BEFORE THE OFFICE OF ADMINISTRATIVE HEARINGS
STATE OF KANSAS

IN THE MATTER OF THE APPLICATION OF THE CITIES OF HAYS, KANSAS AND RUSSELL, KANSAS FOR APPROVAL TO TRANSFER WATER FROM EDWARDS COUNTY PURSUANT TO THE KANSAS WATER TRANSFER ACT	OAH Case No. 23AG0003 AG

PREPARED DIRECT TESTIMONY OF EDWARD HARVEY ON BEHALF OF WATER PROTECTION ASSOCIATION OF CENTRAL KANSAS AND EDWARDS COUNTY, KANSAS (COLLECTIVELY "INTERVENORS")

May 30, 2023

A. INTRODUCTION

Q **Please state for the record your name, position, and business address.**

A Edward Harvey. I am the founder and Principal of Harvey Economics. My business address is 469 South Cherry Street - Suite 100, Denver, Colorado 80246.

Q. **What is your educational and professional background?**

A I have a strong educational background and extensive experience in the field of resource economics, specifically in the context of water resource management. I hold a Master of Science in Business Administration (MSBA) with a specialization in Economics from the University of Denver, as well as a Bachelor of Arts (BA) degree in Economics, also from the University of Denver.

With a total of 50 years of professional experience, I have spent the past 20 years working at Harvey Economics, where I have focused on conducting economic studies related to water, mineral, energy, and environmental resource use. My expertise lies in analyzing the economic and financial impacts of water availability, drought, water quality, infrastructure development, irrigation, water conservation, and non-structural water resource issues.

As a part of my professional involvement, I have been affiliated with several reputable organizations. These include the Colorado Commission for Judicial Performance, the American Water Works Association (AWWA) and the Colorado Water Congress. These affiliations allow me to stay up-to-date with the latest developments and best practices in the field of water resource management.

Q **Please describe your experience and qualifications.**

A My experience and qualifications are more comprehensively described in the attached curriculum vitae, which is Exhibit 1 to this testimony. I have dedicated the majority of my career to studying the economic impacts of water, mineral, energy, and environmental resource use, as well as community changes in the western United States. With over 50 years of experience in this field, I have conducted a wide range of studies and analyses, including financial feasibility studies, rate studies, economic impact assessments, future resource demand analyses, and resource valuation studies.

Throughout my career, I have focused on conducting economic studies related to water availability, drought, water quality, infrastructure development, irrigation, water conservation, and non-structural water resource issues. I have worked extensively on projects involving water supply planning, water demand projections, and evaluating the economic and socioeconomic implications of various water-related initiatives.

Some notable projects I have been involved in include the Halligan Water Supply Project EIS in Colorado, where I led the development of long-term water demand projections and evaluated the impacts of expanding Halligan Reservoir on water rates and connection fees, socioeconomic and land use resources. I also played a key role in the Moffat Collection System Project EIS, conducting economic, financial and social

impact analyses for the expansion of an existing water supply reservoir for Denver Water.

In addition, I have worked on water projects such as the Lake Ralph Hall EIS in Texas, the Windy Gap Firming Project EIS in Colorado, and the Northern Integrated Supply Project (NISP) EIS in Colorado, where I provided expertise in developing water demand projections, assessing project purpose and need, and evaluating the financial feasibility and socioeconomic impacts of proposed water supply projects.

My experience extends to groundwater management, water transfers, and irrigation water allocation. I have conducted analyses of groundwater pumping fees, examined the economic effects of water transfers, and provided expert testimony in arbitration and legal proceedings related to water rights and allocation.

Furthermore, I have worked on studies assessing regional economic impacts, long-term water demand projections, and the effects of water supply projects on various sectors such as agriculture, tourism, construction, public facilities, and fiscal impacts.

Overall, my qualifications and experience enable me to provide comprehensive and insightful analysis of water-related issues, offering valuable expertise in understanding the economic implications, resource demands, and sustainability considerations associated with water resource development and management.

Q **Did you collaborate with anyone at HE in preparing your report?**

A Yes. Susan Walker.

Q **What is Ms. Walker's background and experience?**

A Susan H. Walker is a Director at Harvey Economics and has been an invaluable member of the company since 2005. Her expertise lies in planning endeavors related to water, energy, tourism, and other natural resource sectors. With a focus on economic and demographic research, analysis, and modeling, Ms. Walker has completed various projects involving rate studies, demand projections, socioeconomic impact analysis, cost-benefit analysis, project financing, and resource and facility valuation.

Throughout her career, Ms. Walker has worked with municipalities, utilities, special districts, private industry, as well as county, state, and federal agencies. Her project experience showcases her ability to tackle complex assignments and provide comprehensive insights into economic and water-related issues.

One notable project is the BennT Creek Regional Water Authority Growth Projections Study in Colorado, where Ms. Walker developed projections of housing unit growth for the Authority's water service areas. This involved incorporating information from real estate developers, state and county planning documents, zoning regulations, historical growth trends, and economic prospects to estimate future water demands.

In the Morgan County Quality Water District Growth Study, Ms. Walker conducted a comprehensive study on population and economic growth in rural Morgan County, Colorado, to project future water demands for the district. Her work involved

analyzing economic and demographic factors influencing regional growth and developing projections for residential, commercial, industrial, and agricultural customers over a 50-year period.

Currently, Ms. Walker is working on the Eagle County Water Demand Projections project in Colorado. Collaborating with the Eagle River Water & Sanitation District and Upper Eagle Regional Water Authority, she is responsible for preparing long-term water demand projections based on historical and projected population growth, economic conditions, conservation efforts, and water losses.

In addition to these projects, Ms. Walker has contributed her expertise to the Halligan Water Supply Project EIS, White River Reservoir Project, Parker Water Project, Chino Valley Water Demands and Water Pipeline, Platte River Basin Water Plan Update, Northern Integrated Supply Project EIS, Upper Gunnison Demand Management Impact Study, and more. Her work spans across different states and involves assessing future water demands, economic impacts, project financing, and benefit-cost analysis.

Overall, Susan H. Walker's extensive experience, expertise in economic and demographic research, and her contributions to a wide range of water-related projects make her a valuable asset to Harvey Economics and the field of natural resource economics.

Q **On whose behalf are you testifying today?**

A I am appearing on behalf of Water PACK and Edwards County, Kansas. Water PACK is an association of agricultural producers and businesses organized to promote, foster, and encourage the beneficial, economical, and sustainable use of quality water. Many of its members are located in proximity to the R9 Ranch in Edwards County, Kansas which is the water source that is the subject of the applicant cities transfer application. Edwards County is the geographic locale in which the R9 Ranch is located.

Q **What have you reviewed to prepare this testimony and your report?**

A We reviewed and evaluated the KWTA Application and supporting information submitted by the Cities and other publicly available information, including the Water Transfer Act and the implementing administrative regulations.

Q **Are you familiar with the Kansas Water Transfer Act, K.S.A. 82a-1501, et.seq.?**

A. Yes.

Q **Are you familiar with the Water Transfer Act implementing regulations, K.A.R. 5-50-1, et.seq.?**

A Yes.

B. THE R9 PROJECT

Q **What is your understanding of the purpose of the R9 Ranch project?**

A The R9 Ranch project involves extracting and transporting water from the R9 Ranch in Edwards County to the Cities of Hays and Russell via a pipeline. The purpose is to meet a portion of the future water needs of the Cities.

Q **Who retained Harvey Economics (HE) and why?**

A Harvey Economics (HE) was retained by the law firm Lee Schwalb LLC, representing WaterPACK and Edwards County in the KWTA proceedings, to evaluate the net future water needs of the Cities of Hays and Russell pertaining to the need for the R9 Ranch project.

Q **What are your principal conclusions with respect to your evaluation of the net future water needs for the Cities of Hays and Russell?**

1. The GPCD water demand projection method (population times gallons per capita per day or GPCD) is appropriate in this instance.
2. The water demands projected by the Cities have been mischaracterized as equating to future water needs, which require that existing supplies be subtracted from future water demands.
3. More project planning is required to determine the net future water needs to evaluate the need for this Project.
4. The long-term, minimal growth or declining population trends for Hays and Russell are not unique for western Kansas, and these trends are not solely attributable to a lack of water.
5. There is no justification for assuming that Hays and Russell will have the same growth rate going forward.
6. The two percent annual growth rate through 2040, which the Cities adopted for project planning purposes, is excessive and unsupportable.
7. The GPCD assumptions applied by the Cities are flawed and unreliable.
8. The Cities' individual water use and population data should have been used as the source for determining GPCD assumptions.
9. The Cities have robust conservation and drought emergency programs similar to many municipal programs throughout the western U.S.
10. A recalculation of future water demand for the Cities, however preliminary, indicates that net future water needs for the Cities will be much less than the Cities have indicated in their KWTA Application and supporting information.
11. Due to the R9 Ranch project costs, existing water customers in the two Cities will experience much higher water rates for the water they are presently consuming, resulting in a cost to them without offsetting benefit.
12. The R9 Ranch project represents a net cost, not a benefit, for the Cities and the State of Kansas.

These conclusions, based on the analysis conducted by Harvey Economics, provide key insights into the appropriateness of the GPCD method, the discrepancy between water demands and water needs, the population growth assumptions, and the overall viability and financial impact of the R9 Ranch project. The Cities must undertake additional project planning and evaluation to fully assess the net future water needs and the cost-benefit dynamics of the project.

Q **Did you review the 2019 *Master Order Contingently Approving Change Applications Regarding R9 Water Rights?***

A Yes.

Q **Did the Master Order address the Reasonable-Need Limitations for the Cities?**

A Yes, at Subsection XIII.B.b, Bates page KDA 000102.

Q **What were the Reasonable-Need Limitations presented in the 2019 Master Order?**

A The Reasonable-Need Limitations presented in the 2019 Master Order were 5,670.2 acre-feet for Hays and 1,815.0 acre-feet for Russell. These limitations were based on the Cities' population and GPCD water demand projections.

Q **How does HE view the water needs projected by the Cities?**

A Water demands projected by the Cities have been misinterpreted as future water needs. Future water needs should account for existing water supplies subtracted from future water demands.

Q **What methodology did the Cities use to determine their future water demands?**

A The Cities used the GPCD (gallons per capita per day) water demand projection method. This method requires population projections for a certain jurisdiction to be applied to an assumed water use per capita measure for that jurisdiction. Both Cities assumed an average annual growth rate of two percent through 2041 and applied a simple average GPCD for their respective water regions to those population projections. Russell also included additional projected industrial water demands.

Q **What is HE's opinion on the GPCD water demand projection method?**

A We consider the GPCD water demand projection method (population multiplied by gallons per capita per day or GPCD) to be appropriate in this case. However, HE has numerous, serious issues with how this method was implemented in this instance, specifically the growth assumption and the GPCD values used by the Cities as inputs into their calculations of future water demand.

Q **Is there justification for assuming the same growth rate for Hays and Russell in the future?**

A There is no justification for assuming that Hays and Russell will have the same growth rate going forward. The demographic and economic base of each city are different. Each city's growth rate should be considered separately.

Q **Is the Cities' growth assumption appropriate?**

A The assumption of two percent annual population growth appears to be based on outdated information – historical growth from as far back as 1950.Recent trends indicate much lower growth rates for Hays and population decline for Russell. The Cities have not provided sufficient support to substantiate a two percent annual growth rate over the next 20 years.

Q **What are the actual growth rates for the Cities of Hays and Russell?**

A Over the last four decades, growth for Hays has averaged about 0.65 percent per year, with slower growth (0.29 percent per year) between 2010 and 2020.Russell has experienced a continuously declining population since 1980. The slow or declining growth is unlikely attributed to water availability solely, but most likely influenced by various factors.

Population projections developed by the University of Kansas suggest a 0.34 percent annual growth rate for Hays and a 0.06 percent annual growth rate for Russell through 2045, based on the future outlook for Ellis and Russell counties. Those projections, based on current data and information, differ significantly from the Cities' growth assumption.

Q **How does HE view the population trends of Hays and Russell?**

A We note that the long-term trends of minimal growth or declining populations in Hays and Russell are not unique to those cities. Many communities in western Kansas are experiencing similar trends. Those trends are the result of many factors, and are not solely due to a lack of water.

Q **Are the Cities' GPCD values appropriate?**

A The GPCD assumptions applied by the Cities are flawed and unreliable for several reasons.

1. The Cities' use of simple regional average GPCD values, instead of City specific GPCD values, does not account for the differences in populations served by individual water providers and does not reflect the specific economic, demographic and housing characteristics of Hays or Russell, which may differ from other communities within their respective regions.

2. The Cities' assumed GPCD values reflect the average over the 5-year period between 2011 and 2015 are insufficient and out of date. More recent and longer term historical GPCD data is now available for both Cities, as well as for other water providers across the State. The more recent data indicates a decreasing trend in GPCD for the majority of communities in Region 5 and Region 6ML.

The Cities' individual population and water use data should have been utilized to determine the GPCD values used to calculate future water demands. Additionally, the

most recent and up to date GPCD data for each City should be used to determine future water demands.

Q **How do the revised population projections and GPCD assumptions affect the water demand calculations?**

A Applying the revised population projections and appropriate GPCD values, HE estimates a lower water demand for both Cities. For example, using Hays' long-term average GPCD of 86, the estimated 2040 water demand is about 62 percent less than the City's calculation of reasonable need. For Russell, application of an average GPCD of 79, plus inclusion of 700 acre-feet of additional industrial demand, would result in an estimated 2040 water demand that is about 40 percent less than indicated by that Russell's calculation of reasonable need.

Q **What water supplies do the Cities have, and how does it relate to their net water need?**

A HE extracted information about the Cities' water supplies from publicly available documents and studies. However, many of those reports were more than 10 years old and may not include complete information on the Cities current water supplies. The Cities each have their own portfolio of water supplies, primarily dependent on groundwater sources. The safe annual yield available from those supplies reflects water available in dry years. Estimates of the Cities' safe annual yield from available supplies were developed by the Cities' engineers or other consultants. HE estimated the 2040 water demands for each City and compared them to the estimates of current safe annual yield to determine the net water need for each City.

Q **What are the estimated net water needs for the Cities based on the R9 Ranch project?**

A HE's estimates of 2040 water demands for each City, considering revised population projections and appropriate GPCD values, are presented in Exhibit ES-1 in the HE report. These estimates provide an indication of the net water needs for each City in relation to their existing water supplies.

HE's preliminary recalculation of future water demand indicates that the net future water needs for the Cities are highly likely to be significantly lower than what the Cities have indicated in their KWTA Application and supporting information. HE acknowledges that there is much information that would be required to confirm or modify this preliminary assessment of net future water need.

Q **What does HE recommend regarding the evaluation of net future water needs?**

A We suggest that more project planning with better data is necessary to accurately determine the net future water needs and assess the requirement for the R9 Ranch project.

Q **Do the Cities have conservation and drought emergency programs?**

A Yes. The Cities have robust conservation and drought emergency programs, similar to many municipal programs throughout the western United States.

Q **How will the R9 Ranch project impact existing water customers?**

Due to the costs associated with the R9 Ranch project, existing water customers in the two Cities will experience much higher water rates for the water they presently consume. This results in a cost to them without an offsetting benefit.

A **What is HE's overall assessment of the need for the R9 Ranch project?**

We conclude the need for the R9 Ranch project is premised upon insufficient data faulty calculations, and upon unsupportable assumptions. We believe it represents a net cost, rather than a benefit, for both the Cities and the State of Kansas.

Edward Harvey

State of ~~Kansas~~ Colorado)
County of ~~Johnson~~ Denver)

Subscribed, acknowledged and sworn to before me by Edward Harvey this 25th day of May 2023.

(Seal)

JOSUE HUERTA-CABALLERO
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20184014410
MY COMMISSION EXPIRES APRIL 29, 2024

Signed

Review of the Reasonable-Need Limitations Determining Future Water Needs for the Cities of Hays and Russell, Kansas

In Support of Kansas Water Transfer Act Evaluation

May 25, 2023

Review of the Reasonable-Need Limitations Determining Future Water Needs for the Cities of Hays and Russell, Kansas

In Support of Kansas Water Transfer Act Evaluation

Prepared for

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Executive Summary

Harvey Economics (HE) was retained by the law firm Lee Schwalb LLC, representing WaterPACK in the KWTA proceedings, to evaluate the net future water needs of the Cities of Hays and Russell (Cities) pertaining to the need for the R9 Ranch project. The R9 Ranch project involves the extraction and transport of water from the R9 Ranch, located in Edwards County, to the Cities via pipeline. HE reviewed and evaluated the KWTA Application and supporting information submitted by the Cities and other publicly available information.

The Cities' approach to determining future water needs is commonly known as the gpcd water demand projection method. This method requires population projections for a certain jurisdiction be applied to an assumed water use per capita measure, gallons per capita per day (gpcd). Both Cities assumed an average annual growth rate of two percent through 2041 and applied a simple average gpcd for their respective water regions to those population projections; Russell also included additional projected industrial water demands.[1] The resulting Reasonable-Need Limitations presented in the 2019 Master Order were 5,670.2 acre-feet for Hays and 1,815.0 acre-feet for Russell.[2]

The gpcd water demand forecasting methodology is widely accepted and appropriate in this case. However, future water demands do not equate to future water needs. Future water needs are determined by offsetting future water demands against existing water supplies. Additionally, HE has numerous, serious issues with both the growth assumption and the gpcd values used by the Cities in their water demand projections.

The Cities' two percent annual population growth assumption appears to be loosely based on the average annual percentage population change for Hays between about 1950 and 1990. Therefore, the assumed growth rates for each City are based on data many decades old. Historical data of that vintage does not reflect more recent trends, current conditions, or future outlook for the Cities. Over the last four decades, and certainly in the last 10 years, growth for Hays has averaged much less than 1.0 percent per year and Russell has continued to experience a population decline. This slow or declining growth is a phenomenon also experienced by many other communities in western Kansas for a multitude of reasons unrelated to the availability of water supplies. Looking forward, future population changes for the Cities will also depend on many considerations. To date, the Cities have not provided sufficient support to substantiate a two percent annual growth rate over the next 20 years.

Population projections indicate a 0.34 percent annual growth rate for Ellis County and a 0.06 percent annual growth rate for Russell County through 2045.[3] Application of a 0.34 percent growth rate for Hays would result in a 2040 population of about 22,110, about 35 percent less than the City's projection. Application of a 0.06 percent growth rate for Russell would result in a 2040 population of about 4,435, about 39 percent less than that City's projection.

[1] Hays is located in Region 5, Russell is located in Region 6ML. The Cities' calculations of simple regional averaged included water providers serving a population of 500 or more residents.
[2] *Master Order Contingently Approving Change Applications Regarding R9 Water Rights*, Subsection XIII.B.b, March 2019.
[3] University of Kanas, Institute for Policy & Social Research, *The Kansas Statistical Abstract*, 2021.

Hays assumed a gpcd of 149.6, while Russell assumed a gpcd of 137.3 in their calculations of future need. Those values reflect a simple average of larger water providers in Regions 5 and 6, respectively, over the 2011-2015 period. Although a population-weighted regional average would more accurately reflect regional water use, regional water use patterns cannot be relied upon for assuming city-specific water use patterns. The economic base, housing and demographic characteristics of communities vary across the region and Hays' and Russell's gpcd values reflect their own unique circumstances. Based on available information, the long term average gpcd for Hays and Russell are approximately 40 percent less than the Cities assumed in the KWTA application. Moreover, recent data indicate that gpcd values have continued to decline in recent years The declining trend in per capita water use is likely due, at least in part, to the Cities' robust water conservation programs.

Application of Hays' long-term average gpcd of 86 (2008-2022) to HE's revised population projections for the City would result in a 2040 water demand of 2,136 acre-feet, an increase of about 180 acre-feet, as compared to the City's 2022 water production data and about 62 percent less than indicated by Hays' calculation of reasonable need. For Russell, application of an average gpcd of 79 over the 2013-2017 period to HE's revised population projections for the City, plus inclusion of 700 acre-feet of industrial demand would result in a 2040 water demand of 1,092 acre-feet, a decrease of about 56 acre-feet as compared with average historical water diversions and about 40 percent less than indicated by Russell's calculation of reasonable need.

The Cities each have their own portfolio of water supplies, largely dependent on groundwater sources. Safe annual yield available from those supplies reflects water available in dry years. Exhibit ES-1 presents HE's estimates of 2040 water demands for each City, along with estimates of current safe annual yield, in order to estimate the net water need for each City.

Exhibit ES-1.
Preliminary Scenario of Net Future Water Needs for the Cities

	2040 Water Demand	Current Safe Yield (Supply)	Unmet Demand (Net Available Supply)
City of Hays	2,136 AF	2,397 AF	-261 AF
City of Russell	1,092 AF	1,840 AF	-748 AF

This scenario of net future water need suggests that the Cities might not need any additional water supplies for the foreseeable future.

Additionally, given a current estimated cost of $134.9 million, the R9 Ranch project will become a substantial expense for water ratepayers in Hays and Russell. These customers will very likely experience major increases in their water rates, with little or no benefit. Hence, the R9 Ranch project will very likely result in a net cost to the water ratepayers of Hays and Russell.

Upon completion of our work, HE reached the following conclusions and opinions:

1. The gpcd water demand projection method (population times gallons per capita per day or gpcd) is appropriate in this instance.

2. The water demands projected by the Cities have been mis-characterized as equating to future water needs, which require that existing supplies be subtracted from future water demands.

3. More project planning is required to determine the net future water needs to evaluate the need for this Project.

4. The long term, minimal growth or declining population trends for Hays and Russell are not unique for western Kansas, and these trends are not solely attributable to a lack of water.

5. There is no justification for assuming that Hays and Russell will have the same growth rate going forward.

6. The two percent annual growth rate through 2040 which the Cities adopted for project planning purposes is excessive and unsupportable.

7. The gpcd assumptions which the Cities applied are flawed and unreliable.

8. The Cities' individual water use and population data should have been used as the source for determining gpcd assumptions.

9. The Cities have robust conservation and drought emergency programs similar to many municipal programs throughout the western U.S.

10. A re-calculation of future water demand for the Cities, however preliminary, indicates that net future water needs for the Cities will be much less than the Cities have indicated in their KWTA Application and supporting information.

11. Because of the R9 Ranch project costs, existing water customers in the two Cities will experience much higher water rates for the water they are presently consuming, yielding a cost to them without offsetting benefit.

12. The R9 Ranch project represents a net cost, not a benefit, for the Cities and the State of Kansas.

SECTION 1
Introduction

This study evaluated the future water needs of the Cities of Hays and Russell, Kansas (Cities) as offered by those Cities in their application under the Kansas Water Transfer Act (KWTA). This study was prepared by Harvey Economics (HE) who was retained on April 25, 2023, by the law firm Lee Schwalb LLC, representing WaterPACK in the KWTA proceedings.

Harvey Economics is a resource economics consulting firm headquartered in Denver, Colorado. This report was authored by Edward Harvey and Susan Walker. Resumes for both can be found in Appendix A.

Background and Study Objectives

The Cities of Hayes and Russell prepared and submitted projections of future water needs from 2017 through 2041 to the Kansas Division of Water Resources in support of the 2019 Master Order, which established the amount of water subject to a change of use from agriculture on the R9 Ranch to municipal use.[4] The Chief Engineer utilized the Cities' projections of need in his determination of Reasonable-Need Limitations which initially established the amount of water which could be withdrawn from the R9 Ranch.[5]

Given the size of the withdrawal and the distance to the intended location of use, the Cities were required to seek approval for transferring the R9 Ranch water in accordance with the Kansas Water Transfer Act (KWTA). In attempting to demonstrate the benefits of this transfer, the Cities incorporated the same projections of future water needs submitted previously to and adopted by the Division of Water Resources:

As described in the First Amended Application under the KWTA:

> "…the Chief Engineer has imposed the Reasonable-Need Limitations on each of the Cities. These Limitations cap the total quantity of water that can be diverted from the R9 Water Rights for municipal use by each of the Cities, when combined with all other water rights owned by each City."

This Harvey Economics study examines the projections of future water needs submitted by the Cities in their First Amended Application under the KWTA:

1. Is the methodology for projecting future water needs appropriate?

[4] *Master Order Contingently Approving Change Applications Regarding R9 Water Rights*, Subsection XIII.B.b, March 2019.

[5] This amount was later adjusted allowing for flexible annual withdrawals, subject to a Ten-Year Rolling Aggregate Limitation.

2. Are the calculations and assumptions the Cities utilized in projecting water demands supportable?

3. What are the present and future water supplies which the Cities can bring to bear in meeting future demands?

4. How much water do the Cities require to meet future unmet needs?

Study Contents

This main body of this report contains the following sections:

- *Section 1. Introduction* – Study purpose and content.
- *Section 2. The Cities' Projections of Future Water Needs* – Approach adopted, specific assumptions and calculations, weaknesses in approach.
- *Section 3. Population Projections for the Cities* – Historical and projected growth for the Cities, shortcomings in the Cities' projections.
- *Section 4. Water Use Trends and GPCD Assumptions* – Historical and projected gallons per capita per day (gpcd) for the Cities, mistaken calculations, unsupportable assumptions.
- *Section 5. An Alternative Scenario of Future Water Needs for the Cities* – Preliminary water demand projections, alternative scenario of net future water needs.
- *Section 6. HE Conclusions and Opinions*– Conclusions about the Cities' future water needs, and expert opinions.

Caveats

This evaluation was based largely on the KWTA Application and supporting information provided by the Cities, the Cities' information reported by the Kansas Division of Water Resources, and published information related to demographics, economic development, water use and related topics. It is likely that the Cities have additional studies and information that HE has not seen, which might modify our evaluation. Through counsel, we have requested additional information, but a response to that was not available at the time of this writing.

SECTION 2
The Cities' Projections of Future Water Needs

This section describes the Cities' methodology and calculations for determining their future water needs. HE then evaluates that methodology and those calculations.

Cities' Methodology

The Cities' approach for determining future water needs was described in the Chief Engineer's Master Order in setting the Reasonable-Need Limitations for the City of Hays and the City of Russell.[6] The Cities requested the use of a specific method for projecting water use, commonly known as the gpcd water demand projection method. This method requires population projections for a certain jurisdiction be applied to an assumed water use per capita measure, gallons per capita per day (gpcd).

The Cities then assumed that the gpcd water demand projection method would produce results equal to their future water needs. However, there is no indication that the Cities subtracted their presently available water supplies to identify their net future water needs.

Water Need Calculations Applied by the Cities

The Cities applied the following assumptions in calculating their future water needs:

- An assumed population growth rate of two percent (2%) per year;
- The 5-year average daily per capita water use by municipalities with populations that exceed 500 people in the respective Water Region (Region 5 for Hays and Region 6ML for Russell);
- Any additional water sales, other metered water, unmetered water or treatment losses, to the extent not otherwise included in the 5-year average daily per capita municipal use.

The calculated Reasonable-Need Limitations for each city are provided in Appendices D and E of the Master Order and are also presented below for ease of discussion purposes.

City of Hays. Hays has projected its future water needs for year 2041 to be 5,670.23 acre-feet of water, calculated as shown in Exhibit 2-1.[7]

[6] *Master Order Contingently Approving Change Applications Regarding R9 Water Rights*, Subsection XIII.B.b, March 2019.

[7] According to the Master Order, "Upon a City's providing the Chief Engineer with written notice along with the appropriate supporting documentation …….the Reasonable-Need Limitation for the City will increase any time the method set out in Subsection XIII.B.b results in a greater quantity for such City."

Exhibit 2-1.
Calculation of City of Hays' Reasonable-Need Limitation

Region 5 - Hays, Kansas	2012 - 2021 Reasonable Need	2022 - 2031 Reasonable Need	2032 - 2041 Reasonable Need
Hays' 2016 US Census Bureau Estimated Population	21,027		
2% Growth Multiplier for 4 Years	1.08243222		
2% Growth Multiplier for 10 Years		1.2189944	1.2189944
Hays' Assumed Population		22,760	27,745
Hays' Estimated End of Decade Population	22,760	27,745	33,821
Region 5 Average per Capita Water Use in Gallons (2011-2015)	149.57	149.57	149.57
Days per Year	365.25	365.25	365.25
Gallons	1,243,417,193	1,515,718,620	1,847,652,540
Gallons per Acre-Foot	325,851.4	325,851.4	325,851.4
Acre-Feet	3,815.9	4,651.6	5,670.2
Additional Water Sales, Other Metered or Unmetered Water and Treatment Losses (Acre-Feet)	0	0	0
Calculated Reasonable Need	**3,815.9**	**4,651.6**	**5,670.2**

Note: Additional water sales, other metered or unmetered water and treatment losses are only added into the calculation to the extent they are not already included in the average daily per capita water use assumption.

Source: Master Order Contingently Approving Change Applications Regarding R9 Water Rights, 2019, Appendix D

City of Russell. Russell has projected its future water needs for year 2041 to be 1,815.0 acre-feet, as calculated in Exhibit 2-2.[8]

[8] According to the Master Order, "Upon a City's providing the Chief Engineer with written notice along with the appropriate supporting documentation …….the Reasonable-Need Limitation for the City will increase any time the method set out in Subsection XIII.B.b results in a greater quantity for such City."

Exhibit 2-2.
Calculation of City of Russell's Reasonable-Need Limitation

Region 6 - Russell, Kansas	2012 - 2021 Reasonable Need	2022 - 2031 Reasonable Need	2032 - 2041 Reasonable Need
Russell's 2016 US Census Bureau Estimated Population	4,506		
2% Growth Multiplier for 4 Years			
2% Growth Multiplier for 10 Years			
Russell's Assumed Population		4,877	5,946
Russell's Estimated End of Decade Population	4,877	5,946	7,248
Region 6 Average per Capita Water Use in Gallons (2011-2015)	137.25	137.25	137.25
Days per Year	365.25	365.25	365.25
Gallons	244,508,776	298,054,834	363,327,179
Gallons per Acre-Foot	325,851.4	325,851.4	325,851.4
Acre-Feet	750.4	914.7	1,115.0
Additional Water Sales, Other Metered or Unmetered Water and Treatment Losses (Acre-Feet)	700	700	700
Calculated Reasonable Need	1,450.4	1,614.7	1,815.0

Notes: (1) Additional water sales, other metered or unmetered water and treatment losses are only added into the calculation to the extent they are not already included in the average daily per capita water use assumption.
(2) The 700 acre-feet of additional water sales is water sold by the City to industrial, stock and bulk customers.

Source: Master Order Contingently Approving Change Applications Regarding R9 Water Rights, 2019, Appendix D

Harvey Economics Evaluation of Approach

The gpcd water demand forecasting methodology is widely accepted and appropriate here, especially for smaller municipalities. HE supports the choice of that forecasting approach for the Cities of Hays and Russell in this instance.

However, future water demands do not equate to future water needs. Future water needs are determined by offsetting future water demands against existing water supplies.[9] With this calculation, water planners can identify how much additional water a municipality will require in the future. For the Cities currently, existing supplies are meeting existing water customers' needs, with the possible exception

[9] *Water Supply Handbook: A Handbook on Water Supply Planning and Resource Management*, Institute for Water Resources, U.S. Army Corps of Engineers (Revised IWR Report 96-PS-4), 1998.

of drought emergency years. The net water requirements must be calculated to evaluate the Cities' future water needs.

It is HE's opinion that the water demands projected by the Cities have been mis-characterized as equating to future water needs, which have thus far not been presented in the proceedings of the Division of Water Resources or the First Amended Application under the KWTA.

HE has numerous, serious issues with the data used by the Cities in the water demand projections, as addressed in the next sections of this report.

SECTION 3
Population Projections for the Cities

Population projections are a critical component of the water demand projections and determination of water needs for the Cities of Hays and Russell. This report section identifies and evaluates the population projections the Cities have used in their KWTA Application. We address the historical and projected population changes and the reasons for those changes in communities in western Kansas, including Hays and Russell and their respective counties.

City of Hays and City of Russell Population Growth Assumptions

For the purposes of the calculation of Reasonable-Need Limitations, the Cities have assumed a two percent (2.0%) annual population growth rate going forward through 2041, apparently based on a report published in 2002.[10] That growth rate assumption appears to be loosely based on the average annual percentage change for Hays between about 1950 and 1990 (1.8% per year). The foundation of the two percent annual growth rate assumption seems to be that population growth has slowed ever since the early 1990s drought and the implementation of conservation measures, but that with additional water supplies and water availability, the Cities could grow at the levels seen 30 to 70 years ago, prior to that 1990's drought. The underlying theory seems to be that the real or perceived lack of reliable water supplies has dampened the Cities' growth and that with adequate water supplies, population growth would return to the levels experienced last century.

Harvey Economics Evaluation of the Cities' Population Projections

Out of date basis for growth assumption. First, it is important to note that the underlying support for the Cities' growth assumption is based on information more than 25 years old with no apparent update to the original study. Since that time, Kansas and the U.S. have experienced the dawning of the internet, three recessions, boom periods, a pandemic, and social evolution. A study that old should only be used for background, not accepted as the basis for the population projections.

More serious, the dated study in question further relies on time periods which stretch back to the Korean War. The economic, demographic and social changes which have occurred since the period 1950 to 1990 deeply weaken the validity of the Cities' growth rate during that time for the purposes of the KWTA Application.

Given these observations, the question becomes what does a more recent picture of population change look like for the Cities and for western Kansas? What is the explanation for those trends that can indicate how the population for the two cities might change in the future?

[10] Docking Institute of Public Affairs, Memo to David Pope on behalf of the Public Wholesale Water Supply District No.15, *Planning Horizon, Projections of Population and Industrial Growth in Hays, Industrial Demand in Russell, and the Potential for Partnership with other Water Districts and Incorporated Cities,* 2002.

Historical population changes for the City of Hays and Ellis County. Over about the last 40 years, Hays grew by an annual average of 0.65 percent per year (Exhibit 3-1).

Exhibit 3-1.
Historical population changes for the City of Hays and Ellis County, 1980 – 2021

	City of Hays	Ellis County
1980	16,301	26,098
1990	17,814	26,004
2000	20,013	27,507
2010	20,510	28,452
2020	21,116	28,934
Avg Ann Growth (1980 - 2020)	0.65%	0.26%
Avg Ann Growth (1980 - 1990)	0.89%	-0.04%
Avg Ann Growth (1990 - 2000)	1.17%	0.56%
Avg Ann Growth (2000 - 2010)	0.25%	0.34%
Avg Ann Growth (2010 - 2020)	0.29%	0.17%
July 1, 2020	20,894	28,931
July 1, 2021	20,795	28,790
% Change (2020 -2021)	-0.47%	-0.49%

Sources: University of Kansas, Institute for Policy & Social Research, The Kansas Statistical Abstract, 2021, https://ipsr.ku.edu/ksdata/ksah/; Kansas Division of the Budget, Certified Kansas Population data, https://budget.kansas.gov/population/.

However, since the year 2000, the City's growth has amounted to much less than the longer-term average. Clearly, growth since 1980, especially in more recent years, would suggest a much lower growth rate than two percent for the City of Hays.

Historical population changes for the City of Russell and Russell County. Over about the last 40 years, Russell's population declined by an average of about half a percent per year (Exhibit 3-2), although the City did experience 0.32 percent growth between 2020 and 2021.

Exhibit 3-2.
Historical population changes for the City of Russell and Russell County, 1980 – 2021

	City of Russell	Russell County
1980	5,427	8,868
1990	4,783	7,835
2000	4,696	7,370
2010	4,506	6,970
2020	4,401	6,691
Avg Ann Growth (1980 - 2020)	-0.52%	-0.70%
Avg Ann Growth (1980 - 1990)	-1.26%	-1.23%
Avg Ann Growth (1990 - 2000)	-0.18%	-0.61%
Avg Ann Growth (2000 - 2010)	-0.41%	-0.56%
Avg Ann Growth (2010 - 2020)	-0.24%	-0.41%
July 1, 2020	4,374	6,672
July 1, 2021	4,388	6,703
% Change (2020 -2021)	0.32%	0.46%

Source: University of Kansas, Institute for Policy & Social Research, The Kansas Statistical Abstract, 2021, https://ipsr.ku.edu/ksdata/ksah/; Kansas Division of the Budget, Certified Kansas Population data, https://budget.kansas.gov/population/.

Any assumption of population growth for the City of Russell is not borne out by the historical record since 1980.

The Docking Institute memo was incorrect in stating, "As was pointed out, the drought in the early 1990s and the resulting conservation measures have had a significant impact in growth in the City of Hays." As shown in Exhibits 3-1 and 3-2, during the decade before the drought (1980 to 1990), Hays' population only grew by 0.89 percent per year and Russell's population declined by 1.26 percent per year.

Historical population growth for other Kansas communities. The slow or declining growth experienced by Hays and Russell over the past several decades is not unique to those Cities; it is a phenomenon also experienced by many other communities in western Kansas. Exhibit 3-3 summarizes the population changes that have occurred in Region 5 (Hays) and Region 6ML (Russell) since 1980. Appendix B of this report provides a map of the different regions used by the Division of Water Resources to calculate per capita water use.

Overall, the population of Region 5 has been very stable since 1980, declining by only a small amount over time. However, of the 14 communities with a population of 500 or above, Hays is the only municipality that experienced population growth over the historical period. All other 13 communities lost between about 100 and 1,000 residents each during that period.

Region 6ML experienced a larger decline in population over the historical period. Of the 32 communities located in Region 6ML (with populations greater than 500), five experienced some population growth, while the remaining 27 lost residents.

Exhibit 3-3.
Historical Population Changes for Region 5 and Region 6ML, 1980 – 2020

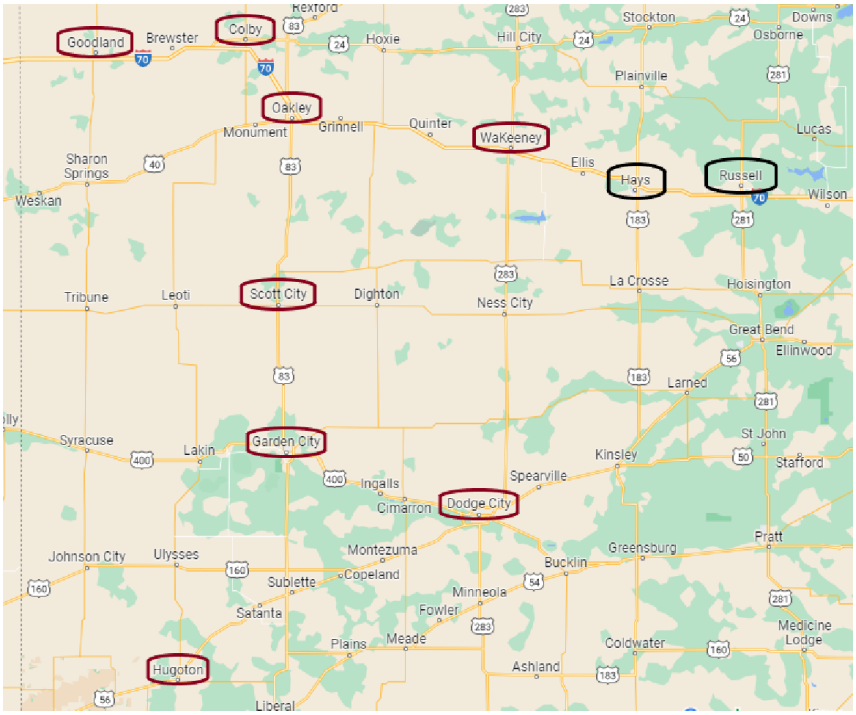
	Region 5 (Hays)	Region 6ML (Russell)
1980	40,754	121,973
1990	39,789	115,379
2000	40,758	115,988
2010	39,861	115,657
2020	39,320	109,500
Avg Ann Change (1980 - 2020)	-0.09%	-0.27%

Note: Population totals for each Region include those communities with populations greater than 500 people.

Source: University of Kansas, Institute for Policy & Social Research, The Kansas Statistical Abstract, 2021, https://ipsr.ku.edu/ksdata/ksah/

Outside of Regions 5 and 6ML, four communities located along interstate highways or other major roads in western Kansas have experienced modest growth, while four others have seen population declines. These communities, as well as the Cities, are shown in Figure 3-1. Exhibit 3-4 identifies population changes for these select larger communities.

Figure 3-1.
Map Identifying Select Western Kansas Communities



Source: Google Maps, 2023; Harvey Economics, 2023.

Exhibit 3-4.
Historical Population Changes for Select Western Kansas Communities, 1980 – 2020

City	1980	1990	2000	2010	2020	Avg Ann Change (1980 - 2020)
WaKeeney	2,343	2,045	2,173	2,045	2,046	-0.71%
Oakley	2,343	2,045	2,173	2,045	2,046	-0.34%
Colby	5,544	5,510	5,450	5,387	5,570	0.01%
Goodland	5,708	4,983	4,948	4,489	4,465	-0.61%
Dodge City	18,001	21,129	25,176	27,340	27,788	1.09%
Garden City	18,256	24,097	28,451	26,665	28,151	1.09%
Scott City	4,154	3,785	3,855	3,816	4,113	-0.02%
Hugoton	3,165	3,179	3,708	3,904	3,747	0.42%

Source: University of Kansas, Institute for Policy & Social Research, The Kansas Statistical Abstract, 2021, https://ipsr.ku.edu/ksdata/ksah/

Of these eight larger cities in western Kansas, only two communities grew by more than one percent per year during the past 40 years - Dodge City and Garden City. Both have become meat packing and agri-business centers, and also benefit from tourism. No larger communities in western Kansas experienced a growth rate anywhere near two percent per year since 1980.

These data strongly suggest that a long-term two percent annual growth rate for Hays and for Russell is unrealistic. That area of the State as a whole has faced the issue of sluggish or declining growth for a long time. Hays' and Russell's growth patterns are similar to those of the larger area.

There is no evidence that the economic or population trends in Region 5, Region 6, or western Kansas as a whole can be attributed solely to a shortage of water. These data indicate that the explanation for stable or declining populations for the Cities and other western Kansas communities go far beyond water supplies.

Population and economic growth in rural Kansas. Population declines in rural areas of Kansas are the result of a number of factors. For example, a recent study focusing on young adults in rural areas of the State found that quality affordable childcare, internet access, the availability of affordable housing and the existence of jobs with livable wages were important issues driving decisions of where to settle down with their families.[11] Those amenities can be hard to come by in rural areas.

The economics of maintaining family agricultural operations can also be a challenge, given the costs associated with machinery and other investments and fluctuating commodity prices.[12] Bigger farms with fewer employees has been the trend. Newer technology has also reduced the need for as many employees. As a result, many young people are leaving family farms in rural areas for other

[11] Kansas Sampler Foundation and the Kansas Office of Rural Prosperity, *Kansas Power Up and Go, the Action Report,* 2021.
[12] Corrie Brown, *Rural Kansas is Dying,* The Counter, 2018. https://thecounter.org/rural-kansas-depopulation-commodity-agriculture/

opportunities in larger cities. The overall decline in population growth and increase in average age in rural areas affect the makeup and availability of the rural labor force.

Some recent work research addresses the economic development potential of Ellis and Russell counties.[13] These reports do not mention the lack of water as a restricting growth factor.

Factors driving economic development. Myriad factors influence commercial and residential development, including the following:[14]

- Regional transportation infrastructure and facilities (access to airports, highways, railroads);
- Size of the local workforce and availability of educated or skilled workers;
- Labor costs;
- Tax rates and / or specific financial incentives;
- Land availability for development;
- Compatibility with other industrial, commercial or residential land uses or existing business enterprises;
- Availability and cost of utilities, specifically water, electric power, natural gas, and broadband access;
- Distance from other areas of commerce, or from customer base;
- Quality of the school district and other quality of life components;
- Availability and affordability of residential housing options;
- State, national and global trends and policies affecting locally important sectors, such as agriculture, energy development and manufacturing; and
- State-level and national migration trends, social factors, and political factors.

The availability of water can be one of a large number of considerations that businesses or migrating populations weigh in their locational decisions. This re-location selection process is often opaque.

The Applicant's belief that lack of water supply has constrained growth in recent decades is invalid. The lack of growth in the region is pervasive and the explanation for that trend is complex.

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[13] Development Opportunity Profile, Ellis County, Kansas, 2019 and Development Opportunity Profile, Russell County, Kansas, 2021, both completed by e^2 Entrepreneurial Ecosystems.

[14] USDA, Economic Research Service, *Rural America at a Glance*, 2022; Kansas Sampler Foundation and the Kansas Office of Rural Prosperity, *Kansas Power Up and Go, the Action Report,* 2021; *Factors Affecting Economic Development and Growth*, 2019, https://smallbusiness.chron.com/factors-affecting-economic-development-growth-1517.html; McKinsey & Company, *Rural rising: Economic development strategies for America's heartland*, 2022; Kansas Policy Institute, *Expanding Broadband Access in Kansas*, 2021; Pew Research Center, *What Unites and Divides Urban, Suburban and Rural Communities*, 2018; Management Study Guide, *Top Five Factors that Spur Economic Growth*, https://www.managementstudyguide.com/top-five-factors-that-spur-economic-growth.htm, undated; US News &World Report, *What are the Four Factors of Production?,* 2020; High Plains Public Radio, *Housing Crisis Threatens to Stifle Rural Kansas Towns Hoping to Grow*, 2021.

Population projections for Ellis County and Russell County. Population projections are available at the County level through 2070.[15] Projections developed for Ellis and Russell counties indicate similar growth trends in the future as seen in the historical data. Exhibit 3-5 reports a projected population growth rate for Ellis County of 0.34 percent per year through 2045 and a growth rate of 0.06 percent per year for Russell County through 2045.

Exhibit 3-5.
Projected Population Changes for Ellis County and Russell County, 2020 - 2045

	Ellis County	Russell County
2020	29,716	7,213
2025	30,363	7,326
2030	31,120	7,370
2035	31,744	7,357
2040	32,051	7,330
2045	32,354	7,320
Avg Ann Growth (2020 - 2045)	0.34%	0.06%
Avg Ann Growth (2020 - 2025)	0.43%	0.31%
Avg Ann Growth (2025 - 2030)	0.49%	0.12%
Avg Ann Growth (2030 - 2035)	0.40%	-0.04%
Avg Ann Growth (2035 - 2040)	0.19%	-0.07%
Avg Ann Growth (2040 - 2045)	0.19%	-0.03%

Note: Population data for the year 2020 is an estimate.

Source: University of Kansas, Institute for Policy & Social Research, The Kansas Statistical Abstract, 2021, https://ipsr.ku.edu/ksdata/ksah/.

These population projections point to a much lower growth rate than that assumed by the Cities in their KWTA Application.

HE Summary Observations

Growth rates from the 1950s, 60s, 70s or 80s are not applicable to, or reflective of, future growth rates for Hays or Russell. The Cities' assumption of a two percent annual population growth rate through 2040 is unrealistic and unsupportable. Population growth rates over the past 40 years have been much less, averaging 0.65 percent per year for Hays and in decline for Russell. These trends are common in western Kansas, not all of which is short of water. The explanation for these stable to declining population levels is multi-faceted. There are no indications to suggest that a substantial reversal of past trends will occur in the future.

Additionally, there is nothing that would suggest that the same growth rate should be used for both Hays and Russell. The Cities have different amenities and economic conditions. Historically, growth patterns have been very different.

[15] University of Kansas, Institute for Policy & Social Research, The Kansas Statistical Abstract, 2021, https://ipsr.ku.edu/ksdata/ksah/.

SECTION 4
Water Use Trends and GPCD Assumptions

As indicated earlier, the Cities' water demand projections and Reasonable-Need Limitation estimates rely on population projections multiplied by average gallons per capita per day, or gpcd. This section of the report describes the Cities' gpcd calculation, identifies additional water use data, and points out the shortcomings in the Cities' gpcd assumptions.

Basis for City of Hays and City of Russell GPCD Assumptions

For the Reasonable-Need Limitations and KWTA Application, the Cities utilized the same data sources and calculation method:

- Hays gathered gpcd data for the 14 municipal water providers serving populations of 500 or more within Region 5. These data can be found in Appendix C.
- Hays calculated a simple average gpcd for the 14 municipal water providers for each year during a 5-year period from 2011 through 2015. That data is shown in Exhibit 4-1.
- Hays then calculated the five-year average for these simple averages and adopted that simple regional average, 149.6, as the assumed gpcd average that would apply to Hays from 2017 through 2041, again as shown in Exhibit 4-1.
- Russell followed the same gpcd calculation procedure as Hays but utilized the 32 water providers in Region 6ML serving populations of 500 or more, found in Appendix D. The simple average of these water providers for the 2011-2015 period was 137.3 gpcd, also depicted in Exhibit 4-1.

Gpcd data used to make these calculations are provided in the annual Municipal Water Use Reports prepared by the Kansas Division of Water Resources.[16]

Additional Historical GPCD Data

Exhibit 4-1 presents additional average gpcd data for Regions 5 and 6ML and for the Cities of Hays and Russell from 2011 through 2017, including two more years than the Cities included in their KWTA Application.[17] Also, the Division of Water Resources calculates a weighted average rather than a

[16] https://agriculture.ks.gov/divisions-programs/dwr/water-appropriation/water-use-reporting

[17] The presented dataset begins with the year 2011, since that is the starting point for the gpcd used in calculation of the Reasonable-Need Limitations; however, data is also available for prior years. Municipal Water Use Reports are not available after 2017.

simple average of gpcd for each region. This produces a substantial difference in gpcd for Hays (135 vs. 149.6) and a small difference for Russell (139 vs. 137.3).[18]

Exhibit 4-1.
Regional and City-Specific GPCD Values, 2011 - 2017

Location	2011	2012	2013	2014	2015	2016	2017	Average (2011 -2015)	Average (2013 - 2017)
Region 5 - 2015 Report	149	149	126	116	114	NA	NA	131 (pop-wtd)	NA
Region 5 - 2017 Report	149	149	133	121	121	111	114	135 (pop-wtd)	120 (pop-wtd)
City of Hays (Region 5)	99	102	88	81	88	82	83	92	84
Hays KWTA Application	163	174	146	129	136	NA	NA	149.6	NA
Region 6ML	151	152	129	133	128	126	132	139 (pop-wtd)	130 (pop-wtd)
City of Russell (Region 6ML)	146	149	101	135	137	157	145	134	135
Russell KWTA Application	151	150	127	128	130	NA	NA	137.3	NA

Notes: (1) Region specific gpcd values are population weighted (pop-wtd) values for all communities in those areas.
(2) Hays' and Russell's KWTA Application used the simple average gpcd for water providers serving populations greater than 500 people.
(3) The 2017 Municipal Water Use Report provided revised gpcd data for Region 5 for the years 2013, 2014 and 2015.

Sources: Kansas Division of Water Resources, Municipal Water Use Reports; Master Order Contingently Approving Change Applications Regarding R9 Water Rights, 2019.

Obtained from the City's website, Exhibit 4-2 provides historical population and water production data and a calculation of gpcd for the City of Hays, from 2008 through 2022. Hays gpcd trends are illustrated in Figure 4-1.

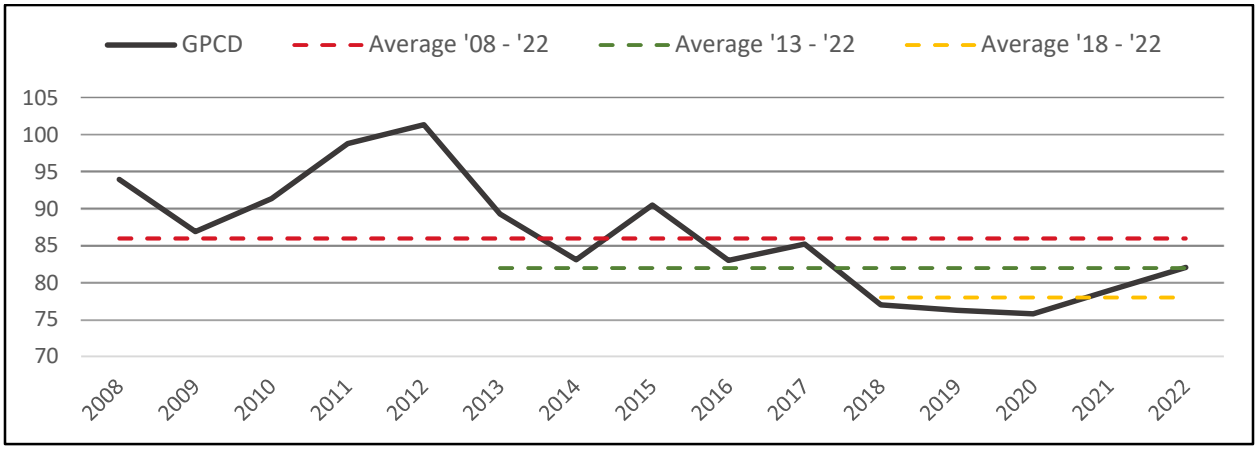
[18] In recent years, Municipal Water Use Reports have also included weighted average gpcd values for each of the States' 14 Regional Planning Areas. Hays and Russell are both located within the Smoky Hill-Saline Regional Planning Area. The weighted average gpcd for this region from 2011-2017 is 103.

Exhibit 4-2.
City of Hays Historical GPCD Estimates, 2008 - 2022

Year	Population	Total Gallons	GPCD
2008	20,225	693,967,220	94
2009	20,459	649,131,500	87
2010	20,510	684,321,800	91
2011	20,776	749,681,936	99
2012	21,039	779,128,136	101
2013	21,003	684,559,131	89
2014	20,997	636,724,576	83
2015	21,064	696,002,757	91
2016	21,014	636,873,796	83
2017	20,888	649,870,100	85
2018	20,847	585,651,659	77
2019	20,805	578,888,334	76
2020	21,226	587,004,372	76
2021	21,116	608,403,348	79
2022	21,299	637,962,800	82
Average (2008 - 2022)			86
Average (2013 - 2022)			82
Average (2018 - 2022)			78

Source: City of Hays, Water Production and Distribution, https://www.haysusa.com/358/Water-Production-Distribution.

Figure 4-1.
Hays GPCD Trends



Source: City of Hays, Water Production and Distribution, https://www.haysusa.com/358/Water-Production-Distribution

More recent data about population, water use or gpcd have not been forthcoming from the City of Russell, with the exception of the City's current Water Conservation Plan. As approved by the Governing Board of the City of Russell in 2022, the Water Conservation Plan expresses the following:[19]

- The City of Russell used 145 gallons per capita per day in 2017.[20]
- The calculated 2017 gpcd value of 145 gallons includes water sold to industrial customers.
- Excluding industrial usage, the City's average gpcd between 2013 and 2017 was 79 gallons.

Evaluation and Analysis of the Cities' GPCD Assumptions

The data, calculation and assumptions utilized by the Cities in the future water needs projections and Reasonable-Need Limitation assumptions incorporate a number of flaws as described below.

1. The historical data used to make a gpcd assumption should be the most recent data available. The Municipal Water Use Reports run through 2017; Hays and Russell have more recent internal water utility data that should have been used. For long-term projections, a longer historical time frame is desirable.

2. The Cities made an incorrect calculation by using a simple regional average instead of a weighted average. Taking Hays as an example, average gpcd values for the 14 providers included in Region 5 ranged from a low of 84 to a high of 283 for the period 2011-2015. The community with the highest average gpcd (Greensburg) has a population of less than 1,000 people; however, that value is given equal weight as compared to Hays' 92 gpcd which reflects more than 20,000 people. Calculating a simple average gpcd value does not appropriately weigh each average value to account for the size of the community.

3. There is no supportable justification for Hays or Russell to adopt regional water use averages rather than the water use patterns evident in their own communities. The economic base, housing and demographic characteristics of each community are different, leading to distinct water use patterns. Region 5 includes eight counties in a narrow north-south strip of Kansas. Although the Division of Water Resources defines the States' Regions, there is no evidence suggesting that Hays' is similar to other communities in Region 5, especially those located some distance away. For example, Greensburg, the community with the highest gpcd in the region, is located in Kiowa County, more than 95 miles to the south of Hays.

   Water use and population data should be available on a long-term historical and up-to-date basis for Hays and Russell and average gpcds for each City should be utilized. The difference in gpcd would be large with this change: over 60 percent for Hays, for example.

[19] City of Russell, *Water Conservation Plan for the City of Russell, Kansas,* 2022.
[20] That is consistent with the data presented in the 2017 Kansas Municipal Water Use Report, as shown in Exhibit 4-1.

Russell's gpcd assumption includes industrial use which the city maintains will not change in the future.[21] If industrial demands are held constant, the portion of the gpcd that is subject to change in the future is 79, which is more than 50 percent less than the assumption Russell adopted.

4. Water use trend data would suggest that gpcd has declined in recent years and recognition of those trends should be given in a future gpcd assumption. The inclusion of 2016 and 2017 data, and the resulting calculation of a more recent 5-year average gpcd for Region 5, indicate that per capita water use has decreased for communities in that region (120 gpcd between 2013 and 2017, as compared to 135 gpcd for the region between 2011 and 2015). Data provided in those reports show that 12 of the 14 water providers (above 500 people) in Region 5 have experienced declines in average gpcd when comparing the 2011-2015 average with the 2013-2017 average. Hays' own data, as shown in Exhibit 4-2, also indicates a reduction in gpcd over time. The average gpcd for Hays over the most recent 5-year period (2018-2022) is 78 gallons.

The Cities' Water Conservation Programs

The Cities have robust conservation programs which serve to reduce water use and gpcd. These programs have been in place for many years and are updated periodically.

Hays' current water conservation plan was approved in 2014.[22,23] That document outlines a number of educational practices (i.e., public information dissemination), management practices (i.e., universal metering, conservation water rates, leak repair, etc.) and regulations practices (i.e., adoption of development requirements, including xeriscaping and plumbing codes) implemented by the City. Hays applies watering restrictions, when needed, uses effluent on the golf course, offers fixture rebates, and has a cash for grass program. This community also has a water reuse facility. Hays has conservation water rates. The City's water conservation website provides information on current conservation efforts, programs and regulations.[24]

Hays' water conservation plan includes a long-term water use efficiency goal of using less than 95 gpcd each year.

Hays' water conservation plan also includes a Drought / Emergency Response section, which addresses the triggers and actions associated with Water Watch, Water Warning and Water Emergency conditions.

Russell's water conservation program has also been in place for many years. According to the 2022 Water Conservation Plan, conservation measures which have been implemented include educational practices (i.e., public information dissemination), management practices (i.e., universal metering, automated meter reading, toilet rebates, etc.) and regulations practices (i.e., adoption of building codes, outdoor watering restrictions, etc.)

[21] According to the City's water demand projections included in the Master Order, Russell assumes 700 acre-feet of annual industrial water demand through 2041.
[22] City of Hays, *Municipal Water Conservation Plan for the City of Hays,* 2014.
[23] Hays' initial water conservation plan was developed and filed in 1992.
[24] https://www.haysusa.com/160/Water-Conservation

Russell's plan states a water use conservation goal for usage not to exceed 135 gpcd based on the regional average (Region 6ML) of the last five reported years (2013-2017).[25]

Russell's water conservation plan also includes a Drought / Emergency Response section, which addresses the triggers and actions associated with Water Watch, Water Warning and Water Emergency conditions.

The Cities have robust conservation and drought emergency programs. Their programs are generally similar to many municipal programs throughout the western U.S. For example, many smaller municipal providers and rural residential/ agricultural water districts in Colorado have implemented a mix of conservation and drought emergency measures similar to those of Hays and Russell, in response to concerns regarding water supplies, reliability and other concerns.[26]

These conservation programs are but one explanation for the Cities' gpcd levels. The mix of commercial, industrial and public water uses influence gpcd levels. The housing mix and demographic characteristics also affect these levels, among other factors.

HE Summary Observations

The Cities of Hays and Russell calculated gpcd at 149.6 and 137.3, respectively, and assumed those figures going forward for their water demand projections and the Reasonable-Need Limitations assumption. These gpcd numbers are flawed:

a. The data upon which they are based is out of date, since more recent data is available.

b. The Cities' calculations were incorrect. Weighted averages and exclusion of industrial use from the gpcd for Russell (to be added in later) should have been done.

c. The Cities' individual water use and population data should have been used as the source for determining gpcd assumptions, consistent with their approved water conservation plans.

d. The gpcd assumptions do not reflect recent declining trends.

If these flaws were corrected based only on the information available from the KWTA Application, the City of Hays website and Russell's water conservation plan, the difference in the gpcd would be considerable. For Hays, the gpcd assumption would be between 78 and 86, or more than 40 percent less than the figures indicated in the KWTA Application. For Russell, the gpcd assumption would be 79, or more than 40 percent less than indicated in the KWTA Application.

The Cities' conservation programs are robust, consistent with a number of western U.S. water providers. There are myriad factors that might explain the Cities' past and current gpcd levels.

[25] The 2017 Municipal Water Use Report presents the Region 6ML 5-year average (2013-2017) gpcd as 130 gallons, as shown in Exhibit 4-1.

[26] City of Fountain, Colorado, 2018 Water Efficiency Plan; Morgan County Quality Water District, Water Conservation Plan, 2018; City of Sterling, Colorado, 2021 Municipal Water Efficiency Plan. Each of those plans were approved by the Colorado Water Conservation Board.

SECTION 5
An Alternative Scenario of Future Water Needs for the Cities

Given the conclusions from the previous sections of this report, the question of how much additional water the Cities need becomes vitally important. To definitively answer that question, HE would need to have much more information about the two Cities, their water use patterns, and their existing water supplies. One of the main conclusions from our evaluation is that much more planning work needs to be accomplished before the net water needs in the KWTA Application can be properly considered.

However, a second question must also be raised: is it important to know the net future water needs of the Cities to determine whether this application for a water transfer will result in a net benefit to the State of Kansas. If the net water needs do not approximate the 2041 Reasonable-Need Limitations of 5,670.2 acre-feet for Hays and 1,815.0 acre-feet for Russell (7,485.2 acre-feet in total) or the Ten-Year Rolling Aggregate Limitation of 48,000 acre-feet over a 10-year period with an annual limit of 6,756.8 acre-feet, the question of net benefit deserves a different type of scrutiny.

In order to answer this second question, HE has prepared a generalized range of net future water needs to determine whether those future water needs might be significantly different than those set forth in the KWTA Application. In this section, we examine future water demands, existing supplies and net future needs. Based on those net future needs, HE reflects upon the implications for net benefits of the Cities' proposed transfer.

A Future Water Demand Scenario for the Cities

In Section 2 of this report, we have identified the water demand projection method (population times gpcd, plus additional sales or other water use) utilized by the Cities and approved by the Chief Engineer. HE adopts that methodology for the purpose of devising an alternative water demand scenario for the Cities.

Hays water demand scenario. Hays' population grew by 0.65 percent per year from 1980 through 2020, but the City's growth slowed to an average of 0.29 percent per year over the course of the most recent decade (2010 to 2020). State projections suggest a 0.34 percent average annual growth rate for Ellis County through 2045. For the sake of scenario planning, HE will apply the 0.34 percent growth rate to Hays through 2040. This will result in a 2040 population of about 22,110, an increase of about 6.3 percent from Hays' 2021 population estimate.

Water use patterns for Hays averaged 86 gpcd from 2008 through 2021, although gpcd trends in Hays are declining. HE will adopt the 86 gpcd for purposes here.

Applying the Hays population projections to the gpcd assumption, the 2040 water demands for Hays would amount to 2,136 acre-feet.[27] This would be an increase of about 180 acre-feet compared with water production in 2022.

Russell water demand scenario. Russell's population has been in a long-term decline. State population projections for Russell County call for an almost constant population going forward, a growth rate of 0.06 percent per year, which HE adopts for the purpose of this report. This will result in a 2040 population of 4,435, an increase of about 1.2 percent from Russell's' 2021 population estimate.

Without current Russell water use data, HE must rely on the gpcd data provided by other sources. Available information from the City's most recent water conservation plan indicates a gpcd of 79, to which future industrial use must be added; industrial water use peaked at 700 acre-feet in 2004.

With Russell's population projections applied to the gpcd assumption and with the addition of industrial water use, Russell's 2040 water demands can be estimated at 1,092 acre-feet.[28] This would be a decrease of about 56 acre-feet compared with average water diversions between 2004 and 2013 (1,148 acre-feet).[29]

HE's water demand scenarios for the Cities need to be confirmed with additional data, but their plausibility compared with the implausible water demand projections offered by the Cities in the KWTA Application suggest a very substantial difference.

Current Water Supplies for the Cities

To determine the net water needs for the Cities, we must consider currently available water supplies and subtract them from future demands. HE's estimate of the Cities' current water supplies are based solely on publicly available information. The focus is on water supplies available in dry years, also referred to as safe annual yield.

City of Hays' water supplies. Several reports address Hays' current water supplies. According to Bartlett & West Engineers, Hays draws its water supply from several primary sources, including the Schoenchen well field in the Smoky Hill River alluvium, a City well field and the Dakota well field.[30] The City is limited to a total withdrawal of 3,675 acre-feet from all sources combined.[31] Burns and McDonnell estimated Hays' safe yield from all sources was about 2,397 acre-feet in 2003.[32] The U.S.

[27] The annual gallonage figure is divided by 325,851 gallons for conversion to acre-feet.
[28] The annual gallonage figure is divided by 325,851 gallons for conversion to acre-feet.
[29] Bartlett & West, Inc., *Water Supply Study for the City of Russell, Kansas,* 2014.
[30] Bartlett & West Engineers, *Water Supply Alternative Review for the City of Hays, Kansas and City of Russell, Kansas,* 2003.
[31] Hays' approximately 3,700 acre-feet of water rights was confirmed in the 2019 presentation to the Ellis County Commission.
[32] Burns and McDonnell, *Evaluation of Lake Wilson and Kanopolis Reservoir, Final Report for Water Supply to Public Wholesale Water Supply District #15,* 2003.

Army Corps of Engineers indicated Hays' safe annual yield as 2,352 acre-feet in its 2010 Wilson Lake Water Supply Environmental Report.[33]

In 2019, representatives from Hays confirmed the City's approximately 3,700 acre-feet of water rights from all sources and stated that the City plans to continue to utilize those sources, in addition to water from the R9 Ranch, in the future.[34] The City also emphasized that dry years really cause water supply issues for both Hays and Russell.

City of Russell water supplies. According to Bartlett & West Engineers, Russell has three primary water supply sources, including the Smoky Hill River system (surface diversion from the River and the Pfeifer well field), surface water from Big Creek and a storage contract with the Bureau of Reclamation with a water right to withdraw from Cedar Bluff Reservoir.[35] The City has access to a total of 5,814 acre-feet of water. According to Bartlett & West, "the lack of available water is caused by the local groundwater restrictions, streams running dry during the summer months, and a high evaporation rate at Cedar Bluff Reservoir.".[36] The Bartlett & West study also refers to a Black and Veatch water survey that suggest Russell's supplies may sustainably yield about 2,137 acre-feet per year. The Division of Water Resources has limited Russell to a quantity not to exceed 1,840 acre-feet on an annual basis.[37,38] The U.S. Army Corp of Engineers also adopts 1,840 acre-feet as the safe annual yield for Russell.[39]

Hays' 2019 presentation to the Ellis County Commission also briefly described the use of Cedar Bluff Reservoir resources. According to that presentation, Hays has about 2,000 acre-feet available from the Reservoir for purposes of wellfield recharge. Russell also has 2,000 acre-feet in the Reservoir for purposes of wellfield recharge.[40] Recharge of the Cities wellfields can be relatively challenging due to the sandy conditions of the area. The Cities do not view Cedar Bluff Reservoir as a reliable source of water.

Based on the above information, HE assumes for the purpose of this report that Hays has a current safe annual yield of 2,397 acre-feet and Russell has a safe annual yield of 1,840 acre-feet.

Net future water needs for the Cities. From HE's preliminary analyses, the net future water needs of the Cities are presented in Exhibit 5-1.

[33] U.S. Army Corps of Engineers and Kansas Water Office, *Wilson Lake Water Supply Draft Environmental Report*, 2010.
[34] Mr. Toby Dougherty, Hays City Manager, Presentation at the Ellis County Commission Meeting, April 8, 2019.
[35] Bartlett & West Engineers, *Water Supply Alternative Review for the City of Hays, Kansas and City of Russell, Kansas,* 2003; *Water Conservation Plan for the City of Russell, Kansas,* 2022.
[36] Bartlett & West, Inc., *Water Supply Study for the City of Russell, Kansas,* 2014.
[37] Bartlett & West, Inc., *Water Supply Study for the City of Russell, Kansas,* 2014.
[38] However, HE assumes that the imposed Division of Water Resources' limitation trumps that sustainable yield estimate.
[39] U.S. Army Corps of Engineers and Kansas Water Office, *Wilson Lake Water Supply Draft Environmental Report*, 2010.
[40] Russell's recharge water must pass through Hays' wellfield prior to reaching Russell's wellfield.

Exhibit 5-1.
Preliminary Scenario of Net Future Water Needs for the Cities

	2040 Water Demand	Current Safe Yield (Supply)	Unmet Demand (Net Available Supply)
City of Hays	2,136 AF	2,397 AF	-261 AF
City of Russell	1,092 AF	1,840 AF	-748 AF

This scenario of net future water needs suggests that the Cities might not need any additional water supplies for the foreseeable future.

HE acknowledges that there is much information that would be required to confirm or modify this scenario of net future water need. However, even if these future water demands were understated by 50 percent, Hays' net future water needs would be 807 acre-feet (3,204 acre-feet of demand less 2,397 acre-feet of current safe yield supply), and Russell would still have 202 acre feet of available supply (1,638 acre-feet of demand less 1,840 acre-feet of current safe yield supply).

Although preliminary, this scenario analysis has important implications. For instance, the future water supply screening process would need to be re-visited if a much smaller amount of additional water supplies is needed. The project financing might need to be reconsidered.

R9 Ranch Benefits to the Cities and the State of Kansas

This scenario analyses of the Cities' net future water need strongly suggest that the Cities will need much less water in the foreseeable future than they have indicated in the KWTA Application and the Reasonable-Need Limitations derived previously. This fact has important implications when considering the benefits of the project.

The R9 Ranch project will entail substantial up-front expenses, including the development of the wellfield and construction of a pipeline. Current estimates place project costs at $134.9 million by 2025.[41] Additional costs associated with water treatment and pumping may also apply. Without much future growth, there is a high likelihood that the costs of this project and the water supply it provides will be borne largely or even entirely by the existing customers of the Hays and Russell water systems. These customers will very likely experience major increases in their water rates with little or no benefit. Hence, the R9 Ranch project will very likely result in a net cost to the water ratepayers of Hays and Russell. If water rates do not increase substantially, the financing of the project is brought into serious question.

In sum, the R9 Ranch project as presently described in the KWTA Application produces a net cost to the Cities and the State of Kansas.

[41] *The Cities' Response to Water PACK's and Edwards County's Motion for Leave to File First Amened Joint Petition for Intervention, December 23, 2022.*

SECTION 6
HE Conclusions and Opinions

Harvey Economics (HE) was retained to evaluate the net future water needs of the Cities of Hays and Russell (Cities) pertaining to the need for the R9 Ranch project. We reviewed and evaluated the KWTA Application and supporting information submitted by the Cities and other publicly available information.

HE reached the following conclusions and opinions:

13. The gpcd water demand projection method (population times gallons per capita per day or gpcd) is appropriate in this instance.

14. The water demands projected by the Cities have been mis-characterized as equating to future water needs, which require that existing supplies be subtracted from future water demands.

15. More project planning is required to determine the net future water needs to evaluate the need for this Project.

16. The long term, minimal growth or declining population trends for Hays and Russell are not unique for western Kansas, and these trends are not solely attributable to a lack of water.

17. There is no justification for assuming that Hays and Russell will have the same growth rate going forward.

18. The two percent annual growth rate through 2040 which the Cities adopted for project planning purposes is excessive and unsupportable.

19. The gpcd assumptions which the Cities applied are flawed and unreliable.

20. The Cities' individual water use and population data should have been used as the source for determining gpcd assumptions.

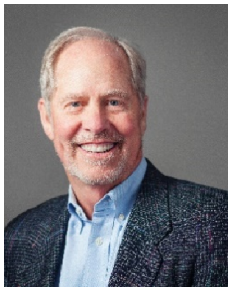
21. The Cities have robust conservation and drought emergency programs similar to many municipal programs throughout the western U.S.

22. A re-calculation of future water demand for the Cities, however preliminary, indicates that net future water needs for the Cities will be much less than the Cities have indicated in their KWTA Application and supporting information.

23. Because of the R9 Ranch project costs, existing water customers in the two Cities will experience much higher water rates for the water they are presently consuming, yielding a cost to them without offsetting benefit.

24. The R9 Ranch project represents a net cost, not a benefit, for the Cities and the State of Kansas.

APPENDIX A
Resumes for Ed Harvey and Susan Walker



YEARS EXPERIENCE

Total **50**

At Harvey Economics **20**

EDUCATION

MSBA, Economics, University of Denver

BA, Economics, University of Denver

PROFESSIONAL AFFILIATIONS

Colorado Commission for Judicial Performance

AWWA

Colorado Water Congress

American Planning Association

LOCATION

Denver, CO

Edward Harvey, Harvey Economics

Ed Harvey has devoted the bulk of his career to studying the economic effects of water, mineral, energy and environmental resource use and community changes in the western U.S. During his 50-year career, Mr. Harvey has completed financial feasibility studies, rate studies, economic impact studies, analyses of future resource demands and resource valuation studies. He conducts economic studies related to water availability, drought, water quality, infrastructure development, irrigation, water conservation and non-structural water resource issues. Mr. Harvey created the natural resource economics practice at BBC Research & Consulting in 1973 and served as a Managing Director from 1981 until 2002 when he formed Harvey Economics.

Select Project Experience

Halligan Water Supply Project EIS, Colorado. Mr. Harvey is leading the development of multiple components of this EIS, focused on the expansion of Halligan Reservoir in northern Colorado. In addition to developing long-term water demand projections for the City of Fort Collins, Mr. Harvey also led an evaluation of the impacts of the proposed reservoir expansion and project alternatives to socioeconomic, recreational and land use resources. HE's impact analysis addressed such topics as changes in regional agricultural operations, changes in recreational activity levels and the effects of construction activity on local residents.

Moffat Collection System Project EIS, Colorado. Mr. Harvey led the economic, demographic and social impact analysis of the Moffat EIS under the direction of the U.S. Army Corps of Engineers. This project focused on the expansion of an existing water supply reservoir for Denver Water. Mr. Harvey explored the purpose and need for the project and examined the socioeconomic impact of a host of alternatives, addressing construction economic benefits, tourism impacts, other economic impacts, public facility and social service impacts, fiscal impacts, environmental justice, and water rate effects. In addition, Mr. Harvey directed the preparation of economic, demographic and water demand projections for incorporation into Denver Water's 2002 Integrated Resource Plan.

Lake Ralph Hall EIS, Texas. Mr. Harvey led the development of water demand projections and evaluation of project purpose and need for the Upper Trinity Regional Water District as part of this EIS, concerning construction of the Lake Ralph Hall Reservoir in rural Fannin County, Texas. That effort involved detailed understanding of regional demographic and economic trends and future conditions, as well as knowledge of current water use patterns and future conservation efforts of participating water providers. Mr. Harvey also led the socioeconomic, recreation and land use impact analyses for the proposed reservoir development.

Windy Gap Firming Project EIS, Colorado. Mr. Harvey led the Harvey Economics team in developing 50-year water demand projections for the purpose and need statement of this EIS, working as the third party contractor to Northern Water and U.S. Bureau of Reclamation. The project involved 14 participants in a proposed

water supply project in the northern Front Range of Colorado. HE developed independent projections of those participants' future water demands, considering each participant's conservation efforts.

Northern Integrated Supply Project (NISP) EIS, Colorado. Under Mr. Harvey's direction, Harvey Economics developed the water demand and conservation components used to evaluate Purpose and Need for the NISP EIS. This USACE led EIS focused on a proposed project involving more than a dozen participants, reflecting a wide range of water demands and water use characteristics. HE's research approach entailed extensive data collection, evaluation and analyses of information provided by the participants and conclusions about future water demands and need for NISP.

White River Reservoir Feasibility Study, Colorado. Mr. Harvey assessed the need for and economic benefits of a proposed new reservoir in Rio Blanco County. This two-part effort for the Rio Blanco Water Conservancy District entails an analysis of current and future water demands and additional water storage facilities in the region. The second phase of this work includes quantification of benefits and an assessment of the ability of beneficiaries to pay for the project. Hydropower, recreation and environmental benefits are important elements of the financial feasibility study. Projections of visitor spending and associated fiscal benefits to local jurisdictions over a 50-year period were developed.

Douglas County Rural Water Plan, Colorado. Mr. Harvey completed the economic and financial components of this study for the Douglas County Rural Water Authority, focused on evaluation of rural wells reliance on declining groundwater resources. The study explored the feasibility of creating a regional water supply and distribution system using surface water. Mr. Harvey developed population and water demand projections, a comparative benefit-cost analysis, and a financial feasibility study. The purpose of this work was to provide a county-wide rural water supply system that would minimize environmental impacts, be economically feasible, energy sustainable, and that would meet the long-term water supply goals and objectives of county water suppliers.

Big Chino Water Demands, Arizona. Mr. Harvey led the effort to examine the economic ramifications of a water transfer from a ranch to the Prescott Valley communities in an inter-basin transfer. Growing communities outside the basin sought to transfer water from the Basin to establish assured water supply We examined water demand needs and financial implications in the Big Chino Basin in Yavapai County, Arizona. Mr. Harvey provided expert testimony to the Arizona Department of Water Resources regarding water demand and financing issues. Financial feasibility of the project was a focus.

Snake-Salt River Basin Planning Study, Wyoming. Mr. Harvey prepared water demand projections for this basin study in north-western Wyoming, which included Jackson Hole. An extensive evaluation of the tourism industry and future prospects by activity type was part of his work. He projected economic and demographic conditions for Teton and Lincoln Counties. These projections formed the basis for projections of municipal, agricultural, recreational and environmental water use. These projections were utilized to evaluate water supply needs and development options. Mr. Harvey made three presentations to the Basin Advisory Group and led forecasting methodology discussions.

Upper Gunnison Demand Management Impact Study, Colorado. Mr. Harvey completed this study focused on the regional economic impacts of a potential loss of irrigation water due to curtailments related to the Colorado River Basin shortages. The initial stages of this work included an understanding of the types of demand management programs relevant to agricultural water use; the agricultural characteristics and operations of the District at the micro-level; and other sectors potentially affected by changes in agricultural water

consumption (domestic water use, recreation, environmental resources). The effects of stream flow changes on environmental resources were also addressed as part of the study.

Arkansas Valley Alternative Transfer Mechanisms (ATM) Projects, Colorado. Mr. Harvey has completed a variety of work in the Arkansas Valley over many years on behalf of the City of Aurora. Relevant projects include evaluation of shared land and water ownership models between the municipality and farmers; evaluation of other types of lease agreements and water purchases; and assessment of the "tipping point" of impacts to local agricultural communities and economies as the result of water leases.

San Luis Valley Groundwater Fees, Colorado. Mr. Harvey served as an expert economic witness in an arbitration between irrigators grappling with the allocation of groundwater supplies in the face of shortages. Harvey Economics completed an analysis of groundwater pumping fees for the certain members of the Rio Grande Water Conservation Sub-District. Mr. Harvey examined agricultural water use, yields, operating costs and profits for growers in this area. Ability to pay was a critical issue. Harvey testified at the arbitration hearing.

Arizona Water Transfers. In the first inter-basin water transfer case in Arizona, Mr. Harvey represented La Paz County and demonstrated the scope of economic effects associated with large transfers of irrigation water from rural areas to urban centers. Mr. Harvey quantified the economic effects of major ground water transfers for Arizona. This work contributed to compromises, mitigation measures and eventual regulation. In a separate case, he also provided expert testimony regarding groundwater withdrawals in Northern Maricopa County

Animas La Plata Feasibility Study, Colorado. Mr. Harvey determined the need for additional water supplies for a region of southwestern Colorado as part of an on-going project to develop conditional water rights. He also completed financial analyses of several specific projects designed to develop those rights.

Cache la Poudre Diligence Cases, Colorado. Mr. Harvey testified on behalf of Northern Water in the Thornton water transfer case regarding water demands and population projections. He prepared for a diligence case for Northern Water related to conditional rights in the Cache la Poudre River Basin.

Valuation, Utilization and Transfer of BOR Assets, Kansas and Nebraska. Mr. Harvey provided technical consulting and negotiation support to assist in reaching an agreement among the Western U.S. water and electric power utilities. In the early 2000's, HE established a value for a number of Nebraska and Kansas water district interests in Bureau of Reclamation facilities as part of negotiations.

Additional Legal Support Experience

Expert Witness and Deposition Experience. Mr. Harvey has extensive practice preparing for and serving as an expert witness in legal cases and providing deposition in support of water rights cases, agricultural matters, and other economic topics.

Office of Judicial Performance Evaluation, Colorado. Mr. Harvey served as Vice Chair and eventually Chair of Judicial District Commissioners for the State of Colorado. The mission of this appointed commission is the evaluation of all Colorado's appellate judges. In this role, a primary responsibility is the oversight, review and application of a large survey of lawyers, prosecutors, litigants, witnesses, juries and court personnel within the State's 22 judicial districts. Commissioners are responsible for evaluating judges through courtroom observations, reviewing case data, conducting interviews and surveys as the basis for forming retention recommendations for each judge that are shared with local voters.

Depositions and Testimony by Edward Harvey:

1. Conditional Water Rights Case, Southwestern Water Conservation District; Case No. 13-CW-3011; District Court, Water Division #7, CO
    a. Applicant; For SWCD; Trout Raley Montano Witwer & Freeman LP; Bennett William Raley
        i. Water needs projected for Colorado water rights case
2. NAVAJO NATION WATER RIGHTS CASE – Gila River General Stream Adjudication
    a. Arizona Department of State Lands and various utilities
        i. Water demand projections
3. Conditional Water Rights Case, Rio Blanco Water Conservancy District; Case No. 14-CW-3043; District Court, Water Division #6, CO
    a. Applicant; For RBWCD; White & Jankowski LLC; Alan Curtis
        i. Need for reservoir storage
4. Pure Cycle and Rangeview Metropolitan District vs. State of Colorado; Case No. 2011-CV-8565 and 2012-CV-1246; District Court, Denver County, CO
    a. Defendant; For the State of Colorado; Hogan Lovells; Andrew Lillie
        i. Evaluation of economic damages
    b. HE provided support to the Land Board in deposition before trial.
5. State of Colorado vs. College America; Case No. 2014-CV-34530; District Court, Denver County, CO
    a. Plaintiff; For the State of Colorado; Office of the Attorney General (CO); Jay Simonson
        i. Labor force effects and economic damages in consumer fraud case
6. Caerus Piceance LLC vs. Berry Petroleum Company, LLC; Case No. 2020-CV-30377; District Court, Denver County, CO
    a. Defendant; For Berry Petroleum; Hogan Lovells; Jessica Livingston Black
        i. Economic damages evaluation
7. McClain vs. The Sports Authority; JAG Arbitration No. 2012-0842A; Judicial Arbiter Group, Denver, CO
    a. Claimant; For McClain; McElroy, Deutsch, Mulvaney & Carpenter; Glen Laird
        i. Economic damages in wrongful termination case

8. Purgatoire Water Case, Colorado. Harvey developed economic benefit reports for an administrative proceeding related to run-off from secondary injections wells for Exxon.

9. Wyoming School Finance Lawsuit – 1993 to 2005. Harvey testified during three phases of a trial challenging the constitutionality of the Wyoming school finance system. Expert testimony on behalf of the plaintiffs covered a host of issues in the case, including statistical, financial and economic examinations of the equity of the system and the impacts of inequity, including educational outcomes.

10. Gila River Adjudication – 1986 to 1995. Economic effects of water re-allocation to Native American Nations. Harvey helped prepare an amicus brief to the US Supreme Court.

11. WQCD Cost/Benefit Study, Colorado. Cost benefit models were developed by region and at the statewide level for three levels of regulation. Harvey provided testimony to the Colorado Department of Public Health and Environment, Colorado Water Quality Control Commission. The regulation was approved.

Susan H. Walker, Harvey Economics

Ms. Walker is a firm Director at Harvey Economics and has been with the company since 2005. Her work largely focuses on planning endeavors related to water, energy, tourism and other natural resource sectors. Ms. Walker's project experience includes rate studies, demand projections, socioeconomic impact analysis, cost – benefit analysis, project financing and valuation of resources and facilities. She is an expert at economic and demographic research, analysis and modeling. Ms. Walker has completed work for municipalities, utilities, special districts and private industry, as well as county, state and federal agencies.

YEARS EXPERIENCE

Total **20**

At Harvey Economics **18**

EDUCATION

MS, Forest Economics, Colorado State University

BS, Forest Management, University of Vermont

PROFESSIONAL AFFILIATIONS

AWRA

AWRA CO

Colorado Water Congress

LOCATION

Denver, CO

Relevant Project Experience

BennT Creek Regional Water Authority Growth Projections, Colorado. Ms. Walker developed projections of housing unit growth for the Authority's current and future water service areas located within Adams, Weld and Arapahoe counties. Growth projections developed over a 50-year time period incorporated information obtained from real estate developer interviews; state and county planning documents; local zoning and density regulations; known planned developments; historical growth trends and other information about future economic growth and prospects in this area of Colorado. Housing unit projections were used by Authority engineers to develop projections of future water demands as part of a water rights court case.

Morgan County Quality Water District Growth Study, Colorado. Ms. Walker completed a study for a rural water district focused on projections of population and economic growth in Morgan County and future water demands for the District. Located in northern Colorado, the District serves a large rural residential and agricultural area, including several small communities and many large dairies. Based on an understand of the economic and demographic factors influencing regional growth, Ms. Walker developed projections of the District's residential, commercial, industrial and agricultural customers over a 50-year period and applied appropriate water use patterns to customer data to estimate future water demands.

Eagle County Water Demand Projections, Colorado. Ms. Walker is currently working with the Eagle River Water & Sanitation District (District) and Upper Eagle Regional Water Authority (Authority) to prepare projections of water demands over the next 50 years. Ms. Walker researched historical and projected regional and local population growth and economic conditions to project future households served by each entity. Recent historical water use patterns, anticipated conservation savings and estimated water losses were incorporated into Ms. Walker's water demand model. Raw water irrigation demands were also included in the projections. The demand projections effort also considers information about the District's and Authority's service area boundaries, physical system and required safety factor. In conjunction with data on the District's and Authority's current supplies and firm yield, the projected demands will allow for a calculation of future project need.

Halligan Water Supply Project EIS, Colorado. Ms. Walker's work on the Halligan EIS includes the development of population and water demand projections for the City of Fort Collins in order to support the purpose and need for the proposed expansion of Halligan Reservoir. Those projections were based on projections of regional economic and demographic conditions, growth patterns and water use trends. Ms. Walker

also completed an evaluation of socioeconomic, recreational and land use effects of the proposed project. Those analyses quantify impacts to agricultural activity; area residents and businesses; water rates and tap fees; traffic volume and transportation patterns; and changes to local recreational amenities, activity levels, experiences and the local recreational economy.

White River Reservoir Project Need and Financial Feasibility, Colorado. Ms. Walker evaluated the need for and economic benefits of a potential new reservoir in western Colorado. She conducted an analysis of future water demands for municipal use, energy development, recreation and agricultural use and worked to quantify benefits to each sector from additional regional water storage. Using projected capital and operating costs, Ms. Walker completed a benefit cost analysis for three alternatives. A financing plan identified potential project partners, associated benefits and cost shares.

Parker Water Project Need and Financial Feasibility, Colorado. The Parker Water and Sanitation District (PWSD) and the Lower South Platte Water Conservancy District (LSPWCD) developed a joint plan for developing, storing and transmitting water from the South Platte River. Harvey Economics prepared a report addressing both the need for the project and its financial feasibility. Ms. Walker's work focused on evaluation of PWSD's future water needs. She reviewed existing reports, documents and other data sources describing historical and anticipated growth and water demands and conducted additional secondary research to verify or validate future economic and demographic conditions for Douglas County and the Parker area and assumptions underlying the determination of project need. Review of PWSD's water conservation plan was also a focus.

Chino Valley Water Demands and Water Pipeline, Arizona. Ms. Walker researched current water use trends in Yavapai County, Arizona and estimated future per capita water use as part of Harvey Economics' effort to project future water demand for the Chino Valley. Estimates of future water use take into account projected population growth, commercial development and employment trends for the area, which are based on an understanding of the regional economy. Ms. Walker reviewed fiscal impacts of pipeline construction and delivery of water between the Chino Valley and the City of Prescott, Arizona. She also reviewed project cost data and the City's financial documents as part of Harvey Economics' work to assess the City's ability to finance the pipeline.

Platte River Basin Water Plan Update, Wyoming. As part of an update to the original Platte River Basin Plan for the Wyoming Water Development Commission, Ms. Walker developed water demand projections under three alternative future scenarios, including high, low and medium population growth and water use scenarios. She first created a profile of current economic and demographic conditions in the Basin, focusing on specific water use sectors. She then researched and projected future outlook scenarios for each of the Basin's important economic sectors and ultimately projected water demands under each scenario for the Basin as a whole and for each of the seven subbasins. This work included evaluation of both consumptive and non-consumptive environmental and recreational water demands.

Northern Integrated Supply Project EIS, Colorado. Ms. Walker evaluated the conservation programs of the 15 water providers that are participants in the Northern Integrated Supply Project (NISP) EIS. Located in northern Colorado, the NISP EIS focused on several water storage and distribution alternatives. Project participants include a mix of Front Range cities and water districts. Ms. Walker worked to determine the amount of water saved as a result of each participant's existing and anticipated future conservation programs. Estimates of conservation savings were incorporated into water demand projections through 2060.

Susan H. Walker, Continued

Upper Gunnison Demand Management Impact Study, Colorado. Ms. Walker quantified the regional economic impacts of potential water demand management programs within the Upper Gunnison Basin. That work included an understanding of the agricultural characteristics and operations of irrigators and other sectors potentially affected by changes in agricultural water consumption (domestic water use, recreation, environmental resources). Ms. Walker estimated changes in irrigated acres, hay production, cattle sales, revenues and expenses and built an economic model to estimate the economic impacts to individual ranches, each District sub-basin, and the Upper Gunnison Basin as a whole, including impacts to regional spending levels, employment, income and overall economic activity.

Alternative Agricultural Transfers Roundtable, Colorado. Ms. Walker provided Colorado's Alternative Agricultural Transfers Roundtable with information about financial concerns and other issues associated with water leasing programs. She provided information on the costs and benefits of alternative transfer programs, including administrative and operating costs to the parties involved and resource costs of purchasing a water lease. She identified third party benefits and beneficiaries and addressed costs that could be borne by the public or other groups. Ms. Walker also compared the economic impacts of alternative transfer programs to permanent dry-up conditions in local areas of agricultural importance.

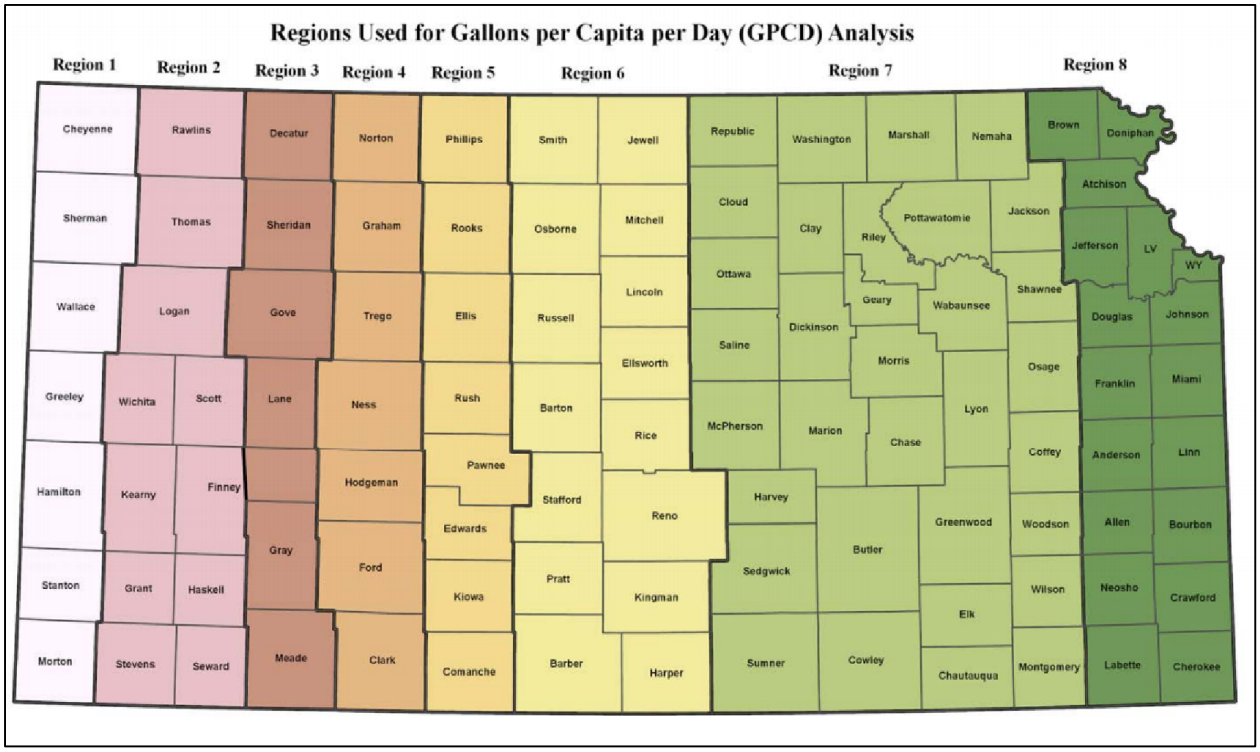
Wall Reservoir and Dam Rehabilitation Project, Wyoming. Ms. Walker is working to complete a comprehensive benefit-cost analysis of dam rehabilitation activities aimed at reducing seepage and improving dam safety. She is working to describe and quantify the economic benefits associated with additional water for agricultural operations; expanded recreational opportunities; reduced risk of flood damage to properties, human life and agricultural acreage; development of wildlife habitat; and improved water quality. Benefits will be estimated for a period of 50 years, and then compared with project costs to determine feasibility.

Glendo Reservoir Full Utilization Study, Wyoming. Working for the Wyoming Water Development Commission (WWDC), Ms. Walker quantified the economic costs and benefits associated with re-operation of Glendo Reservoir. She evaluated costs and benefits to recreational amenities and State Park finances; hydropower generation; agricultural productivity and access to irrigation water supplies; and environmental amenities. This project involved the Bureau of Reclamation, US Army Corps of Engineers, the States of Wyoming and Nebraska, several State of Wyoming agencies and other stakeholders.

New Fork Lake Dam Enlargement, Wyoming. Ms. Walker completed economic analyses for a project intended to increase storage volume in the existing New Fork Lake, located near Pinedale, WY. For each of three alternatives, she evaluated the potential benefits to recreation, fisheries, public safety, flood control and fire suppression. Ms. Walker developed a series of 50-year benefit-cost models, incorporating all project costs and benefits, the largest of which were agricultural. Her evaluation of the irrigation district's ability to pay focused on varying grant/ loan splits and knowledge of current district finances.

Interstate Stream Commission Cost Benefit Study, New Mexico. This study, conducted for the Interstate Stream Commission, provided a basis for the funding of certain water development projects in New Mexico. For each project, Ms. Walker identified specific beneficiaries, annual water yields and detailed cost schedules. She worked to quantify the benefits of developed water to municipal and industrial uses, recreational activity, environmental uses and the agricultural industry. Using her estimates of project benefits and the available cost data, Ms. Walker developed a cost benefit model that incorporated the information for a period of fifty years and allowed for a comparison of costs and benefits over that period.

APPENDIX B
Map of Kansas Regions



Source: Kansas Department of Agriculture, Division of Water Resources.

APPENDIX C
Region 5 Municipal Water Providers, Historical GPCD

Public Water Supplier	2010 Census	2011 GPCD	2012 GPCD	2013 GPCD	2014 GPCD	2015 GPCD	Avg GPCD (2011 - 2015)
Hays	20,510	99	102	88	81	88	92
Larned	4,054	225	218	179	171	167	192
Phillipsburg	2,581	139	168	141	147	177	154
Ellis	2,062	101	109	75	72	75	86
Plainville	1,903	149	139	118	110	126	128
Kinsley	1,457	126	127	123	125	117	124
La Crosse	1,342	145	159	138	112	106	132
Stockton	1,329	115	121	114	120	116	117
Victoria	1,214	110	113	84	58	55	84
Coldwater	828	226	235	255	167	177	212
Greensburg	777	309	362	269	233	242	283
Haviland	701	174	189	134	136	127	152
Logan	589	174	197	144	115	144	155
Protection	514	196	192	176	164	187	183
Simple Average		163	174	146	129	136	149.6

Note: These water providers serve a population of 500 people or greater.

Source: Master Order Contingently Approving Change Applications Regarding R9 Water Rights, 2019, Appendix D

APPENDIX D
Region 6ML Municipal Water Providers, Historical GPCD

Public Water Supplier	2010 Census	2011 GPCD	2012 GPCD	2013 GPCD	2014 GPCD	2015 GPCD	Avg GPCD (2011 - 2015)
Hutchinson	42,080	155	153	137	141	137	145
Great Bend	15,995	122	131	114	114	105	117
Pratt	6,835	210	224	186	219	228	213
Russell	4,506	146	149	101	135	137	134
Beloit	3,835	126	141	124	120	123	127
Lyons	3,739	253	231	183	159	165	198
Kingman	3,177	131	138	108	118	100	119
Ellsworth	3,120	117	128	108	119	125	119
Hoisington	2,706	113	103	100	89	86	98
South Hutchinson	2,457	173	165	142	140	152	154
Sterling	2,328	107	100	91	90	91	96
Anthony	2,269	139	143	142	121	111	131
Ellinwood	2,131	125	135	101	91	100	110
Medicine Lodge	2,009	180	159	152	135	244	174
Smith Center	1,665	168	181	156	167	134	161
Harper	1,473	165	147	140	137	121	142
Osborne	1,431	144	191	141	119	121	143
Buhler	1,327	143	157	121	122	121	133
Lincoln Center	1,297	114	113	96	101	94	104
St. John	1,295	166	150	132	137	115	140
Haven	1,237	140	124	95	100	102	112
Nickerson	1,070	84	85	75	71	78	79
Stafford	1,042	151	155	100	106	107	124
Kiowa	1,026	157	114	182	162	127	148
Downs	900	149	181	137	132	131	146
Mankato	869	184	206	170	183	172	183
Wilson	781	109	112	94	96	101	102
Pretty Prairie	680	142	126	92	96	97	111
Claflin	645	158	168	128	114	136	141
Attica	626	272	249	199	257	253	246
Little River	557	149	118	95	105	130	119
Macksville	549	135	137	119	110	112	123
Simple Average		151	150	127	128	130	137.3

Note: Region 6ML includes water providers with a population of 500 people or greater.

Source: Master Order Contingently Approving Change Applications Regarding R9 Water Rights, 2019, Appendix E