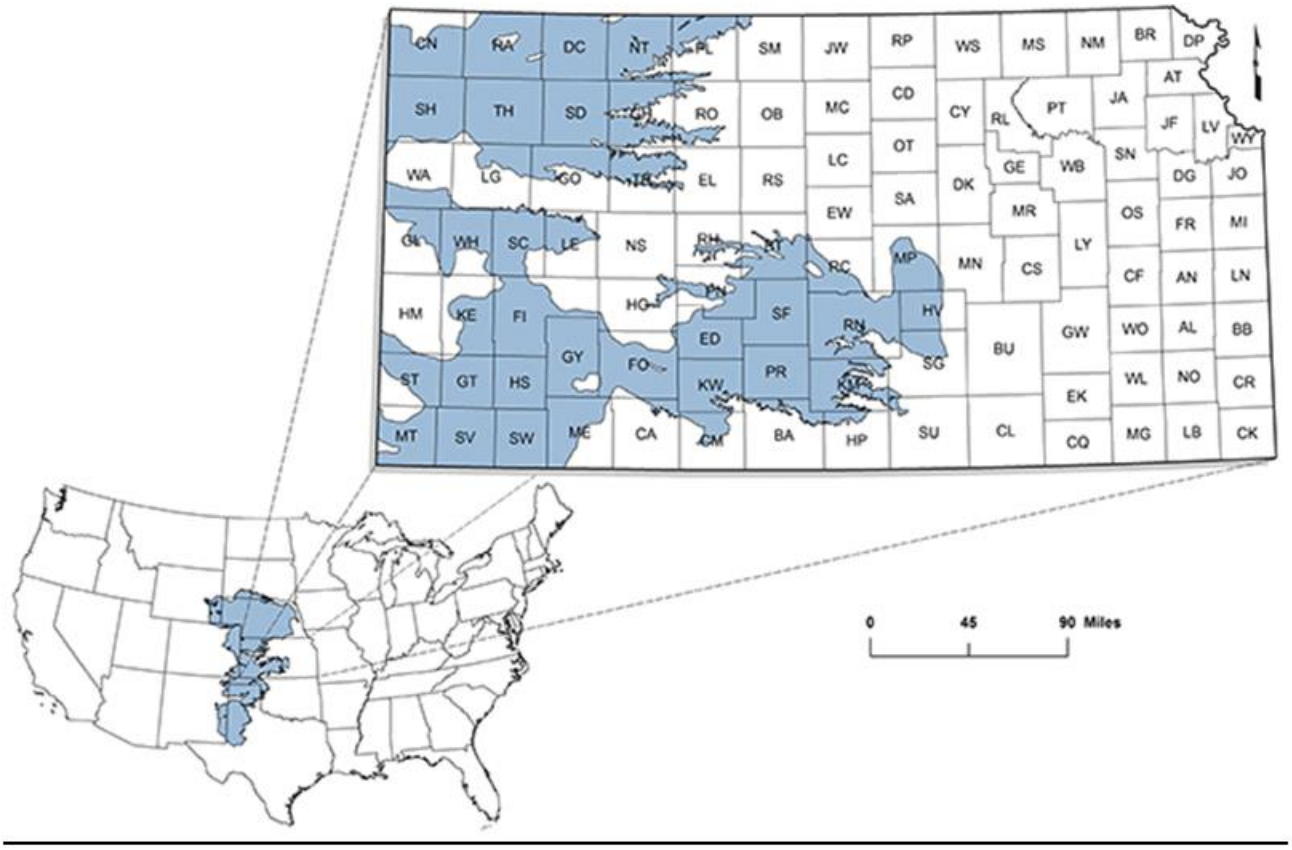
**The State Water Plan Guiding Principles**

# Conserving & Extending the High Plains Aquifer




## Background

The High Plains Aquifer (HPA) is the largest, most economically important groundwater source in Kansas. As can be seen below in Figure 1, it underlies western and south-central Kansas and is composed of several hydraulically connected aquifers. [(1)] The Ogallala, which is the largest of these, occurs in the western third of Kansas, an area that is semi-arid with limited surface water. The eastern extension of the High Plains Aquifer is composed of younger sediments that make up the Great Bend Prairie and Equus Beds aquifers. Lying above the Ogallala Formation are Pleistocene and younger stream valley deposits that bear water; where these are connected to the underlying aquifer, they are considered part of the High Plains aquifer.

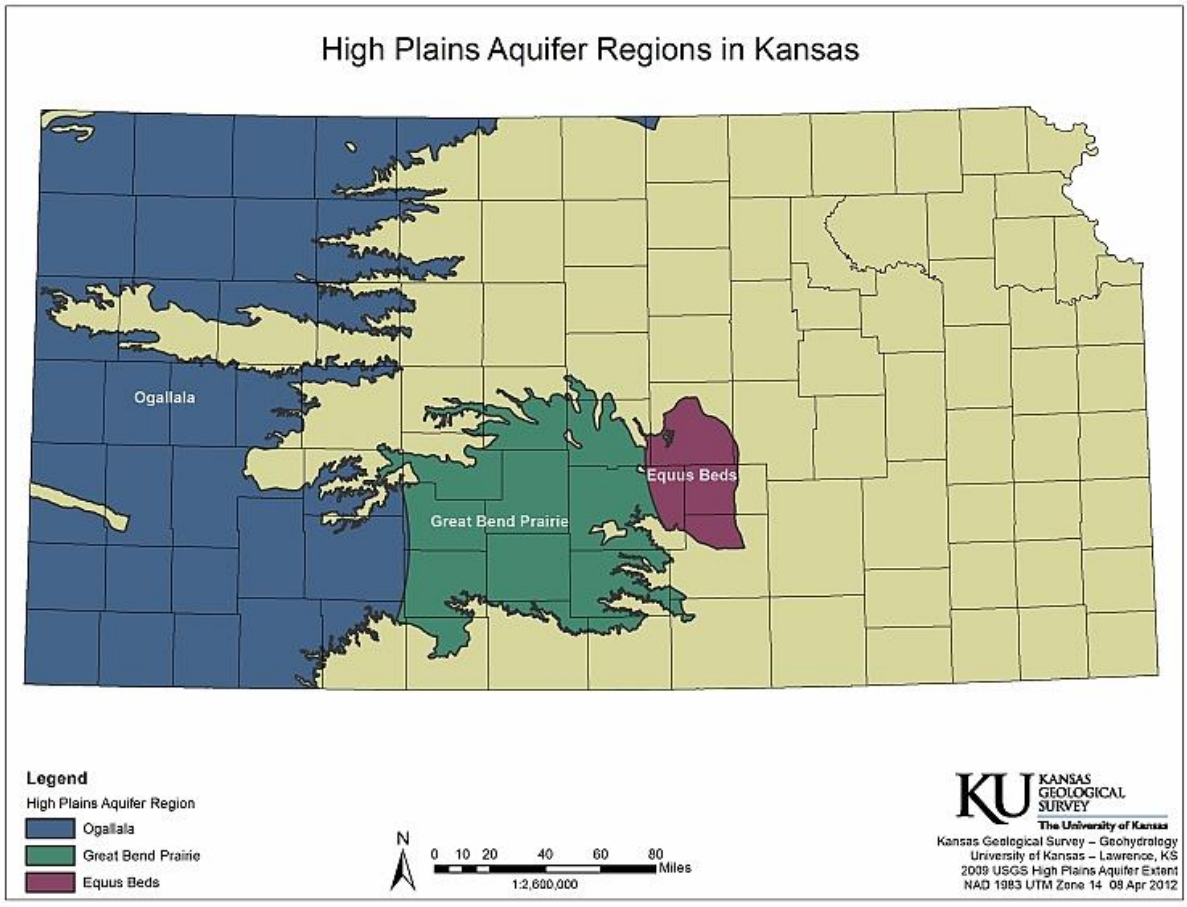



Figure 1. Map of the High Plains Aquifer in Kansas. [1]

In western and south-central Kansas, groundwater has historically been the most reliable source of large volumes of water for irrigation, municipal, and industrial use. To date, there have been over 50,000 water rights approved in all of Kansas with a majority of those approved for groundwater use in the HPA (fig. 2). [1]

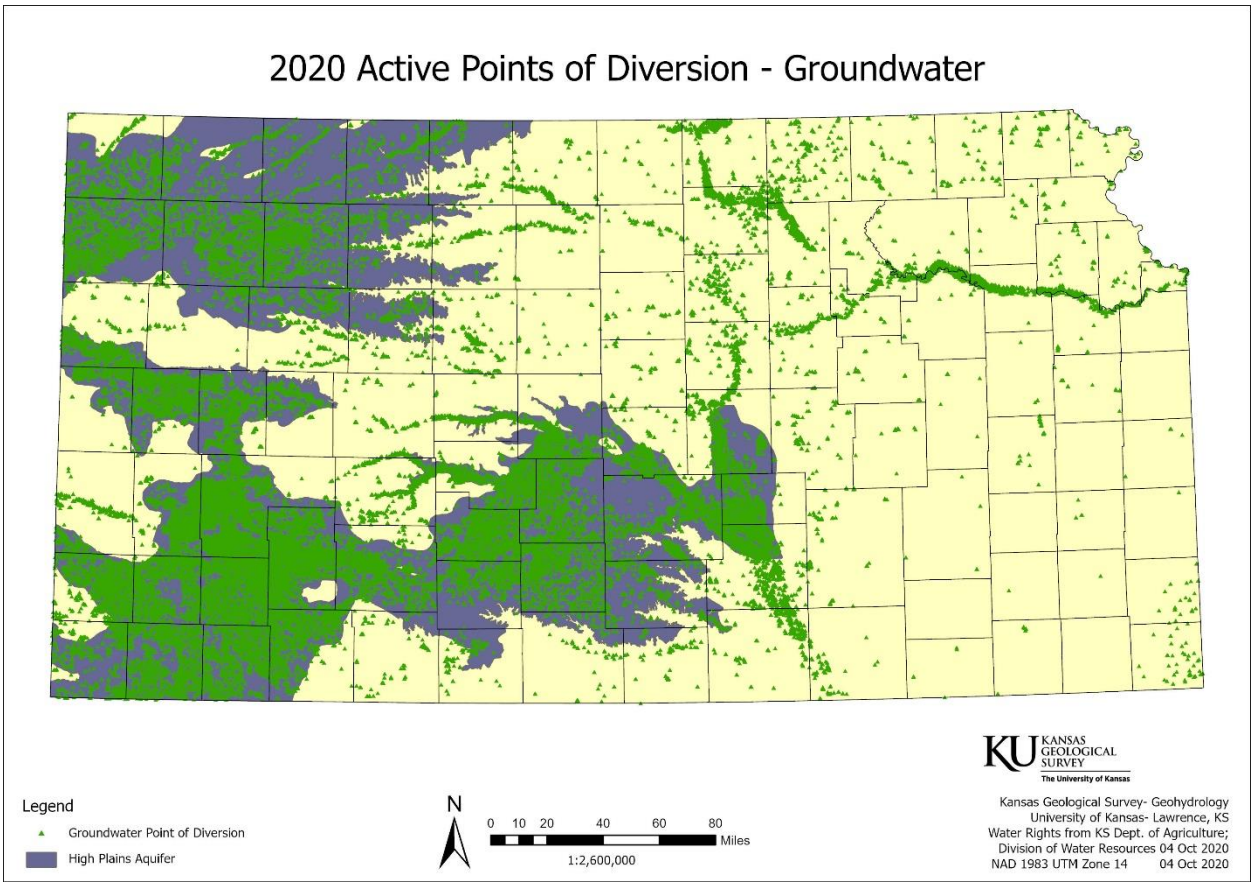



Figure 2. Map showing the 2020 active groundwater points of diversion in Kansas. [1]

The total average reported irrigated acres for 2010 to 2020 in the HPA is estimated to have been around 2.7 million acres. [22] Corn has been the most commonly grown crop in recent years. Given that corn may need up to 2 feet of water per acre per year, the HPA region may require up to 5.58 million acre-feet of water per year to grow corn and other crops. Although this total includes contribution from precipitation and some surface water, groundwater from the HPA has and will continue to be a very significant contributor.

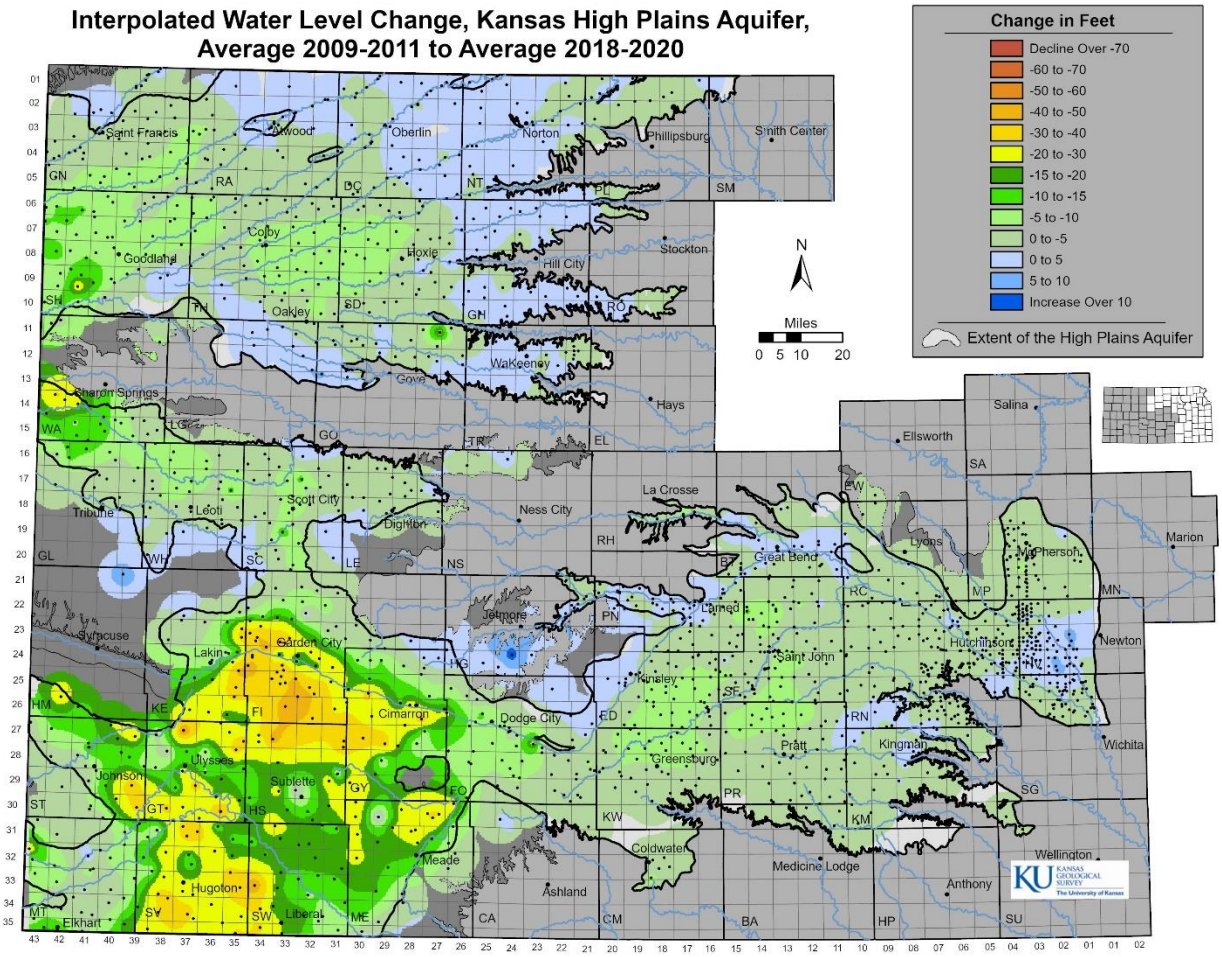



Figure 3. Map of the High Plains Aquifer region in Kansas showing the total water-level changes from 2009-2011 to 2018-2020. [(1)]

When pumping demands exceed the amount of water that recharges an aquifer, groundwater declines occur (fig. 3). [(1)] In the Kansas HPA, the saturated thickness and rates of groundwater decline are highly variable (fig. 4). [(1)] While some areas of the aquifer have effectively been depleted, other areas have substantial volumes of water still in storage. The Ogallala portion of the High Plains aquifer with its greater depths to water (fig. 5), lower precipitation, and lower recharge rates typically has higher groundwater declines relative to south-central Kansas. [(1)] The rate of water-level decline typically ranges from only a few inches to several feet per year, but can be as much as 15+ feet per year during drought conditions. Under current pumping demands, many areas of the aquifer have already experienced significant reductions in well yields, or are projected to within the next decade.

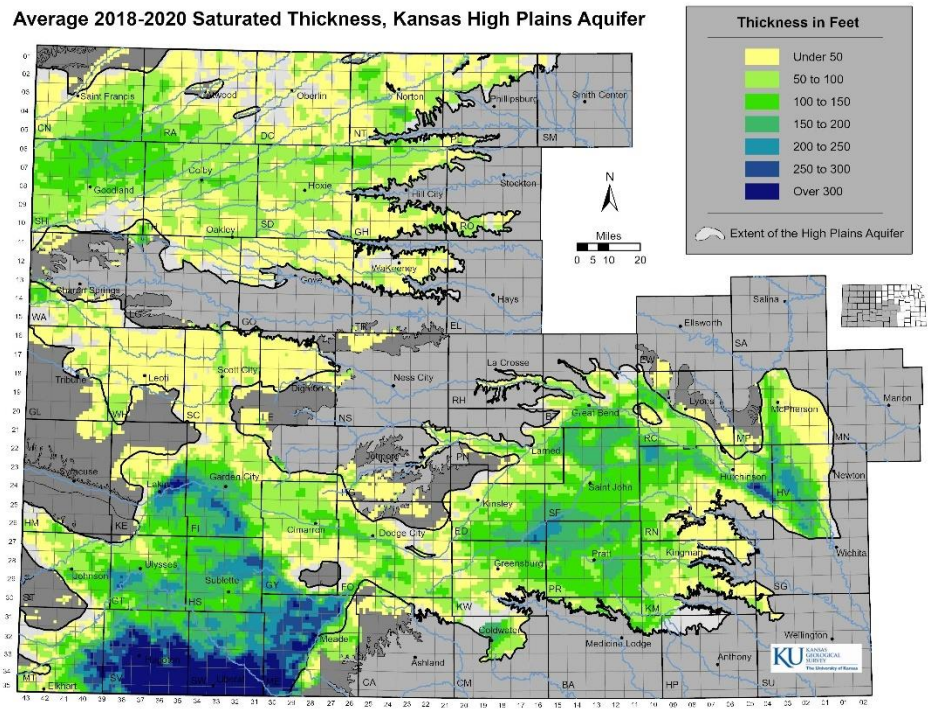



Figure 4. Map of the High Plains Aquifer region in Kansas showing the average saturated thickness for 2018-2020. Saturated thickness is the vertical thickness of the hydrogeologically defined aquifer in which the pore spaces of the material forming the aquifer are filled (saturated) with water. (1)

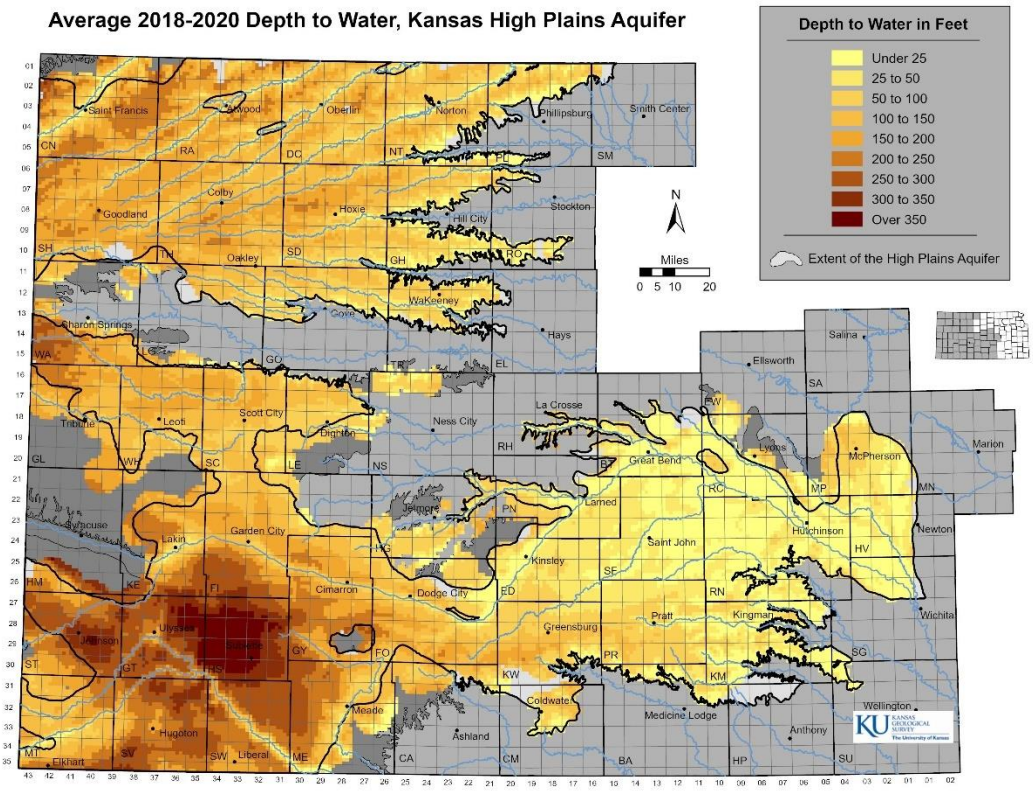



Figure 5. Map of High Plains Aquifer region in Kanas showing the average depth to water for 2018-2019. (1)

The Kansas HPA supports an extensive agricultural complex including irrigated crops, a large cattle and dairy industry, meat packing plants, and biofuel plants. Research has shown that the value of water, as measured in revenue generated, continues to increase for irrigated crops with more efficient crop water management, higher yielding crops, and higher prices. A separate economic study completed in 2013 by the Kansas Department of Agriculture showed that the statewide revenue for irrigated and dryland corn was 513 million and 43 million dollars, respectively. [23] Clearly, water resources are an important linchpin of the local and statewide economy. Thus, we should all strive to ensure that groundwater and surface water will be available for future generations of Kansans.

As the population continues to grow, there is a need for more crops, cattle, and energy. Each of these needs requires water for production. With the finite amount of water available in Kansas, we must strive to be efficient water consumers. The conservation efforts listed below are being utilized within the state to help conserve water and other resources. The state vision is to Conserve and Extend the High Plains aquifer for generations to come.

## Management Approach

The High Plains aquifer is essential to the economy and environment, as well as the well-being of our citizenry. A variety of local, state, and federal groups and agencies work together to help implement water conservation efforts within the region with the commitment to make every drop count. Local Groundwater Management Districts (GMDs), along with state and federal agencies like the Kansas Water Office (KWO), Kansas Department of Agriculture – Division of Water Resources (KDA-DWR), Kansas Department of Agriculture – Division of Conservation (KDA-DOC), Kansas Department of Health & Environment (KDHE), Kansas Geological Survey (KGS), K-State Research and Extension, United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS), United States Department of Agriculture – Farm Service Agency (USDA-FSA), and local Conservation District offices provide assistance to producers within the region through cost-share and incentives programs, conservation and environment programs, and education and outreach. New water appropriations are closed across most of the region by order of either the Chief Engineer or local GMDs (fig. 6), or are effectively closed through safe yield rules and regulations, or under special management restrictions (fig. 7). [2] Water rights owners adhere to a seniority system with “first in time, first in right” when it comes to water right disputes. It is through the willingness of water right owners in the region, who recognized the need for change, that the conservation efforts being made have had positive impacts to the aquifer.

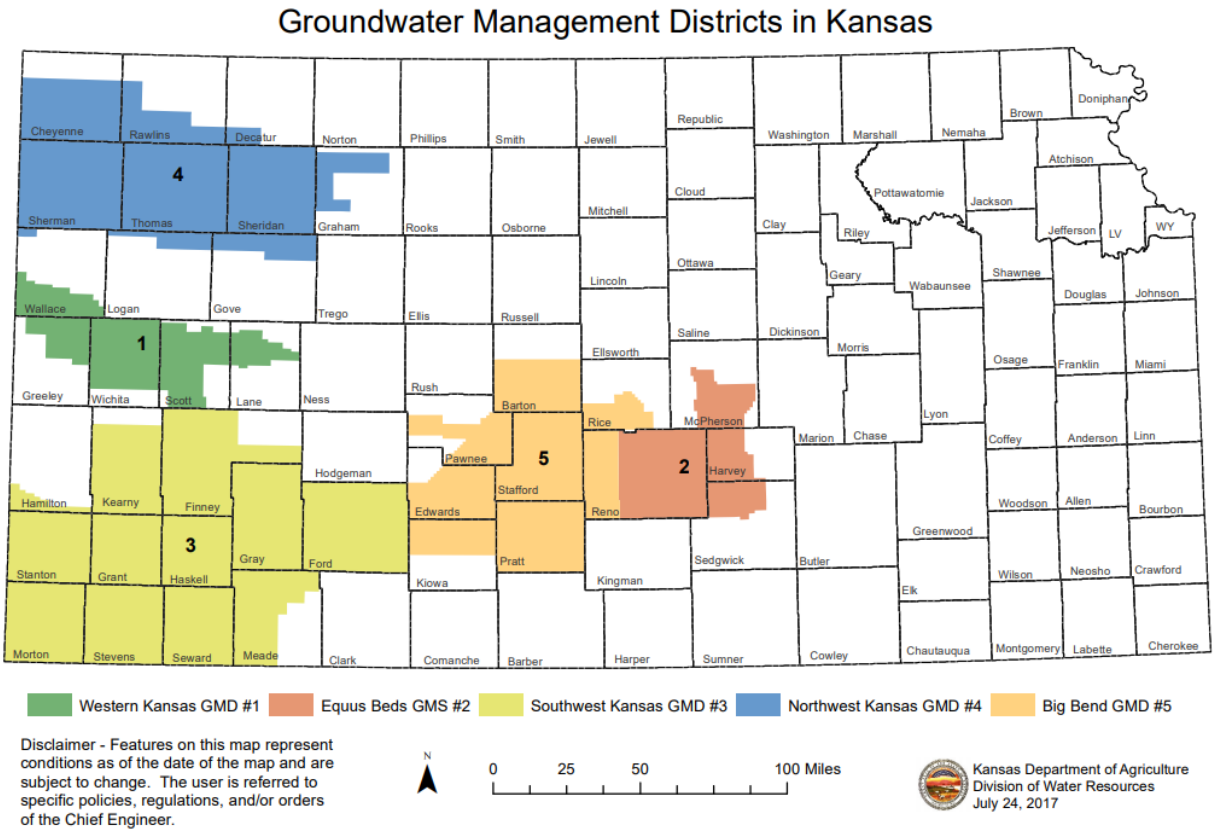



Figure 6. Map of the Groundwater Districts in Kansas. [2]

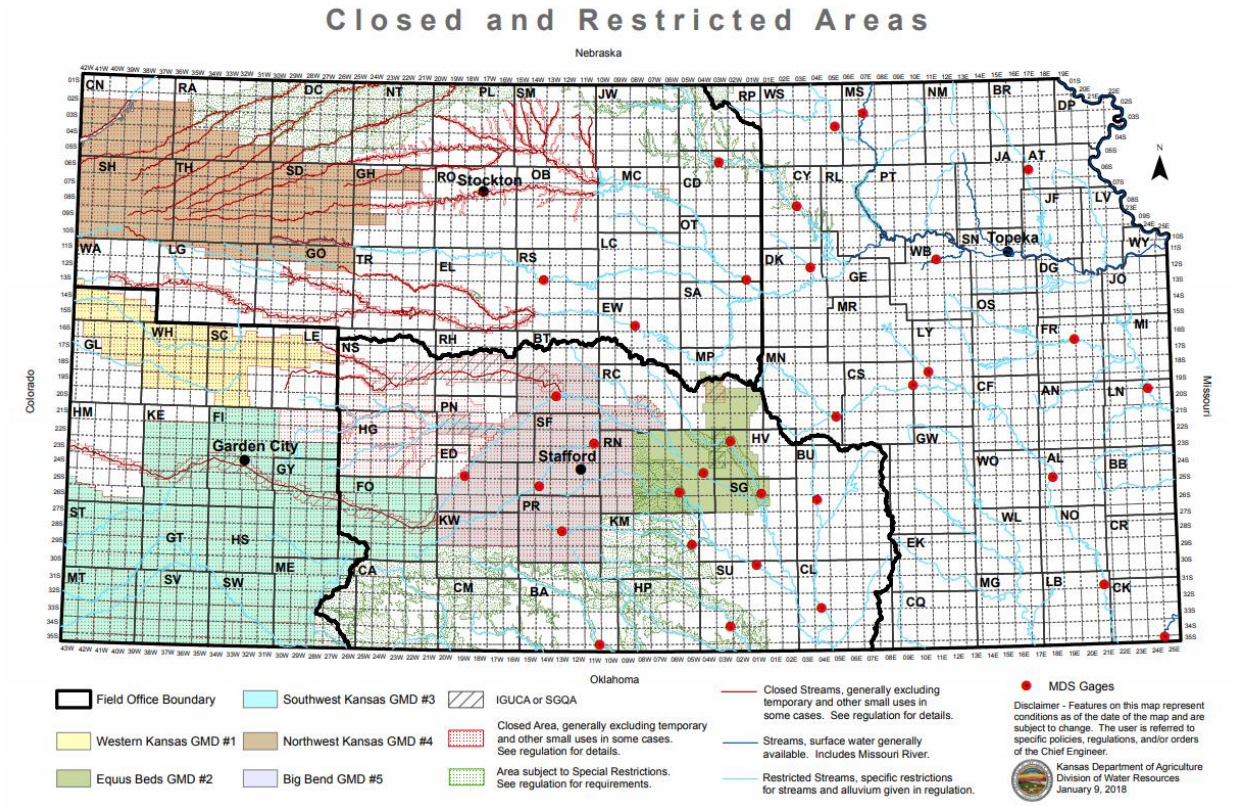



Figure 7. Map showing closed and restricted areas in Kansas to new water appropriations and the Groundwater Management Districts. (2)

The Mission from the *Vision for the Future of Water Supply in Kansas,* "Provide Kansans with the framework, policy and tools, developed in concert with stakeholders, to manage, secure and protect a reliable, long-term statewide water supply while balancing conservation with economic growth", describes the goal of the management approaches that are being implemented. The four guiding principles that helped to direct the development of the state Vision document are listed below. These principles will continue to guide the implementation and development of all future management approaches.

- Locally driven solutions have the highest opportunity for long term success. Therefore, the intentional focus of the action items presented in the Vision are to provide the necessary tools and support to allow for greater flexibility and management of water resources at the local level.
- Policies and programs should not unintentionally penalize those who have already demonstrated good stewardship with the state's water resources.
- Voluntary, incentive, and market-based water conservation and land management activities are the preferred tools for ensuring a reliable statewide water supply.
- Action is necessary now to ensure a reliable supply into the future.

The conservation efforts listed in the following table are some of the efforts currently being utilized within the state of Kansas to help conserve water and other resources.

| Regional Conservation Efforts | | |
|---|---|---|
| **Cost-Share & Incentives** | Water Transition Assistance Program (WTAP) | A program offered by KDA-DOC that pays water right owners in targeted areas that are closed to new water rights appropriations, to permanently dismiss all or a portion of their active water right(s). [3] |
| | Conservation Reserve Enhancement Program (CREP) – Kansas Upper Arkansas River | USDA-FSA offers a program to producers in the Upper Arkansas River counties in Kansas that pays irrigators to permanently transition acreage out of irrigated production and into grasslands or other conservation practices. [4] |
| | Water Banking | A market-based program currently in south-central Kansas that provides water conservation measures and allows the movement of water right allocations to areas of need within the same sub-basin, through long term leases of water rights. [5] |
| | Irrigation Technology Initiative | KDA-DOC offers cost-share funds to assist landowners with irrigation efficiency technology. This initiative is designed to promote irrigation efficiency and water conservation by providing cost-share assistance to landowners for automated soil moisture probes. [6] |
| | Environmental Quality Incentives Program (EQIP) | USDA-NRCS program that provides financial and technical assistance to producers to implement water conservation practices. [7] |
| **Conservation & Environment** | Regional Advisory Group (RAC) | Regional planning committees were established by KWA to focus on priority goals for the region and develop an action plan to help address water concerns and other issues within their region. [8] |
| | Local Enhanced Management Area (LEMA) | A program that allows a Groundwater Management District (GMD) to take action to conserve water usage in portions or all of their district. If recommended by the GMD and ordered by the Chief Engineer, the conservation measures temporarily override the appropriated water rights in the region. A LEMA has the potential to be highly effective due to local commitments and changes in farming practices. [9] |
| | Water Conservation Areas (WCA) | A program offered by KDA-DWR that allows individual farms the flexibility of their water right(s) on their land for a limited time period, as long as they officially agree to reduce water use during that period. [10] |

| | | |
|---|---|---|
| Education & Outreach | K-State Research and Extension (KSRE) | Offers information and guidance through their Mobile Irrigation Lab, KanSched, and Crop Water Allocator that help producers make the most efficient, economic use of their crop water. KSRE is looking into more water-tolerant crops and are experimenting with multiple crop varieties in order to learn what works best in different climates and if any new crop variety can be obtained for further water conservation. (11) |
| | Water Technology Farms | Kansas Water Office (KWO) offers producers free enrollment into the program to help demonstrate and educate other producers on the benefits of utilizing new irrigation technologies, practices, and services. (12) |
| | HPA Index Well Network | A Kansas Geological Survey (KGS) program that is focused on developing an improved understanding of aquifer dynamics at scales appropriate for management. The program has a monitoring network of 25+ wells with much of the data being presented in real-time on the KGS website to allow Kansans to understand conditions in the HPA in their area. An additional goal is to directly examine issues and areas of particular interest to the GMDs and KDA-DWR. (13) |

## Measuring Success

Much of the Ogallala portion of the High Plains aquifer has been heavily depleted since predevelopment. Projections in some areas show no more than 20 years of water remaining if pumping continues at current rates. Other areas in west-central Kansas have already reached the point of no return where many acres of once irrigated land have now been converted to dryland crops or cattle grazing. Some small areas in southwestern Kansas show more than 100 years of water remaining, but this is far from the rule in most of the HPA in western Kansas.

Although there are economic advantages to conserving water for future use, as well as consideration of future generations' needs, many producers still use their water rights to maximize the current benefit. Yet recent studies have shown that the same amount of yield or more can be accomplished with less water if new farming practices are introduced. (24)

The KGS currently has over 25 "Index Wells" that have been installed in the High Plains aquifer region and are recording water levels every hour (fig. 8). (13) The first three sites, located in Haskell (GMD3), Scott (GMD1), and southern Thomas (GMD4) counties were drilled in 2007. (13) Figures 9, 10, and 11 show the seasonal changes and trends in the water table for these three wells since they were installed.

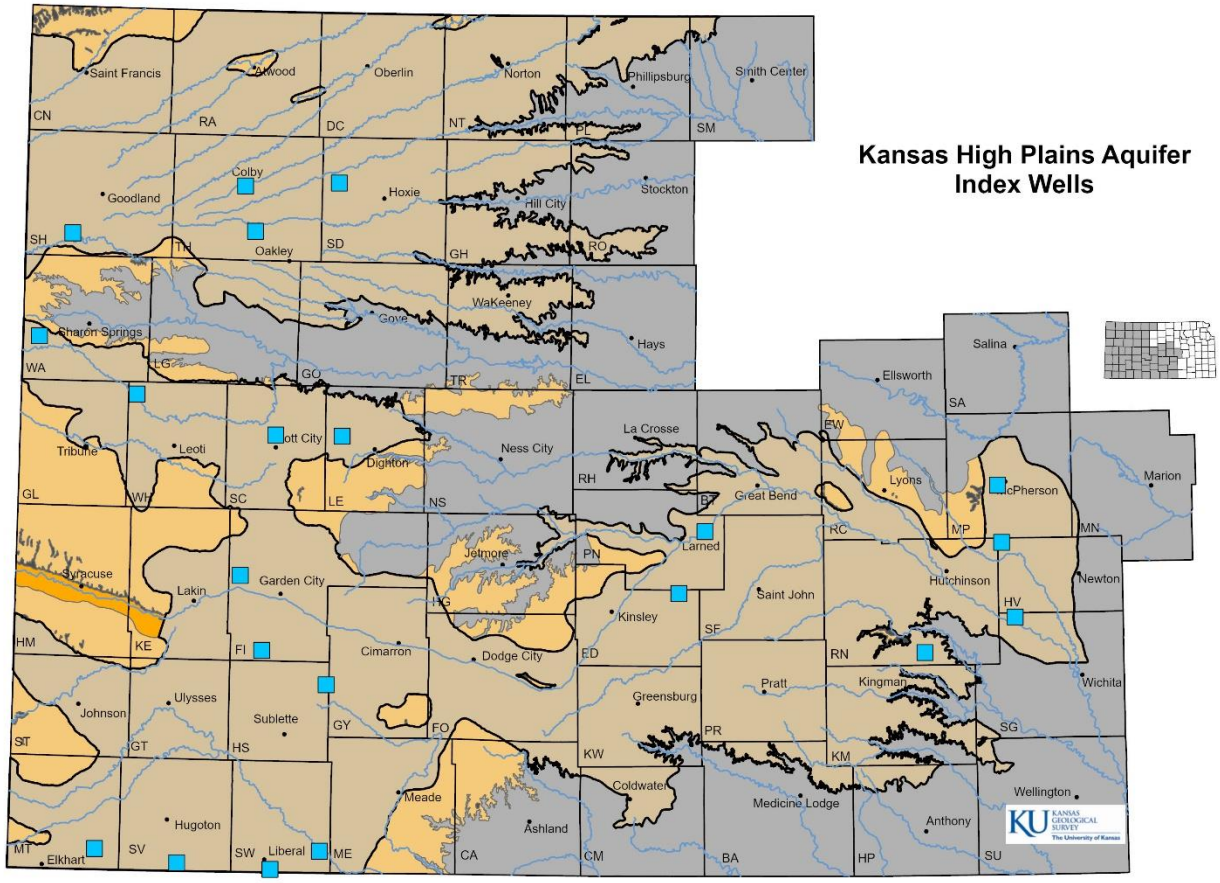



Figure 8. KGS Index Wells in the Kansas High Plains Aquifer. The blue boxes show the locations of each well. [13]

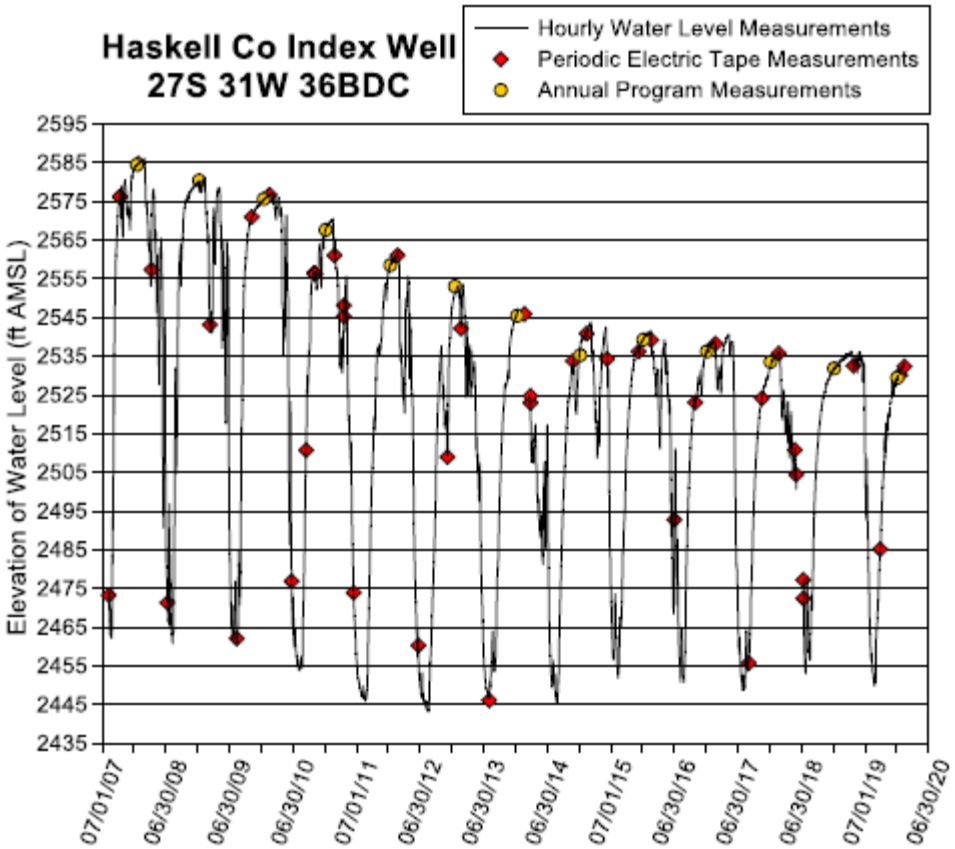



Figure 9. Haskell County index well hydrograph. The reduction in the rate of decline beginning in 2015 was due to a temporary curtailment of nearby pumping; the bottom of the aquifer is at an elevation of 2,405 ft. [13]

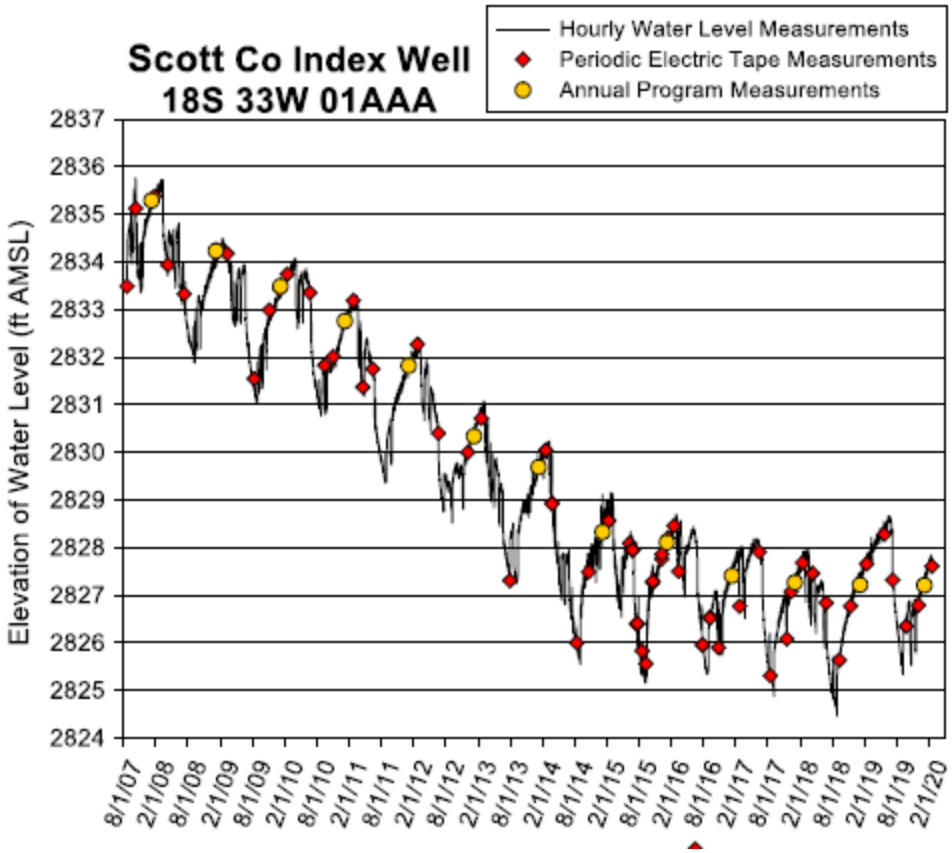



Figure 10. Scott County index well hydrograph. The increase in water level from 2018 to 2019 was due to a lengthy recovery period with virtually no pumping; the bottom of the aquifer is at an elevation of 2,744 ft. [13]

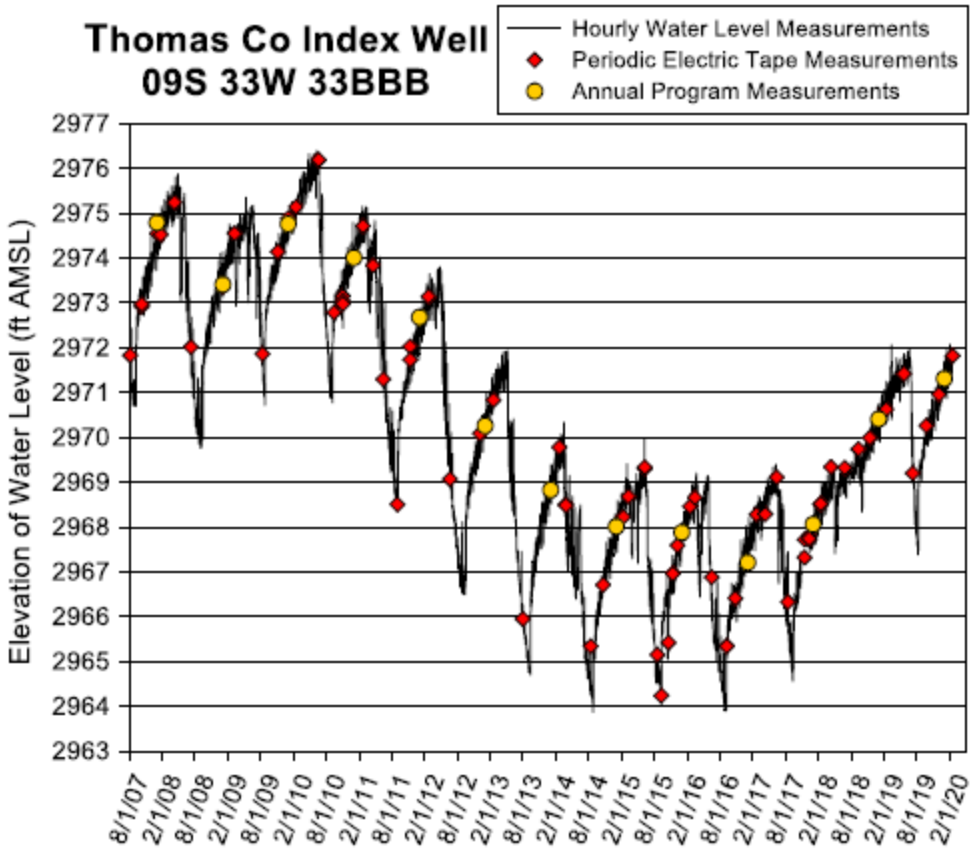



Figure 11. Thomas County index well hydrograph. The water-level increase in 2018 was due to a late-spring hailstorm that destroyed the crops in the immediate vicinity and ended the 2018 pumping season; the bottom of the aquifer is at an elevation of 2,904 ft. [13]

As can be seen in the graphs, water levels can vary substantially in a single year in response to irrigation-based pumping during the growing season and climatic conditions. In recent years, the overall rate of decline has improved as much of the HPA region has seen above average precipitation rates and resulting lesser pumping demands. When favorable and timely rains do not occur, groundwater withdrawals increase and water levels typically fall.

In addition to the index well program, the KGS and KDA-DWR measure roughly 1,400 wells across the High Plains aquifer each winter to monitor regional changes in the groundwater supply. The data collected can be accessed through the KGS WIZARD Water Well Levels Database available on the KGS website. [26]

Precipitation-based aquifer recharge is highly variable across Kansas. It can be influenced by a variety of factors including depth to water, intensity of water inflow, total precipitation and rate, temperatures, soil types, and regular land use. Research is also being conducted to explore if there is potentially a recharge source from the 20,000 plus playa lakes [14] in central and western Kansas. While infiltration of water at the land surface is helpful, it may take years to decades or even longer for a drop of water to travel from the surface to the water table depending on the location, depth, and material in the subsurface. The best method to keep groundwater available longer is to pump less.

Groundwater rights in Kansas allow for specific annual authorized quantities and uses that can be pumped year to year. Stakeholders have incentives to use all they are entitled to from a common pool, to reap short term benefits, when the negatives (water declines) are spread across many users. However, common pool resources have been successfully managed by and for those that rely on them, particularly with a locally developed plan that has clearly defined goals, rules, and regulatory oversight; an example of this is the Local Enhanced Management Area (LEMA) program. [9]

Sheridan County 6 (SD-6), was the first approved LEMA in Kansas. After initially meeting a water conservation goal of 20%, they almost doubled it, reducing withdrawals by 39%. LEMA participants renewed the program for another 5-year cycle in 2018. [15] GMD No. 4 has since developed another LEMA, which regulates nearly their entire district. [15] The success of GMD No. 4's execution of LEMAs has motivated other GMDs to look towards implementing them into their regions as well, with GMD No. 1 initiating a new one in Wichita County in 2021. [16]

Then Governor Brownback signed a bill in April of 2015 that allowed for the establishment of Water Conservation Areas (WCAs). [10] WCAs are a simple, streamlined, and flexible tool that allows any water right owner or group of owners the opportunity to develop a management plan to reduce withdrawals in an effort to extend the usable life of the aquifer in their area. To date, 53 WCA plans have been approved in the High Plains Aquifer region with a total of over 86,000 irrigated acres.

Water Technology Farms continue to showcase the latest in irrigation technology, field-scale research, and water conservation efforts. [12] The farms are public-private partnerships that began in 2016 and continue to demonstrate producers can reduce water use and input cost, while increasing overall profitability. This program is for the demonstration of technologies, such as soil moisture probes, mobile drip irrigation (MDI), sub-surface drip irrigation (SDI), more efficient nozzle packages, variable rate pivot systems, observational index wells, farm weather stations, direct crop sensing probes, dairy ice sweepers and water reuse systems, and services that include aerial imagery, soil sampling and mapping, soil health analysis, water tracking, cover crops, and no-till farming practices. With growing interest each year, more and more producers are realizing the impact that water-smart technology can have on their operations and the water-saving benefits for future generations.

Recent studies show that by using less water and introducing new farming practices, the same amount of yield or more can be produced. Crops varieties are also being introduced that use less water. [25] Thus, bringing to mind the concept of "less water use with a greater economic return", encouraging producers in the region to consider adopting new tools and practices.

Further efforts that have taken place in the HPA region are with the Ogallala Water Coordinated Agriculture Project (OWCAP), which is a USDA-NIFA funded, multidisciplinary research, and outreach project focused on helping to address issues related to groundwater declines and long-term agricultural sustainability in the High Plains region. [17] The Ogallala Water team's research aims to support the producers and other decision makers in the region to help sustain a productive and profitable agriculture, and to advance the knowledge needed to mitigate risks related to the aquifer's decline. [18]

In 2018 OWCAP hosted the Ogallala Aquifer Summit in Garden City, Kansas. During the summit attendees participated in interactive workshop sessions, Q&A periods, and evening social events, one of which featured Kansas' Water Technology Farms. [19] A report was compiled to summarize the ideas and input shared, and "next

steps" needed to continue the momentum generated at the Summit with regard to cross-state relationship building and collaboration. [19, 20]

Another summit took place in 2021 that was hosted virtually. The event was designed to build on and expend beyond the information shared and activities catalyzed by the inaugural 2018 summit. The goals of the summit were to increase networking and collaboration among the region's water-focused community members, encourage momentum of activities related to advancing ag water management and sustaining the vitality of the High Plains communities, and identify common vision, practices, and opportunities applicable across state lines that have the potential to benefit the aquifer region over the short- and long-term. Over two hundred individuals participated in the summit. Those that participated included producers, water district and city managers, technology and commodity group representatives, state and federal agency staff, university/extension staff, students, and others. Keynote speakers and panelist served as springboards for thought-provoking, and action-oriented discussions among participants in small group facilitated workshops that took place throughout the event. [21]

Helping to educate and change the mindset of Kansans in the High Plains aquifer region is crucial for helping to conserve water. Seeing the numbers and results of efforts being made proves that these methods work. It is all about being good stewards and prolonging the life of this finite resource.

## Recommended Actions and Strategies

Throughout the course of a calendar year, the Kansas Water Authority (KWA) and Regional Advisory Committees (RAC) meet regularly to address resource concerns and future agendas. Starting in the fall of 2019, the KWO held regional meetings with local stakeholders to discuss concerns in their areas and recommendations on steps to resolve such issues. Based on stakeholder feedback, it is suggested to take the following steps to help conserve and extend the High Plains Aquifer in the Kansas. These steps can help make a difference now but may also make an impact for generations to come. It is evident that improved coordination on water related issues with the state's primary water-related agencies through the creation of the Governor's Water Resources Subcabinet is necessary. This Executive level Subcabinet would provide agency collaboration to implement joint activities.

| **Recommended Actions and Strategies – Conserving & Extending the HPA** |
|---|
| Policy or Program Recommendations |
| • Increase incentives for water conservation programs<br>• Continue to support the KGS Index Well Program<br>• Provide more support to DWR for Compliance and Enforcement<br>• Provide greater support for promotion, development and management of Local Enhanced Management Areas (LEMAs) |
| Implementation Actions |
| • Continue to share pertinent HPA information<br>• Develop a curriculum to be taught in schools explaining the past, present, and future of the HPA and related issues<br>• Continuing to bring the eight Ogallala states to together to work on collaborative projects |
| Data, Research, and Studies |

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|---|
| • Increase support for Water Technology Farms<br>• More research on drought tolerant and low-water crops suitable for the area<br>• Provide the public with reports that include studies demonstrating the benefits of pumping less water |
| Funding and Resource Needs |
| • Make fully funding the State Water Plan a priority<br>• Coordinate with the Kansas Department of Commerce and the Marketing Division of the Kansas Department of Agriculture to consider incentives to recruit businesses and focus economic development on businesses that value water conservation, use water efficient technologies, and reduce the removal of water from the state<br>• Encourage value added processing within Kansas by providing financial or water right credit incentives to dairies and feedlots |

## Resources:

1. Kansas Geological Survey, High Plains/Ogallala Aquifer Information
   http://www.kgs.ku.edu/HighPlains/index.shtml

2. Kansas Department of Agriculture – Division of Water Resources, Map Library
   https://agriculture.ks.gov/divisions-programs/dwr/dwr-library/maps

3. Kansas Department of Agriculture – Division of Conservation, Water Conservation Programs
   https://agriculture.ks.gov/divisions-programs/division-of-conservation/water-conservation-programs

4. United States Department of Agriculture – Farm Service Agency, Conservation Reserve Enhancement Program – Kansas Upper Arkansas River, Fact Sheet
   https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/2017/crep_kansas_upper_arkansas_river_jan2017.pdf

5. Central Kansas Water Bank Association
   https://ckwba.org/

6. Kansas Department of Agriculture – Division of Conservation, Financial Assistance
   https://agriculture.ks.gov/divisions-programs/division-of-conservation/financial-assistance

7. United States Department of Agriculture – Natural Resources Conservation Service, Environmental Quality Incentives Program
   https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

8. Kansas Water Office, Regional Advisory Committees
   https://kwo.ks.gov/about-the-kwo/regional-advisory-committees

9. Kansas Department of Agriculture – Division of Water Resources, Local Enhanced Management Areas
   https://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/local-enhanced-management-areas

10. Kansas Department of Agriculture – Division of Water Resources, Water Conservation Areas
https://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/wca

11. K-State Research and Extension
https://www.ksre.k-state.edu/

12. Kansas Water Office, Water Technology Farms
https://kwo.ks.gov/projects/water-technology-farms

13. Kansas Geological Survey, High Plains/Ogallala Aquifer Information, Index Well Program
http://www.kgs.ku.edu/HighPlains/OHP/index_program/index.shtml

14. Playa Lakes Joint Venture
https://pljv.org/

15. Groundwater Management District No. 4
https://www.gmd4.org/index.html

16. Groundwater Management District No. 1
https://www.gmd1.org/

17. The Ogallala Water Coordinated Agriculture Project
http://ogallalawater.org/

18. The Ogallala Water Coordinated Agriculture Project, Project Scope
http://ogallalawater.org/project-scope/

19. The Ogallala Water Coordinated Agriculture Project, 2018 Ogallala Aquifer Summit
http://ogallalawater.org/2018-ogallala-aquifer-summit/

20. The Ogallala Water Coordinated Agriculture Project, Ogallala Summit Summary Report
http://ogallalawater.org/ogallala-summit-summary-report/

21. The Ogallala Water Coordinated Agriculture Project, 2021 Ogallala Aquifer Summit
http://ogallalawater.org/2021-ogallala-aquifer-summit/

22. Reference to total irrigated acres in HPA

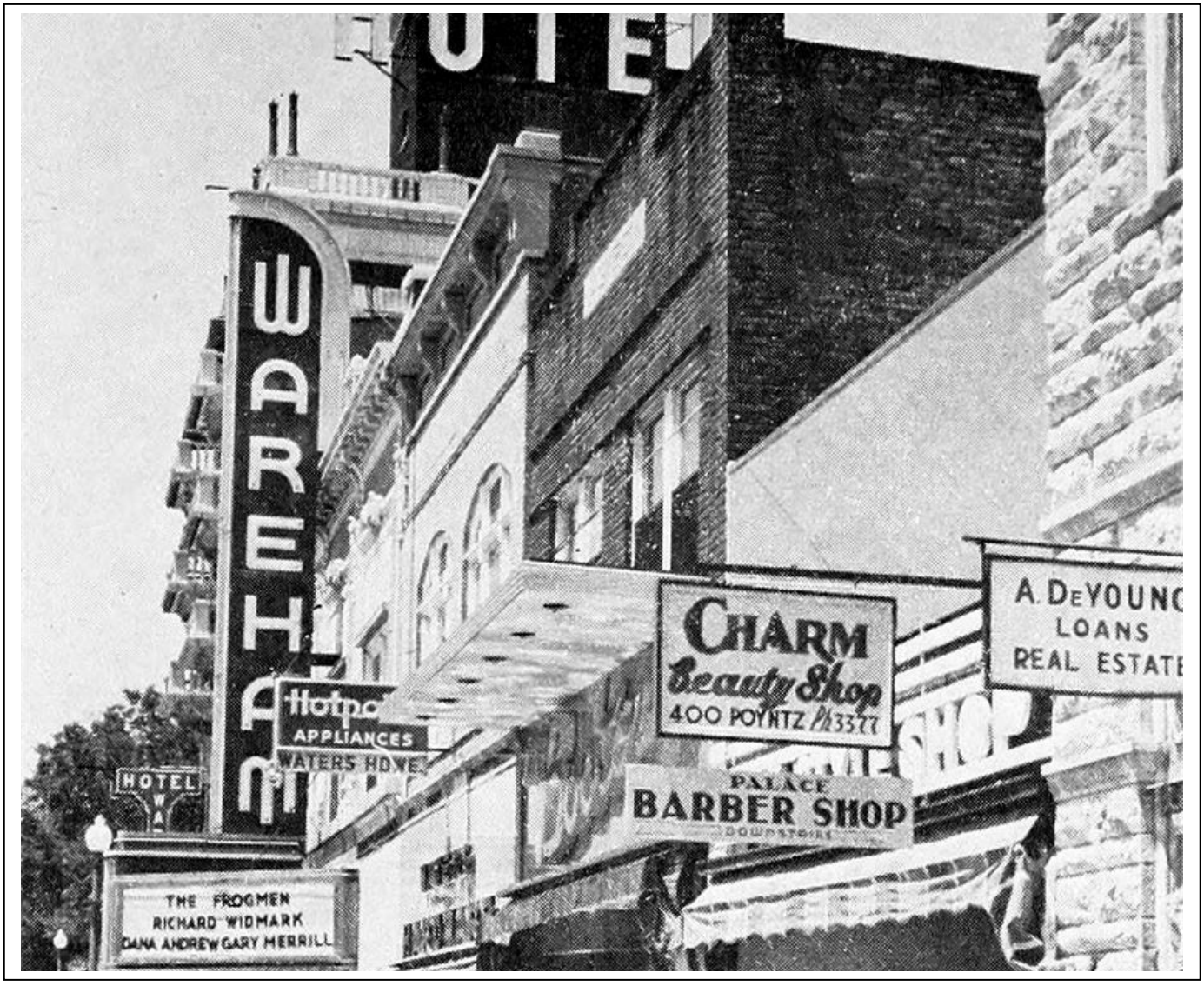
23. Reference to KDA study

24. Reference to more studies that show the same amount of yield or more can be accomplished with less water if new farming practices are introduced

25. Reference to crop varieties that are being introduced that use less water

26. Kansas Geological Survey, WIZARD Water Well Levels Database
http://www.kgs.ku.edu/Magellan/WaterLevels/index.html

# Reducing our Vulnerability to Extreme Events




## Background and Issue

Extreme weather events impact Kansas regularly. Severe flooding occurred in Kansas in 1935, 1951, 1965, 1973, 1976, 1981, 1983, 2007, 2011 and again in 2019. Kansas has also repeatedly experienced droughts, with most aware of the "dirty thirties" and the 1950s drought, and while these events have typically been used as standards for severe droughts in Kansas in the past hundred years, paleoclimate proxy evidence indicates droughts in Kansas of even greater severity and duration over the past thousand years. [(1)] The state's diverse climate and propensity for both extremely wet and dry conditions creates unique challenges. In some years, both flooding and drought can occur simultaneously, as they did in 2011 when above-average snowpack melt

and precipitation impacted the Missouri River system and caused northeast Kansas to flood while much of the state was in a moderate to exceptional drought. [2]

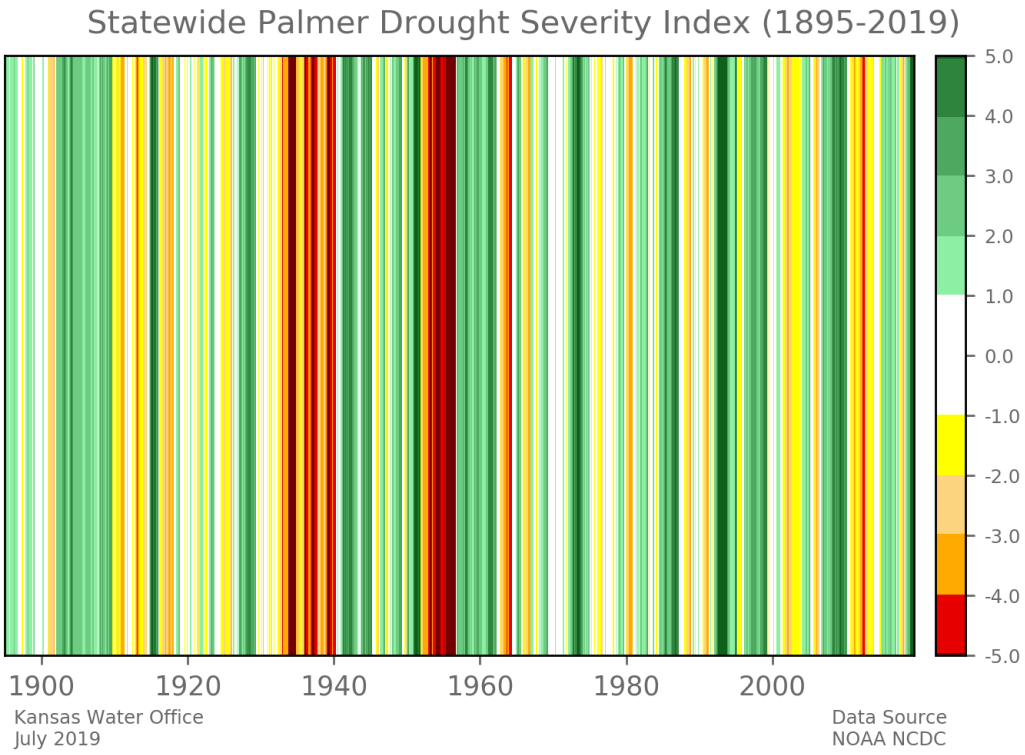



Figure 1. Historical Kansas Palmer Drought Severity Index (PDSI) values.
PDSI utilizes precipitation, temperature, and available water content data to estimate relative dryness. Classifications typically range from extremely wet (PDSI > 4.0) to extreme drought (PDSI < -4.0). Historical PDSI data illustrates the year-to-year variability of water resources in Kansas, as well as the severity of extreme events like the 1930s and 1950s droughts.

Climatologists have warned that Kansas is facing a warming trend in our future accompanied by a potential increase in the frequency, duration, and intensity of extreme events. Recent decades support this trend, with temperature increases particularly notable in the spring, [3] which affects the planting of crops. The Fourth National Climate Assessment, 2018, projects that average annual temperatures will increase in the Southern Great Plains by 4.4 to 8.4 degrees Fahrenheit by the late 21st century, compared to average conditions for 1976-2005. [4] Even small increases in average temperatures result in increased evaporation and evapotranspiration, as well as raise the risk of heat waves, wildfires, and droughts. Additionally, higher surface water evaporation and more turbulent atmospheric conditions can lead to severe weather.

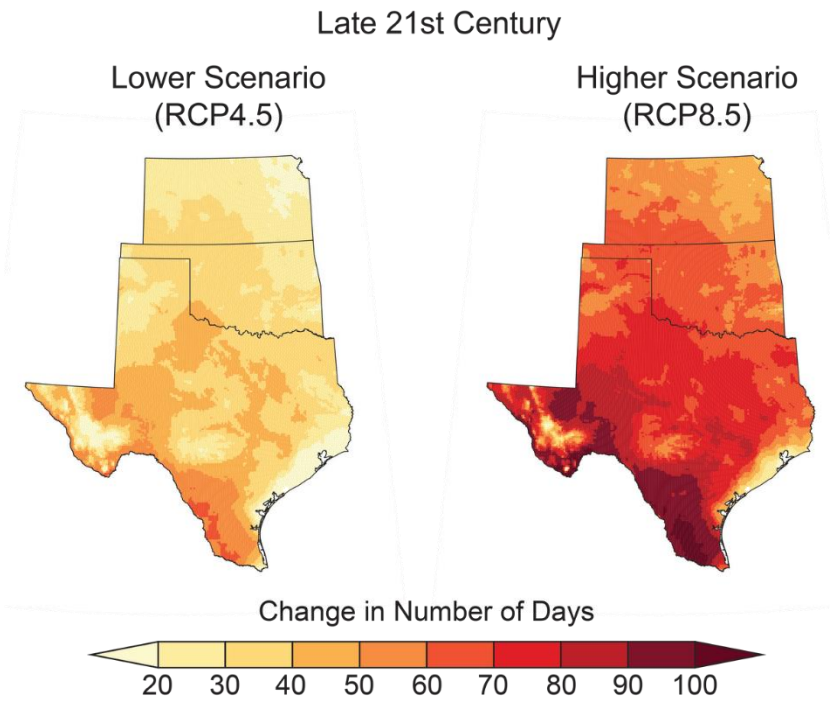



Figure 2. Projected increase in number of days above 100°F throughout the Southern Great Plains. The Representative Concentration Pathways (RCP) are greenhouse gas concentration trajectories used by the Intergovernmental Panel on Climate Change (IPCC) and are labeled based on projected radiative forcing values (RCP4.5 - lower scenario, RCP8.5 - higher scenario), a measure of the greenhouse effect, in 2100. [4]
(from Kloesel et al., 2018)

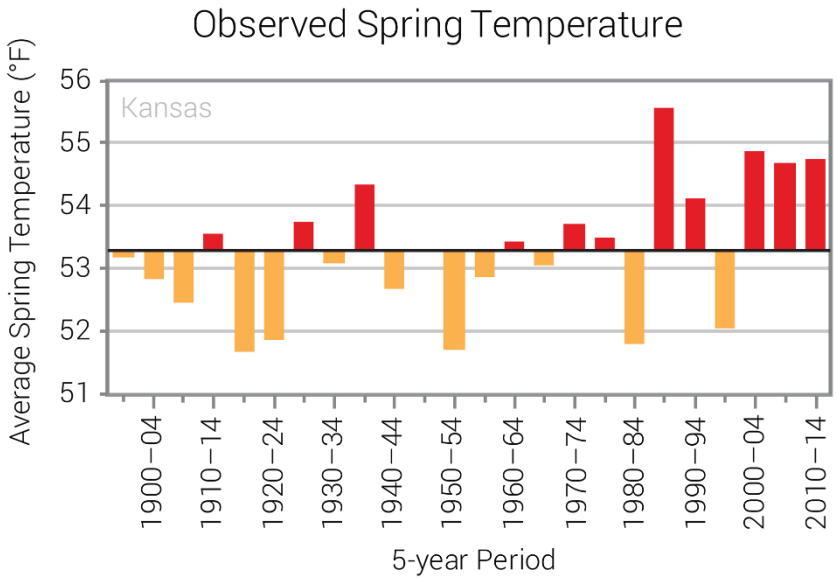



Figure 3. Warming trends in Kansas have been particularly noticeable in the spring in recent decades. [3]
(from Frankson et al., 2017)

Future predictions for average annual precipitation are somewhat uncertain, with projections indicating a slight increase in winter precipitation and decrease in summer precipitation. However, the anticipated increase in the frequency and intensity of extreme precipitation events could result in generally decreased soil moisture, as soil would have less time to absorb the precipitation and longer periods between precipitation

events to dry out. Such conditions would have a direct, negative impact on agriculture and put a greater strain on flood management infrastructure.

The precipitation figure below illustrates the inherent variability and climatic challenges in our state. What has historically allowed the State of Kansas to grow and prosper is the monitoring and utilization of water resources to combat extreme events. The State supports extensive monitoring, such as the Kansas Mesonet[5] and the streamgaging partnership with the United States Geological Survey (USGS)[6], to evaluate historical events and assess when current conditions are approaching a critical point. The Kansas Mesonet, housed at Kansas State University, supports multiple state agencies and water resource managers through their network of weather stations, weather summaries, and climate analyses. In addition to housing the State's Weather Data Library, the Mesonet provides education and outreach to ag producers and K-12 stem initiatives, research support for our State's universities, and many other decision support tools to Kansans. To access the Weather Data Library or to learn more about the services provided by the Kansas Mesonet, visit their website. The USGS streamgaging network provides near real-time, continuous flow monitoring throughout the state of Kansas. Monitoring data are used to generate flow statistics and duration curves and are posted on the USGS website through the National Water Information System. These efforts help us to understand how extreme events have impacted Kansas in the past and project how they may continue to do so in the future.

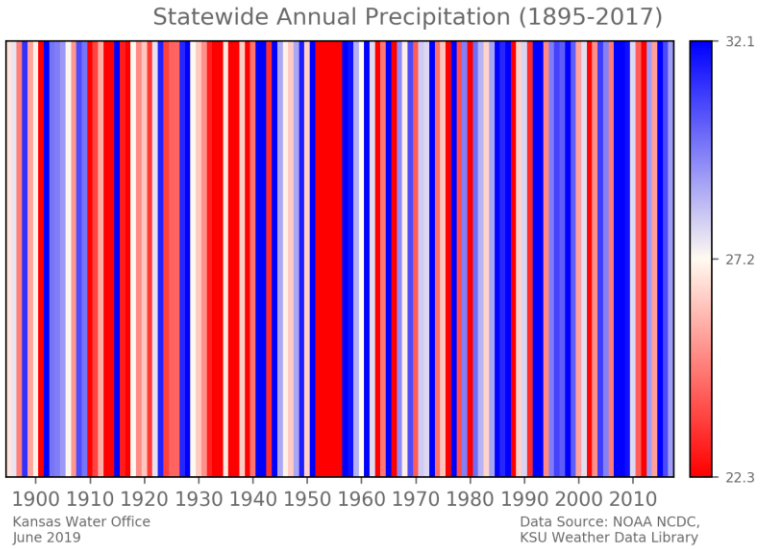
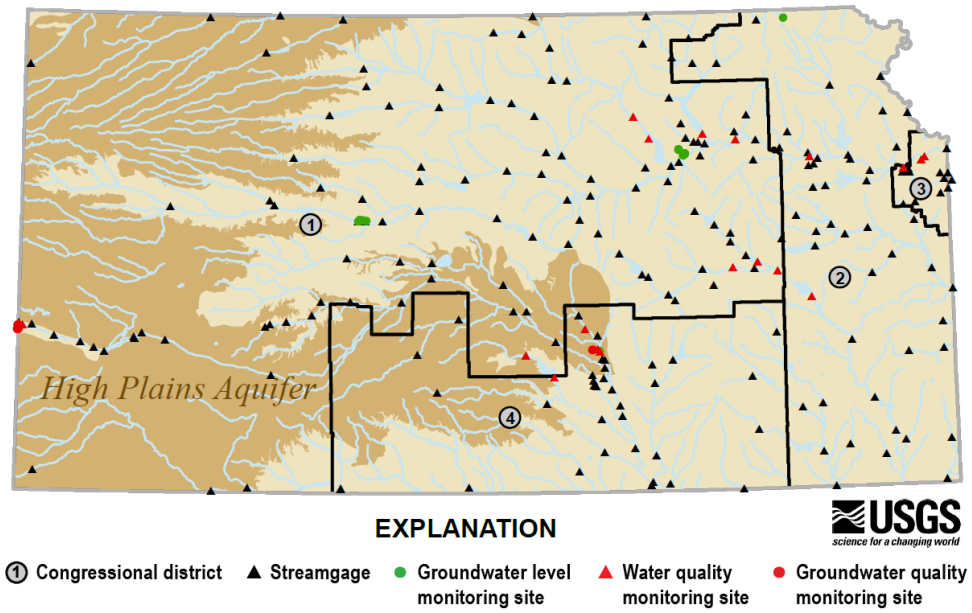



Figure 4. Statewide annual precipitation, inches (1895-2017).
Blue stripes indicate years with above average precipitation (>27.2") and red stripes indicate years with below average precipitation (<27.2"). The variation in color patterns demonstrates the diverse range of water resource conditions, both in duration and frequency of wet and dry conditions, that Kansas experiences.

Figure 5. USGS monitoring network in Kansas. [7] (from Painter et al., 2017)




## Flooding in Kansas

Flooding usually occurs quickly when precipitation exceeds infiltration and then exceeds channel capacity. Preparations to warn of flooding, protect infrastructure, and keep sediment and nutrients from entering water bodies can decrease adverse effects and duration of impacts. Intense precipitation events also increase the presence of sediment, nutrients, and various pollution loads in streams, which end up in reservoirs that store flood waters. Once sediment enters a reservoir during a flood event, it is deposited in the flood pool or on the lake bed, decreasing the available storage space needed to withstand future floods and droughts. Much of the State's lost storage in reservoirs can be attributed to inflows of sediment during flood control operations. Local and regional water utility infrastructure can also be at risk, threatening the delivery of safe drinking water to users.

In 2019, saturated conditions in the Great Plains early in the year were amplified by the wettest spring on record and additional summer rains. Thanks to the state's system of federal reservoirs, levees and watershed dams, we were able to concentrate most flood damage to our reservoirs and riparian corridors. This localized damage, however, came at a cost to the State. Significant water storage space was lost in our reservoirs due to the substantial sediment and debris inflows. Our low-lying riparian areas, often accompanied by productive farm ground, public infrastructure, and other assets, endured long periods of inundation and the erosive forces of flood waters.

During the 2019 flood disaster, the Kansas Department of Agriculture's Division of Water Resources (DWR) reported only 10.0% of homes within Kansas' mapped floodplains were carrying flood insurance through the National Flood Insurance Program (NFIP). They also reported that the 287 NFIP claims made in Kansas during that time totaled $3.78 million. [8] Floodplain maps provide guidance for local land use planning. However, other considerations often take precedence when development occurs in floodplains. Mapping these flood prone areas is an ongoing effort that requires in-depth analysis of floodplain characteristics, fluvial morphology, and planning for increased flood magnitudes. Ultimately, the effectiveness of real-time hydrology information is reliant on our ability to share the information with multiple user groups.

Figure 6. Flooding in Elmdale, KS - May 8, 2019
Photo taken by Chase County Emergency Management Director Scott Wiltse.

Additionally, the State oversees the permitting, construction, and inspection of our smaller watershed reservoirs. As these structures age, they become less functional and a potential breach danger to downstream residents if not properly maintained. Water utilities tend to be vulnerable to flood events due to their proximity to surface water resources. Water treatment intakes may be compromised by a blockage or loss of power. Wastewater systems can be overwhelmed by stormwater entering municipal sewer systems and may also be over-topped by adjacent floodwater. The development of vulnerability assessments and emergency plans is key to minimizing these disruptions of safe water to Kansans. Managing a flood event requires well-developed procedures for communication between forecasting agencies, emergency responders, government officials, utility providers, and the general public. Real-time information on weather, stream flow, reservoir storage, levee integrity, and other factors and infrastructure are used to inform the State's emergency operations. The Kansas Division of Emergency Management (KDEM) provides guidance for hazard response in the 2017 Kansas Response Plan[9] and information on mitigation in the 2018 State Hazard Mitigation Plan.[10]

## Drought in Kansas

Each year, drought costs the United States an average of $8-9 billion, as estimated by the USGS. [11] Kansas is one of the many states with a history of significant impacts from drought. In recent years, drought-related losses in Kansas have been particularly significant in agriculture. In 2017, Kansas ranked 2nd in the country for total crop acres. The total value of agricultural products sold in 2017 was $18.8 billion according to the USDA's National Agricultural Statistics Service. [12] In 2011, however, the Kansas Department of Agriculture estimated that drought caused roughly $1.8 billion in crop losses in Kansas including the price farmers would have received for the lost production and nearly $366 million in drought-related herd liquidation to overfilled cattle livestock auction houses. Even more destructive, the 2012 drought caused more than $3 billion in drought-related crop losses in Kansas. Additionally, more than $1.3 billion in crop insurance indemnity payments for failed commodities were paid to Kansans in 2012 according to the U.S. Department of Agriculture's Risk Management Agency.[13] More recently, though less severe, the 2018 drought resulted in a drought

declaration for the majority of the state with losses throughout the Great Plains and Southwest regions of the country estimated by the NOAA National Centers for Environmental Information (NCEI) at approximately $3.1 billion.[14]

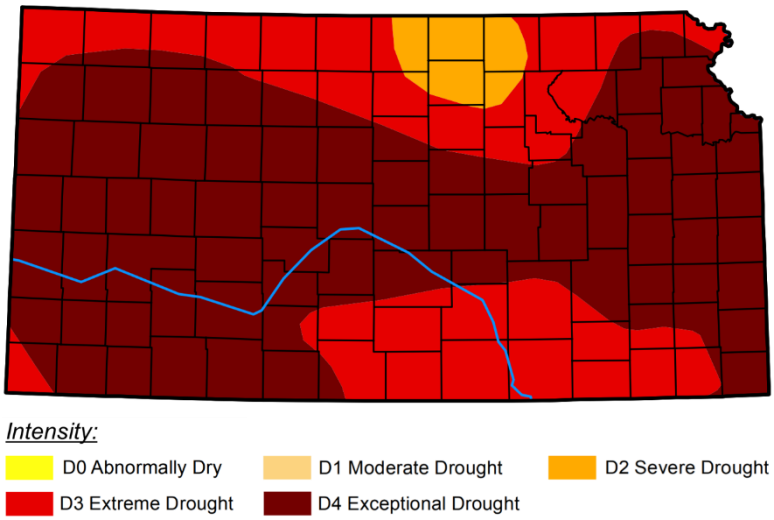



Figure 7. Kansas drought conditions in late August 2012. [15]
(Adapted from Brewer, 2012)

Adapting to changing conditions and minimizing harm from severe droughts is vital for Kansas agriculture. The use of cover crops can help reduce vulnerability to drought by increasing soil pore space, which increases infiltration, reduces evaporation, keeps soils cooler, and potentially impacts yields positively during drought. Additionally, no-till or strip-till farming practices, along with drought tolerant crops and decision-support tools such as irrigation scheduling and crop water allocation planning can help manage risk. Many federal and state lakes provide an alternate water supply for livestock during droughts. Whatever measures are taken, maximizing conservation practices and efficient water use during a drought is critical.

Clearly, even a single year of extreme drought can result in severe agricultural impacts. Drought impacts, however, are not limited to agriculture. Intense flash droughts can rapidly impact water supplies. With approximately two-thirds of the Kansas population relying on surface water for municipal and industrial needs, depletion of these resources creates a significant strain on communities and businesses. The Kansas Water Office recommends that water system operators monitor, plan, and coordinate to minimize drought impacts.

**Municipal Water Conservation Plans:**[16]

Having a state-approved water conservation plan, through the Kansas Water Office, is a public water system's first line of defense against drought. Technical assistance for developing a plan is available through the Kansas Water Office upon request. While there is no overall requirement, a public-water supplier may be required to develop a water conservation plan as a condition of a water right, involvement in a program or as a condition of a grant. Many Suppliers recognize the value of water conservation for their community and voluntarily develop a water conservation plan. The Kansas Rural Water Association provides free technical assistance for developing municipal water conservation plans through the State Water Plan fund.

**Public Water Supply Emergency Response Plans (ERPs):**[17]

KDHE requires the development of these plans to address all threats to a public water supply and steps to restore the safe delivery of water following a natural or man-made disaster. Drought plans are currently not a requirement, but a suggested action plan of the ERP.

For communities using a common source of supply, drought plans should be consistent in use restrictions to minimize societal issues of fairness and equity. Alternate supplies also need to be developed for Public Water Supply (PWS) systems vulnerable to drought.

Ultimately, drought mitigation planning is needed by all sectors that use water. Additional storage of water in reservoirs or aquifers would give Kansans greater ability to manage for potential changes in precipitation timing, duration, and frequency, such as extended dry spells. This can be accomplished through conservation practices to extend and conserve groundwater resources, building or purchasing additional storage, or the recovery of existing surface storage lost to sedimentation. All potential options for drought mitigation should be pursued to protect Kansans and the future economic health of the State.

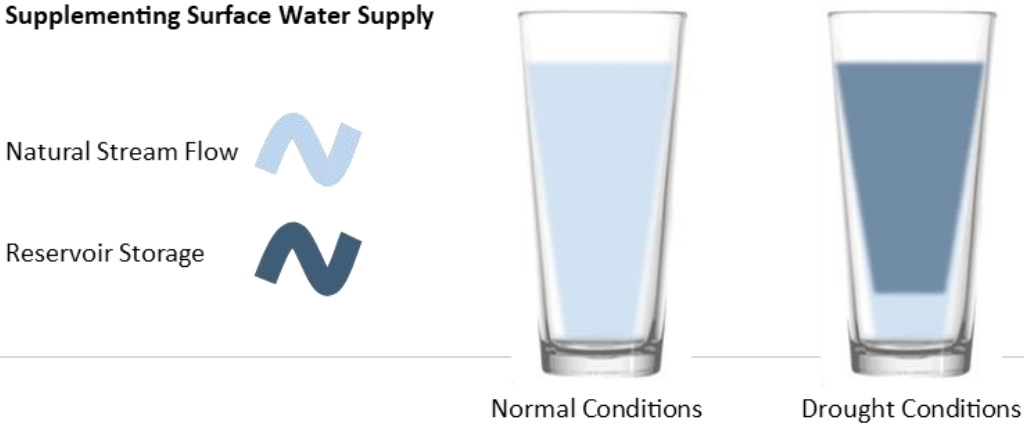
## Management Approach

Kansas relies heavily on access to surface and subsurface water resources for everyday use. When managing through extreme events, these storage resources play a critical public safety role in fighting drought or holding back flood water.

**Reservoir Management through Federal Partnership**

The United States Army Corps of Engineers (USACE) and the United States Bureau of Reclamation (USBR) operate the State's federal reservoirs primarily for flood control. During a flood event, reservoir operations by these federal agencies are designed to minimize flood damage to entire basins across multiple states.

All 24 federal reservoirs in Kansas also provide critical water supply during times of drought. The majority of water supply in USBR reservoirs is used to meet irrigation demands in western and central Kansas. USACE reservoirs are predominantly in the East and are primarily used to satisfy municipal and industrial needs. These are operated cooperatively between the USACE and the Kansas Water Office. During drought, the majority of flow in several of the State's major rivers is actively managed with prescribed releases from USACE reservoirs, often providing the majority of water to your tap.



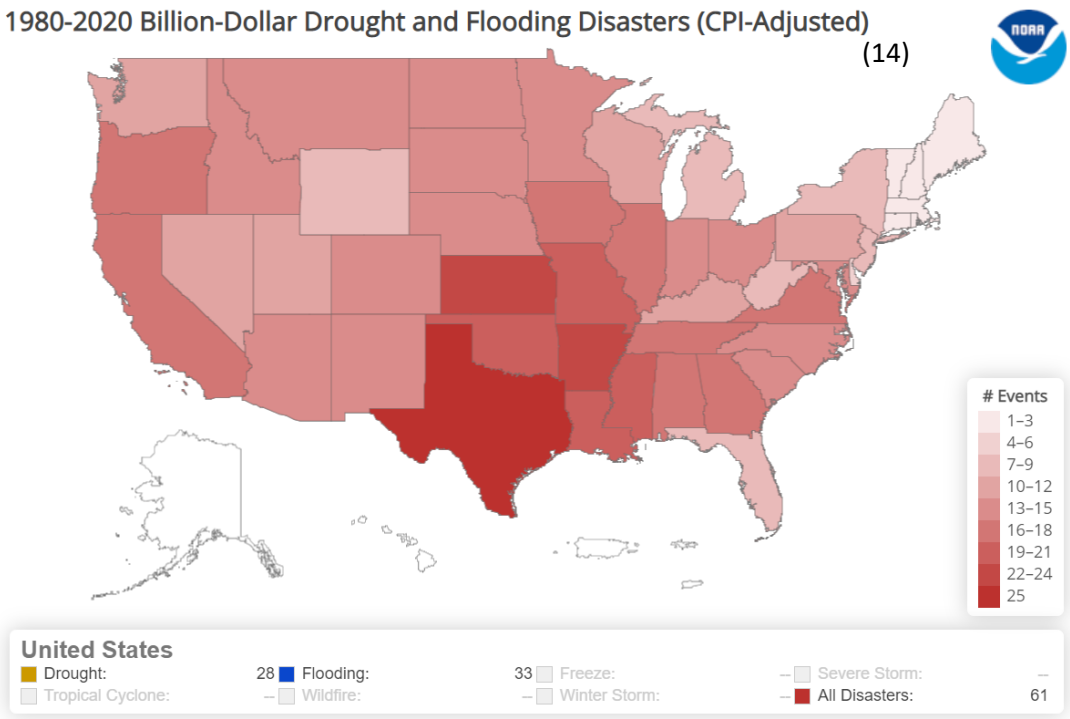
**Managing Drought**

In addition to the management of reservoir storage, the Kansas Water Office (KWO) is responsible for monitoring drought, publishing a monthly drought report, and notifying the Governor when drought conditions exist within the state. The KWO monitors conditions through numerous federal and state climate, weather, agricultural, and agency tools to compile and track pertinent conditions in Kansas. Coordination of drought response activities in Kansas is accomplished through the Governor's Drought Response Team, which is charged with monitoring conditions, coordinating resources, and supplying the Governor's Office with updates or recommendations to deploy additional resources as needed. The Director of the KWO serves as the committee chair and advises the Governor when to assemble this team, which represents 11 state and federal agencies. The use of Kansas water resources in times of shortage is guided by the Kansas Water Appropriation Act and the State Water Plan Storage Act.

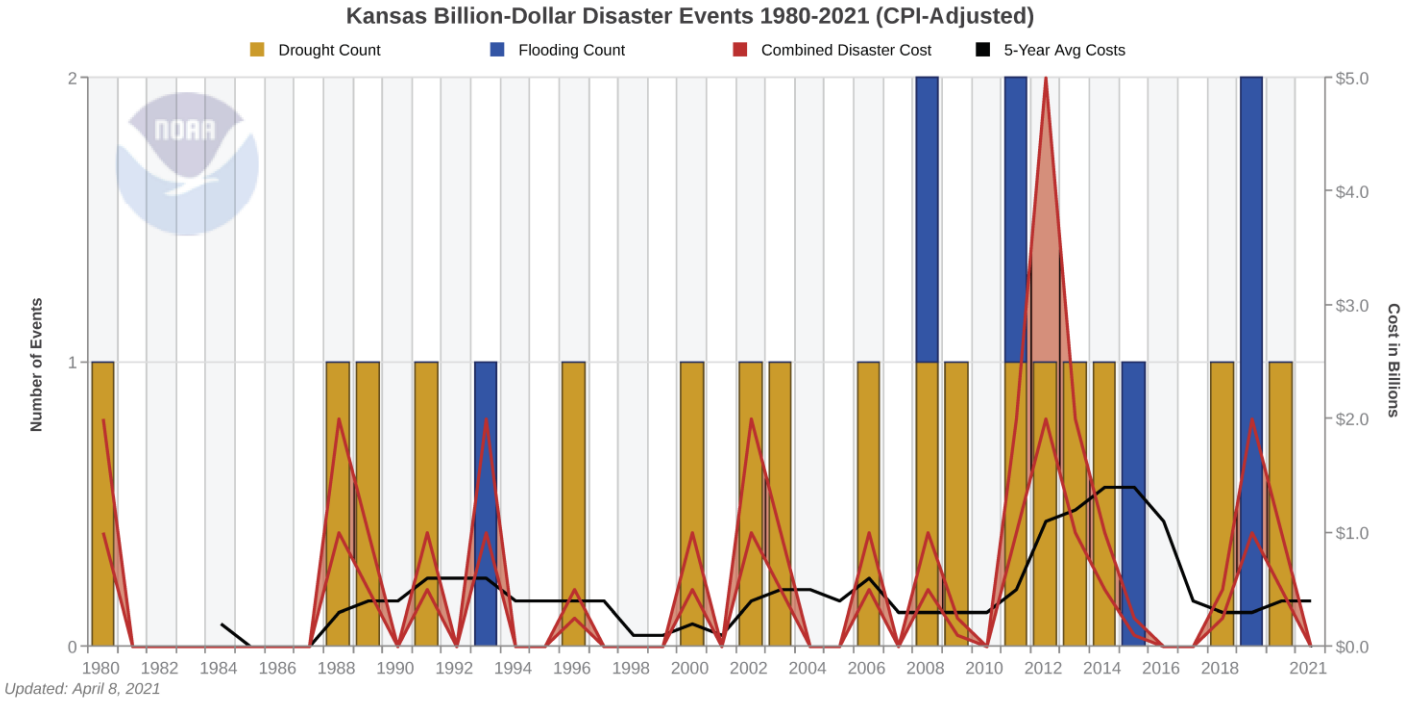
**Assessment, Prevention, and Recovery**

The State of Kansas has developed programs within multiple agencies tasked with floodplain management and mapping, non-federal dam safety, flood control lake development, disaster response planning, hazard mitigation, and others. Additionally, the State engages with many federal agencies that supply information on weather forecasts, river conditions, damage estimates, and disaster relief for qualified applicants.

## Measuring Success




*Please note that the map reflects a summation of billion-dollar events for each state affected (i.e., it does not mean that each state shown suffered at least $1 billion in losses for each event).*




In Kansas, our best measure for extreme event resiliency is economic impact. A high economic impact from flooding or drought would suggest a vulnerability or inability to withstand such an event. From 1980 to 2020, 6 Flooding and 17 Drought billion-dollar (CPI-adjusted) disaster events affected Kansas.[14] Weather and climate disaster statistics are collected and distributed by NOAA's National Center for Environmental Information. Assessment data are provided by a number of sources including insurance companies and state and federal agencies.

## Recommended Actions and Strategies

In response to the increasing frequency of natural disasters across the country, federal assistance programs are shifting focus to projects that reduce or eliminate the risk of repetitive damage. The National Institute of Building Sciences has found that the economic benefits of hazard mitigation significantly outweigh the costs by as much as 6:1 when using traditional cost-benefit analysis. Typically, federal programs require a portion of State or local cost share. This effort to spend federal dollars more efficiently has created a competitive environment among states to put forth well-informed and partially funded mitigation projects. These projects require stakeholder engagement, planning, engineering, and capital. It is critical that the State of Kansas engage in this process if we wish to join our neighboring states and minimize extreme event impacts in the future.

| **Recommended Actions and Strategies – Flood** |
|---|
| Policy or Program Recommendations |
| • Improve collaboration between state, federal, and public stakeholders and encourage pooling of resources to enhance flood planning and response.<br>• Pursue better coordination of data sharing and public information. |
| Implementation Actions |

- Assemble a group of subject experts to identify the areas of greatest need and opportunity, improve flood planning and response, and determine the best path forward.
- Compile critical flood information currently spread across several agencies into a single, publicly-accessible location with a user-friendly interface.
- Continue the development of real-time flood inundation mapping and other water-related disaster support tools and resources in Kansas.
- Work with state and federal agencies and emergency managers to develop a methodology for assessing damages to stakeholders from floods in a timely manner.
- Develop flexible reservoir management strategies that provide the ability for precautionary drawdowns if there are indications of coming flood conditions.
- Promote the use of dry dams and flood easements to temporarily hold flood water behind roadways or other opportunistic land features.
- Support monitoring to evaluate the impact of flood conditions on water quality, such as debris and nutrient runoff, and incorporate identified concerns into flood management strategies.

### Data, Research, and Studies

- Work with state and federal partners to identify existing data gaps, including needs for additional stream gages within the monitoring network to improve river forecasting.
- Continue the development of advanced flow modeling for future flood planning, and identify basins lacking the data necessary to support more sophisticated modeling methods.
- Evaluate past climate and stream gage data, current climate trends, and projections for extreme event frequency, size, and duration in Kansas to update flood planning based on such statistics as appropriate.
- Support efforts to improve forecasting to predict extreme conditions and pursue flexible reservoir management strategies that maximize the benefit of such information.

### Funding and Resource Needs

- Shift focus from reactionary to preventative, emphasizing mitigation efforts that reduce or eliminate the risk of repetitive flood damage, and be more competitive for funding from federal assistance programs.
- Determine existing infrastructure needs to repair damage from past floods and prevent additional losses from occurring in the future.
- Prioritize sustainable development and avoid rebuilding in the floodplain to reduce repetitive damages.
- Work with federal partners to maximize matching funds and pursue cost-effective measures that address data and infrastructure needs.

| Recommended Actions and Strategies – Drought |
|---|
| Policy or Program Recommendations |
| • Prioritize the conservation and maintenance of existing water storage, both surface water and groundwater, to ensure sufficient supply under future drought conditions.<br>• Ensure sufficient staff and in-state expertise to optimize drought planning strategies.<br>• Develop and promote new drought mitigation tactics for water managers to utilize through an updated water conservation planning document. |
| Implementation Actions |
| • Develop sediment management plans for water supply reservoirs, emphasizing sustainability and the preservation of existing storage.<br>• Develop flexible reservoir management strategies that provide the ability to eliminate drawdowns and increase water storage if there are indications of coming drought conditions.<br>• Utilize BMPs and conservation practices, such as cover crops, no-till or strip-till, drought-tolerant crops, irrigation scheduling and crop water allocation planning to prepare for and reduce negative impacts from drought.<br>• Make drought plans a mandatory component of emergency plans.<br>• Update water conservation plan guidelines and ensure all communities and rural water districts have current water conservation and drought management plans.<br>• Educate landowners on the importance of groundwater conservation, the need for sustainable practices, and encourage participation in existing programs.<br>• Support monitoring to evaluate the impact of drought conditions on water quality, such as HAB occurrence, and incorporate identified concerns into drought management strategies. |
| Data, Research, and Studies |
| • Investigate and pursue innovative sediment management technologies, such as Water Injection Dredging (WID) and hydrosuction, to preserve reservoir storage and pass sediment downstream.<br>• Improve forecasting to predict extreme conditions and pursue flexible reservoir management strategies that maximize the benefit of such information.<br>• Investigate the potential for water supply reallocations in Perry and Milford Reservoirs to ensure sufficient storage for water quality releases.<br>• Evaluate past climate and stream gage data, current climate trends and, projections for extreme event frequency, size, and duration in Kansas to update drought planning based on such statistics as appropriate.<br>• Develop advanced models that incorporate climate variability modeling into the water supply model to optimize drought planning strategies.<br>• Investigate the potential for technologies like aquifer storage and recovery (ASR), artificial recharge, and dry dams to reduce runoff and evaporation losses. |
| Funding and Resource Needs |
| • Work with the legislature and federal partners to identify consistent funding to maximize matching opportunities related to reservoir management and agriculture.<br>• Prioritize funding for the development of sediment management plans and pilot projects. |

- Expand in-state expertise related to drought forecasting, modeling, and planning and secure sufficient funding to address any staffing needs that are identified.
- Pursue funding necessary to assist and incentivize landowner participation in groundwater conservation programs.

Actions should consider both short and long-term economic and environmental impacts to communities, agriculture producers, the energy sector, transportation infrastructure, and recreation facilities. Ultimately, reducing vulnerability to extreme events in Kansas is best accomplished by acknowledging the risks and mitigating likely impacts from flooding or drought. This requires plans and actions that will assure the safety of our citizens and provide a clean, sufficient water supply to Kansans.

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# Improving the State's Water Quality

## Background

Kansas has developed a robust monitoring and assessment program to track trends and conditions in water to achieve the objectives of the *State Water Plan (SWP)* and to maintain state primacy for administration of federal water quality programs.

The Kansas Department of Health and Environment (KDHE) has primary responsibility for surface water chemical and biological monitoring and assessment. In addition to KDHE statewide monitoring and assessment programs, many other entities including federal, state, and local agencies and consultants have conducted focused assessments and reports on specific geographic areas or water quality concerns. Information provided in this section is mostly limited to state agency programs.

Water quality monitoring and assessment operations in Kansas are administered primarily by KDHE and are used to determine impaired water status. KDHE maintains several ongoing programs that collectively fulfill the environmental surveillance and reporting requirements of the Clean Water Act (CWA) and provide the technical data needed to identify and respond to existing and emerging water pollution problems. The 2020 Integrated Water Quality Assessment[(1)] is a compilation of water quality issues across the state. The KDHE Watershed Planning, Monitoring, and Assessment Section (WPMAS) monitors water quality conditions in streams and publicly owned lakes and wetlands throughout Kansas. The 2020 KDHE list of impaired waters[(2)] identified:

- **86% of state's assessed stream miles are impaired for one of these uses - aquatic life, contact recreation, or food procurement**
- **Over 96% of the state's assessed lakes are impaired for one of these uses - aquatic life, contact recreation, or food procurement**
- **Less than 5% of the state's assessed wetlands support aquatic life and recreational uses**

Programs administered by the WPMAS are designed to meet the environmental surveillance and reporting requirements of the CWA and other applicable federal and state laws[(3)]. Information obtained through these efforts is applied in the development of the state's biennial Integrated Water Quality Assessment and 303(d) list of water quality-limited surface waters. Water quality data are also applied in the formulation of total maximum daily load[(4)] (TMDLs) for 303(d)-listed water bodies, used to inform water quality standards development, and guide implementation of pollutant and pollution reduction activities. The WPMAS works with other KDHE programs, such as the Spill Response and Storage Tank Program, to identify potential risks to natural resources resulting from the unauthorized release of pollutants[(5)] to the waters of the state. The 2019-2028 Kansas Water Quality Monitoring and Assessment Strategy[(6)] is a good tool to use when reviewing regulatory expectation, budgetary realities and technological and methodological advances in environmental surveillance.

## General Water Quality Issues

### Surface Water

The Kansas 2020 303(d) list identifies 486 station/pollutant combinations of water quality impairment on lakes, wetlands, and stream systems (watersheds), encompassing 2,278 stream segment/pollutant combinations, and needing the development of Total Maximum Daily Load plans (TMDLs) to address the offending pollutants. The 2020 list also identifies 514 station/pollutant combinations of waters that were previously cited as impaired in prior lists but now meet water quality standards, with 44 of these being new in 2020. Waters listed on the 303(d) list are individually targeted for TMDL development according to a priority ranking established by KDHE and approved by EPA.

To address some of these water quality concerns, multiple agencies and NGO's are collaborating to provide viable management tools. Several of these agencies and organizations

continue to promote stream buffers,[7] which have proven to reduce the movement of sediment, phosphorus and nitrogen into streams. Mature stream buffers affect the channel movement by adding strength and surface protection to the streambanks. Additional policies need to be put in place to protect riparian forests in strategic locations. A significant amount of research has been conducted concerning the effects of wetlands on water quality. The research indicates there are positive effects a healthy, functioning wetland has on water quality. The Kansas Water Office serves as the wetland [8] coordinator for the state engaged with numerous partners across the state on wetland activities.

Aquatic Nuisance Species (ANS) are a source of significant ecological and socio-economic problems throughout North America. Currently there are more than 30 water bodies in Kansas and their exiting streams that are infested with zebra mussels, see Figure 1. In 1999, non-indigenous species (aquatic and terrestrial) in the United States were estimated to cause major environmental damages and losses adding up to more than $138 billion per year. [9] The Kansas Department of Wildlife and Parks (KDWP) continues to work diligently to limit the spread of ANS species though multiple media outlets such as their webpage [10]. There are multiple regional and national coordination entities [11] working in collaboration to address ANS issues.

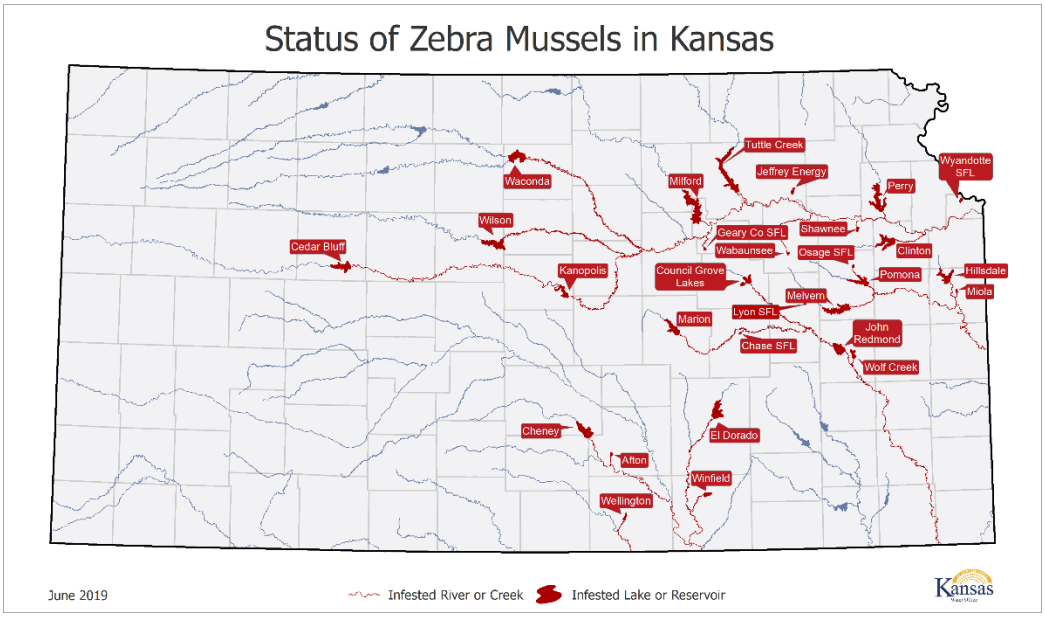


Figure 1. Zebra Mussel Infested Waters, KDWP

The Kansas Department of Health and Environment (KDHE) Harmful Algae Bloom (HAB) Response Program was established in 2010 with over 100 water bodies affected by HABs in the past 10 years. A HAB refers to a dense growth of algae that has the potential for creating toxins that have acute and chronic effects on liver, kidney, lungs, and nervous system, and there are no known antidotes toxins. There is an upward trend on the number of water bodies affected by HABs, Figure 2 illustrates the affected waters in 2020. KDHE's complaint-based program addresses blooms on public waters,[12] with no agency sampling or laboratory analysis being

conducted on private waters.[13] Managers of private waters are encouraged to perform a jar test and use private labs if they believe they are experiencing a bloom. Under the KDHE program, there are three levels of Advisories: Watch, Warning and Hazard. This problem is world-wide problem so the Environmental Protection Agency (EPA) [14] has compiled a great deal of information/research on HABs.

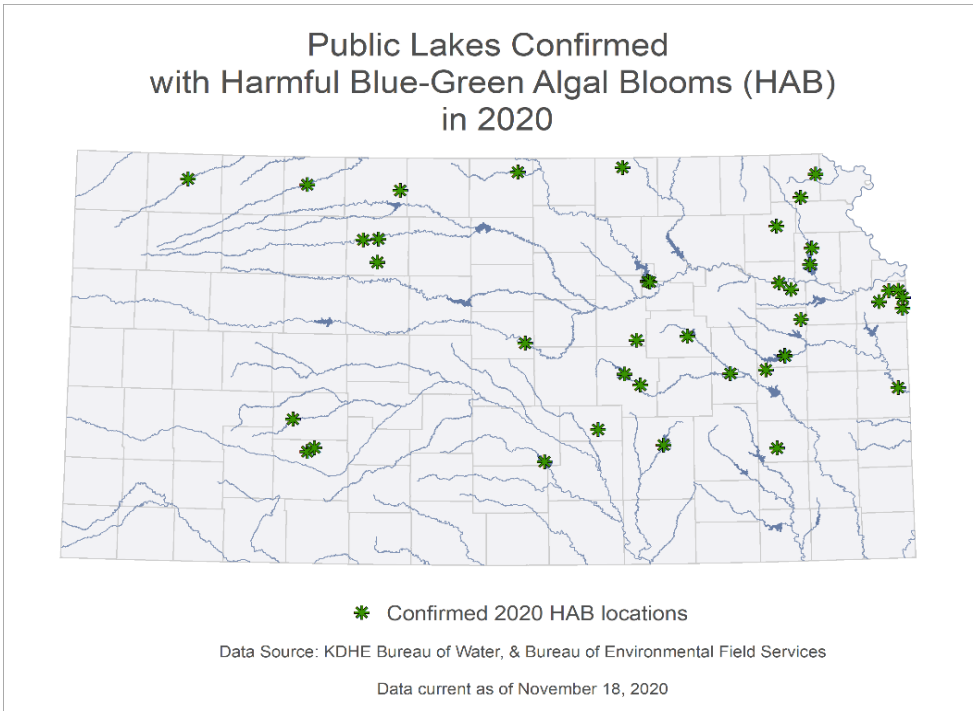


Figure 2. 2020 HAB Lakes, KDHE

The Guiding Principle: Securing, Protecting, and Restoring our Kansas Reservoirs mentions the use of stored water supply to provide dilution of background naturally occurring water quality concerns. As seen in 2018 and 2020 within the Kansas and Smoky Hill rivers, the use of water stored within reservoirs was necessary to dilute chlorides and sulfates that are naturally occurring in the upper portions of the watersheds. In 2018, Tuttle Creek and Milford reservoir releases were required to dilute high chlorides that were released from Wilson Reservoir. While in 2020 during periods of prolonged low flows in the Smoky Hill and Kansas Rivers, releases were also needed from Tuttle Creek and Milford reservoirs to dilute high chloride waters that were being discharged from the Smoky Hill River alluvium after the flooding seen in 2019. The Tuttle Creek Reservoir Water Control Manual states that water stored within a water quality pool of Tuttle Creek will be used to maintain downstream chlorides below 250 mg/L to improve water quality and protect water supply uses. The USGS has multiple gauges that monitor dissolved chlorides[15] at several locations around the state. With the projected loss[16] of storage at Tuttle Creek reservoir, there will be reduced quantities of water available to be held in storage for dilution and the support of improved water quality through periods of drought and low flows on the Kansas River.

## Groundwater

Currently there are a number of groundwater projects that are being conducted around the state to address quality concerns. The Kansas Water Office is currently funding a study in the Missouri Region Planning area to evaluate groundwater quality[17] with the Kansas Geological Survey (KGS) conducting the work. Nitrate is the most common inorganic contaminant in Kansas groundwater. Previous studies have found that about 30% of domestic wells in Kansas have nitrate levels greater than the Maximum Contaminant Level (MCL) for public drinking water (KGS study). Figure 3 illustrates how the nitrates get into the water supply and Figure 4 shows areas in the state that have nitrate problems.

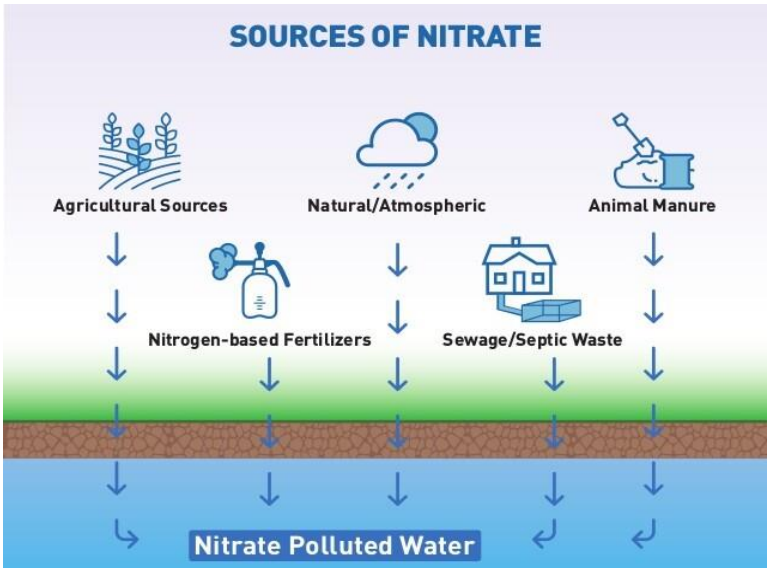


Figure 3. How nitrate moves into groundwater, Beta Analytic Inc.

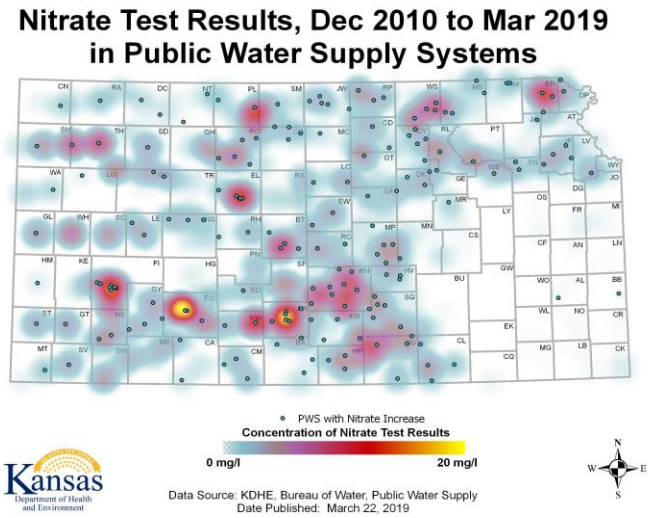


Figure 4. Nitrate Test Results in Public Water Supply Systems, KDHE

One groundwater quality issue of concern is the Equus Beds chloride plume. [18] This problem stems from oil field production with produced water having been deposited in open pits and allowed to seep into the groundwater. The groundwater plume has high chloride concentrations up to 1,600 milligrams per liter, rendering it unusable for most purposes. Initial steps have been taken to document the movement of the plume and possible solutions to address the problem. The KWO and KDHE have collaborated on this study using SWPF resources evaluating the extent of the chloride plume with an estimated remediation cost of $50,000,000. [19]

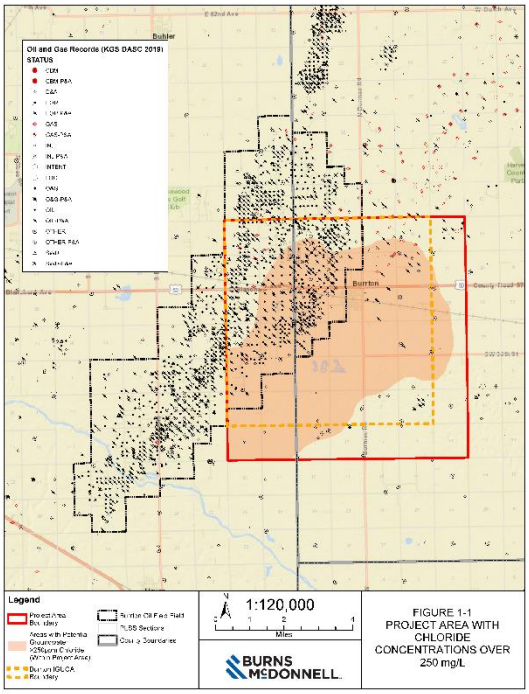


Figure 5. Project Area with Chloride Concentrations over 250 mg/L, Burns & McDonnell

The KDHE is leading a group of agencies in continuing a 2009 groundwater study [20] looking at naturally-occurring minerals in private water wells in southwest Kansas. A total of thirteen parameters from arsenic to uranium are being analyzed for presence and levels. Additionally, beginning in 2019 KWO, KDHE, KDA, KGS and Southwest KS Groundwater Management District No. 3 partnered on a two-year groundwater study focused on analyzing the impacts of naturally occurring minerals on water used for human consumption from private water wells within the Upper Arkansas Regional Planning Area.[21] The project invited homeowners within the study area (portions of Hamilton, Kearny, Finney, Gray and Ford Counties) to provide voluntary water samples. Areas of high concentrations of salinity, uranium, and other constituents, and their relationship to factors such as water use and well construction, are being determined.

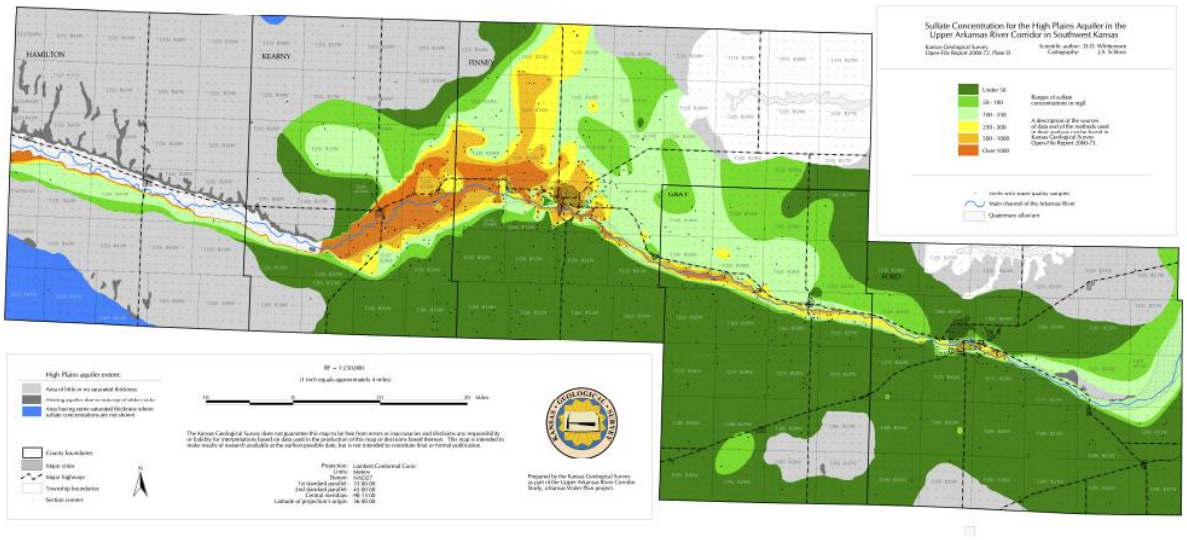


Figure 6. Sulfate Concentration for the High Plains Aquifer, KGS

KDHE is collaborating with Fort Hays State University (FHSU) on a 2-year study in the northwestern [22] part of the state on a similar project. Private well owners will be given the opportunity to have their wells tested for common minerals and contaminants, allowing KDHE to understand the extent of contamination issues in the region. The study area includes portions of Norton, Phillips, Decatur and Rawlins Counties analyzing water samples for minerals including arsenic, selenium, nitrate, chloride, iron, manganese, sulfate and uranium.

## Surface Water Monitoring Programs

KDHE's Stream Chemistry Monitoring Program's sampling network is comprised of 327 monitoring sites spanning all the major river basins in Kansas. Annually, 160 permanent sites are visited by staff on a quarterly basis, whereas the remaining 167 sites are monitored using a four-year rotational approach. Sampling stations are chosen to represent water quality conditions in more than 97% of the state's contributing drainage area.

KDHE has maintained a Stream Biological Monitoring Program since 1972. This program examines the structural attributes of aquatic macroinvertebrate assemblages and utilizes this information to provide a more refined picture of the ecological status of streams in Kansas. Unlike water chemistry measurements alone, which reflect conditions occurring at the moment of sample collection, biological monitoring provides an integrated measure of environmental conditions over time frames ranging from weeks to years, depending on the biological assemblage of interest. About 45 long-term core network stations located in watersheds of major rivers and streams are sampled every year when conditions allow. Additional sites are visited each year as dictated by TMDL development needs, special studies, and pollutant investigations. Since inception, the program has collected macroinvertebrate samples and conducted freshwater mussel surveys at 225 sites throughout the state and the current

database contains more than 90,000 high resolution (predominantly genus/species level) records from over 2,200 separate samples.

The KDWP manages a Stream Survey and Monitoring Program[23] with multiple crews collecting valuable data. Although this program has no regulatory or enforcement authority, its goal is to assess biological communities present within Kansas streams. Sampling generally occurs from late spring to summer and each year focuses on a river basin of interest.
The lake and wetland monitoring program surveys water quality conditions in publicly owned and publicly accessible lakes and wetlands throughout Kansas. Individual water bodies are sampled on a 3 to 6-year rotational schedule and water quality information is maintained on 175 lakes and wetlands in the state. These include all 24 federal reservoirs, most state fishing lakes, and various other county or locally owned and several privately owned but publicly accessible lakes.

The stream probabilistic monitoring program differs from the stream chemistry monitoring program in that monitoring sites are a randomly selected subset of Kansas streams. Results generated through the probabilistic monitoring program can be extrapolated with known statistical confidence to the state's entire population of streams, including hundreds of smaller water bodies largely outside the historical and current purview of the targeted monitoring programs.

### Fish Tissue Contaminant and Fish Consumption Advisory Programs

Working with other state and federal agencies, KDHE also collects and analyzes fish tissue samples from streams and lakes throughout Kansas. On an annual basis, fish tissue from 200 to 300 individual fish captured from about 40 monitoring sites are analyzed for mercury. Organic contaminant concentrations, e.g., pesticides and Polychlorinated biphenyls (PCBs), are evaluated at 5 to 10 monitoring sites per year. Sample site selection for both mercury and organic contaminants is based on a combination of targeted long-term screening sites as well as collection according to the screening sampling design in support of the KDHE Stream Probabilistic Monitoring Program. Based on this data, KDHE in partnership with KDWP issues annual fish tissue consumption advisories which identify fish or other aquatic life that should be eaten in limited quantities or avoided altogether. Advisories are formulated using United States Environmental Protection Agency (EPA) risk assessment methods which account for contaminant level and length of exposure, current Kansas limits.[24] In some waters of the state it is recommended that no fish is consumed, this information is also listed in annual fishing regulations published by KDWP.

### Watershed Restoration and Protection Strategies

Interested stakeholders form local leadership teams assess watersheds and develop Watershed Restoration and Protection Strategy[25] (WRAPS) plans to restore and protect them. WRAPS efforts can address a variety of water resource concerns statewide. The concerns can include water quality, water supply protection, flooding, and wetland and riparian habitat protection or

restoration.  Solutions to identified concerns are developed locally by stakeholders within the watershed. WRAPS groups draw upon available water quality information and may supplement existing data with targeted assessments to guide planning and implementation activities. In some cases, Soil and Water Assessment Tool (SWAT) modeling is applied to their watersheds.

Currently there are 36 KS WRAPS watershed plans that include costs associated with BMP implementation, technical assistance, additional project coordination, and education. If plan expenses are totaled for all WRAPS Projects and extended through the length (years) of each watershed plan, the total amount needed to address the water quality impairments identified in WRAPS plans is approximately $624,800,000. [26]

### Water Quality Based Effluent Limitations

Prior to the issuance of any permit that authorizes a facility to discharge effluent to the waters of the state, KDHE must certify, in writing, that the planned release of effluent will not result in violations of Kansas Surface Water Quality Standards (KSWQS), other applicable state laws, or any federally[27] promulgated water quality standards. A review of the discharge's potential impact on the quality of the receiving surface water is conducted by KDHE. Currently, about 1,500 municipal, industrial, commercial, and federal facilities in Kansas are authorized by KDHE to release treated effluent to the waters of the state.

### Nonpoint Source Pollution Management Report

KDHE prepares a report each year describing the state's Nonpoint Source Pollution[28] (NPS) management objectives, projects implemented during the previous year in support of these objectives, and documented improvements in water quality attributable to NPS pollution control efforts.

## Groundwater Monitoring Program

Kansas no longer maintains a statewide groundwater quality monitoring program and funding for the renewal of such an effort appears unlikely in the near future. However, an earlier monitoring program (suspended in 2002 due to budgetary constraints) evaluated groundwater quality at more than 200 sites in Kansas. Individual wells in the monitoring network were sampled on a two-year rotational basis, with approximately half of these wells being sampled in any given year. The program's surviving electronic database contains roughly 150,000 records spanning 120 different physical, chemical, and radiological parameters and 327 groundwater quality monitoring locations.

## Water Reuse

There are reuse projects taking place statewide, some with large amounts of water being reused. For example, the Spirit Corporation in Wichita is treating 2-3 million gallons of

water/day for reuse. Most of the reuse water across the state is applied to ball fields, golf courses or agriculture fields. The technology is there to treat water from toilet to tap however there is still a negative public perception and a significant financial investment. A Water Reuse presentation [29] was given at the 2017 Governor's Water Conference outlining of issues with water reuse. Water reuse is one of the areas that multiple cities and industries are utilizing providing environmental and economic benefits.

## Additional Reports

A variety of additional reports, special publications, and peer-reviewed journal articles are generated by KDHE [30] to disseminate water quality information to the broader scientific community, elected officials, regulated entities, and the general public.

## Measuring Success

Multiple items can be used to measure the success of Improving the State's Water Quality:

- Reduction of impaired waters on 303(d) list in accordance with WRAPS 9-element plans
- ANS is limited to current infested waters
- Reduction in the number of HAB events and duration
- Limit reservoir storage loss through initiatives and implementation
- Enhance groundwater quality through remediation steps
- Expansion of water reuse technology

| **Recommended Actions and Strategies – Water Quality** |
|---|
| Policy or Program Recommendations |
| • RAC Goals addressing water quality/reuse (CM, EW, GBP, KS, MO, NEO, SHS, SR, UR, USH, VE)<br>• Continue to support KDHE in Water Quality management<br>• Legislative support for increased soil health practices<br>• KDHE nutrient reduction work group<br>• Current Research Appropriations (Bathymetric Surveys, Kansas River Alluvium, Streambank Stabilization and Real-Time Flood Mapping) |
| Implementation Actions |
| • Follow RAC Action Items (list out or provide lint to Regional WP sections)<br>• Continue to work closely with USGS, KGS, and KDHE on appropriate actions<br>• Encourage more adoption of soil health implementation<br>• Encourage and promote municipalities & PWS water reuse efforts<br>• Promote more water quality off-site mitigation and carbon sequestration partnerships<br>• Encourage Communities to play a bigger role water quality initiative with support from local Conservation Districts |
| Data, Research, and Studies |

| |
|---|
| • Facilitate/support data collection of groundwater and surface water quality<br>• GMD 5 study with Kansas State University (KSU) concerning nitrate levels in private wells with assistance from DOC-CD and KDHE<br>• ADD KDHE mineralization studies in SW and NW KS |
| Funding and Resource Needs |
| • Partnerships with private companies or other entities to aid in BMP implementation<br>• Use of State Water Plan funds or other funding opportunities to secure data/information |

## Resources:


1. Kansas Department of Health and Environment, Bureau of Water (BOW). https://www.kdheks.gov/befs/download/Kansas_IR_2020_Final.pdf

2. Kansas Department of Health and Environment, BOW – Watershed Planning, Monitoring, and Assessment Section. https://www.kdheks.gov/tmdl/2020/2020_303_d_List_Approved.pdf

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4. Kansas Department of Health and Environment, BOW – Watershed Planning Section. https://www.kdheks.gov/tmdl/basic.htm

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6. Kansas Department of Health and Environment, BOW – Watershed Planning, Monitoring, and Assessment Section. https://www.kdheks.gov/befs/download/MonStrategy_2019.pdf

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10. Kansas Department of Wildlife, Parks and Tourism. https://ksoutdoors.com/Fishing/Aquatic-Nuisance-Species

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12. Kansas Department of Health and Environment, BOW. https://www.kdheks.gov/algae-illness/

13. Kansas State University, Pollution Prevention Institute. https://www.sbeap.org/water-quality/harmful-algal-blooms

14. Environmental Protection Agency.
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20. Whittemore, D.O., and Petroske, E., 2011, Advanced chemical characterization of Arkansas River water for TMDL development: Final report to U.S. Environmental Protection Agency for Grant No. X7-97703501, 60 p.

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22. Kansas Department of Health and Environment.
https://www.kdheks.gov/NWmineralization/?index.htm

23. Kansas Department of Wildlife, Parks and Tourism, Ecological Services Section.
https://ksoutdoors.com/Services/Stream-Assessment-and-Monitoring-Program

24. Zears, Kristi. "Kansas Issues Fish Consumption Advisories for 2020" Kansas Department of Health and Environment, Released January 24, 2020.
https://khap2.kdhe.state.ks.us/NewsRelease/PDFs/1-24-20%20fish%20tissue.pdf

25. Kansas Department of Health and Environment, Watershed Management Section – Watershed Restoration and Protection Strategy (WRAPS).
https://www.kdheks.gov/nps/wraps/index.htm

26. Kansas Department of Health and Environment, Watershed Management Section – WRAPS.
https://www.kdheks.gov/nps/wraps/index.htm

27. Environmental Protection Agency (EPA) Clean Water Act (CWA) Section 401 Certification.
https://www.epa.gov/cwa-401/clean-water-act-section-401-state-certification-water-quality

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# Increasing Awareness of Kansas Water Resources

## Background

As the *Long-Term Vision for the Future of Water Supply in Kansas* was being developed and more than 600 public input meetings were held across Kansas, one message heard repeatedly was the need for increased education and outreach for Kansans of all ages on water resource issues within the state. While there are many existing water-related educational programs available for both youth and adults, it was noted through these public input meetings that a central message and coordinated educational resources were lacking in helping us to better connect users to their water resources. Many of the Action Items in the *Long-Term Vision for the Future of Water Supply in Kansas*, as well as some goals developed by Regional Goal Leadership Teams, highlight the need for additional development of a state-wide water message and a "one-stop-shop" [(1)] for information and learning resources. To meet this goal, an inter-agency and inter-organizational coordinating team was formed in 2015. This team met throughout 2016 and hosted a series of outreach meetings to solicit input into the development of statewide education and public outreach materials as well as develop tangible action plans aimed at strengthening Kansans' knowledge and awareness of water and water-related issues. From those meetings, a *Vision Education Public Outreach Supplement Section* was created and

now serves as the foundation for the *Kansas Water Plan* Guiding Principle: Increasing Awareness of Kansas Water Resources.

## Formative Document

The following are overarching principles which directed the development of the *Vision Education Public Outreach Supplement Section* to the *Vision*. These overarching principles will continue to serve as precepts for this guiding principle. No actions are intended to displace current water education programs. Instead, these initiatives are designed to promote such programs and to encourage the development of complementary programs.

Long standing water education programs include: youth conservation poster and essay contests hosted through the County Conservation Districts, local community water festivals, Kansas Association of Conservation and Environmental Education (KACEE) Project WET, as well as the Awesome Aqua magazine and natural resource educator's guides developed through Kansas Foundation for Agriculture in the Classroom.[(2)] KACEE, KDWPT, Conservation Districts and others provide an avenue for delivery of critical information.

The initiatives and concepts described are strategic in nature and, as such, do not describe the details of the implementation of the initiatives. The initiative implementation plans will be developed following the approval of the initiatives. Any local, regional or state agency, educational institution, non-government organization, private company or individual stakeholders interested in water education programs are invited and encouraged to provide input and feedback regarding the implementation plans and to participate in these initiatives. These initiatives will be unified through a social marketing campaign and the *Kansas Runs on Water* website[(3)]. All strategies and action items for this principle support the mission to provide Kansans with the framework, policy and tools to manage, secure and protect a reliable, long-term statewide water supply. Water education is key to helping citizens recognize the need for a reliable clean reliable water supply. Many Kansans do not know which watershed they resided in!

## Measuring Success

This collaborative effort represents an opportunity to build upon and maximize the many successful education organizations and activities currently in place in Kansas. While we have many successes related to water resource education in Kansas to celebrate, gaps still exist and opportunities to strengthen Kansans' knowledge and awareness of water and water-related issues remain. Filling the gaps and success in the end will require everyone on all levels working together with a common goal of conserving and protecting our water resources for the next generation. Measuring success may be recognized in numerous ways with varying metrics. Success may be simultaneously measured based off improving attitudes towards water conservation, motivation, cooperative behaviors, and confidence in knowledge of where water comes from, in addition to physically measurable results based off of monitoring. Establishment of region-specific, targeted improvements for household, agricultural, and industrial/municipal water conservation will need to be made. These measures will be shared through the Community Outreach Specialist(s), workshops, and educational events. [4] The value of water education is held deeply by Kansans and is documented in the Goals and Action Plans [5] for the Regional Advisory Committees (RACs) across the state.

| Region | Education & Outreach-Related Goals | | | | |
|---|---|---|---|---|---|
| | **Goal 1** | **Goal 2** | **Goal 3** | **Goal 4** | **Goal 5** |
| **Cimarron** | | X | X | X | |
| **Equus-Walnut** | X | X | X | | X |
| **Great Bend Prairie** | X | | X | X | X |
| **Kansas** | | | X | | X |
| **Marais des Cygnes** | X | X | X | | |
| **Missouri** | | | X | X | |
| **Neosho** | X | | | | |
| **Red Hills** | X | | | | |
| **Smoky Hill-Saline** | | X | X | X | |
| **Solomon-Republican** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Upper Arkansas** | X | | | | |
| **Upper Republican** | | X | | X | X |
| **Upper Smoky Hill** | X | X | X | | |
| **Verdigris** | | | X | X | |

| **Recommended Actions and Strategies – Education** |
|---|
| Policy or Program Recommendations |
| • Appoint an advisory group to establish Kansans' baseline knowledge of water issues. [6]<br>• Create a long-term commitment to water conservation. [7]<br>• Enhance educational programming for state officials.<br>• Encourage the development of higher education agricultural industry-related educational programs.<br>• Utilize agricultural education, 4-H, and FFA to incentivize young people. |
| Implementation Actions |
| • Enhance the statewide marketing campaign, Kansas Runs on Water.<br>• Development and implementation of Kansas water-related educational resources/curriculum.<br>• Create opportunities for collaboration between those involved in youth water education.<br>• Hold a statewide Summit on Water Education for educators and educational organizations.<br>• Develop a grant program for water education organizations and RACs.<br>• Develop a grant-sponsored internship/mentorship program in water-related careers.<br>• Launch, promote, and award financial resources for statewide water education program.<br>• Provide recognition and awards to youth on water-related projects.<br>• Establish and hire Community Outreach Specialist position(s).<br>• Establish and share targeted improvements for household, agricultural, and industrial/municipal water quality and quantity-related conservation.<br>• Develop workshops and professional development opportunities for multiple water-related career paths. |
| Data, Research, and Studies |
| • Establish baseline knowledge of Kansans' comprehension of water issues and assess periodically.<br>• Continuous evaluation of the economic impacts of reduced water use.<br>• Evaluate higher education institutions current academic offerings and identify water-related courses and curricula.<br>• Complete and evaluate U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA) funded grant projects. |
| Funding and Resource Needs |
| • Collaboration amongst participating agencies to leverage funding.<br>• Financial resources needed to fully implement the recommended strategies and actions for Increasing Awareness of Kansas Water Resources could be in excess of $1,000,000 per year depending on the extent to which a full education and outreach campaign is implemented. |

## Resources:


1. A Long-Term Vision for the Future of Water Supply in Kansas. January 2015. Pg 74. https://kwo.ks.gov/docs/default-source/water-vision-water-plan/vision/rpt_water_vision_reformatted_kf1d56e11da40b6667970cff000032a16e.pdf?sfvrsn=0

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3. A Long-Term Vision for the Future of Water Supply in Kansas. January 2015. Pg 73. https://kwo.ks.gov/docs/default-source/water-vision-water-plan/vision/rpt_water_vision_reformatted_kf1d56e11da40b6667970cff000032a16e.pdf?sfvrsn=0

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5. Regional Planning Area Goals and Action Plans. https://kwo.ks.gov/docs/default-source/water-vision-water-plan/vision/rpt-vision-education-public-outreach-supplement-section.pdf?sfvrsn=4

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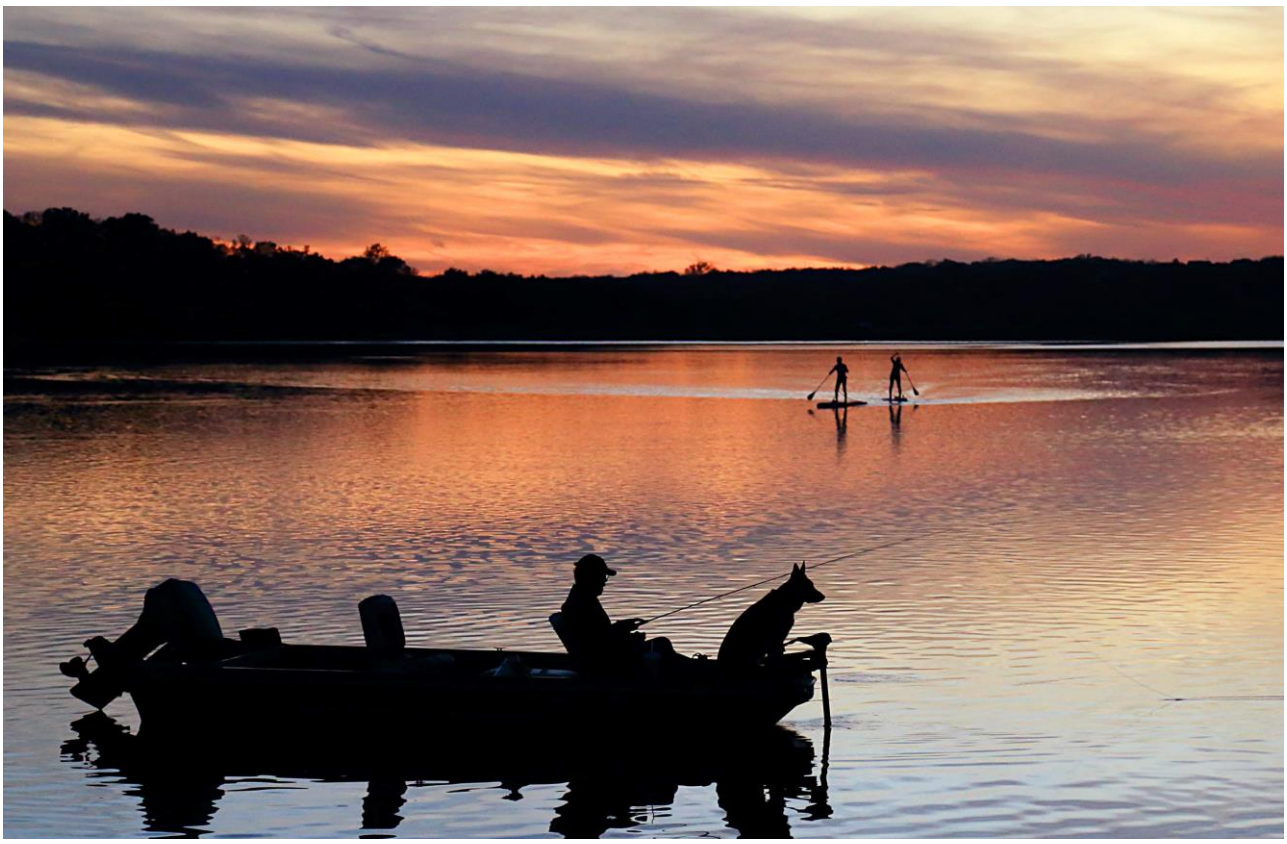
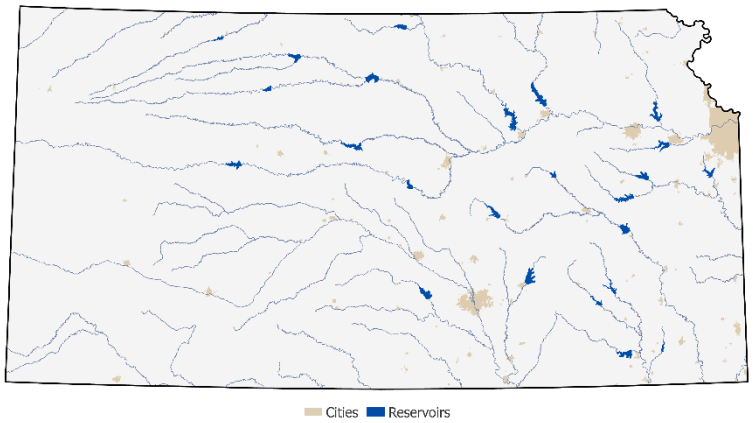
# Securing, Protecting, and Restoring our Kansas Reservoirs



## Background & Issue

Surface water reservoirs serve to protect the public interest and facilitate multiple diverse beneficial uses within the state of Kansas. The future of Kansas reservoirs will impact all water user groups, including agricultural, domestic, industrial, municipal, and recreational water user groups by acting as water supply for these parties.



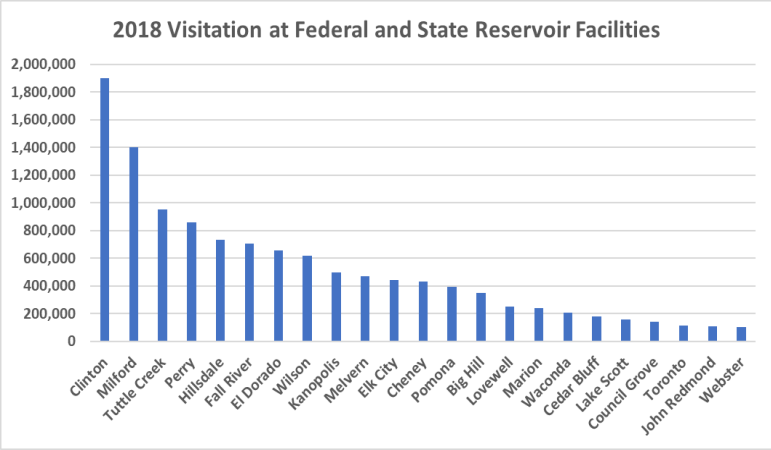

Above: Many rural communities and areas in the eastern half of the state receive water supply from rural water districts that are supplied from reservoirs and can distribute costs.

As a source of municipal water supply, over two-thirds of the state's population are served from municipal water diversions downstream of reservoirs. They are dependent on Kansas

reservoirs maintaining streamflow for diversions, maintaining sufficient water quality for human uses, and providing drought resiliency. For many rural communities, the water supply supported by reservoir releases is the only source of water through periods of prolonged drought. Loss of future reservoir water supply will inhibit rural revitalization efforts and be a regressive expense burden for lower income Kansans, as water suppliers incur elevated costs for water sourcing.

Reservoirs in the state support the water supply needs of a substantial amount of industry and commerce within the state, with a large amount of the state's industrial production being supplied by municipalities, rural water districts, or direct intakes of surface water. Reservoirs supply water to electrical generating facilities, aeronautical production, refinery operations, cement production, and a growing amount of irrigated agricultural acres, all of which require reliable quantity and quality of water supply to continue providing their economic benefits to the state.

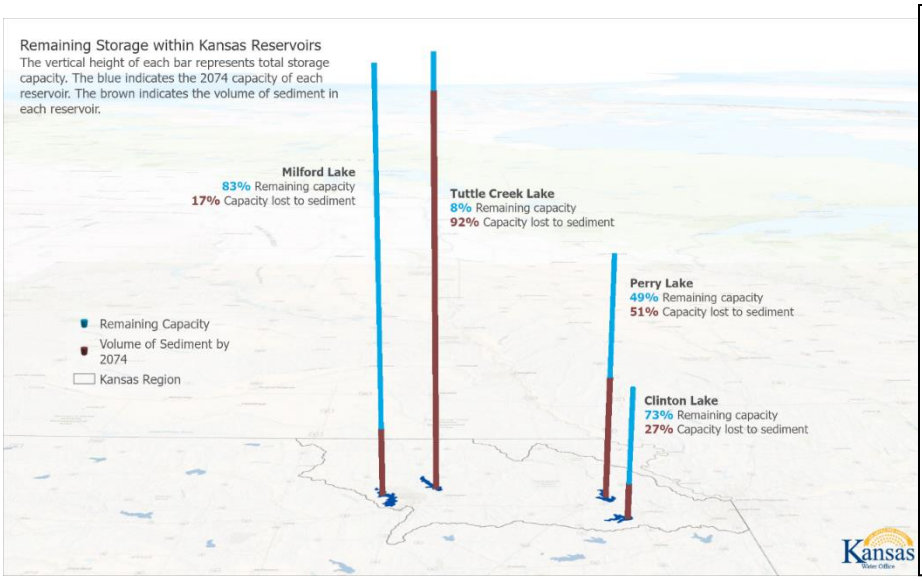
Recreation is a growing economic role of reservoirs, with several million visitors annually participating in on-water and on-shore activities, providing millions of dollars in economic benefits from visitor expenditures within the state. With more cities looking to develop riverfront recreational areas, maintaining reservoir water supply will allow for sufficient stream flow for recreational activities.




The reservoirs serve to reduce the impacts of the variable Kansas climate by reducing the impacts of flooding events that, in the recent past, would have caused widespread damage to agricultural production, in addition to loss of homes, livelihoods, and loss of life. At times, the reservoirs serve as the sole source of water supply through prolonged drought for many Kansans by using storage to support instream uses and maintaining an adequate flow of water to user's intakes. See the Guiding Principle section on Reducing our Vulnerability to Extreme Events for more information on the impacts of climate variability in Kansas.

There are several varied issues impacting the future of the Kansas reservoirs:

1. Storage capacity is continually being lost to sedimentation in reservoirs. Land within the watersheds of reservoirs are losing soil, soil which is then transported to the reservoirs through varied climatic events. Soil is trapped in the reservoirs, which reduces water supply available for future economic growth, future populations, and water supply needs through extreme climate events. Reduced reservoir water storage capacity leads to increased risk of loss for all water user groups dependent on reservoir water supply, flood protection, and water quality support.




Left: Projection of remaining reservoir storage within the Kansas River basin in the year 2074 if the historical sedimentation pattern continues.

Projected that 90% of Tuttle Creek reservoirs initial conservation storage volume would be lost to sedimentation without alternative sediment and basin management actions. Reductions in state owned water capacity at each reservoir on this path.

As calculated by the United States Corps of Engineers during the Kansas River Reservoirs Flood and Sediment watershed study in 2020.

Figure 1. Reservoir Storage, KWO

2. The state's growing unfunded liability and inability to financially support its current contractual obligations for the operation of existing reservoir water supplies suppresses the ability to develop and plan for an adequate water supply for future Kansans. A significant proportion of the state water plan funding comes from user fees that are supported by reservoir water supply. This will leave the state unable to adequately fund the development, protection, and control of water resources necessary to support anticipated water uses, as stated in K.S.A. 82a-928[1].

3. The increase in the number of reservoirs experiencing Harmful Algal Bloom events[2], as well as an increase in event frequency within reservoirs as they continue to accumulate nutrients from natural and agricultural practices within their drainage basins, increases the cost of living for Kansans downstream, reduces economic benefits, and impacts recreational interests. This impacts rural revitalization efforts in communities supplied by reservoir water supply and increases capital expenditure needs.

Figure 2. HAB at Milford Reservoir August, 2020, KWO

## Management Approach

Without intervention, the current course will lead to the state being unable to satisfy its statutory obligations to the people of the state. Specifically, this may lead to a lack of development or control of sufficient supplies of water to meet the future needs of the people of the state.

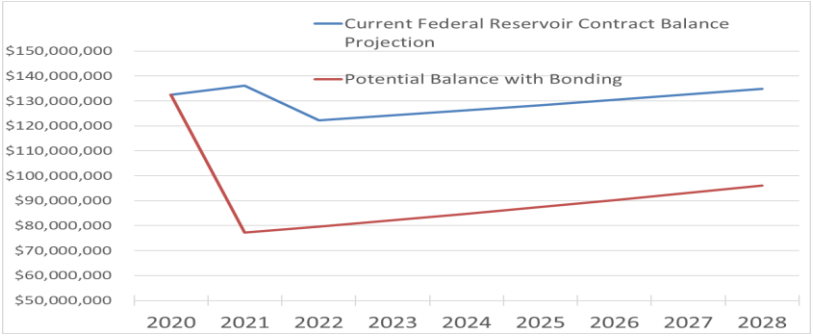
As the source of municipal and industrial water for more than two-thirds of the state's population, reservoirs in Kansas play a key role in water security and drought resiliency planning, both by providing sufficient quantity of water to meet demands and by being a source of water to maintain water quality for drinking water, industrial, or environmental standards during times of degraded natural flow conditions. Reservoir Water Control manuals incorporate the need to use reservoir stored water supply to provide dilution of background naturally occurring water quality concerns, and the water quality fluctuations in response to periods of high or low streamflow events experienced in the variable Kansas climate. It is necessary to maintain adequate quantities of higher quality water in storage within Water Quality pools secured within federal reservoirs to respond to these events and maintain supply security to water users of the state.

Reservoir operations are conducted through multiple Lake and River Regulation Manuals overseen by the United States Army Corps of Engineers (USACE), operational agreements with the multiple Water Assurance Districts, and Water Access Districts, with flood pool operations being managed by the USACE and in coordination with out of state downstream river systems. Rights to water storage within the conservation or multi-purpose pools of 14 Federal reservoirs have been contracted for use by the state of Kansas. Multiple cities and agricultural irrigation groups also have water storage agreements in place, namely the City of Wichita and Cheney reservoir. This multi-purpose pool storage is operated in collaboration with the Federal Government to meet the needs of the many diverse water users and instream water quality demands.

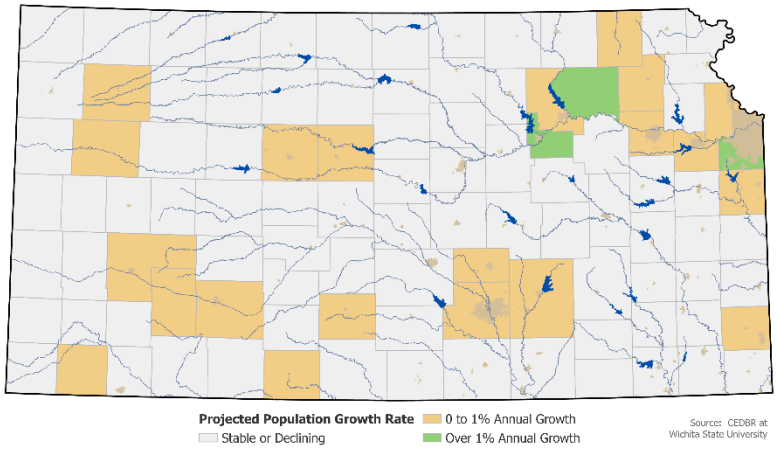
For multiple reservoirs, there exists a financial liability that will need to be addressed by the state of Kansas, specifically where the state has agreed to the purchase of reservoir storage volume but has not needed to call the use of the storage into service. As demands rise, storage volumes are lost to reservoir sedimentation and that storage is needed to meet Kansas needs. The state will need to make the financial payments to call additional water supply into service, as shown below and as outlined in the Public Water Supply Program Comprehensive Capital Development Plan[3].

With low interest rates, the state is evaluating the financial benefits of entering into the current bond market to reduce financial obligations with the federal government for reservoir water supply. Opportunities exist to reduce long-term interest rate obligations and make remaining payments to call some needed reservoir water supply into service. Taking on this financial challenge at the current time will save Kansas water users and the state millions of dollars while addressing the water supply needs for several regions of the state.

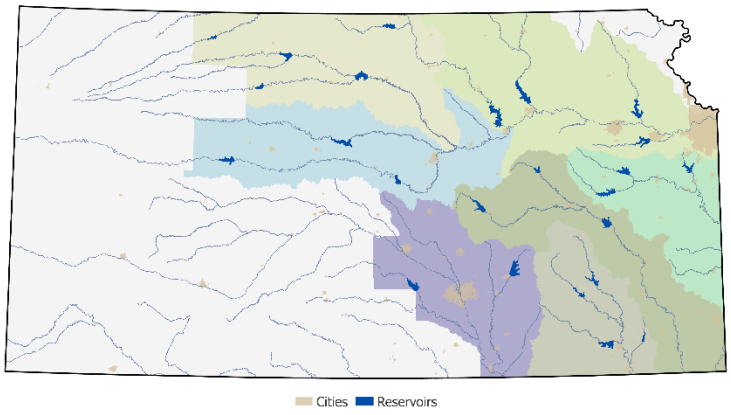
Bottom: Current federal reservoir contract debt obligations and one potential debt bonding projection.



The federal reservoirs of the state were built with expected operational lifespans for their conservation storage capacity, as projected during initial design. With many of these reservoirs now over forty years old, recent and historic bathymetric surveys are showing that reservoir storage capacity is being lost in a trend similar to the initial projections for several Kansas river basins. There is a projected and observed loss of storage as sediment carried by inflowing rivers and creeks is trapped within the reservoirs, with some Kansas reservoirs trapping over 98% of the sediment carried from their headwaters. This makes for future conflicts where the amount of water able to be retained in reservoir storage will be insufficient to meet the demands of multiple user groups and puts the state in the position of being unable to supply adequate amounts of water for anticipated future uses or in contrast to the requirements of K.S.A. 82a-928.




As stated in the Kansas Water Vision[4], there have been targeted investments in the watersheds above multiple reservoirs used for water supply purposes, such as stream bank stabilization projects, water shed dam construction, and increased support for soil health initiatives. However, the acres of agricultural lands that have had conservation practices implemented and the number of streambank stabilization sites completed, with past and current levels of funding, have not remediated the reservoir sedimentation issues.




Above: Regional Advisory Committees supporting increased investment into water supply reservoirs cover all or part of 111 of 125 State House Districts and 36 of 40 State Senate Districts.

As identified by the Blue Ribbon [5] Water Funding Task Force for Water Resource Management additional funding support is needed to adequately reduce sedimentation rates to protect future water supply. The funding task force consisted of a diverse group of stakeholders, legislators, and government officials, who identified a funding need of $21 million per year to support conservation and remediation activities to secure future reservoir water supplies. Regional Advisory committee action plans for the Equus-Walnut (Goals 3 & 4), Kansas (Goals 1- 3, & 5), Marais des Cygnes (Goals 1 & 2), Neosho (Goals 1 & 3), Smoky Hill-Saline (Goal 3), Solomon-Republican (Goals 2&3), and Verdigris (Goals 1 & 3) basins support and advocate for investments to secure and develop reservoir water supplies.

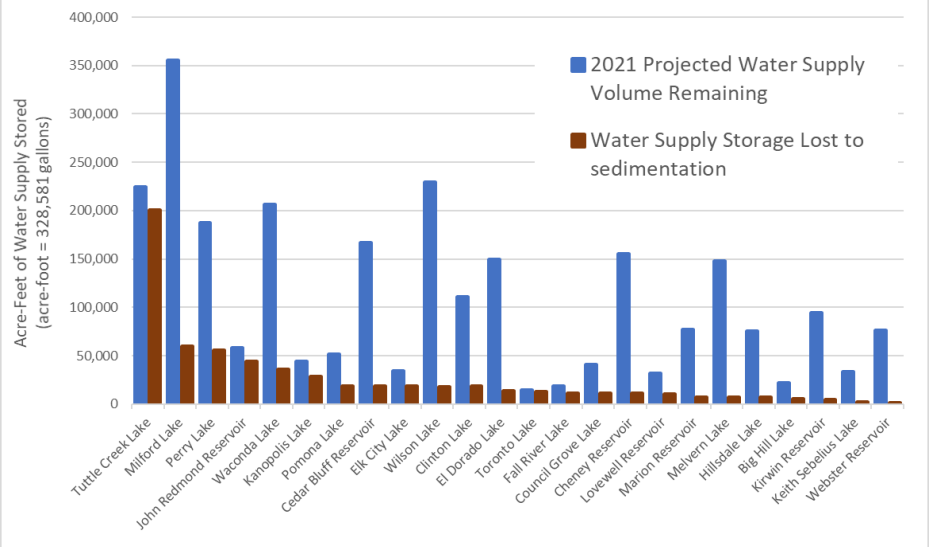
While the initial reservoir designs included projections for the storage loss and operational plans designed to account for climate variations, it is of growing importance for future water supply and recreational planning to fund adequate levels of reservoir research. Adequate funding of reservoir

research is necessary to measure the impacts of conservation initiatives that have been funded with taxpayer and water user fee support. This includes studying the sedimentation reduction provided by streambank stabilization sites, conducting harmful algal bloom pilot studies with monitoring, and measuring the impact of soil health initiatives on the nutrient and sediment loads entering the reservoirs of the state.

Reservoir research support is needed to:

- Identify and implement innovative strategies to reduce flooding and damage reduction
- Utilize new technologies to more efficiently conduct remote sensing and information transfer to impacted stakeholders
- Identify alternative sediment, nutrient, and basin management strategies to reduce impacts to reservoirs
- better quantify the sedimentation issue through updated reservoir bathymetric surveys.
- identify if the reservoirs are losing storage capacity as initially projected or responses to behavioral changes within the watersheds.
- identify impacts of large-scale climatic events, such as the extensive flood events of 2019.

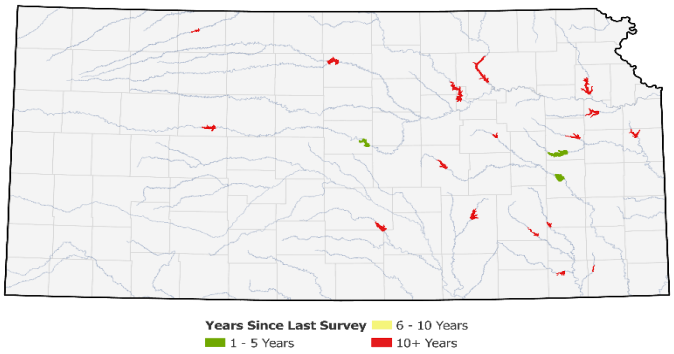
Below: Amount of reservoir water supply storage remaining and lost to reservoir sedimentation.




Water users along the Kansas River will financially, environmentally, and recreationally benefit from having additional storage designated as Water Quality within Milford and Perry reservoir multi-purpose storage pools. The Water Quality pools are dedicated to supporting the low flow quantity and quality requirements of all water user groups dependent on reservoir supported streamflow and instream uses.

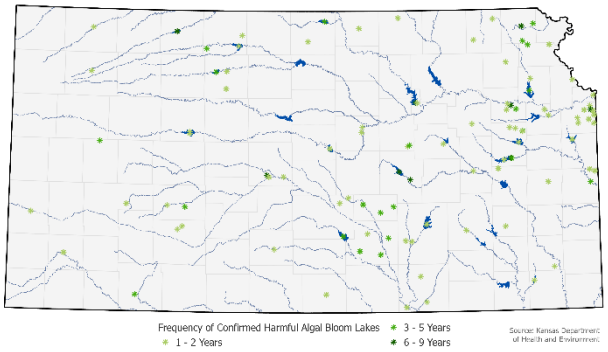
Reservoirs of the state, including Federal reservoirs, multi-purpose small lakes, municipal reservoirs, and watershed dams all play a role in reducing the impacts of extreme flood events on the state and its citizens. Following the prolonged and, in some regions of the state, record flooding of 2019, there were identified several improvements the state should make to prepare before the next destructive flood event. See the Reducing Our Vulnerability to Extreme Events section for more information on flood impacts to Kansans.

With flood operations being conducted in accordance with river and reservoir operations manuals by the USACE, there is an opportunity for the state to invest into the review and development of recommendations to be incorporated into operational manuals. The ongoing Lower Missouri River study with the USACE and states of Iowa, Kansas, Missouri, and Nebraska is studying the current impacts of the flood operations and if there are alternatives that could reduce flooding impacts to the states along the Missouri River. For Kansas specifically, as seen in 2019, operational limits on the amount of allowable Missouri River flow during various flood stages required for record breaking amounts of water to be stored in Kansas reservoirs. Increasing the risk to Kansans by having nearly zero available flood control storage for additional precipitation events and severely impacting recreational user groups. Modifications to the Missouri River control manual could allow the USACE to make earlier releases of water stored in flood control pools of Kansas reservoirs, reducing potential impacts to the state.




Above: Years since last reservoir volumetric survey has been completed. With reservoir research funding level, the state is working to conduct more frequent reservoir surveys to monitor impacts to reservoir sedimentation from practices within watersheds.

Below: Reservoirs with Harmful Algal Blooms confirmed by Kansas Department of Health and Environment testing for 2010 – 2020.




Additionally, the ongoing Kansas River Reservoirs Flood and Sediment study[6] is a collaborative initiative between the USACE and state to review current reservoir conditions, needs, and operations, while also planning for the future water supply needs, challenges, and limitations within the Smoky Hill-Saline, Solomon-Republican, and Kansas Regional Planning Areas. Additionally, the study incorporates how future climatic variability may impact water supply and recreational reservoir uses, including analysis of what happens if no actions are taken to sustain the usable lifetimes of the federal reservoirs.

## Measuring Success

To identify and measure the impact of investments in supporting reservoir goals, there needs to be increased observation and measurement of the condition of the reservoirs. Observing changes to sedimentation and stream channel geomorphology through additional and more frequent data collection will help agricultural, industrial, municipal, and recreational water user groups better plan for their future use demands and capital investments.

Additional reservoir monitoring and research will help to better predict, monitor, and respond to Harmful Algal Bloom events that impact recreational and water supply user groups and to further develop algal bloom response and mitigation techniques.

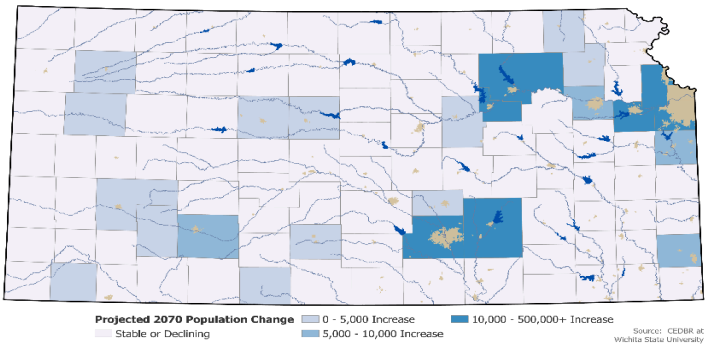
It is necessary to incorporate both quantitative and qualitative metrics into future water resource plan development to monitor whether public funds and user fees are being utilized productively and efficiently to support the future of reservoirs within the state. With the requirements of Performance Based Budgeting, there has been increased incorporation of regionally-supported budget initiatives into State Water Plan Budget proposals and development of performance metrics for expenditures.

The Kansas Water Authority approved the Kansas Water Plan Budget Guidelines in January 2020, stating how funds should be used to:

- meet statutory obligations.
- tie to projects to the 50-year water vision or state water plan.
- support appropriate metrics and benchmarks.
- allocate water user groups' fees to reasonably support that group's future water supply, as seen with sedimentation reduction projects being funded above reservoirs that provide water supply for downstream water user groups and fee payers. allow the flexibility to fund expenditures that can be justified to be in response to an emerging threat to water resources or public health.

## Recommended Actions and Strategies

Though the reservoirs in the state were designed with projected losses to their water supply capabilities, the needs of a growing Kansas population and agricultural use downstream of reservoirs do not have finite lifetimes or projected demand reductions. Multiple regions of the state need to have reservoir water supply secured, protected, or restored to meet the water needs of the future.



| Recommended Actions and Strategies – Securing, Protecting and Restoring Reservoirs |
|---|
| Policy or Program Recommendations |
| • RAC Goals addressing reservoir issues (EW, KS, MdC, NEO, SHS, SR & VE)<br>• Continue to support KDHE in Water Quality management<br>• KDHE nutrient reduction work group<br>• Continue to support reservoir research priorities as developed by the Kansas Water Research coordination group. |
| Implementation Actions |
| • Collaborate with USACE to increase Water Quality pool allocations where needed, which will ensure sufficient flows to support instream uses and maintain water quality for users.<br>• Support watershed conservation practices with soil health initiatives, streambank stabilization, and riparian corridor restoration being some methods outlined in the Kansas Water Vision and Regional Advisory Committee Action Plans.<br>• In regions where it is infeasible to restore water supply storage in current reservoirs, explore additional storage possibilities with the construction of multipurpose small lakes to alleviate regional water supply issues. |
| Data, Research, and Studies |
| • Work to increase efficiency of reservoir operations through low-flow release modifications and operating reservoirs as a system. As data resources and climate conditions allow, incorporate Forecast Informed Reservoir Operations to increase water supply resiliency and efficiency. Develop future climatic scenario reservoir water supply planning capabilities.<br>• Support Harmful Algal Bloom data collection and remediation projects.<br>• Study benefits of watershed conservation practice implementation on sedimentation and nutrient loading rates, utilize budgetary guidelines and performance metrics to direct future funding sources to those that are shown to improve reservoir conditions.<br>• Bathymetric surveys on a more frequent basis to show reservoir storage loss.<br>• Engage in active sediment management studies with federal partners as cost share and funding opportunities arise.<br>• Facilitate/support data collection of groundwater and surface water quality<br>• GMD 5 study with Kansas State University (KSU) concerning nitrate levels in private wells with assistance from DOC-CD and KDHE<br>• Increase the frequency of reservoir bathymetric to monitor progress on sedimentation trends and conduct future water supply planning projections. |
| Funding and Resource Needs |
| • Utilize low borrowing rates to issue bonds to secure reservoir storage. Complete principal and interest payments to the federal government to fulfill contractual obligations.<br>• Fund and implement strategies supported by Regional Advisory Committees to reduce sedimentation and nutrient loading rates within water supply reservoirs. In reservoirs where conservation alone will not satisfy future water supply demands, work towards implementation of active sediment management strategies.<br>• The Blue Ribbon Water Funding Task Force for Water Resource Management identified some funding levels for conservation practices that have not been supported thus far. Additionally, Regional Advisory Committees are having discussions on new methods to fund reservoir conservation initiatives, with some privately funded initiatives being implemented. |

## Resources:


1. Kansas State Legislature. http://www.kslegislature.org/li/b2021_22/statute/082a_000_0000_chapter/082a_009_0000_article/082a_009_0028_section/082a_009_0028_k/

2. Kansas Department of Health and Environment https://www.kdheks.gov/algae-illness/what_is_a_hab.htm

3. Kansas Water Office https://kwo.ks.gov/docs/default-source/kwa-meeting-materials/kwa-member-handbook/5-rpt_2017_pws_ccdp_final_051817.pdf?sfvrsn=4

4. Kansas Water Office https://www.kwo.ks.gov/water-vision-water-plan/water-vision

5. Kansas Water Office https://kwo.ks.gov/docs/default-source/water-vision-water-plan/vision/blue_ribbon_ftf_final_report.pdf?sfvrsn=4

6. Kansas Water Office https://kwo.ks.gov/projects/kansas-watershed-study