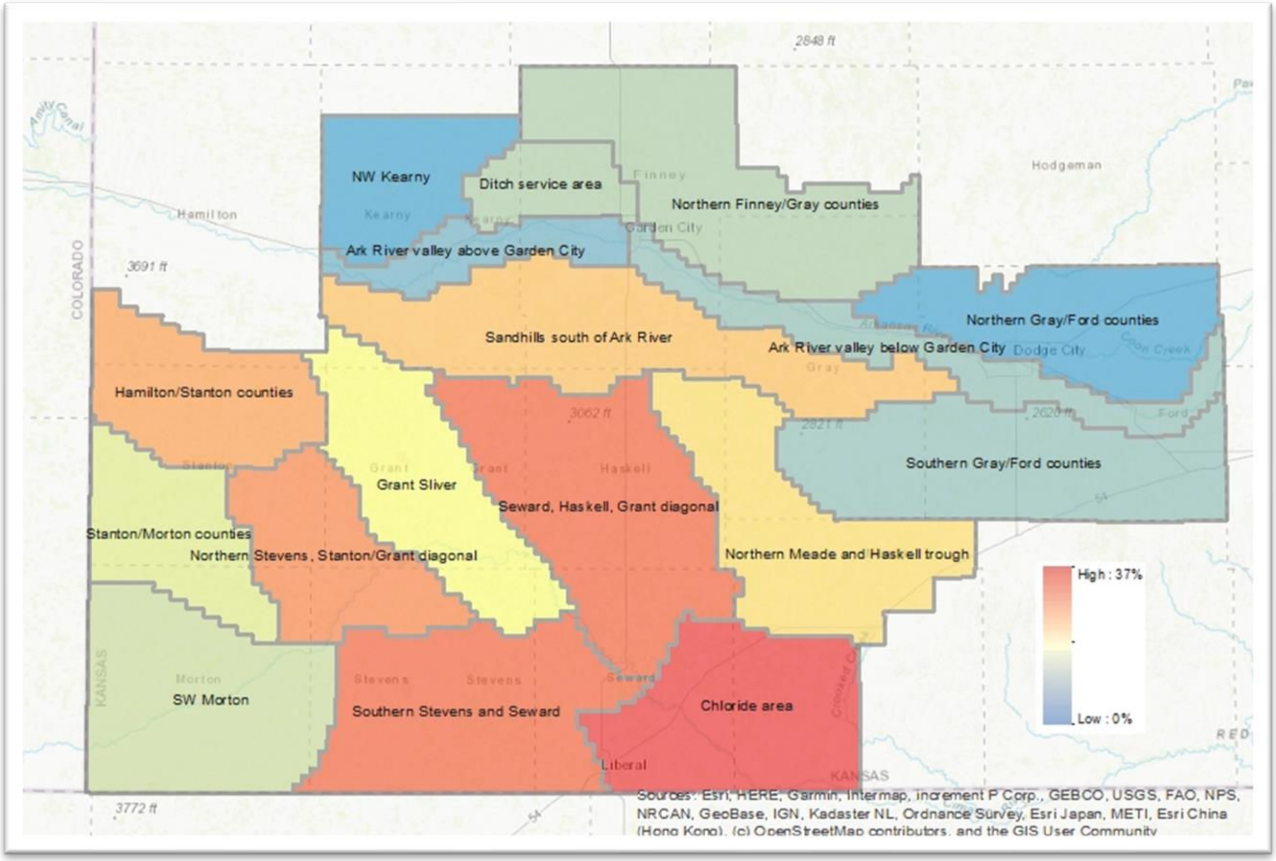


Figure 3. Percent water use exceeding stable water levels by I-CARE Region.

Concerns
Groundwater Depletion.

The High Plains Aquifer in the project area is being consumed and depleted at an unsustainable rate, exceeding 2 ft per year in many locations. Less than half of the predeveloped water supply remains, and action is necessary to ensure that there will continue to be adequate water for people to live and for economic hubs to thrive. See Figure 4 for a map of water level declines over the past 10 years. Note that most of the project area, aside from the outer edges where little aquifer exists, has declined between 15 and 40 ft, or 1.5 to 4.0 ft per year.

Most water use in the project area is for irrigation. In 2022, a total of 1,982,228 AF was pumped in GMD3, with irrigation accounting for almost 96% of total use. Other uses of water include municipal, industrial, stock, recreation, thermal exchange, contamination remediation, fire protection, aquifer recharge and domestic.

Groundwater declines have greatly reduced pumping capacity in most areas, with well pumping rates in many areas dropping from more than 1000 gallons per minute (gpm) to less than 400 gpm. This makes it harder for producers to mitigate the effects of drought. Water declines also reduce the amount of fresh water in the ground to dilute contaminants in return flows to the aquifer, creating some localized areas with high nitrate concentration.

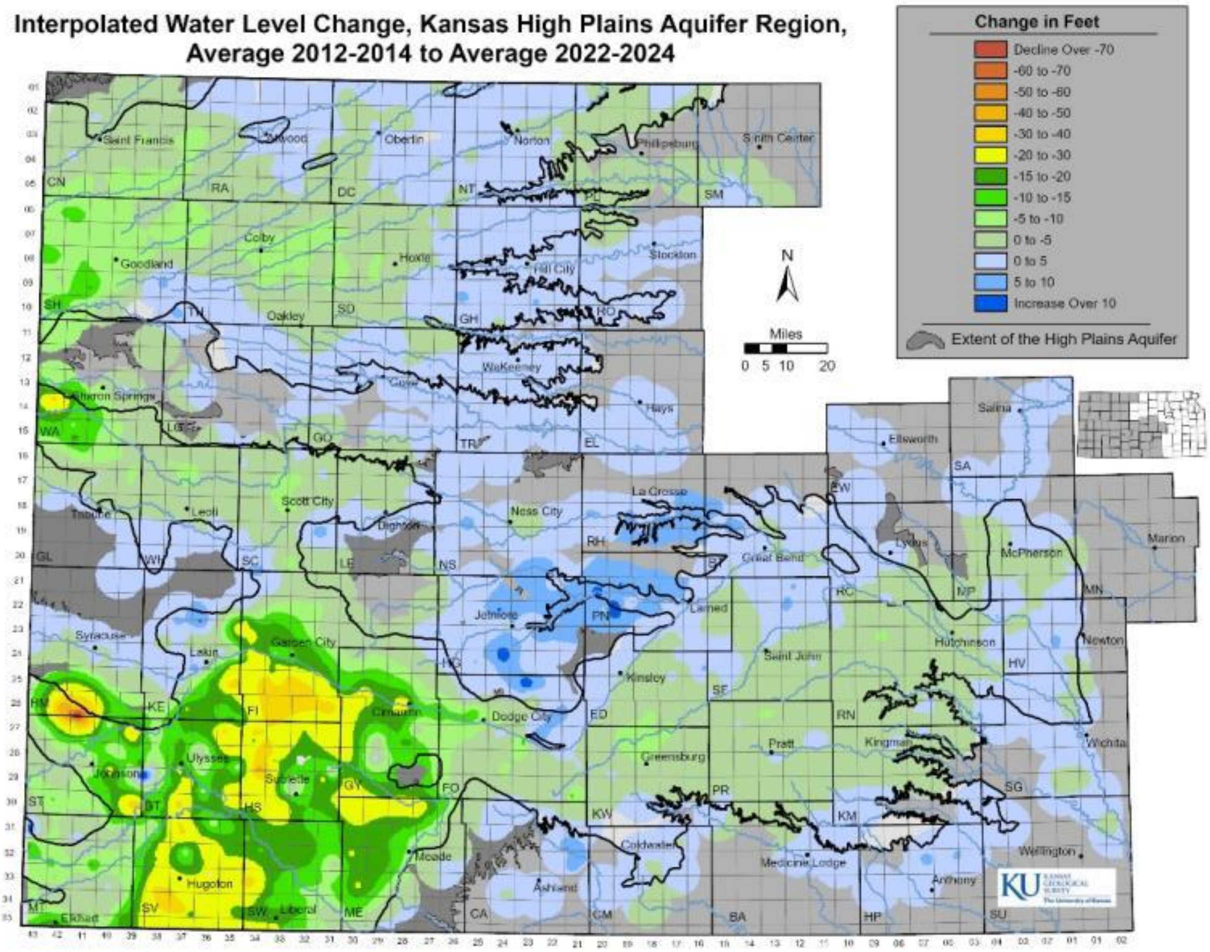


Figure 4. Up-to-date Interpolated water level change, Kansas High Plains Aquifer region, average 2012-2014 to Average 2022-2024. Taken from the Kansas Geological Survey High Plains Aquifer Atlas.

Estimated usable remaining lifetime.

Kansas law requires that GMD areas where an estimate of usable lifetime of groundwater is 50 years or less, or where a similar measure of future water availability can be determined, must be included in the District priority areas of concern. KGS Public Information Circular No. 18 provides a map of the estimated remaining usable lifetime for the aquifer that has been widely referenced across the state since its release. These estimates are based on the time it takes the aquifer to decline to a typical well pumping capacity to reach a 200 gpm threshold or less. However, the map omits some High Plains Aquifer data in GMD3. The deeper Dakota Aquifer system portion of the High Plains Aquifer (HPA) is an important connected groundwater supply used in the District that was not included. Figure 5 illustrates that not all maps of the High Plains Aquifer are complete, and that there are generally three different groundwater supply settings for the role of the deeper bedrock Dakota system in GMD3.

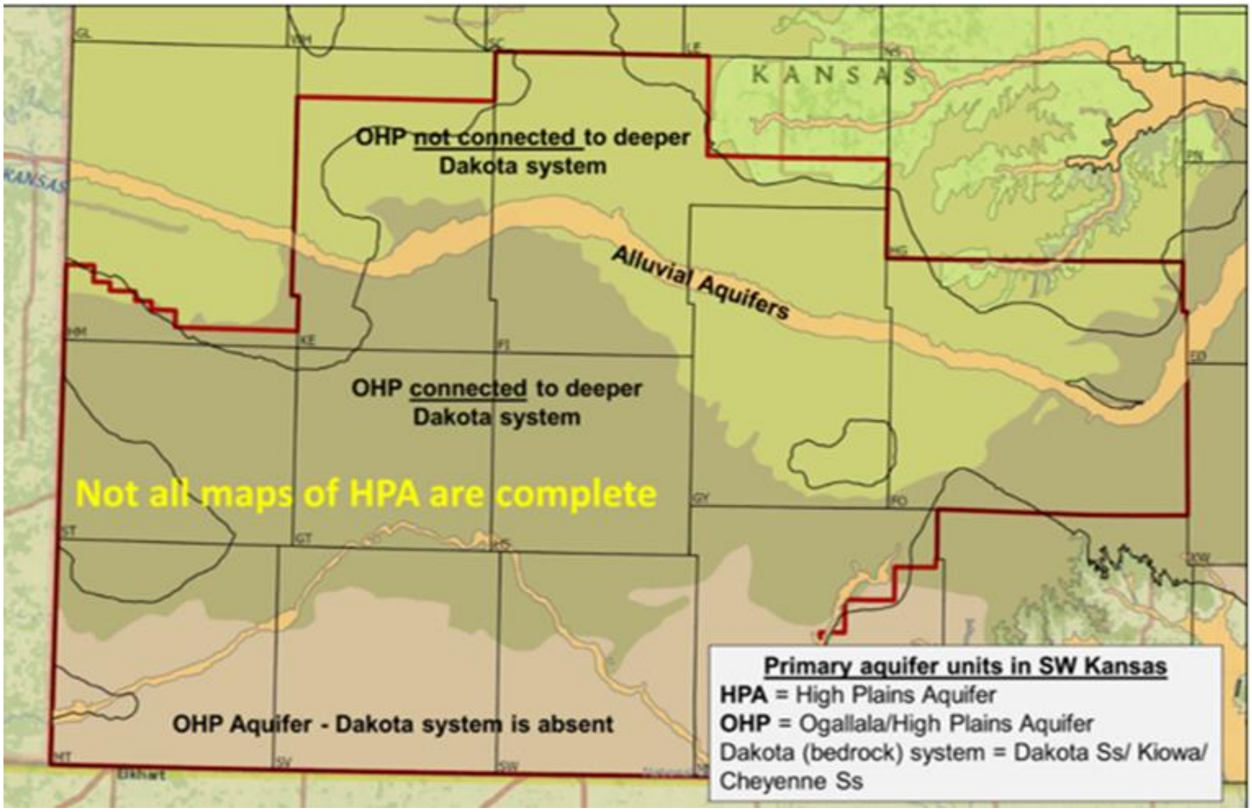


Figure 5. Three different High Plains Aquifer settings in GMD3

Therefore, a similar map measure of estimated future water availability is needed to illustrate the entire HPA supply within GMD3. The updated GMD3 groundwater model (May 1, 2024) predicts up to 60 years ahead. So, an Estimated Usable Lifetime - Status Quo Scenario (60 year) was run to provide an updated mapped measure of estimated usable remaining lifetime (see Figure 6). It may be noteworthy that the GMD3 model is well calibrated in most areas but not so much in some areas. This is due in part to the lack of extensive data for the deep connected Dakota system portion of the HPA.

The model status quo scenario with the Dakota Aquifer resources in the lower map (Figure 6b) suggests areas of concern even in some of the greatest saturated thickness remaining in Kansas due to the predominance of shale and other low transmissivity formations that comprise the aquifer locally. The District is required by statute to include these areas in the GMD3 Board’s priority areas. These estimated usable remaining lifetime measures do not include water quality (usability) concerns nor the potential development of other alternative sources of supply to sustainability extend or restore aquifers and satisfy existing and future water demands.

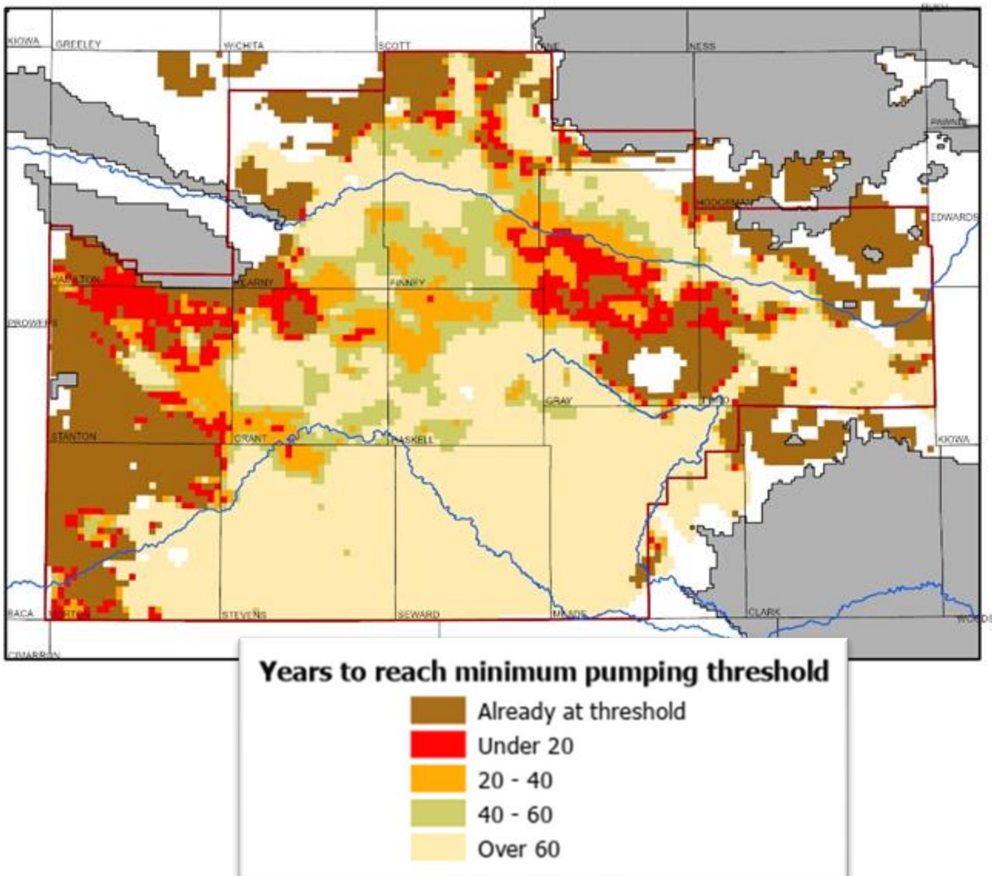


Figure 6a. Project area estimate usable remaining lifetime map data of KGS Public Info Circular 18 reconfigured using 20-year increments for illustrative comparison purposes. The threshold used is the projected years of decline to a typical well capacity of 200 gpm or less.

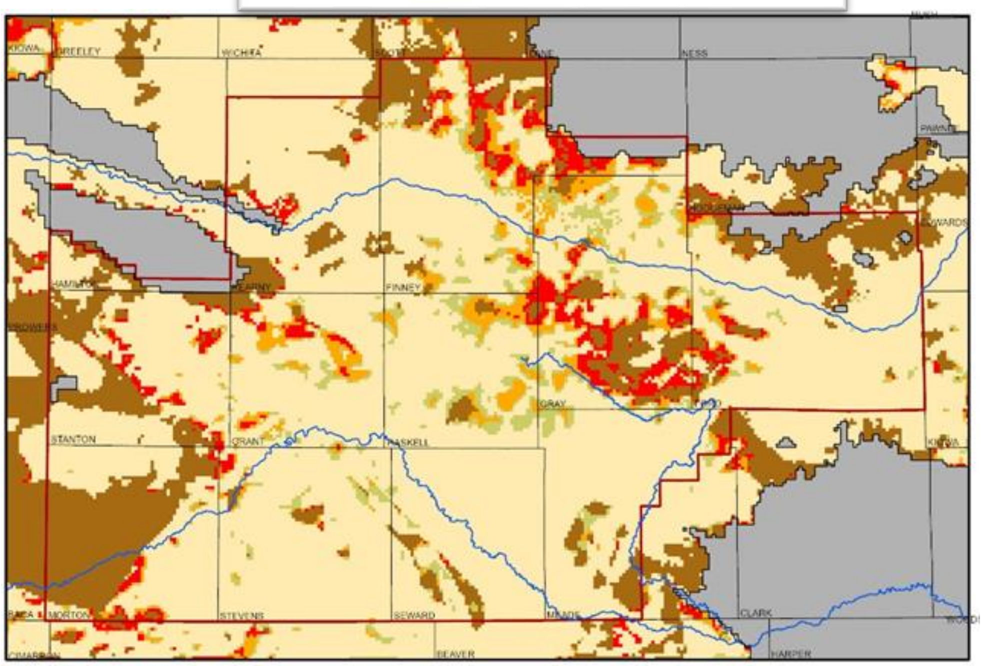


Figure 6b. Estimated usable remaining lifetime map from the latest Status Quo GMD3 Model Scenario. The threshold used is different here, using time it takes the HPA w/Dakota system to decline to a 2000 ft^2/day net transmissivity available to a well (equal to a 20' sand aquifer). From Wilson, B. B., Liu, G., Bohling, G. C., and Butler, J. J., Jr., 2024, *Update of the GMD3 Groundwater Flow Model: Kansas Geological Survey, Open-File Report* (under review for publication).

Water Quality of the Arkansas River Basin

The water quality within the upper portion of the Arkansas River in Kansas is very poor due largely to diminished stream flows, underlying geology of fields upstream of the area, and other uses. The Kansas Department of Health and Environment (KDHE) has identified this stretch of the river as impaired due to gross alpha (bundled with uranium), fluoride, total suspended solids, boron, selenium, and sulfate.

Figure 7 is a map of the distribution of sulfate concentration along the upper Arkansas River corridor. The contamination of the Arkansas River, especially the high levels of salinity and uranium, is diminishing the usefulness of the water, and in some instances, is creating problems that must be addressed at great cost to local stakeholders.

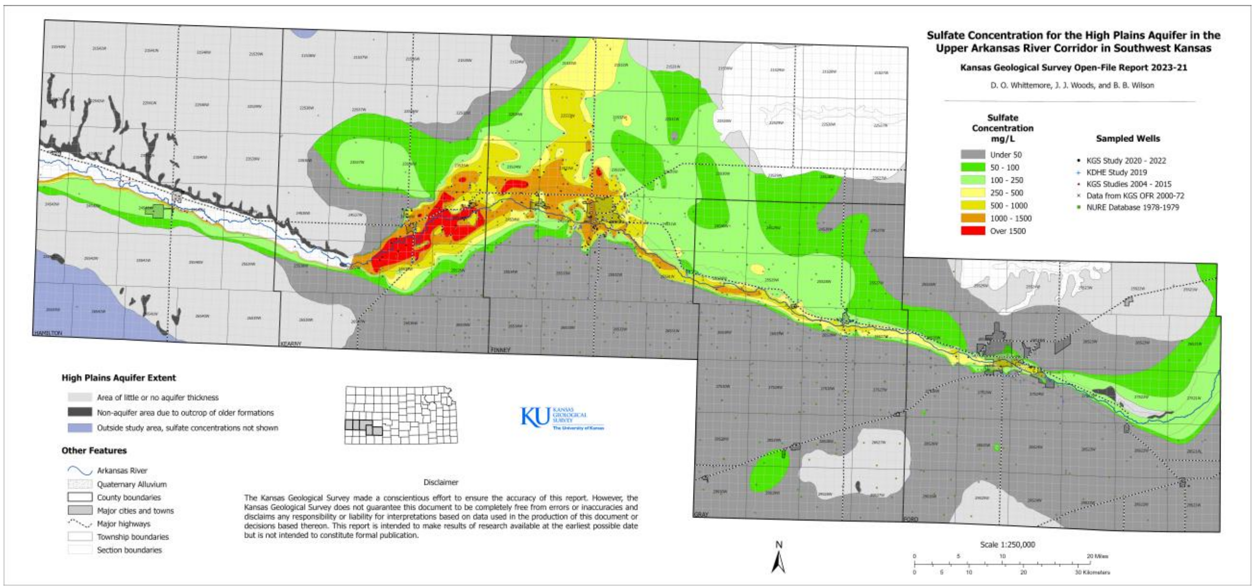


Figure 7. Distribution of sulfate concentration in the High Plains Aquifer in the upper Arkansas River corridor. Image taken from Whittemore 2023.

Water quality and quantity are interrelated and inseparable elements of water supply. The cities of Lakin, Deerfield, Holcomb, and Garden City, KS rely on groundwater that is being contaminated from river and irrigation ditch return flows, making it difficult to meet their municipal drinking water demands. In 2013, the city of Lakin constructed a nano-filtration facility and deep wastewater disposal well, at a cost of about $6 million, to meet the Environmental Protection Agency's (EPA) standards for uranium. This was a significant cost for a community with a population of 2200. The city of Deerfield (population 711) has had to stop using one well for supplying municipal drinking water and have a second well that last tested at 29 µg/L, just 1 µg below the EPA maximum contaminant limit (MCL) of 30 µg/L. Deerfield is currently exploring options for securing a reliable long-term drinking water supply.

Devegetation of the Sand Hills Region

Much of the sand hills region, located just south of the Arkansas River, has been converted from sagebrush prairie to irrigated agriculture. These dune sand soils have poor water retention, meaning that an irrigator is likely to need to apply more water than is needed in other regions to get a crop to harvest. The poor water retention, as well as the topography of the region makes the ground unsuitable for dryland farming and makes it difficult to establish native grasses to restore the native prairie if the irrigation system is removed or inoperable. Declining well yields make it difficult for farmers in some areas to maintain a crop during severe drought, and this has caused some instances of local sandstorms and drifting sands that have buried roads and portions of neighboring fields. The principle natural infrastructure benefit of the sand hill region is its high conductivity of water through sandy soils that are ideal for groundwater recharge. This condition readily accepts and delivers to the High Plains Aquifer all water made available from any source as natural or managed conservation storage.

High Chloride Control Area

The southeast portion of the project area, in southeastern Seward and southwestern Meade Counties, includes an area with deeper bedrock groundwater that is high in chlorides. This is caused by natural saltwater derived from evaporite mineral dissolution intruding from the upper Permian age bedrock into the overlying High Plains Aquifer. Saltwater is primarily of sodium-chloride chemical type. Saline water that intrudes to the High Plains Aquifer affects the usability of water for irrigation, domestic and other uses due to the high sodium and chloride contents (Whittemore et al. 2005). See Figure 8 for a map of chloride levels in Seward and Meade Counties.

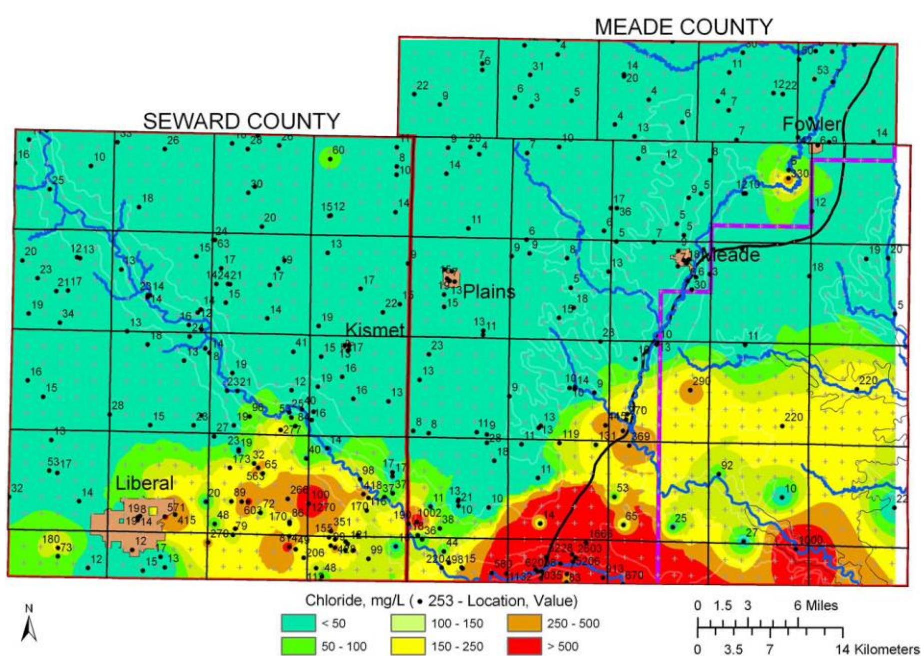
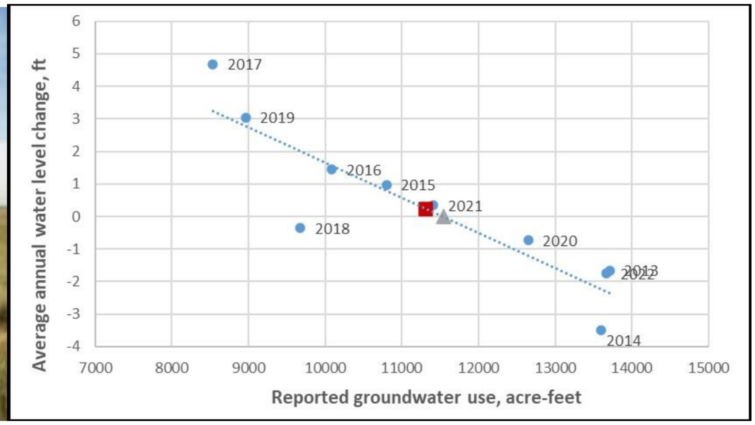


Figure 8. Distribution of sulfate concentration in groundwater aquifers in Seward and Meade Counties. Sourced from KGS Open File Report 2005-27.

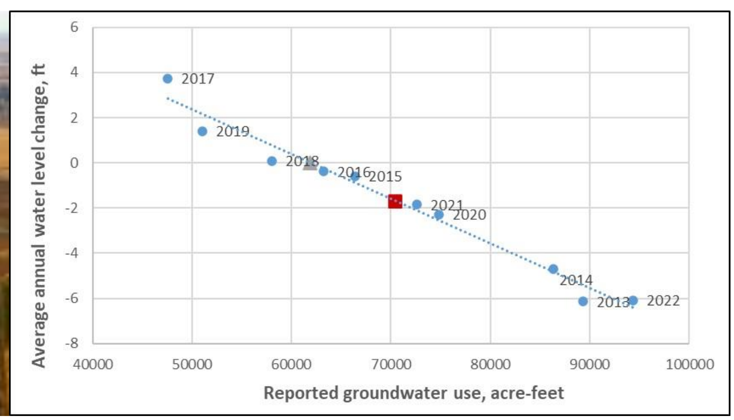
Additional data detail on the GMD3 high priority groundwater area.

NW Kearny County (NWK)



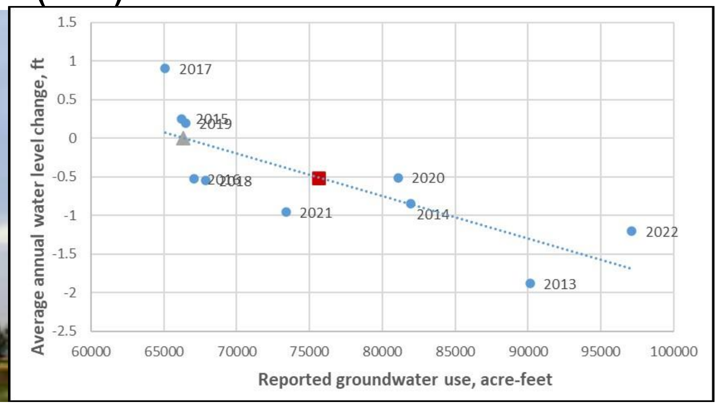
The upland areas of northwest Kearny County represent some of the lowest levels of groundwater use and thinnest portions of the Ogallala- High Plains aquifer within GMD3. The thickness of the aquifer averages 30 ft and increases substantially moving eastward, out of the region, into the Arkansas River valley. Over the last 10 years, water levels have been relatively stable. This region is 308 square miles in size and has 2 sub-regions for peer-to-peer well comparisons. From 2013 to 2022, the average water usage was 11,311 acre-feet and the average water-level change from continuously measured wells in the region was 0.25 feet. 80% of the variation in water-level change can be explained, statistically, by variations in pumping. Water levels have been stable over the last 10 years except for higher water use years, such as seen during dry conditions, which would require a 16% (2,200 acre-feet) reduction in pumping to stabilize water levels.

Ditch Service Area (DSA)



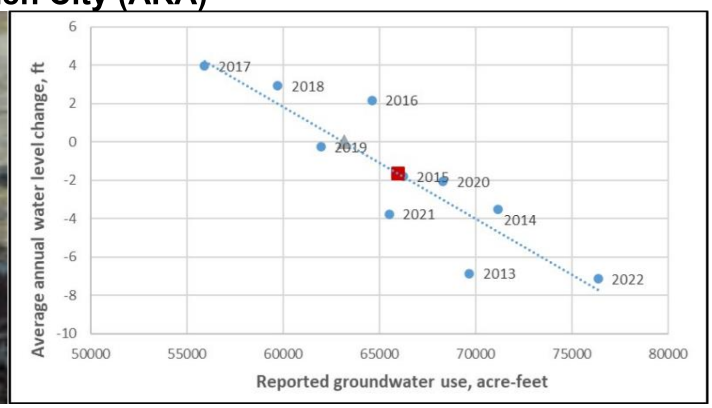
The availability of surface water from ditch delivery systems and proximity to the Arkansas River has significant impacts on groundwater pumping and recharge in this unique area of Kansas. Located in portions of Kearny and Finney counties, the ditch service area has the highest net inflows into the aquifer and the highest statistical relationship of all the I-CARE regions. The average thickness of the alluvial and underlying HPA is estimated to be 127 ft. Infiltration of water, originating from the Arkansas River, into the aquifer has elevated concentrations of sulfate and uranium.

Northern Finney and Gray Counties (NFG)



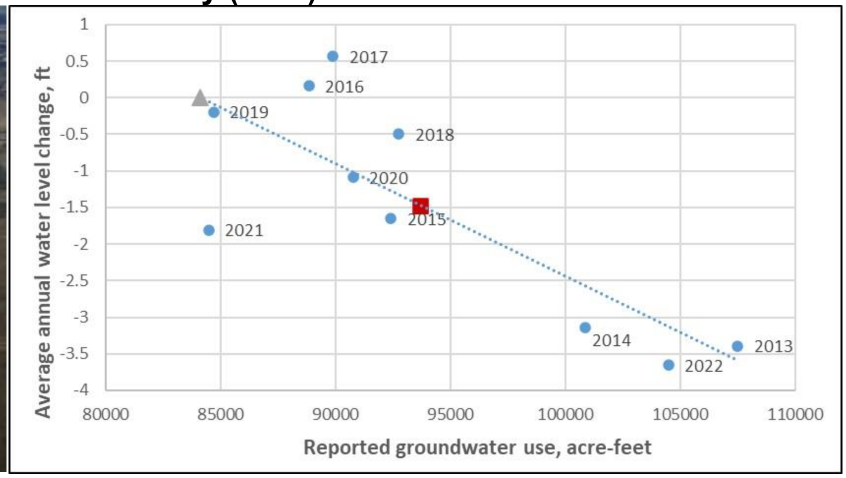
This loess (windblown deposits) region covers the northeastern fringes of the Ogallala extent and generally has lower rates of water usage and water-level declines compared to other areas in GMD3. The thickness of the HPA averages 54 feet and increases moving southward towards the Arkansas River valley.

Arkansas River Valley above Garden City (ARA)



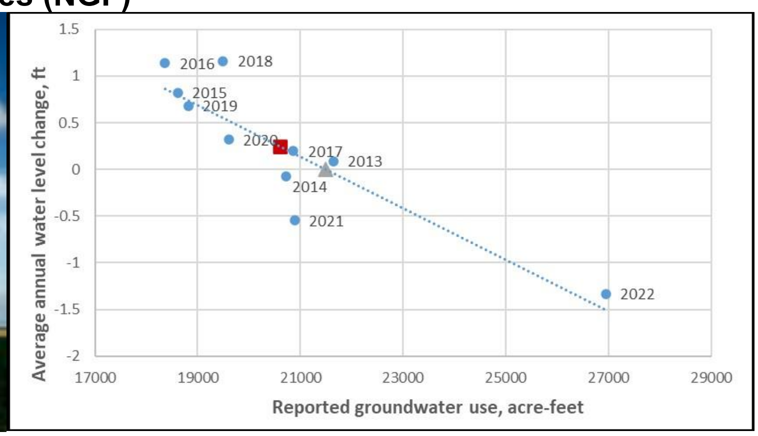
The upper end of the Arkansas River valley in GMD3 typically sees flow in the river, which in turn is diverted to support usage primarily in the ditch service region, located north and west of Garden City. The Ark River Valley has the second highest net-inflows for all the I-CARE regions, likely coming from enhanced recharge from the river itself and focused runoff into the valley. The average thickness of the alluvial and underlying High Plains aquifer is estimated to be 175 ft. Infiltration of water, originating from the Arkansas River, into the aquifer has elevated concentrations of sulfate and uranium.

Arkansas River Valley below Garden City (ARB)



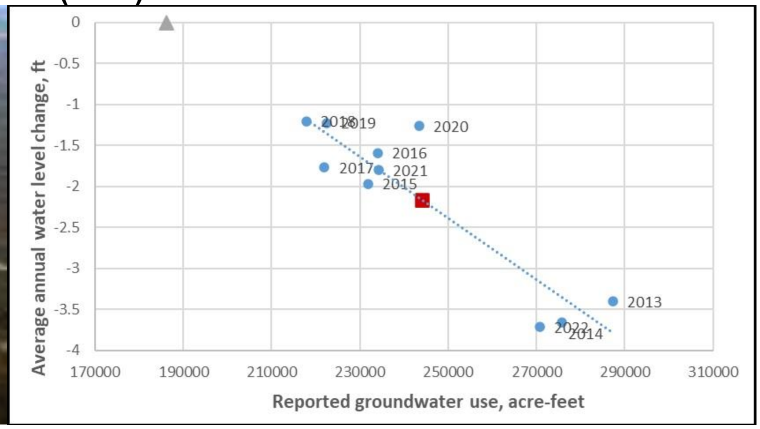
Although streamflow in the Arkansas River typically does not extend eastward beyond Garden City, the lower end of the Arkansas River valley in GMD3 still has relatively high rates of inflow into the underlying High Plains aquifer, likely coming from focused recharge into the valley from runoff. The average thickness of the alluvial and underlying High Plains aquifer is estimated to be 76 ft.

Northern Gray and Ford counties (NGF)



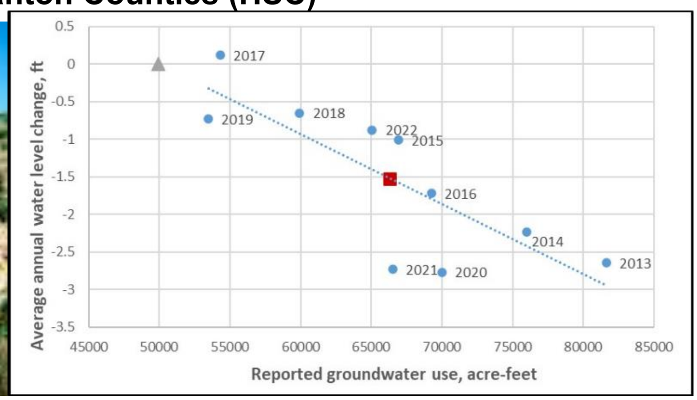
The HPA aquifer in this region transitions from the Ogallala into the Great Bend Prairie, which is centered primarily in south-central Kansas. The Dakota aquifer system also provides water for a small percentage of use here. The area has one of the smaller total uses and net inflows of all the I-CARE regions. Outside of drought years, water levels since predevelopment periods (~1940s) have been relatively stable. The thickness of the High Plains aquifer averages 44 feet and outcrops in areas southeast of Dodge City.

Sand Hills South of Arkansas River (SSA)



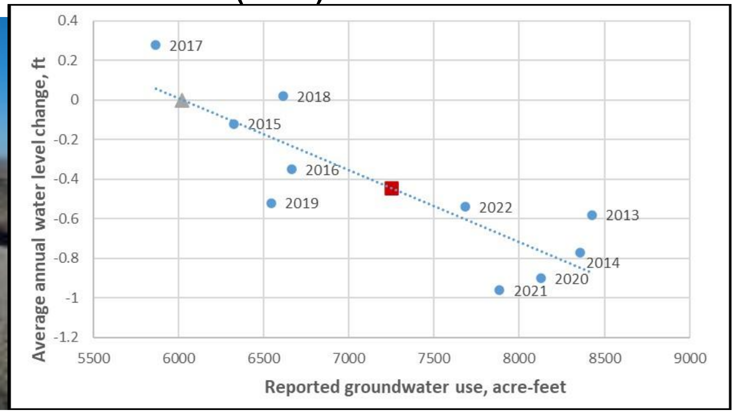
Located south of the Arkansas River, running from Kearny to Ford County, and overlain predominantly by dune sand, this region has some of the highest levels of water use, thickness of the aquifer, and rates of water-level declines of all the I-CARE regions. Enhanced recharge from the porous nature of the sand combined with high irrigation return flows allows the area to have relatively high net inflows. The average thickness of the High Plains aquifer is estimated to be 118 ft.

Southern Hamilton and Northern Stanton Counties (HSC)



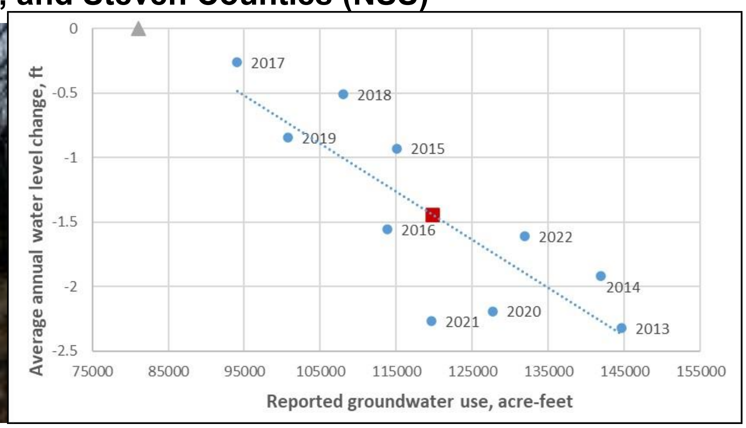
The source of water in this region comes primarily from the sandstone units of the Dakota aquifer system that are underlying and hydrologically connected to the Ogallala/HPA. Often referred to as the Bear Creek Fault Zone, this region is marked by a fractured bedrock trench formed from underlying salt-dissolution. The average thickness of the Ogallala/High Plains aquifer is estimated to be 45 ft while the thickness of the Dakota aquifer averages over 250 ft.

Southern Stanton and Northern Morton Counties (SMC)



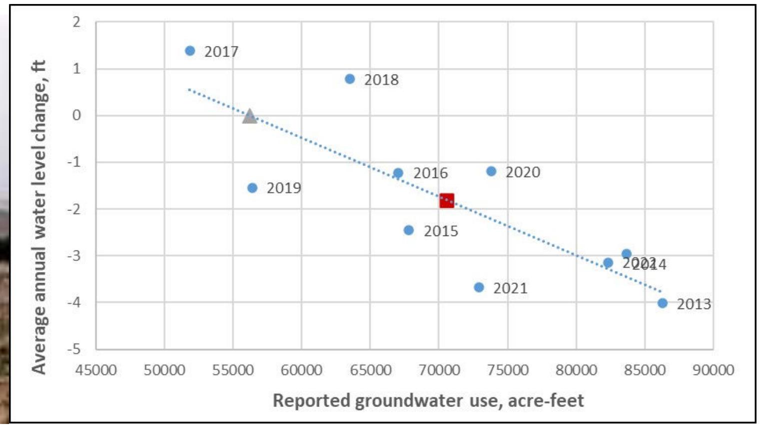
Most of the water in this area comes from sandstone units of the Dakota aquifer system, with the average thickness estimated to be over 200 feet. The Ogallala is very thin and outcrops in areas west and south of Manter, KS. Water use and the net inflows to the aquifer are the lowest of all the I-CARE regions. Obtaining a significant statistical relationship was difficult here and required using additional observation wells within 5 miles of the region's boundaries.

Corner of Stanton, Grant, Morton, and Steven Counties (NSS)



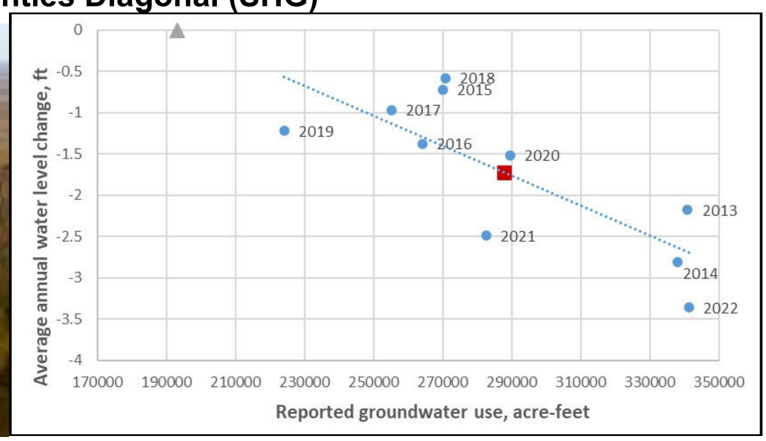
The source of water for this region comes from the Ogallala potion of the HPA and the underlying and hydrologically connected sandstones of the Dakota aquifer. The thickness of the HPA aquifer averages 119 feet. The thickness of the Dakota system averages 103 feet and is greatest in the northeast cover of Morton and southeast corner of Stanton counties. Obtaining a significant statistical relationship was difficult and required using additional observation wells within 5 miles of the region's boundaries.

Grant County Sliver (GCS)



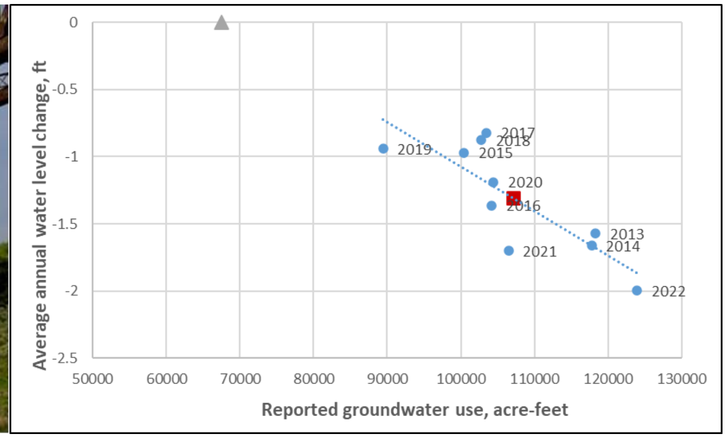
Running from the northern corner of Stevens/Seward counties diagonally northwestward across Grant County, the water source for this region comes from the Ogallala/High Plains aquifer and underlying and hydrologically connected sandstone units of the Dakota system. The average thickness of the Ogallala/High Plains aquifer is estimated to be 126 ft while the thickness of the Dakota aquifer averages 170 ft but increases greater moving from south to north.

Haskell, Seward, and Grant Counties Diagonal (SHG)



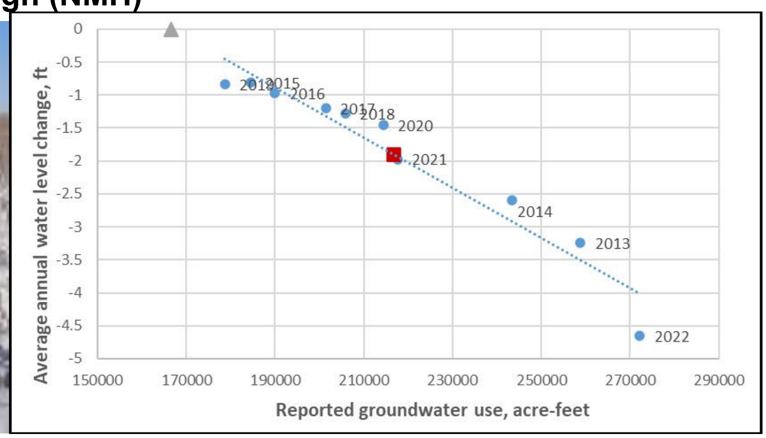
The largest of all the I-CARE regions in terms of extent, the source of water comes from the Ogallala portion of the High Plains aquifer and the underlying and hydrologically connected sandstones of the Dakota aquifer. The thickness of the HPA aquifer averages 187 feet and increases moving southward. Conversely, the thickness of the Dakota averages 144 feet and increases moving northward.

Chloride Area (CL)



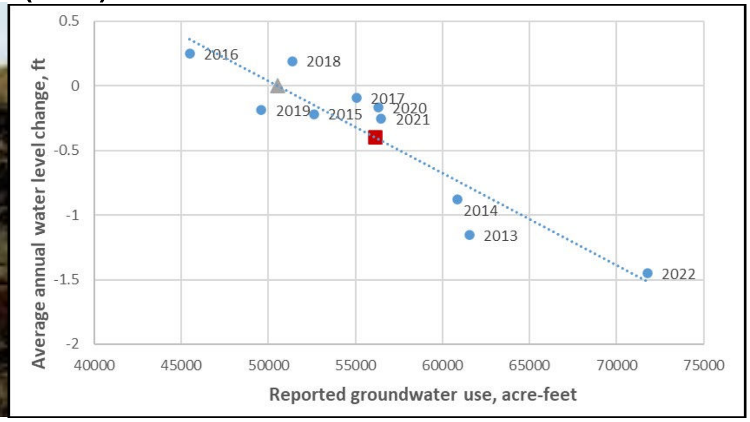
In southeast Seward and southwest Meade Counties, natural occurring saltwater, originating from underlying Permian red bedrock units may intrude upward into parts of the HPA, affecting its usability. Wells are restricted from tapping HPA groundwater that exceeds 250 milligrams per liter (mg/l) chlorides.

Haskell and Meade County Trough (NMH)



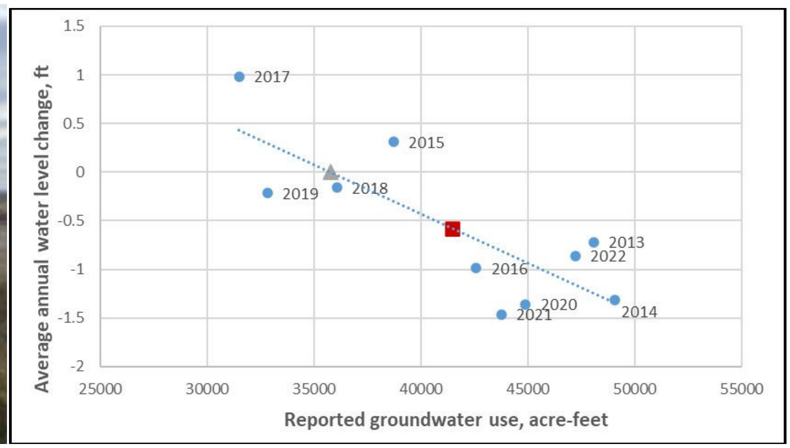
Located over a historical paleo stream channel and the Crooked Creek salt dissolution zone in Meade County, this region has some of the thickest portions of the High Plains aquifer and higher levels of water usage. This contributes higher return flows to the aquifer and results in this region having the third highest net inflows in GMD3. The thickness of the aquifer averages 183 feet and is the greatest in northern Meade County.

Southern Gray and Ford Counties (SGF)



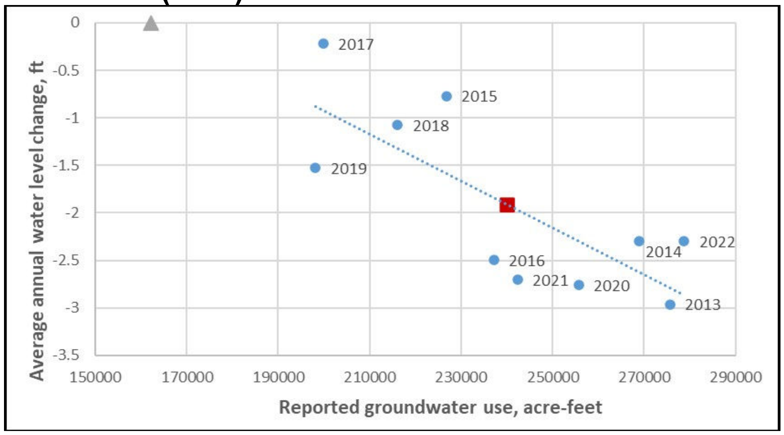
This is the second region in which the Ogallala transitions eastward into the Great Bend Prairie portion of the High Plains aquifer. The bedrock floor of the Ogallala rises to the surface between Montezuma and Ensign, south of Highway 54, effectively limiting any significant use of groundwater. The thickness of the HPA averages 55 feet and is greatest in the eastern extent of the region.

SW Morton County (SWM)



As the name implies, this region is located almost solely in Morton County where the Ogallala portion of the High Plains aquifer represents the primary groundwater source. The Cimarron National Grassland comprises a significant portion of this region. Precipitation runoff flows in the Cimarron River rapidly disappear as recharge to the Alluvial and Ogallala aquifers. Water usage here is relatively small but increases moving west to east, as does the aquifer thickness. The average thickness of the Ogallala is estimated to be 99 feet.

Southern Stevens, and Seward Counties (SSS)



Running along the state line with Oklahoma, this region is characterized by a broad upland that is lacking extensive surface drainage and that is covered by both dune sand and loess soils. Even with some of the greatest saturated thicknesses of the Ogallala/high plains Aquifer, there are some areas where the formations are comprised mostly of shale, which does not immediately provide high amounts of yield to pumping water wells.