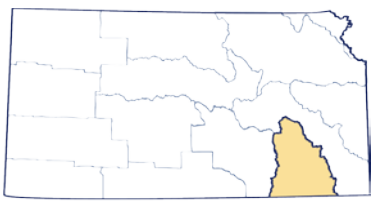
State of the Resource & Regional Goal Action Plan Implementation Report

August 2018

Verdigris

Regional Planning Area



Kansas
Water Office

Table of Contents

Executive Summary

The Verdigris State of the Resource & Regional Goal Action Plan Implementation Report is intended to provide a background of the regional issues and record activities and progress toward regional goals and the *Long-Term Vision for the Future of Water Supply in Kansas (The Vision)* objectives utilizing the most up to date data available at the time of report development.

Surface and groundwater resources within the Verdigris Region suffered from lower than normal precipitation from 2010 to 2016. Due to very low precipitation in 2011, water use peaked at almost 21,000 acre-feet for the region.

Sediment reduction is ongoing within the region with achievements resulting from the implementation of Best Management Practices (BMPs). Prior to 2017, 4% of the average annual sedimentation reduction occurred from implementing streambank stabilization projects, while 96% occurred from the implementation of BMPs. In 2017, all sediment reduction was achieved through BMP implementation.

A Drought Workshop was held in September 2017. Based on this workshop, drought scenarios were evaluated to create plans and strategies to mitigate and manage drought conditions. The Verdigris Regional Advisory Committee (RAC) has initiated work with the KWO, and will continue the use of the Multi-basin Evaluation of Kansas Reservoir Operations (MEKRO) model in order to evaluate the feasibility of reservoir operation changes and water storage increases, including cost estimates, focusing first on Fall River Lake as a priority for reallocation.

Beyond looking at the federal reservoirs to ensure the region has sufficient water supply, the Verdigris RAC is also assessing new potential sites to construct small water supply lakes. This assessment will review the Reservoir Roadmap for the Verdigris Region to evaluate the water supplies currently available and the projected population changes in the region. As part of evaluating new potential sites, PL-566 program structures are being looked at as possible water supply sources. Dams that have been identified for rehabilitation will be evaluated to include a water supply component; currently the federal funding for this program is being secured to finance the addition of water supply to existing structures.

As potential watershed dam sites are chosen for the possibility of construction or rehabilitation, the RAC will work with the watershed districts in the region, along with State Association of Kansas Watersheds (SAKW), the Natural Resources Conservation Service (NRCS), the Kansas Department of Agriculture-Division of Conservation (KDA-DOC), and other pertinent entities. With this collaboration, determination can be made if the construction of a watershed dam is feasible at a chosen site, if it will be able to be used as a water supply source and if it will help reduce sedimentation.

Water Use Trends

Surface water is the primary source of water within the Verdigris Region, accounting for approximately 99% of the total reported water use. Groundwater sources within the region are the alluvial deposits along major streams and are not a primary water source (<1%). Municipal use (55%) is the primary use for surface water sources within the region. Other reported surface water use within the region includes industrial (40%), irrigation (5%), and stockwater (<1%). Stockwater use (60%) is the primary use for groundwater sources. Other reported groundwater use within the region includes municipal (36%), irrigation (3%), and industrial (1%). There is no reported recreation water use for this region.

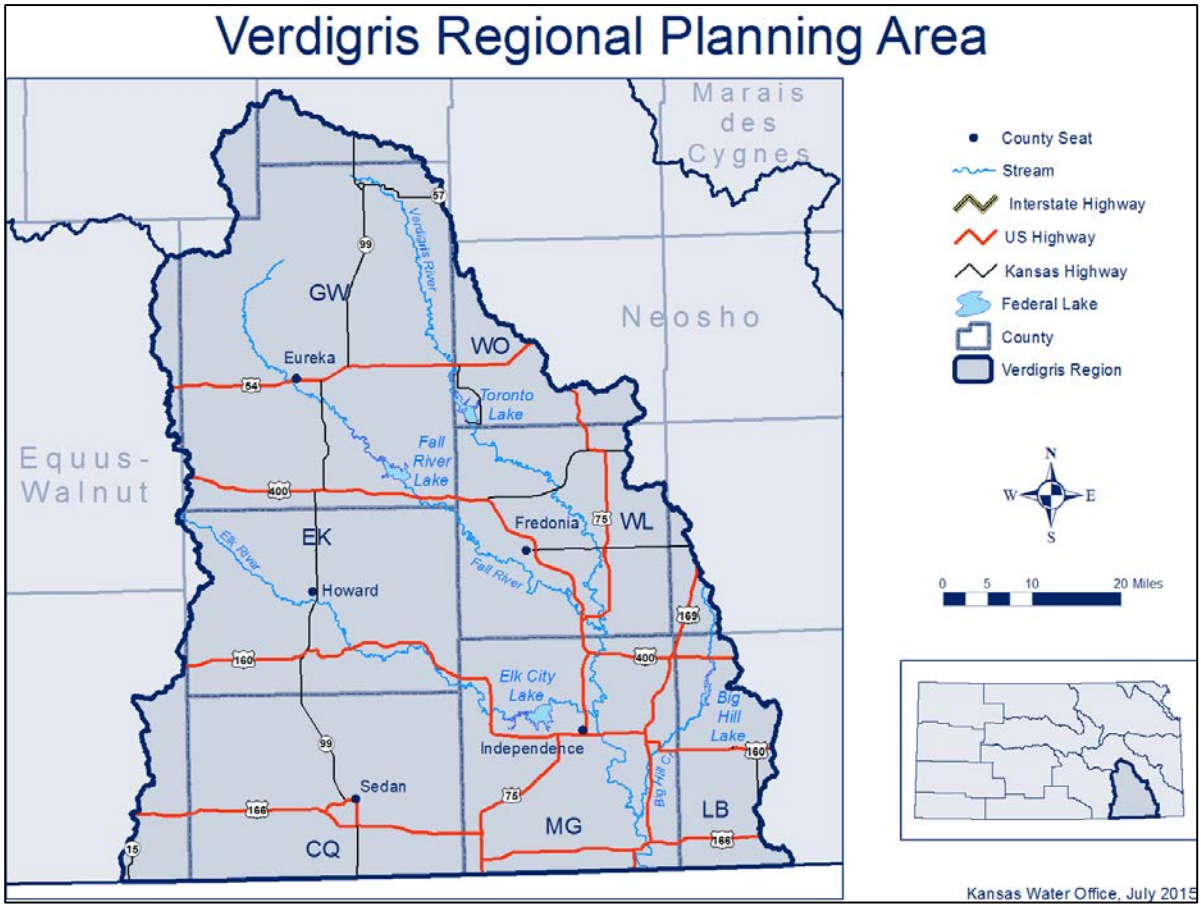


Figure 1: Verdigris Regional Planning Area

Annual reported water use for the region fluctuates based on climate conditions, with higher water use resulting from periods of hot and dry weather during the growing season and lower water use during periods of cooler and/or wetter weather.

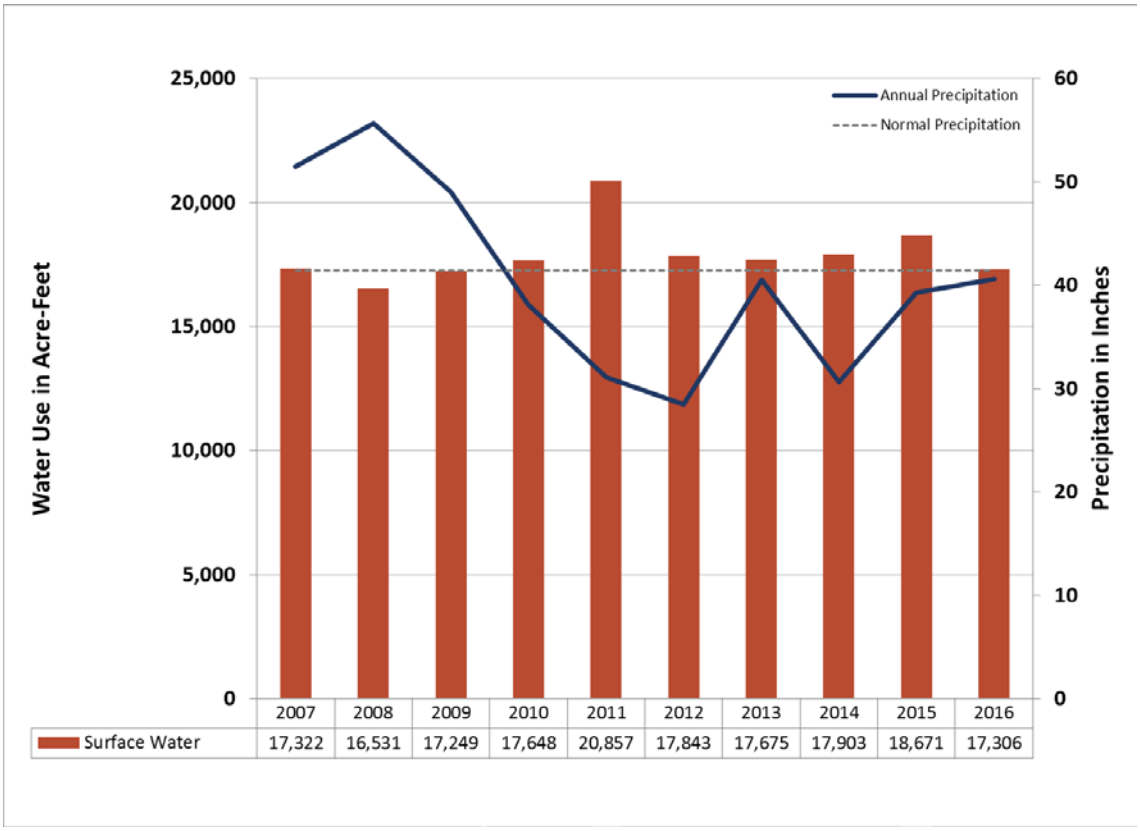


Figure 2: Annual surface water reported use with precipitation data, Verdigris Region

Water Resource Conditions

Groundwater

Groundwater is not a major source of water supply for this region, accounting for <1% of reported water use (Figure 3).

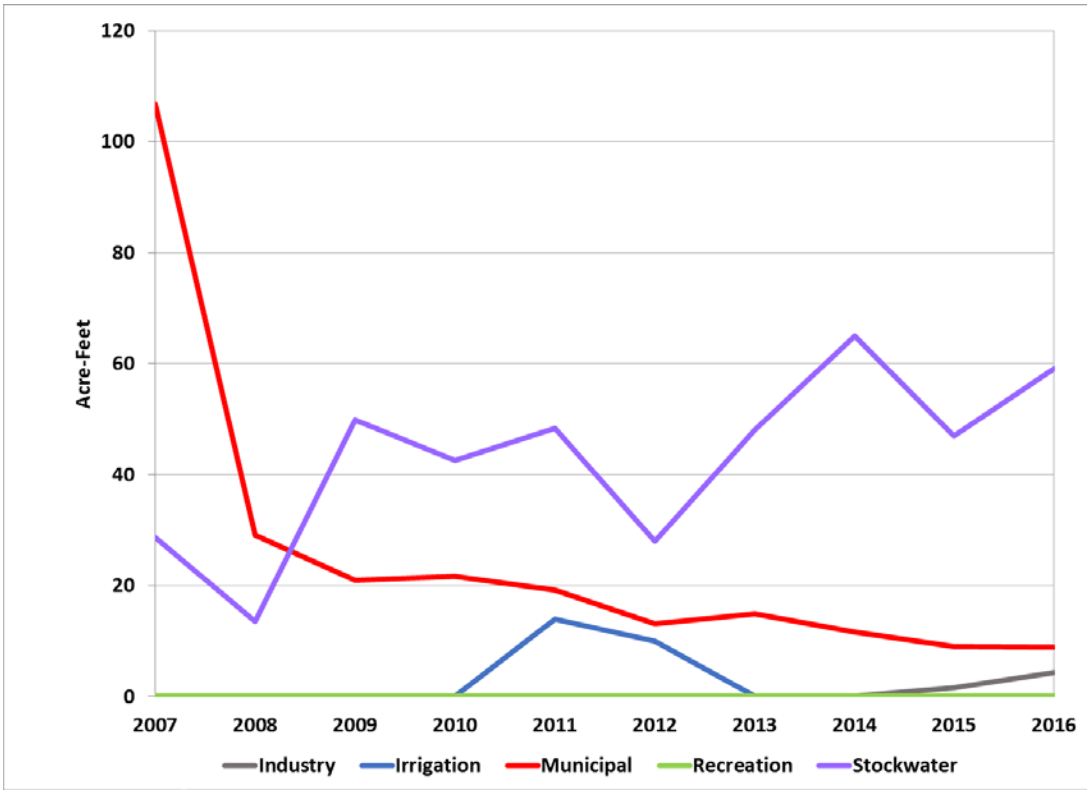


Figure 3: Annual reported groundwater use by type

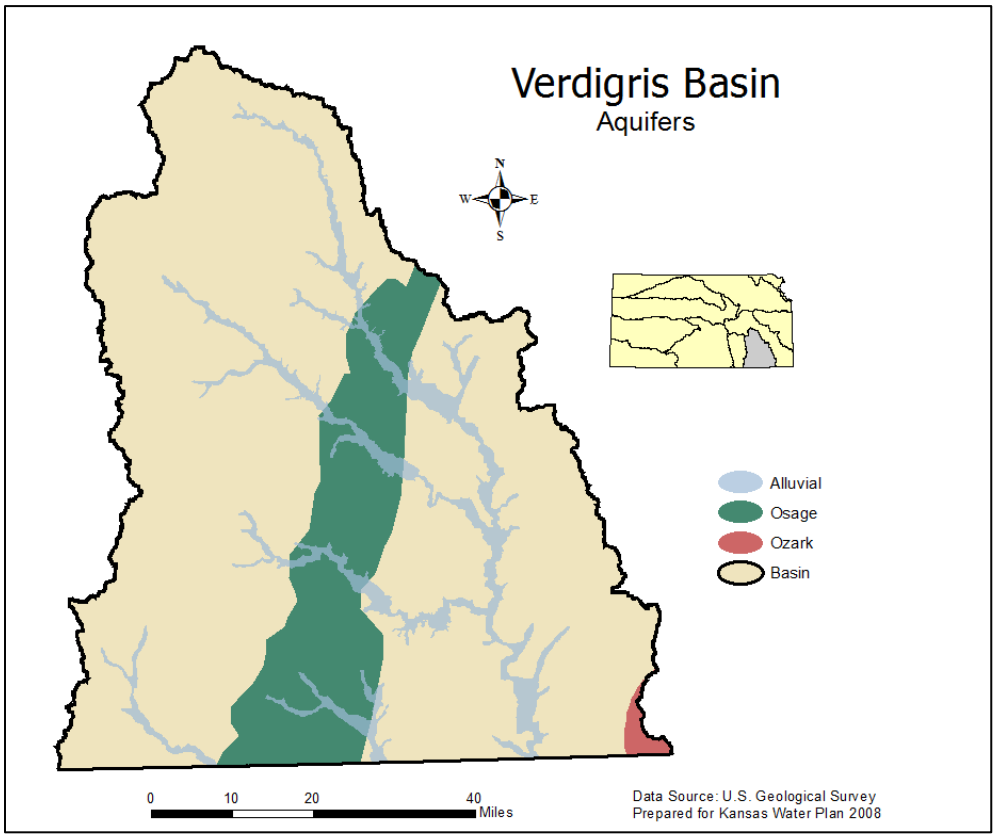


Figure 4: Aquifers of the Verdigris Region

Surface Water

The major streams in Verdigris Region are the Verdigris, Elk, Fall, Caney, and Little Caney Rivers, as well as Big Hill and Caney Creeks. Elk and Fall Rivers as well as Big Hill Creek are tributaries to the Verdigris River, while the Caneys join the Verdigris River in Oklahoma.

Surface water accounts for 99% of the reported water use in the Verdigris Region, with more than 50% being used for municipal use and 40% used for industrial purposes. As seen in Figure 5, both major uses, municipal and industrial use, are fairly steady from year to year, with slight fluctuations due to climatic conditions.

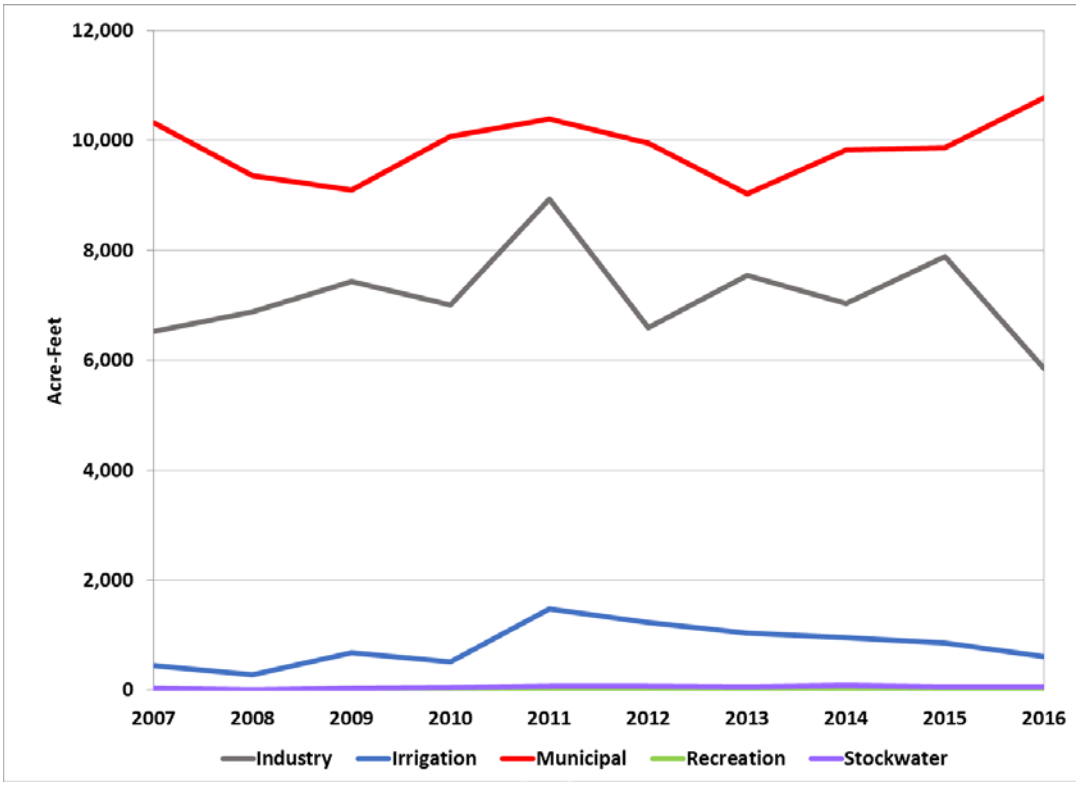


Figure 5: Annual reported water use by type from surface water sources, Verdigris Region

The Verdigris Region has four federal reservoirs, Big Hill Lake, Elk City Lake, Fall River Lake, and Toronto Lake. Other community water resources include the Woodson Wildlife area, Cherryvale City Lake, and LaClaire Lake. Watershed Districts in the region have constructed flood control structures to address rural flooding. Several of these are available as back up sources of drinking water, while most are also used for livestock watering.

Each of the four federal reservoirs have fluctuating water levels throughout the year, as can be seen in the past two years of recorded pool level elevations in Figures 6-9.

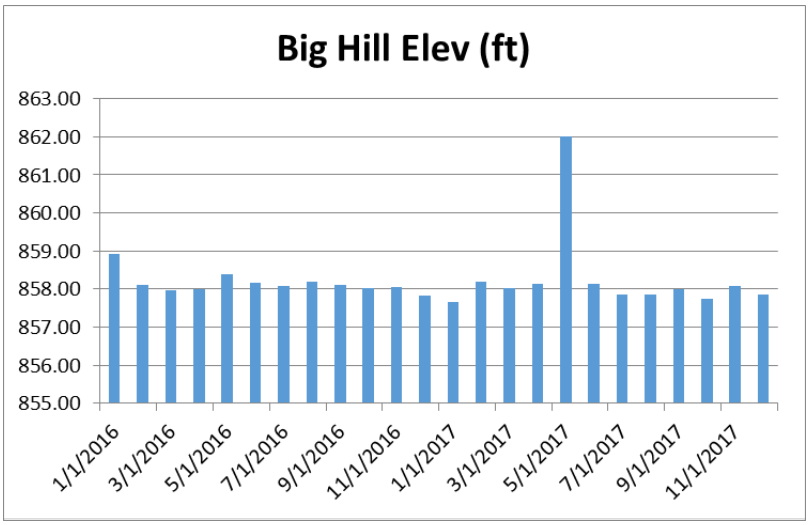


Figure 6: Elevation of Big Hill Lake, conservation pool elevation: 858 feet

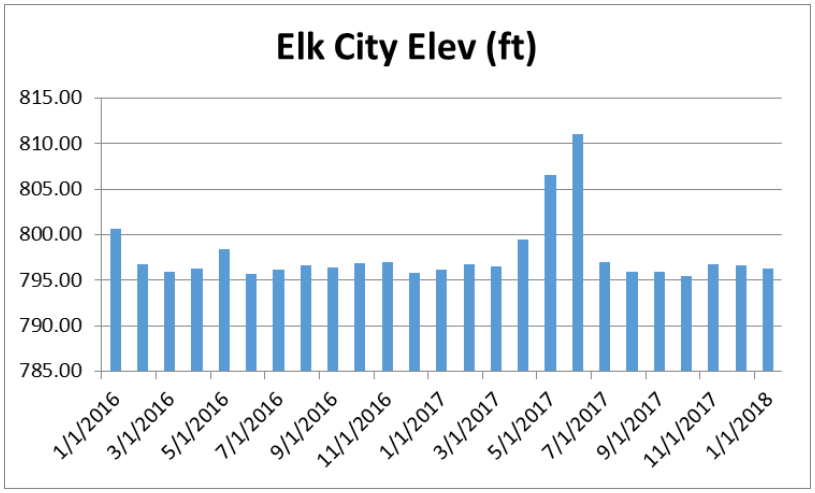


Figure 7: Elevation of Elk City Lake, conservation pool elevation: 796 feet

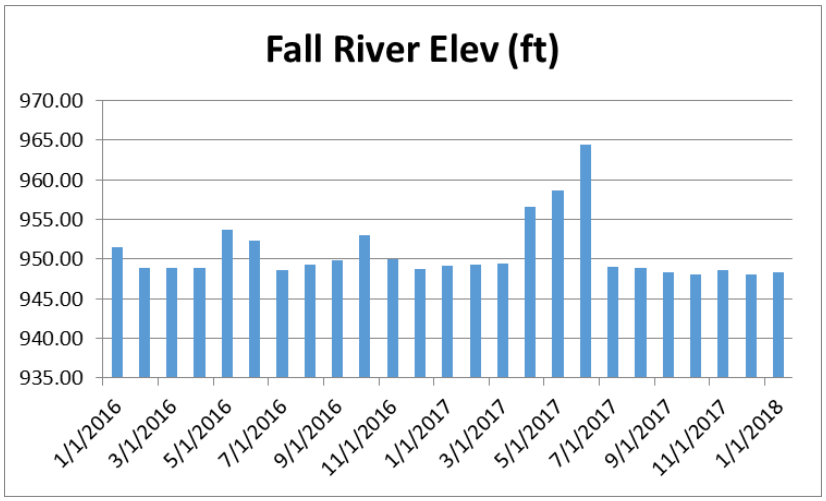


Figure 8: Elevation of Fall River Lake, conservation pool elevation: 948.5 feet

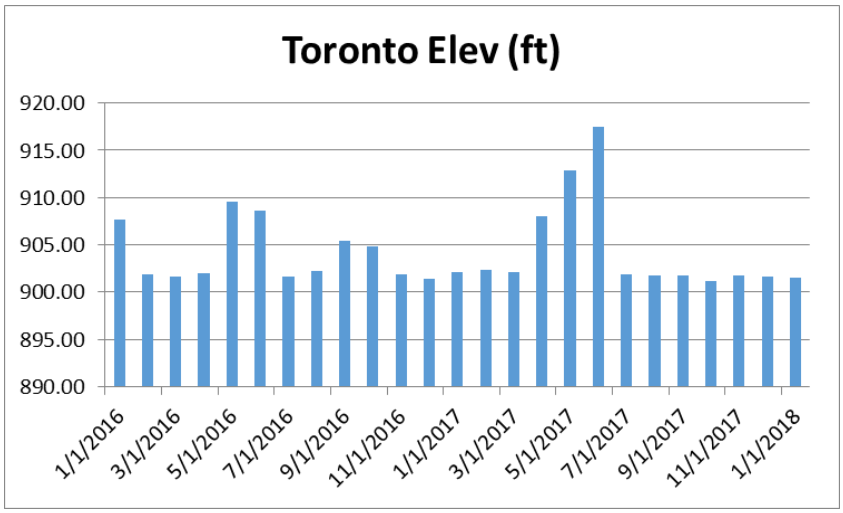


Figure 9: Elevation of Toronto Lake, conservation pool elevation: 948.5 feet

The fluctuation in pool levels is due to precipitation trends and water management strategies to operate the reservoirs for water supply demands and streamflow maintenance. Water supply storage in Big Hill and Elk City is available through the [Water Marketing Program].

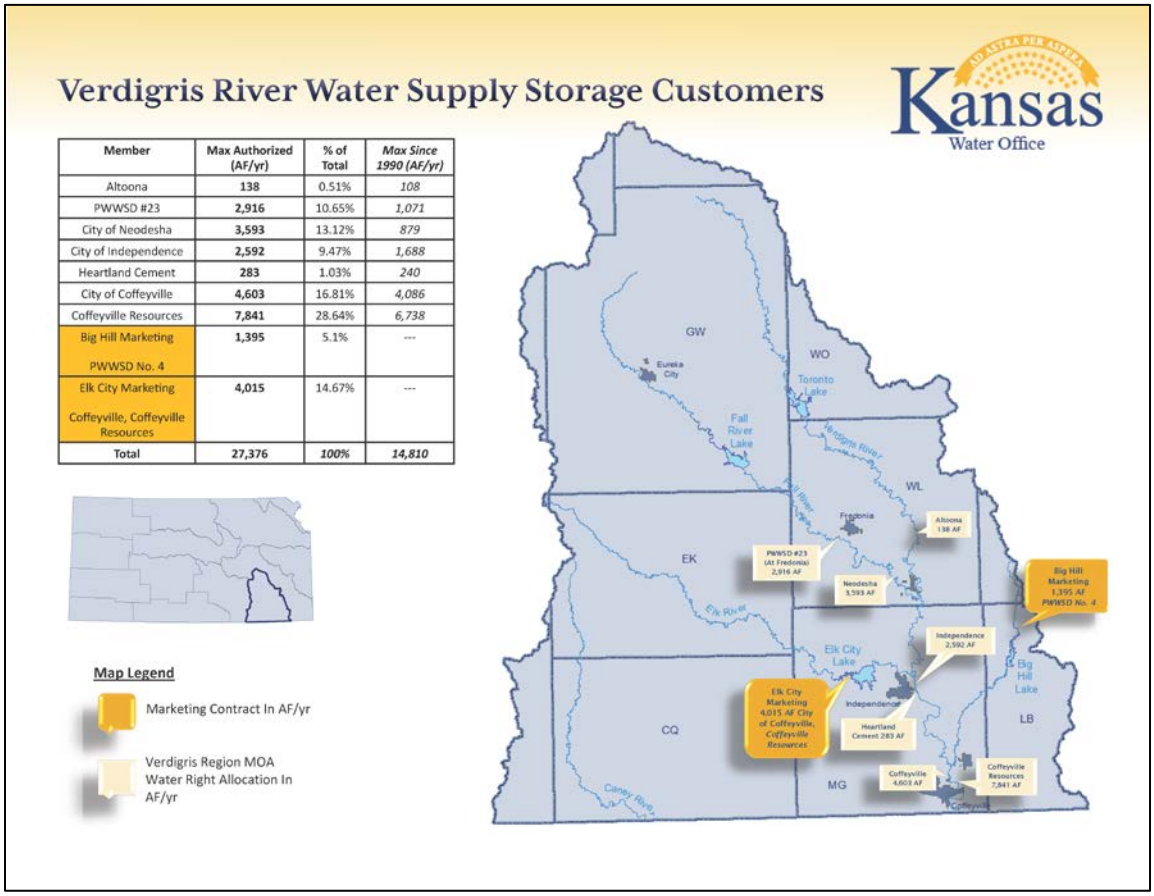


Figure 10: Verdigris River water supply storage customers

Water Quality

Surface Water

Water quality and related water resource issues are addressed through a combination of watershed restoration and resource protection efforts utilizing voluntary, incentive-based approaches, as well as regulatory programs. The Clean Water Act requires states to conduct Total Maximum Daily Load (TMDL) studies and develop TMDLs for water bodies identified on the state's List of Impaired Waters (Section 303(d) List). Total Maximum Daily Loads are quantitative objectives and strategies needed to achieve the state's surface water quality standards. A list of all impaired/potentially impaired water for the Verdigris Region can be found on the Kansas Department of Health and Environment (KDHE) impaired waters website.

The 2014 303(d) list for the Verdigris Region had 51 stream impairments and 4 lake impairments. From the 2014 to the 2016 303(d) list, there were no changes that occurred for the water bodies in the region.

In the Verdigris Region, all four of the federal reservoirs have a TMDL. Big Hill Lake has an eutrophication TMDL, Elk City Lake has both siltation and eutrophication TMDLs, Fall River and Toronto Lakes have dissolved oxygen, siltation, and eutrophication TMDLs.

Water quality and related water resource issues are addressed through a combination of Watershed Restoration and Protection Strategy (WRAPS) efforts utilizing voluntary, incentive-based approaches, as well as regulatory programs. The restoration and protection of watersheds, particularly those watersheds above public water supply reservoirs, is a priority in the Verdigris Region. The Verdigris and Caney rivers drain south into Oklahoma so inter-state water quality issues are also important to ensure high quality water crossing the state line.

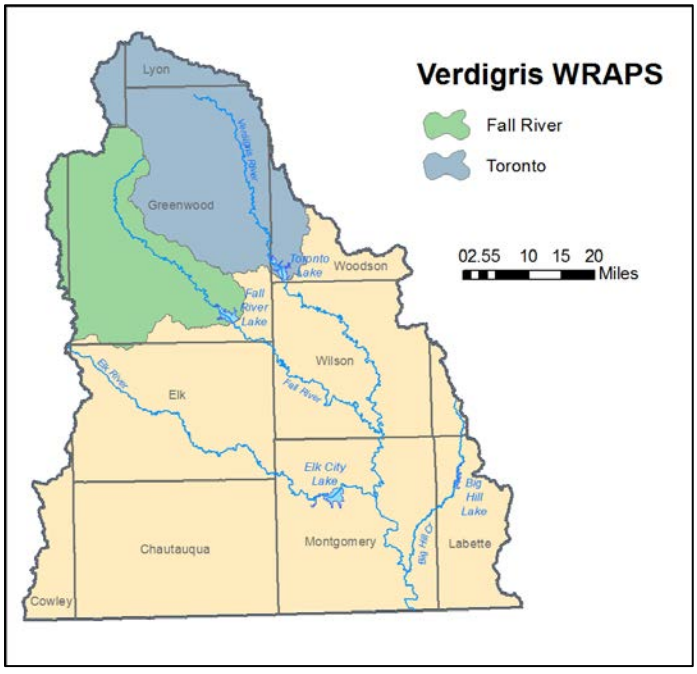


Figure 11: Verdigris Region WRAPS groups

Harmful Algal Blooms

Harmful Algal Blooms (HABs) are common in bodies of water when nutrient loading is excessive, especially phosphorus and during periods of elevated temperatures. Kansas Department of Health and Environment may issue two levels of public health protection notifications: a Public Health Watch or Public Health Warning. These notification levels are determined by the concentration of a harmful toxin(s) or the concentration of cyanobacteria cell counts. However, the Verdigris Region does not experience HABs on a persistent basis. The last documented occurrence of HABs in the region was in 2011 at Big Hill Lake.

Sedimentation

Sedimentation is a major issue in the eastern regions of the state and creates many challenges to managing reservoir water supplies. As reservoirs age, they accumulate sediment, reducing the reservoir's capacity to hold water supply for municipal and industrial customers, meet in lake recreation, and downstream water quality and habitat needs. The reservoirs in this region are all affected by sedimentation and loss of storage capacity is a concern.

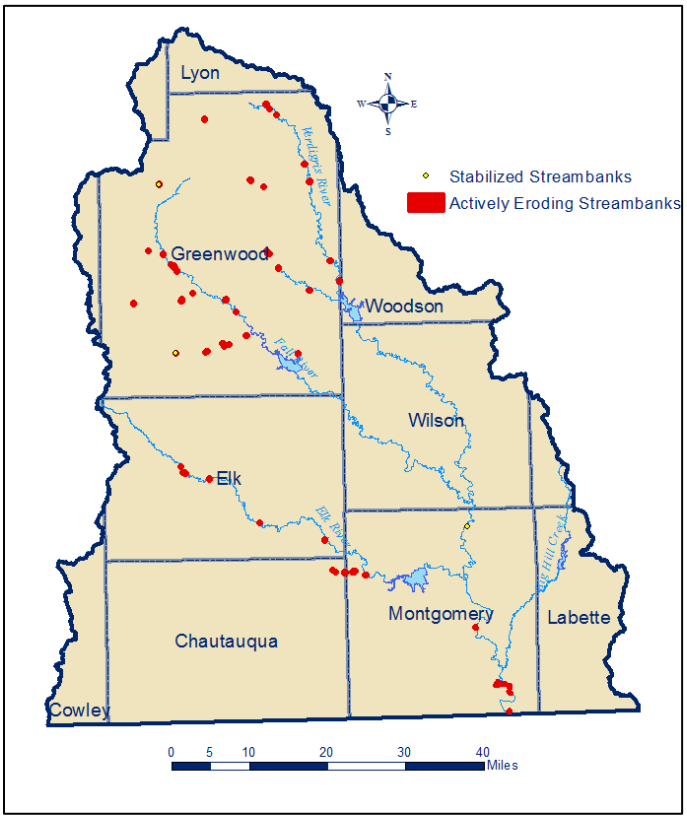


Figure 12: Verdigris Region streambank stabilization projects

The sedimentation rate within in the Verdigris Region is partly due to streambank erosion above each reservoir. Currently, there are 68 streambank hotspots within the region (Figure 12) and two of these 68 sites have been stabilized, reducing the sediment load by an estimated 246 tons per year. There are 66 sites that remain to be completed and if completed, will reduce the sediment load by an additional estimated 79,333 tons per year.

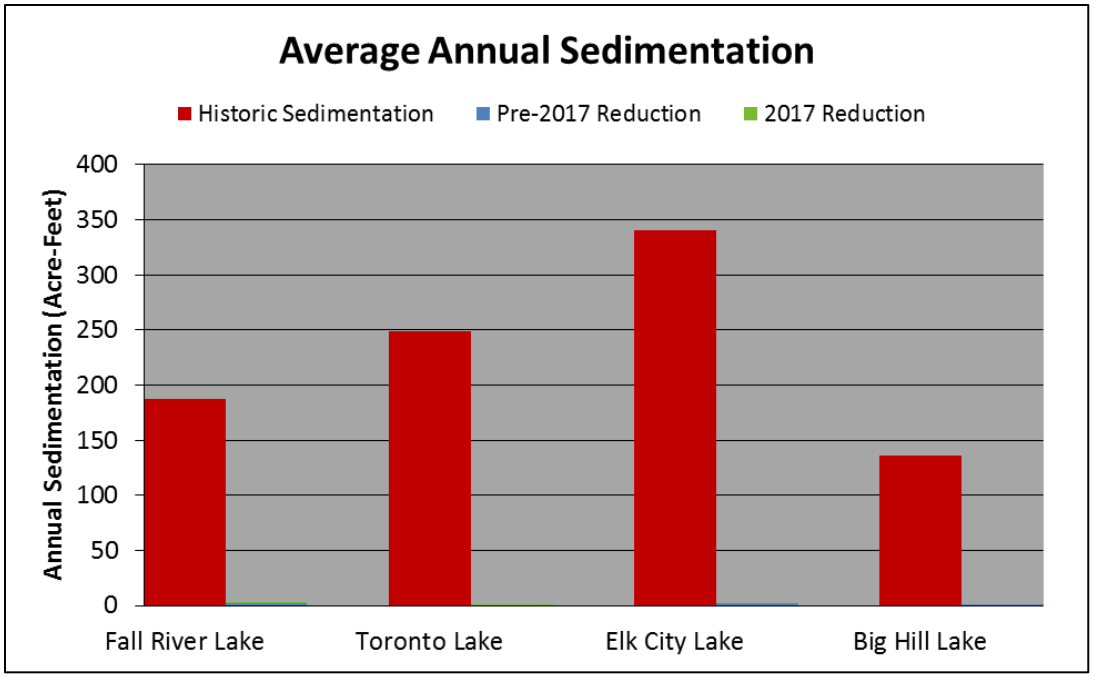


Figure 13: Average annual sedimentation in Verdigris Region reservoirs

Figure 13 shows the average annual sedimentation, estimated using the change in conservation storage between bathymetric surveys, compared to the estimated sediment load reduction due to BMPs and streambank stabilization project implemented in the watersheds above the Verdigris River basin federal reservoirs.

The estimated annual reductions compare total implementation prior to 2017 (beginning in 2004) to reduction in 2017. The results show that Elk City Lake has the highest historical sedimentation rate of approximately 340 acre-feet per year.

Nearly all sediment reduction has been achieved through BMP implementation. Prior to 2017, 4% of the average annual sedimentation reduction occurred from implementing streambank stabilization projects, while 96% occurred from the implementation of BMPs. In 2017, all sediment reduction was achieved through BMP implementation.

Figure 14 shows the change in reservoir sedimentation from the implementation of load reduction practices. Results show the estimated load reduction from implemented practices for all lakes only accounts for a small fraction of the total historical sedimentation.

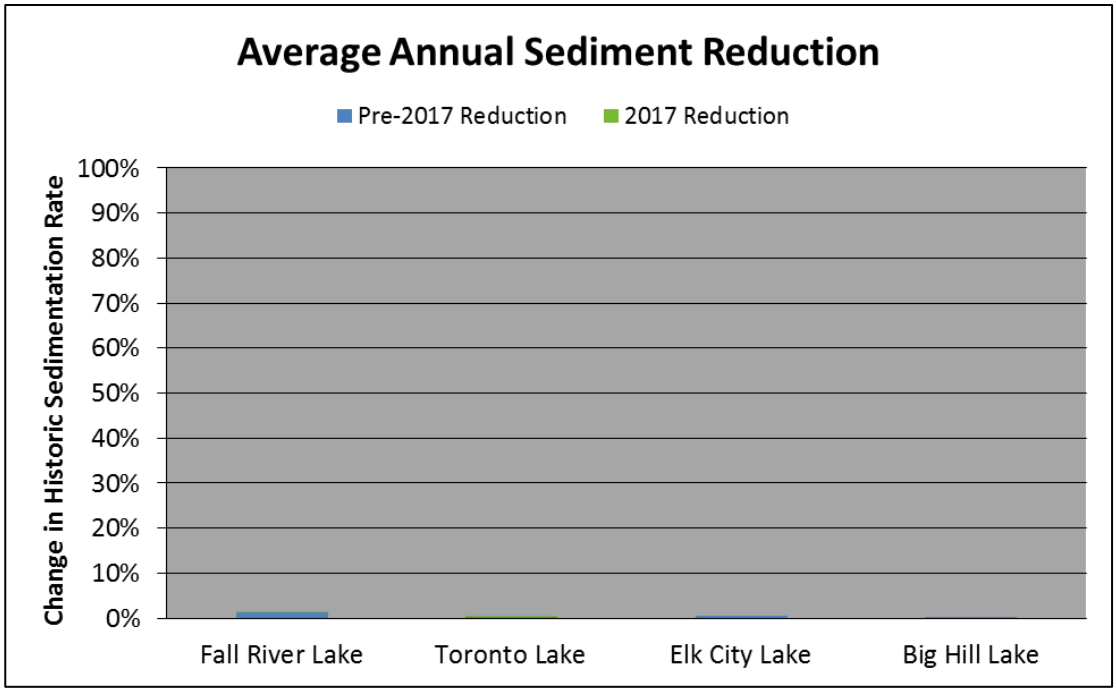


Figure 14: Average annual sediment reduction in Verdigris Region reservoirs

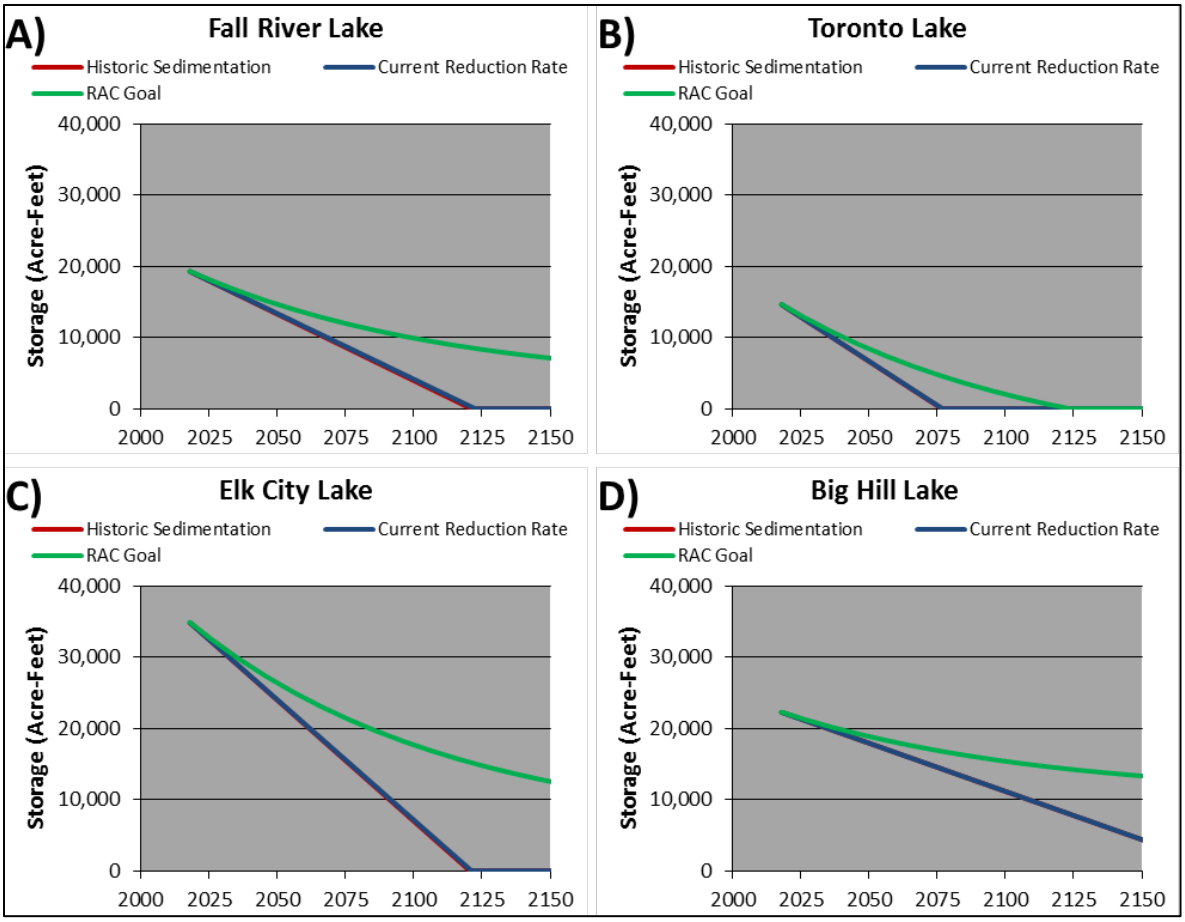


Figure 15: Reservoir capacity at conservation pool for Verdigris Region reservoirs

There is almost a non-detectable difference between the historic sedimentation and the estimated current rates with the projected sedimentation over time in Figure 15. This clearly illustrates the inadequacy of current sediment control practices.

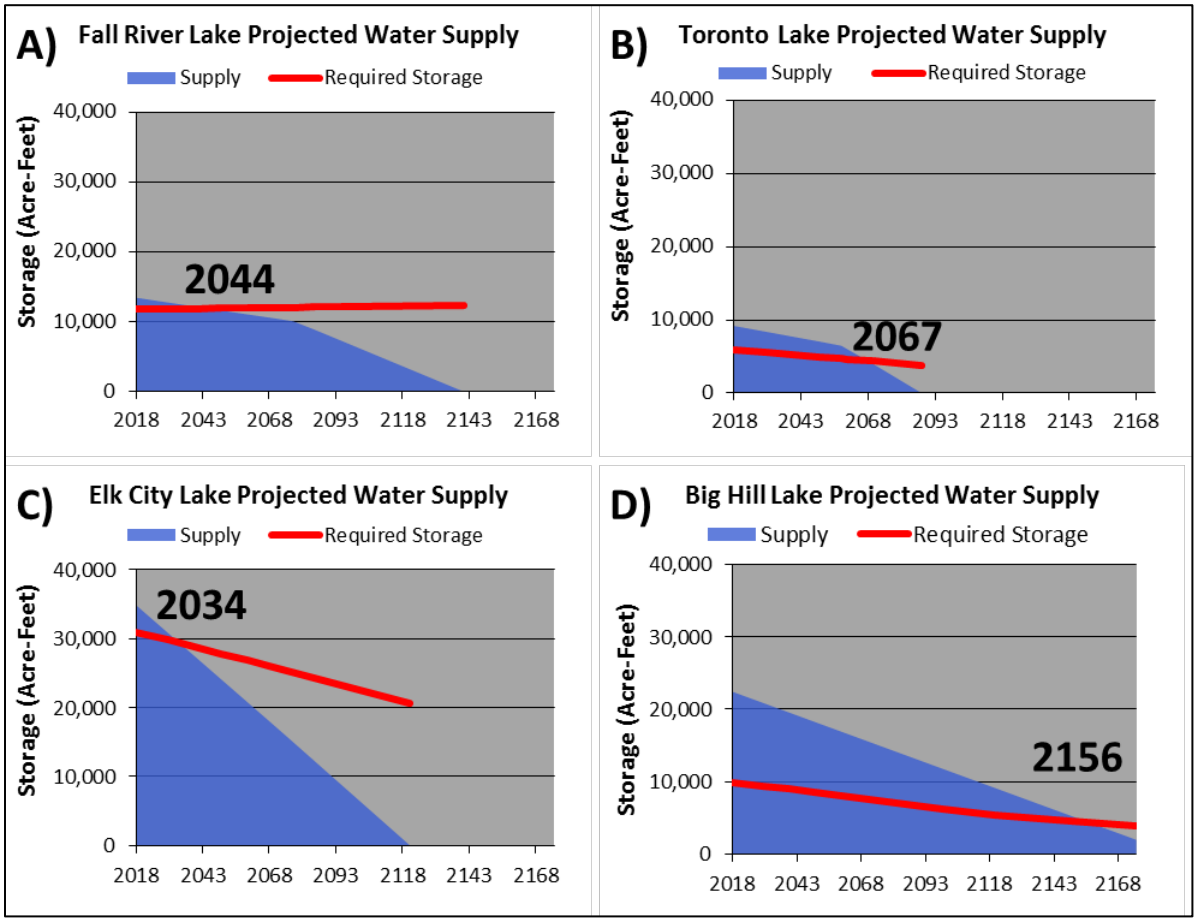


Figure 16: Verdigris Region projected water supply storage

Figure 16 shows the projected reservoir storage at conservation pools (blue) given the historic rate of reservoir sedimentation and the storage required (red) to meet the system's demands and targets for the four federal reservoirs in the basin. Here, Toronto Lake, Fall River Lake, and Elk City Lake are operated with rules that prioritize meeting the demands of the nearest downstream river reach. These operating rules reflect the current protocols for system operations but do not necessarily reflect some operational latitude to modify releases and adapt real-time management to balance system storage.

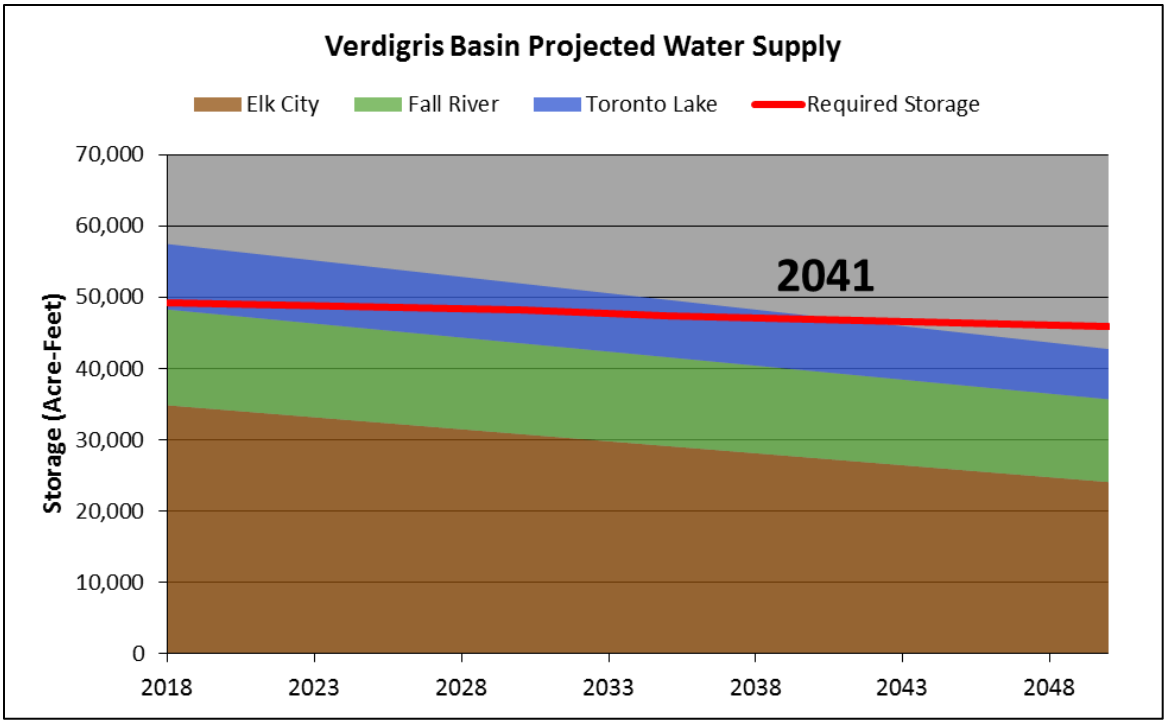


Figure 17: Verdigris Region projected water supply storage

Figure 17 reflects an effort to optimize operations and balance system storage. It is a more realistic representation of the three reservoirs managed as a system. Figure 17 is still important to show, as it helps identify problem areas. In this case, it is very clear that Elk City Lake is responsible for a disproportionate share of system demands, especially in the future, considering its high sedimentation rate.

The analysis was performed with current system operations using a Verdigris River basin model which simulated historic hydrologic conditions between 1950 and 2014, allowing for an estimate of required storage. Given the projected sedimentation and demands, results indicate that the supply will be insufficient to fully meet projected demands through a 1950s type drought within the Verdigris River basin by the year 2041 and 2156 for Big Hill Lake.

Zebra Mussels

Zebra mussels, one of the Aquatic Nuisance Species (ANS) affecting Kansas waters, are not found in the federal reservoirs within the Verdigris Region. Aquatic Nuisance Species affect the quality of water and recreational opportunities within the State of Kansas. The Kansas Department of Wildlife, Parks, and Tourism (KDWPT) has worked diligently on their ANS education and management plan in order to mitigate the problem and work to slow the migration. Since the Verdigris Region is one of the few regions that are not infested with Zebra mussels, those using the water resources in the region need to be diligent about not spreading Zebra mussels from other regions to uninfested water. The KDWPT has a full list of infested waters and how to stop the spread of ANS on their website.

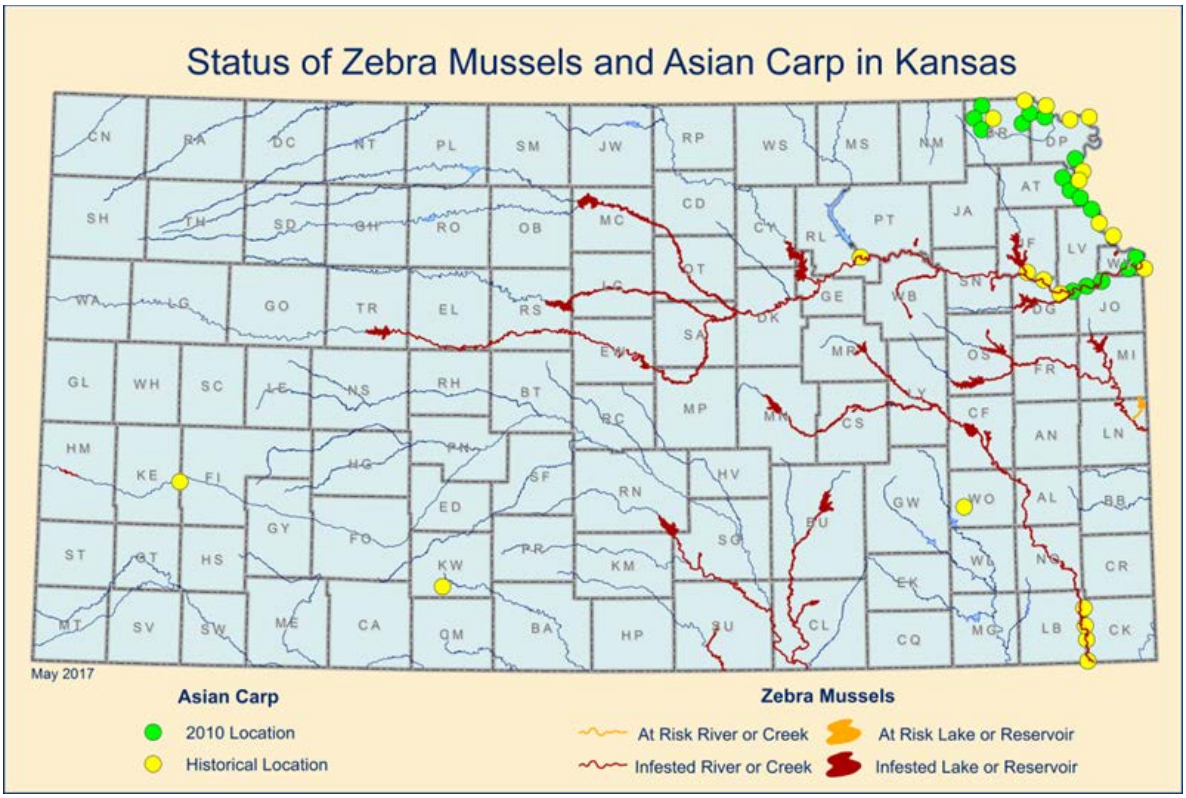


Figure 15: Status of Zebra mussels and Asian carp in Kansas

Implementation Progress

As noted in the goals for the Verdigris Region, implementation of the RAC's plans is critical. In order to reduce sediment loads entering public water supply reservoirs and to ensure adequate supply for the region, progress must be made in the efforts to accomplish these goals. In the past year, the following actions have been taken:

The KWO modeling for the region has started using the Multi-basin Evaluation of Kansas Reservoir Operations (MEKRO) model. It is a hydrologic model utilized by the KWO to assess the operational capability and physical adequacy of the reservoir and surface water systems in Kansas. Inputs to the model include historic inflows, reservoir storage capacities, system demands, and downstream target flows. The model is a planning tool that enables KWO staff and others to evaluate the effects of operational changes, reservoir improvements, reservoir sedimentation, and demand modifications that could impact each individual basin system in Kansas.

To showcase the capabilities of the model and to receive RAC input, a Drought Workshop was held in September 2017. Based on this workshop, continued use and refinement of the model, drought scenarios can be evaluated to create plans and strategies to mitigate and manage drought conditions. The Verdigris RAC has initiated work with the KWO, and will continue to use the model in order to evaluate the feasibility of reservoir operation changes and water storage increases, including cost estimates, focusing first on Fall River Lake as a priority for reallocation and ensuring the supply exceeds

demand beyond 2036. In using this model, to ensure the best possible information is used as inputs, the region's population projections will be evaluated for their supply needs to ensure the demand can be met and exceeded by 10% through the year 2050.

In addition, potential sites to build small water supply lakes have been assessed. The impact on water supply from adding an additional small water supply lake has been considered in the model. The cost of construction, including mitigation requirements, along with the permitting time, has been a hindrance to constructing new water supply lakes. PL-566 program structures have also been evaluated. Dams have been identified that qualify for federally funded rehabilitation and are being looked at to include a water supply component.

Part of the work to reduce sedimentation and improve water quality is the implementation of BMPs. As part of the RAC goals and action plans, they are evaluating the reduction of sediment loads that have occurred through the work done by the WRAPS groups and the conservation districts. This evaluation is looking at the BMPs implemented in both urban and rural settings and includes BMPs such as: cover crops, No-Till, terraces, grass waterways, etc. Table 1 shows a summary of the load reductions in 2017.

Table 1: 2017 load reductions by region and reservoir

Region & Watershed	Nitrogen (lbs/yr)	Phosphorus (lbs/yr)	Sediment (tons/yr)
Verdigris	**4,853**	**2,613**	**810**
Fall River Lake	3,425	1,826	85
Toronto Lake	1,428	787	725
Grand Total	**4,853**	**2,613**	**810**

Implementation Needs

While the Verdigris RAC has begun to address the water supply and water quality concerns within the region, continued work needs to be completed. With approval of the RAC's action plans from the Kansas Water Authority (KWA), the following items need to be addressed or continued to be addressed:

- Evaluate the feasibility of reservoir operation changes and water storage increases and estimate costs of these.
    - This work will begin with a focus on Fall River Reservoir
        - The RAC and KWO have begun utilizing the MEKRO model to evaluate supply and demand by region
        - The KWO is evaluating potential operational efficiencies to help reduce the burden on Elk City Lake and extend the supply/demand cross-over date
            - There is a particular interest in a reduction of the target flow at Independence
    - Continued development of the model's capabilities will need to be addressed and a feasibility report will need to be drafted

    - This report will be completed in coordination with all affected local, state, and federal entities. Based on the outcome of the feasibility report, changes to operations will be implemented and the process of reallocation studies may be initiated
    - This may require funding to complete the reallocation study, along with coordination with the USACE
- Review of the Reservoir Roadmap for the Verdigris Region has identified possible locations to construct a watershed dam. These potential sites need to be evaluated
    - Continued discussions between KWO, Kansas Department of Agriculture-Division of Water Resources (KDA-DWR), KDA-DOC, SAKW, NRCS, and Watershed Districts regarding the potential to construct previously planned structures in the Verdigris Region to reduce sedimentation and offer additional localized water supply sources
    - Costs and benefits of building a new structure and the necessity to meet future demands, needs further evaluation
    - Reservoir permitting processes need to be evaluated to see if there is possibility of streamlining the approval process of small lakes
        - A committee will need to be created involving those working with the permitting of reservoirs, to review mitigation guidelines and construction possibilities
- PL-566 program structures that have been identified as qualifying to include a water supply as a potential use of the structure need to be further evaluated
    - This federal program is underway within the NRCS; currently funding is being sought in the current and following fiscal year. Therefore, once funding is secured to finance the addition of water supply to existing structures, rehabilitation of chosen sites can begin

Conservation practice implementation continues to be necessary to reduce nutrient and sediment runoff impacting the surface waters of the Verdigris Region. Progress made within the region can be compared to the remaining needs identified to quantify the overall financial need to fully implement watershed plans in this region (Table 2). These figures include costs associated with conservation practice implementation, as well as technical assistance needs to help landowners implement conservation practices. Overall, the total remaining need to fully implement WRAPS watershed plans for the region is $2 million.

Table 2: 2017 costs by region

RAC Area	Number of plans	State Interest Priority Score Rank	Updated Information and Education Costs	Updated Total Livestock and Cropland Plan Costs	Updated Technical Assistance Plan Costs	Updated Total Implementation Plan Costs
	(2) Plans					
Verdigris	Toronto	12	$2,353,005.80	$883,774.08	$1,034,850.00	$1,509,415.48
	Upper Fall River	22	$516,177.00	$2,465,248.50	$2,220,108.00	$516,177.00
Total			**$2,869,182.80**	**$3,349,022.58**	**$3,254,958.00**	**$2,025,592.48**

Regional Goals & Action Plan Progress

While *The Vision* provides a framework for the management of the state's water supply overall, regional goals identify and address issues at the local level. In 2015, Regional Goal Leadership Teams were developed for each of the 14 regional planning areas which were comprised of local water users along with input from area stakeholders to help develop regional water supply goals. These goals were adopted by the KWA in August of 2015 and at that same time members for the 14 RACs were appointed. The first task for the newly formed RACs was to develop action plans to correspond with the regional goals. The Verdigris RAC completed action plans for their regional goals in fall of 2016. Information included within this section highlights recent progress made on regional goal action plan implementation.

Regional Goal #1	Goal Theme	Annual Progress			
		2017	2018	2019	2020
In order to manage the water storage capacity in our region, evaluate different processes of managing our reservoirs by 2020. Then using BMPs, including consideration of cost/benefit of the practices: increase water storage capacity by 10% every 10 years with priority given to existing structures, and ensure water supply available from storage exceeds projected demand by at least 10% through the year 2050.	Water Management			--	--
Progress Legend: Not Started | In Progress | Delayed | Cannot Complete | Complete					
2018 Update: Supply and demand of reservoir operations are being evaluated.					
Next Step(s): Refine supply and demand projections and increase accuracy of MEKRO model runs and scenarios.					

Regional Goal #3	Goal Theme	Annual Progress			
		2017	2018	2019	2020
By 2020 evaluate potential sites and the costs and benefits of building new reservoirs within the Verdigris Region to meet future demands. Permitting agencies should streamline processes to speed approval of small ponds and reservoirs.	Additional Sources of Supply			--	--
Progress Legend: Not Started | In Progress | Delayed | Cannot Complete | Complete					
2018 Update: The Reservoir Roadmap is being reviewed. Evaluation of watershed dams is being conducted.					
Next Step(s): • Identify possible watershed dams to be constructed through communication with watershed districts and					

DOC.

- Identify possible PL-566 structures to conduct dam rehabilitation and add water supply. Work to review and improve application of the stream mitigation guidelines.

References

"Blue-Green Algae (BGA) Blooms." *Kansas Department of Health and Environment*, www.kdheks.gov/algae-illness/.

"KDHE Approved Nine Element Watershed Plans | Kansas WRAPS." *Kansas WRAPS*, www.kswraps.org/kdhe-approved-nine-element-watershed-plans.

"Kansas Aquatic Nuisance Species Management Plan." *Kansas Department of Wildlife, Parks & Tourism,* https://ksoutdoors.com/Media/Files/Kansas-Aquatic-Nuisance-Species-Management-Plan.

"Lake Level Management Plans Water Year 2018." *Kansas Water Office*, kwo.ks.gov/docs/default-source/reservoirs/rpt_llmp_wy2018_101217_tj_formattedd1f0e11da40b6667970cff000032a16e.pdf?sfvrsn=0.

"Marais Des Cygnes River Basin Total Maximum Daily Load." *Kansas Department of Health and Environment* , www.kdheks.gov/tmdl/2013/Pomona_Eu_Silt.pdf.

"Surplus Water Available in Water Marketing Program Lakes Calendar Year 2017." *Kansas Water Office*, kwo.ks.gov/docs/default-source/reports-page/water-management/surplus-water-available-in-water-marketing-lakes-cy2017.pdf?sfvrsn=2.

"Watershed Planning, Monitoring, and Assessment Section." *Kansas Department of Health and Environment*, www.kdheks.gov/tmdl/.