Lake Powell Pipeline Project

Water Needs Assessment

April 2016

FINAL

Prepared for:

Utah Division of Water Resources

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MWH

BUILDING A BETTER WORLD

Table of Contents

Executive Summary 1

ES-1 Introduction 1

ES-2 The Districts 1

ES-3 Water Demand Forecast 2

ES-3.1 WCWCD 2

ES-3.2 KCWCD 4

ES-3.3 Conservation and Climate Change 7

ES-3.4 Per Capita Water Use 7

ES-4 Conclusion 8

Chapter 1 – Overview 1-1

1.1 Introduction 1-1

1.2 Study Area 1-1

1.3 The Potential Recipients 1-2

1.3.1 Washington County Water Conservancy District 1-2

1.3.2 Kane County Water Conservancy District 1-4

1.4 Summary Description of the Lake Powell Pipeline Project 1-5

Chapter 2 – Methodology 2-1

2.1 Introduction 2-1

2.2 Service Areas 2-1

2.2.1 Washington County Water Conservancy District 2-3

2.2.2 Kane County Water Conservancy District 2-3

2.3 Water Demand Forecast Methodology 2-5

2.3.1 Projecting Population 2-5

2.3.2 Estimating Per Capita Water Use 2-8

2.3.3 Factors Influencing Per Capita Use 2-8

2.3.4 Conservation 2-9

2.3.5 Forecasting Water Demand 2-10

2.4 Water Supplies 2-10

2.4.1 Surface Water Sources 2-11

2.4.2 Groundwater Sources 2-12

2.4.3 Demand Timing 2-12

2.5 Agricultural Conversion for M&I Supply 2-14

2.6 Calculating Water Conservation 2-15

2.6.1 Demand Hardening 2-16

2.7 Integrated Water Resources Plans 2-17

2.8 Coordination with Local Stakeholders 2-18

Chapter 3 – Water Demand 3-1

3.1 Introduction 3-1

3.1.1 WCWCD Projected Population 3-1

3.1.2 KCWCD Population Projections 3-1

3.2 Per Capita Water Use 3-2

3.2.1 WCWCD 2010 Per Capita Water Use 3-2

3.2.2 KCWCD 2010 Per Capita Water Use 3-3

3.3 Projected Water Demand 3-4

3.3.1 Required Source-Sizing Standards 3-4

3.3.2 WCWCD Water Demand Forecast 3-4

3.3.3 KCWCD Water Demand Forecast 3-5

Chapter 4 – Water Supply Conditions 4-1

4.1 Introduction 4-1

4.2 Washington County 4-1

4.2.1 WCWCD Water Supply Overview 4-1

4.2.2 Water Quality Effects on WCWCD Future Supplies 4-2

4.2.3 WCWCD Existing Supplies 4-3

4.2.4 Total Washington County Municipal and Industrial Water Supplies 4-13

4.2.5 WCWCD Planned Water Supplies 4-15

4.2.6 WCWCD Water Sources not Feasible for Development 4-23

4.2.7 Summary of Planned and Potential WCWCD Water Supply Projects 4-26

4.3 Kane County Water Conservancy District 4-26

4.3.1 Kane County Water Supply Overview 4-26

4.3.2 Kane County Existing Water Supplies 4-27

4.3.3 KCWCD Future Supplies – Planned 4-31

4.3.4 Kane County Future Supplies – Potential 4-34

4.3.5 Summary of Potential Developable Kane County Water Supplies 4-35

Chapter 5 – Water Conservation Programs 5-1

5.1 Introduction 5-1

5.1.1 Historical Conservation and Goals 5-2

5.2 Washington County 5-2

5.2.1 Washington County Water Conservancy District Programs 5-3

5.2.1.1 Water Conservation Demonstration Gardens 5-4

5.2.2 Programs Offered by Cities in Washington County ... 5-8
5.2.3 Conservation Savings ... 5-9
5.2.4 Future Goals and Water Conservation Programs ... 5-9
5.3 Kane County ... 5-11
5.3.1 Current Conservation Program ... 5-11
5.3.2 Conservation Savings ... 5-13
5.3.3 Future Goals ... 5-14
5.4 Conclusions ... 5-16
Chapter 6 – Water Resources Planning ... 6-1
6.1 Introduction ... 6-1
6.2 WCWCD Integrated Water Resources Plan ... 6-2
6.3 KCWCD Integrated Water Resources Plan ... 6-6
6.4 Conclusion ... 6-10
References Cited ... R-1
Glossary ... G-1
Abbreviations and Acronyms ... A&A-1
List of Preparers ... LP-1

List of Tables

Table ES-1 Existing and Future Reliable Culinary Supplies for Washington County 3
Table ES-2 2010 Residential Per Capita Water Use 8
Table 2-1 Projected Future Period Virgin River Flow 2-12
Table 3-1 WCWCD Population Projections 3-1
Table 3-2 Population Projections for KCWCD Groups 3-2
Table 3-3 WCWCD Total M&I Water Demand Forecast 3-5
Table 3-4 KCWCD (Kanab City and Johnson Canyon) M&I Water Demand Forecast 3-6
Table 3-5 Kane County Groups M&I Water Demand with Conservation Forecast 3-6
Table 4-1 WCWCD Existing Projects and Water Uses 4-4
Table 4-2 Water Quality of St. George Reuse Effluent and Utah Water Quality Limits 4-9
Table 4-3 Reliable Culinary Water Supplies – Washington County 4-13
Table 4-4 Washington County Secondary Untreated Use 2010 – Reliable Supply 4-14
Table 4-5 Virgin River below Washington Fields – Percent Exceedance for Daily Streamflow, 1940-2006 4-23
Table 4-6 Future Planned and Potential WCWCD Water Supply Projects 4-26
Table 4-7 Reliable Culinary Water Supplies – Kane County 4-28
Table 4-8 Reliable Water Supplies – East Fork Virgin River 4-28
Table 4-9 Reliable Water Supplies – Alton Town 4-29
Table 4-10 Reliable Water Supplies – KCWCD 4-29
Table 4-11 Reliable Water Supplies – Wahweap Creek 4-29
Table 4-12 Municipal Groundwater Supplies Potentially Available for Development 4-31
Table 4-13 Kane County Groups – 2007 Estimated Agricultural Water Use 4-34
Table 4-14 Developable KCWCD Supplies 4-36
Table 5-1 Conservation Goals[1] 5-2
Table 5-2 WCWCD Water Conservation Programs (WCWCD 2007; WCWCD 2008b; WCWCD 2010) 5-4
Table 5-3 WCWCD Conservation Programs 5-10
Table 5-4 Conservation Program Projected GPCD Reduction Percentage to Year 2060 5-11
Table 5-5 KCWCD Increasing Block Rate Structure for Residential Customers 5-12
Table 5-6 KCWCD (Kanab City and Johnson Canyon) Conservation Programs 5-12
Table 5-7 Kanab City Conservation Management Plan 5-13
Table 5-8 KCWCD Conservation Measures Considered 5-15
Table 6-1 WCWCD Summary of Existing and Future Supplies 6-5
Table 6-2 WCWCD Integrated Water Resources Plan Data 6-6
Table 6-3 Kane County Integrated Water Resources Plan Data 6-8

List of Figures

Figure ES-1 Lake Powell Pipeline Participating Water Conservancy District Service Areas 1-2
Figure ES-2 WCWCD Supply and Total Demand..3
Figure ES-3 KCWCD Supply and Demand – Kanab City, Johnson Canyon 5
Figure ES-4 East Fork Subbasin Supply and Demand – Orderville Town and Glendale 5
Figure ES-5 Alton Town Supply and Demand 6
Figure ES-6 Wahweap Creek Subbasin Supply and Demand...6
Figure 1-1 Water Needs Assessment Study Area.. 1-1
Figure 2-1 Lake Powell Pipeline Participating Water Conservancy District Service Areas 2-2
Figure 2-2 Basins in KCWCD's Service Area 2-4
Figure 2-3 Historical Population Projections for Washington County... 2-6
Figure 2-4 Historical Population Projections for Kane County.. 2-7
Figure 2-5 Monthly M&I Water Use Pattern (Percentage of Total Annual Use 2-13
Figure 2-6 Monthly M&I Secondary Untreated Water Use Pattern (Percentage of Total Annual Secondary Untreated Use) 2-14
Figure 2-7 State of Utah Duty Values 2-15
Figure 3-1 WCWCD 2010 Per Capita Water Use 3-2
Figure 3-2 KCWCD (Kanab City and Johnson Canyon) 2010 Per Capita Water Use................................ 3-3
Figure 3-3 Four Kane County Subbasins 2010 Per Capita Water Use 3-4
Figure 3-4 WCWCD Projected Demand 3-5
Figure 3-5 KCWCD (Kanab City and Johnson Canyon) Projected Demand.. 3-6
Figure 3-6 East Fork Virgin River Subbasin Total M&I Water Demand Forecast 3-7
Figure 3-7 Alton Town Total M&I Water Demand Forecast... 3-7
Figure 3-8 Wahweap Creek Total M&I Water Demand Forecast... 3-8
Figure 4-1 WCWCD Existing Water Supplies 4-5
Figure 4-2 WCWCD Owned and St. George Secondary Untreated Sources and Infrastructure................ 4-11
Figure 4-3 WCWCD Existing and Future Water Supplies.. 4-16
Figure 4-4 WCWCD Existing and Potential Secondary Untreated Infrastructure and Customers 4-20
Figure 4-5 Washington County Irrigated Lands... 4-22
Figure 4-6 Daily Streamflow for Virgin River below Washington Fields 4-24
Figure 4-7 Virgin River below Washington Fields Flow Exceedance Curve 4-25
Figure 4-8 KCWCD Existing Water Supplies.. 4-30
Figure 4-9 KCWCD Potential Water Supplies... 4-33
Figure 4-10 Kane County Water-Related Land Use.. 4-35
Figure 5-1 Culinary Per Capita Water Use for WCWCD 5-9
Figure 5-2 KCWCD (Kanab City and Johnson Canyon) Average per Capita Water Use from 2000 to 20105-14
Figure 5-3 Four Subbasins Average per Capita Water Use from 2000 to 2010.. 5-14
Figure 6-1 WCWCD Supply and Demand – Total... 6-3
Figure 6-2 KCWCD Supply and Demand – Kanab City Johnson Canyon 6-8
Figure 6-3 East Fork Subbasin Supply and Demand – Orderville Town and Glendale 6-9
Figure 6-4 Alton Town Supply and Demand 6-9
Figure 6-5 Wahweap Creek Subbasin Supply and Demand.. 6-10

Executive Summary

ES-1 Introduction

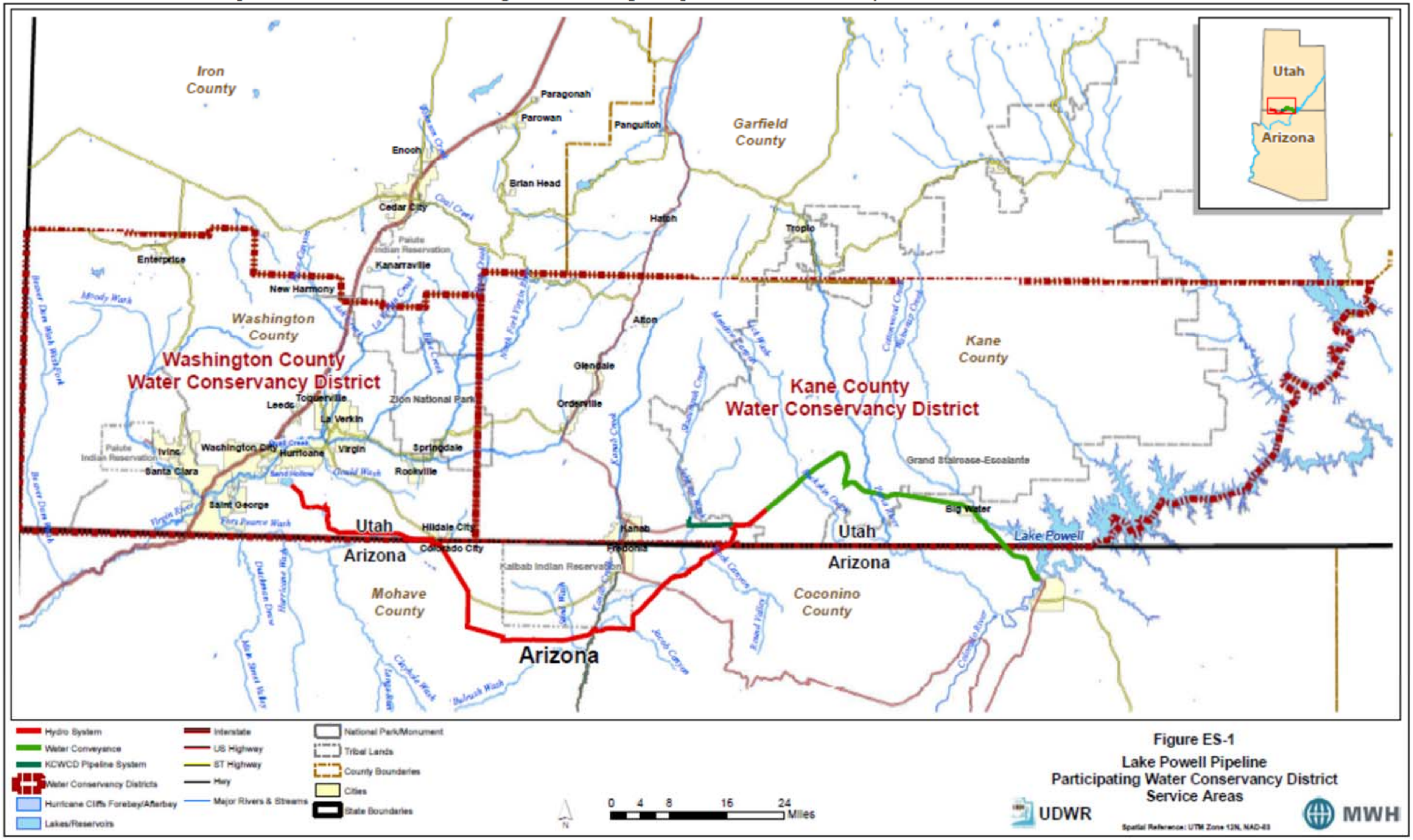
This Water Needs Assessment (Assessment) evaluates the need for future water supplies by the Washington County Water Conservancy District (WCWCD) and the Kane County Water Conservancy District (KCWCD) (collectively the "Districts"). WCWCD and KCWCD are participants in the Lake Powell Pipeline (LPP) Project. The LPP would deliver Utah's Colorado River water from Lake Powell to the service areas of WCWCD and KCWCD shown in **Figure ES-1**.

WCWCD requested 82,249 acre feet (ac-ft) per year and KCWCD requested 4,000 ac-ft per year from the LPP Project.

This Assessment is designed to:

- Estimate the Districts' demand and supply, taking into account conservation and possible effects of climate change, to determine the validity of their requests
- Determine the likely timing of the need for the LPP supply

Figure ES-1 Lake Powell Pipeline Participating Water Conservancy District Service Areas



The Assessment is the basis of the purpose and need for the project and partially fulfills project objectives outlined in Study Plan 19: Water Supply and Climate Change, which was approved by the Federal Energy Regulatory Commission on January 21, 2009.

Information on the topics summarized here can be found in each chapter:

- Chapter 1 – Introduction
  - The Districts' histories and functions that form the basis for their requests for project water
  - The Lake Powell Pipeline project description
- Chapter 2 – Methodology
  - Determination of service areas
  - Estimation of demand
    - Population projections
    - Per capita water use estimates
  - Determination of existing water supplies
  - Estimation of agricultural conversions for future water supplies
  - Conservation measure analysis
- Chapter 3 – Demand
  - Projected populations and per capita usage
  - Role of water conservation
  - Water demand forecast
- Chapter 4 – Supply
  - Current municipal supplies
  - District planned water projects
  - District potential water projects
- Chapter 5 – Water conservation programs
- Chapter 6 – Integrated supply and demand time lines

Each chapter provides an introduction summarizing information covered in that chapter. Accordingly, those who desire to obtain the main conclusions of this report may do so by reading this executive summary, Chapter 1,Chapter 1 – and the introductory section of each chapter. Those desiring to understand calculations and other information supporting the conclusions will find details in the chapter content.

ES-2 The Districts

The Districts are public agencies created by the state to provide and manage water within their specified service areas. Each district has a unique set of circumstances giving rise to the need for the Lake Powell Pipeline water.

WCWCD is the primary water supplier for the major municipalities in the county serving over 85 percent of the county's population, thousands of second homes, 5.6 million tourists each year, 10,000 Dixie State College students and a 245-bed hospital complex. WCWCD has developed an innovative water contract that allows for greater conservation and facilitates the transition of these communities to more desert-wise landscapes. WCWCD and its customers have active conservation programs and are committed to the fulfillment of realistic and practical water conservation achievements that reflect the water-wise standards promoted in its service area for the past 20 years. However, given limitations on Virgin River supply and diversions to the district's off-stream reservoirs, as well as water quality limitations unique to the Virgin River, local supplies will not meet long-term demand.

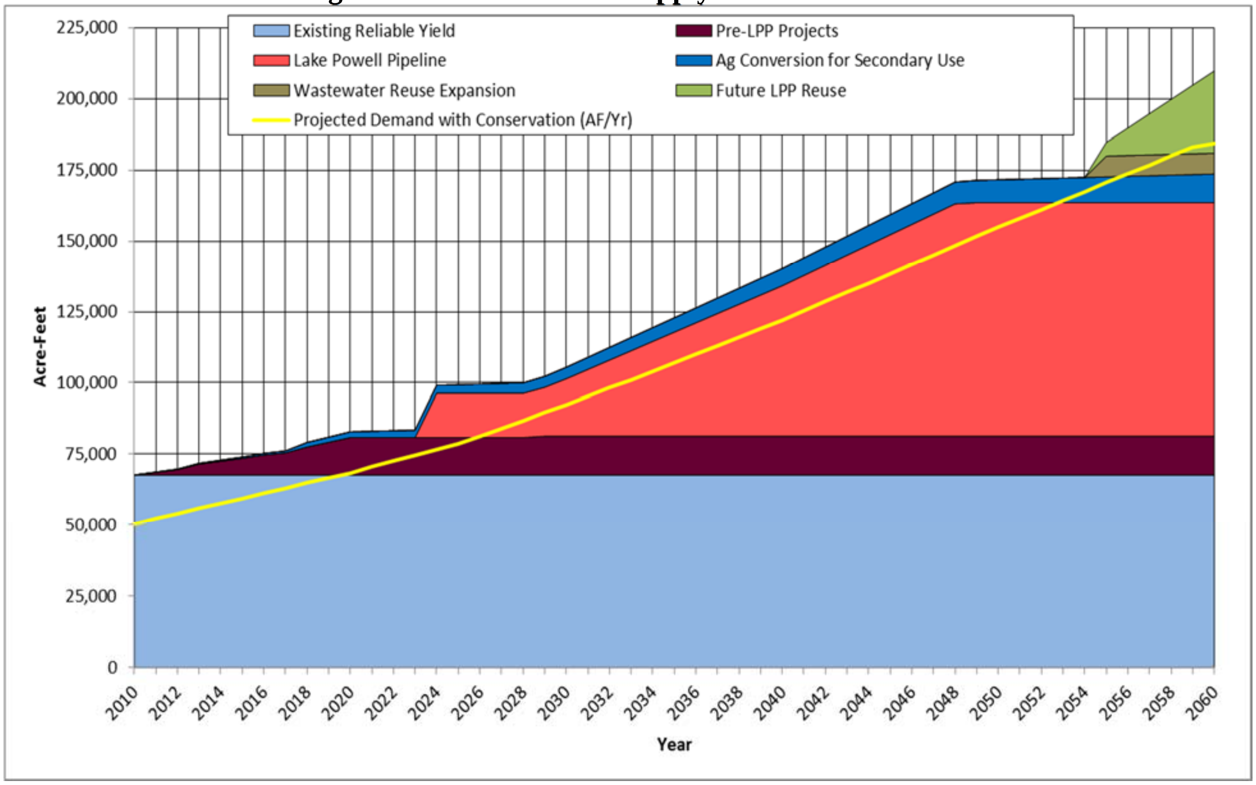
KCWCD was formed in 1992. It has a very limited customer base and limited supply sources at present. Although KCWCD encompasses all of Kane County, much of the district will not be served by the Lake Powell Pipeline. The only substantial community in Kane County, the City of Kanab, has developed its own water supply system, and intends to continue to meet the needs of M&I customers within its current city boundaries, and within future annexation areas as well. Existing KCWCD water supply customers include rural developments located in the Cedar Mountain and Johnson Canyon areas. KCWCD owns and operates wells in the Johnson Canyon area to meet these demands and intends to use Lake Powell Pipeline supplies to meet future demands. The Lake Powell Pipeline would traverse Kane County on its way to Washington County enabling KCWCD to conveniently tap into the pipeline for a reliable long-term supply.

ES-3 Water Demand Forecast

ES-3.1 WCWCD

Total M&I demand for WCWCD is expected to increase from 50,380 ac-ft per year in 2010 to 184,250 ac-ft per year in 2060 (DWRe 2014c). With feasible local project developments estimated to add about 13,670 ac-ft per year, without the LPP, WCWCD demand will exceed supply by about 85,520 ac-ft per year in 2060, with the shortfall starting in about 2028 (**Figure ES-2**). The LPP is the only water source available to meet this demand. The full LPP supply will meet demand through 2060, the end of the study period.

Figure ES-2 WCWCD Supply and Total Demand



These estimates take into account anticipated effects of conservation efforts on demand and climate change on supply. WCWCD's per capita water use dropped 26 percent between 2000 and 2010 and is expected to drop another 12 percent from 2010 values by 2060. There is no practical water conservation program that could offset reasonably anticipated demand over the study period. Climate change effects are estimated to reduce the supply by up to 23 percent in the months of May through July (Reclamation 2014, 50th percentile).

The total reliable water supply for Washington County is summarized in **Table ES-1** below. The 13,670 ac-ft of future supplies include local projects to deliver additional culinary, or potable water prior to construction of the LPP project. The LPP would offer an additional 82,249 ac-ft for culinary use and add 17,120 ac-ft of reuse water that would not otherwise be available.

Table ES-1 Existing and Future Reliable Culinary Supplies for Washington County

Washington County Water Supply				
	WCWCD	Other Suppliers	LPP	Total
Current Supply	32,225	35,452	---	67,677
Future Culinary	13,670	---	82,249	95,919
Future Reuse/Secondary Untreated Supply	17,380	---	28,830	46,210
TOTAL	**63,275**	**35,452**	**111,079**	**209,806**

ES-3.2 KCWCD

KCWCD's service area encompasses all of Kane County. This document includes a brief assessment of four groups in Kane County primarily based on the four major subbasins. While the entire county is considered part of KCWCD's service area, KCWCD currently provides most of its water retail connections in the Cedar Mountain area, which is outside of the basins covered in this study. Within the study area KCWCD provides all of the retail water connections in the Johnson Canyon subbasin, which also serves all of the water needs between Johnson Canyon and the Kanab City limits including a connection to Kanab City to provide a backup water system to their residents. This service area contains the largest future developable private properties in this study area and will receive LPP water in the future. For this reason, Kanab City is grouped with the Johnson Canyon subbasin in this Assessment and Alton Town is represented alone in the Kanab Creek subbasin. Throughout this document, when referring to the four subbasins, Kanab City and the Johnson Canyon subbasin are included along with Alton Town and the East Fork and Wahweap subbasins.

Total M&I demand for the areas served by KCWCD (Johnson Canyon and Kanab City) is expected to increase from about 1,535 acre-feet per year in 2010 to 3,435 acre-feet per year in 2060 (DWRe 2014c). The remaining communities within Kane County are expected to increase demand from 733 ac-ft per year in 2010 to 1,750 acre-feet per year in 2060. A combination of existing and new groundwater supplies is sufficient to meet future needs beyond the planning horizon for the Wahweap Creek subbasin. The East Fork Virgin River subbasin and Alton Town would rely on transfers of agricultural water to meet future demand deficits rather than groundwater within the planning period.

The KCWCD (Kanab City and Johnson Canyon subbasin) reliable supplies are estimated at 2,516 acre-feet per year. When the estimated effects of climate change (Reclamation 2014) are applied to these supplies and a 10 percent planning reserve is added, the reliable supply drops to 2,102 ac-ft per year by 2060. KCWCD reliable supplies are projected to be in deficit by 2035 when they would be exceeded by total water use. KCWCD will use LPP water to meet future demands beyond the reliable supply.

Figure ES-3 through **Figure ES-6** show the relationship between supply and demand, and the sequential timing of new projects brought on line to meet the forecasted total water demand.

Figure ES-3 KCWCD Supply and Demand – Kanab City, Johnson Canyon

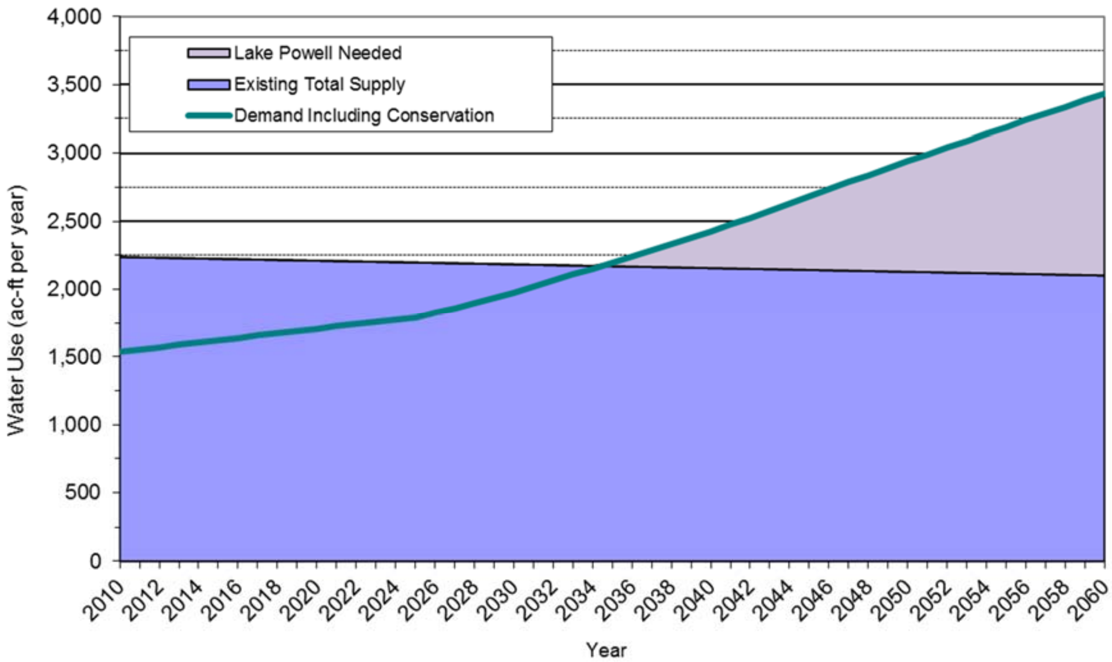


Figure ES-4 East Fork Subbasin Supply and Demand – Orderville Town and Glendale

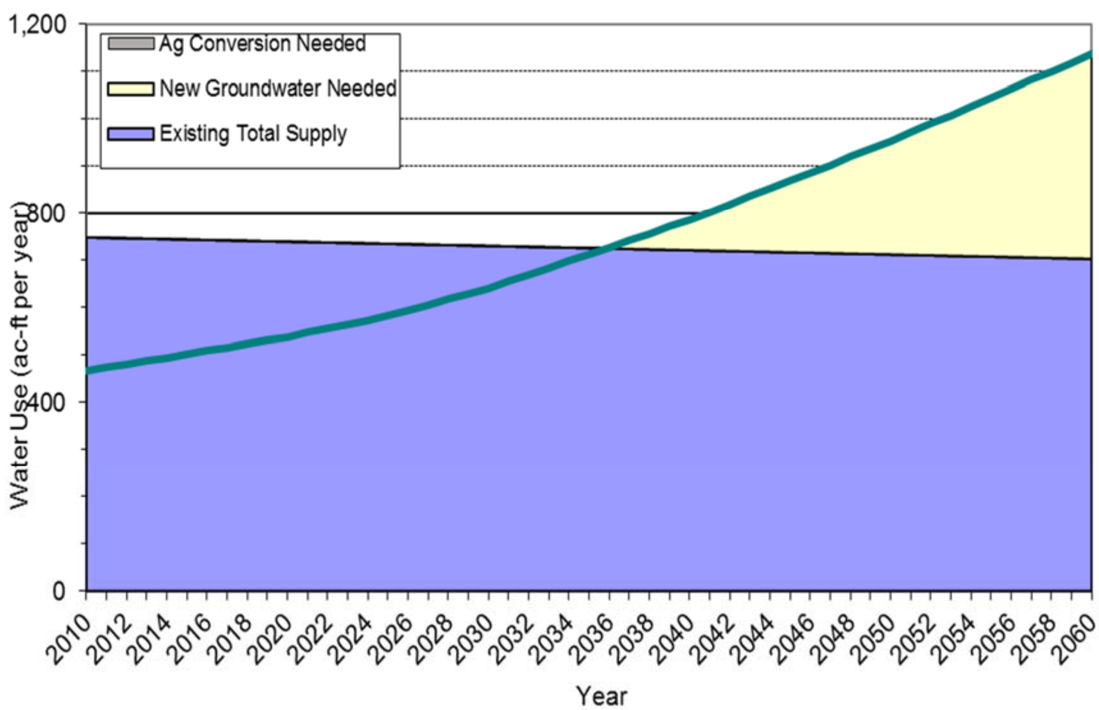


Figure ES-5 Alton Town Supply and Demand

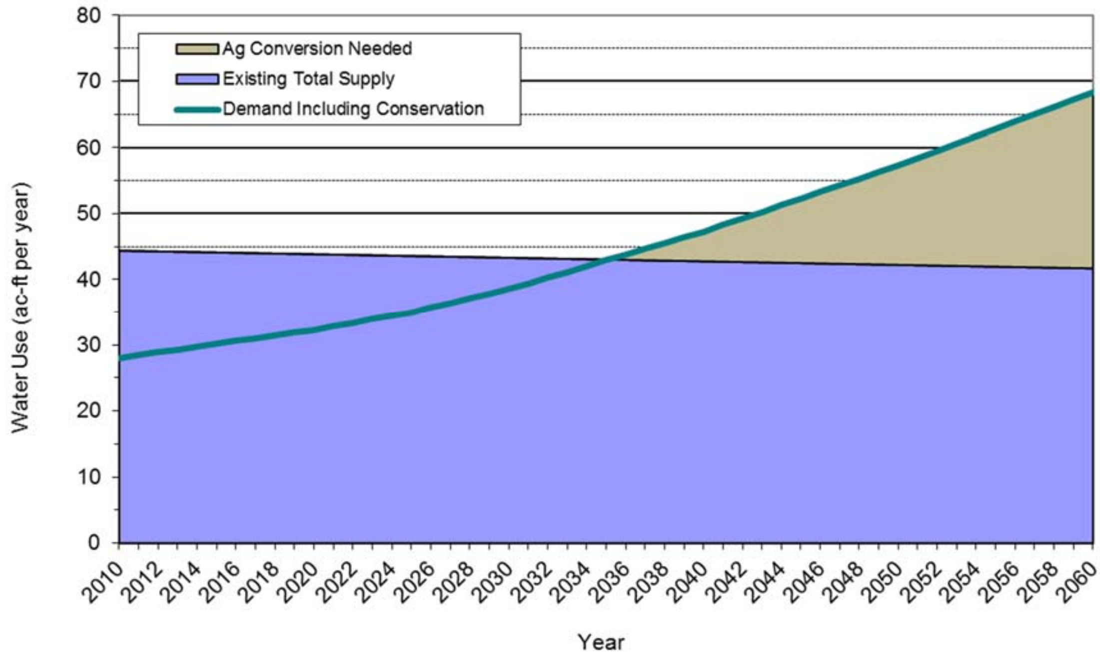
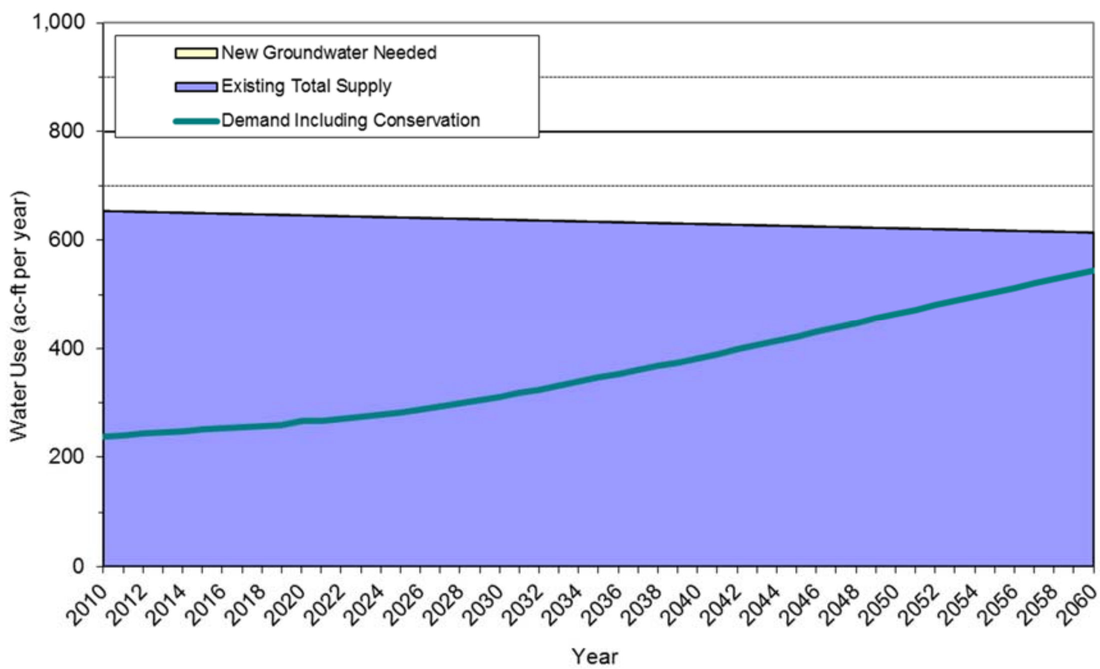


Figure ES-6 Wahweap Creek Subbasin Supply and Demand



ES-3.3 Conservation and Climate Change

Two factors that influence water demand and supply are conservation and climate change. Conservation has been a hallmark of WCWCD's focus since 1995. Several conservation measures have been implemented since 1995 and all municipal customers that are part of the Regional Water Supply Agreement have been required to comply. Because of this, a culture of conservation has begun to develop in the county and between 2000 and 2010 WCWCD achieved 26 percent reduction in per capita water use. WCWCD has already exceeded the statewide established goal of 25 percent reduction by 2025.

KCWCD and the City of Kanab have active conservation plans for the Johnson Creek and Kanab Creek areas. The water conservation programs address conservation education, maintenance of the water distribution system and water sources, as well as increasing block rate structures. Kanab City's conservation approach has been to provide an efficient culinary water supply system to its customers. KCWCD completed the construction of the Jackson Flat reservoir for the Kanab Irrigation Company which has significantly enhanced the pressurized irrigation system. Current and future conservation programs for both districts are discussed in detail in **Chapter 5**.

The U.S. Bureau of Reclamation conducted a statistical analysis of climate change projections of future streamflow at the Virgin River at Littlefield USGS streamflow gauge. Median streamflow is projected to decline between 10 and 35 percent relative to historical streamflow during the months of May through July (Reclamation 2014). This analysis was incorporated into the Virgin River Daily Simulation Model for WCWCD to estimate reliable supplies (DWRe 2014a). The reduction associated with climate change also was applied to the Kane County subbasins' reliable supply.

Climate change is anticipated to cause the runoff season to shift one month earlier in the year. Furthermore, warmer temperatures are anticipated to cause winter precipitation to shift from snow to rain (see **Study Report 19 - Water Supply and Climate Change**). The impacts of these changes may reduce the ability to capture water in WCWCD storage. WCWCD's off-stream storage system is highly dependent upon stream discharge rates, the season of that water, and the rate at which the water occurs in the river. The water rights in the system dictate that water is stored in the winter and spring, when agriculture water is not being used for irrigating. Winter and spring water discharge is based on snowmelt in the mountains. If snow precipitation is limited then the potential for storage is limited. Rain precipitation often causes intense, abrupt storm events. If river flow exceeds the Quail Creek diversion pipeline capacity, water cannot be stored and is lost. Therefore, more storage will not help overcome the impacts of climate change for WCWCD.

ES-3.4 Per Capita Water Use

Per capita residential water usage in WCWCD and KCWCD for 2010 is shown in **Table ES-2**, below. Total per capita water use rates, reported in **Chapter 3**, are addressed in this Assessment because of their value in project planning. By estimating total per capita water use rates and permanent population served, water managers can plan for the likely needs of the future. With the conservation goals applied to the total use, managers have some assurance that sufficient water will be available to fulfill estimated demands as they may be redistributed among various users over time.

Table ES-2 2010 Residential Per Capita Water Use

District	Culinary (gpcd)	Secondary untreated (gpcd)	Total (gpcd)
WCWCD	143	12	155
Kane County Subbasins	141	36	177
KCWCD (Kanab City and Johnson Canyon)	139	15	154
Source: DWRe 2013b; DWRe 2013d; DWRe 2014c			

Total water use numbers calculated in this study do not provide valid comparisons to other water users in the United States. The factors that contribute to the total per capita numbers are a unique combination applicable to southwest Utah. For example:

- This Assessment reports all water use consistent with State of Utah policy, whereas communities in other states may eliminate commercial, institutional, industrial or secondary water use and/or subtract return flows from wastewater to calculate per capita water use.
- The population numbers used to compute per capita water use do not include the large numbers of non-permanent residents; thus, their water usage is attributed to the total per capita usage of the residential population, inflating these numbers.
- The growing season in southwest Utah is long, summers are hot and precipitation occurs outside of peak demand periods, particularly in the WCWCD service area, increasing the need for outdoor irrigation water, unlike areas where precipitation or cooler temperatures reduce the demand for system water.

ES-4 Conclusion

Given available information and taking into account various parameters applicable to this Water Needs Assessment, results set forth in this report are sufficient to support long-range regional water supply planning. This Assessment shows that in the near future, projected water demands will exceed existing supplies in the Districts' services areas, causing them to employ a variety of approaches to meet these demands. Conservation will play a vital role in minimizing the need for additional water, but development of new water sources, including LPP water, will be critical in maintaining a safe and reliable supply of water for communities in Southern Utah.

Chapter 1 – Overview

1.1 Introduction

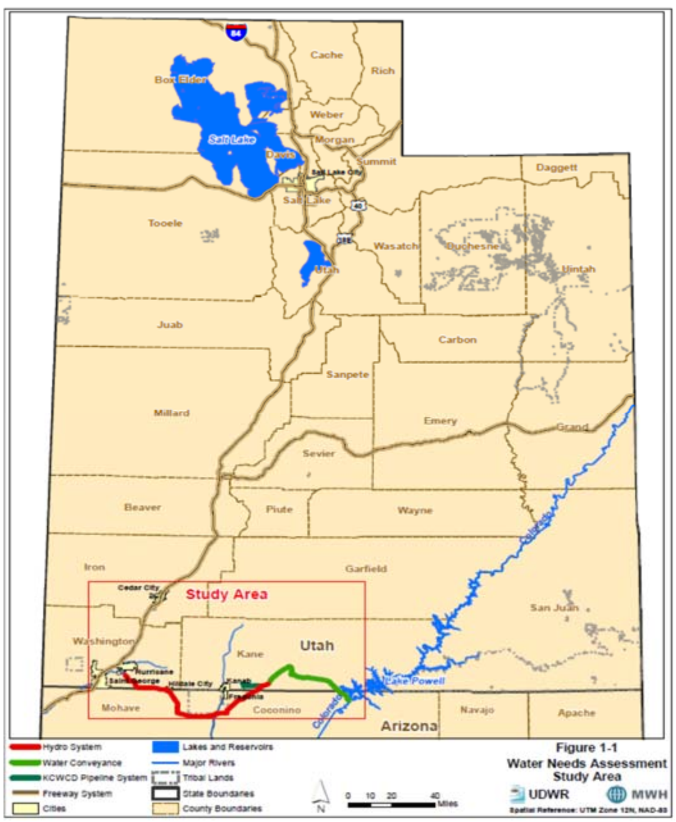
The Lake Powell Pipeline Study Water Needs Assessment was conducted to evaluate the need for future water supplies by the Lake Powell Pipeline (LPP) project participants and is the basis of the Purpose and Need for the project. Study areas generally included only those areas that could be served with project water. The potential project recipients, WCWCD and KCWCD, are public agencies, each with unique circumstances governing water needs. The Lake Powell Pipeline project is a project of the State of Utah that includes water delivery and hydroelectric power generation components.

1.2 Study Area

The study area for this Assessment, shown in **Figure 1-1**, is limited to the areas that are potential recipients of water from the Lake Powell Pipeline, which are:

- All of WCWCD service area
- Portion of KCWCD service area that could be served with water from the LPP

Figure 1-1 Water Needs Assessment Study Area



1.3 The Potential Recipients

1.3.1 Washington County Water Conservancy District

The WCWCD is a public non-profit agency, charged under state law with conserving, developing, managing and stabilizing water supplies within the county to establish a safe, sustainable water supply for human use and for a healthy natural environment in the Virgin River basin. The WCWCD seeks to meet its goals by reference to estimates of water demand derived from the plans established by local and state elected representatives of the people as well as state water and wildlife agencies. As a political subdivision of the state, WCWCD operates under the Water Conservancy District Act (§ 17B-2a-1001 *et seq*.), Limited Purpose Local Government Entities – Local Districts (Utah Code Ann. § 17B-1-101 *et seq*.), Open and Public Meetings Act (Utah Code Ann. § 52-4-1 *et seq*.) and other statutes generally applicable to public agencies. WCWCD has the limited purposes and powers set forth in Utah law applicable to limited purpose local government entities and has no general police powers or governing authority.

Washington County is located in the southwest corner of Utah adjacent to both Nevada and Arizona. The county has diverse topography and climate resulting from a wide range of elevations but is generally characterized by a desert landscape. Most Washington County residents live in fairly narrow corridors along the Virgin and Santa Clara rivers. Washington County is one of the fastest growing counties in the state, and Utah is one of the fastest growing states in the country. While conservation will be an important factor in meeting the demand created by the anticipated growth, the water saved through conservation cannot offset the total demand created over time. Furthermore, changes from traditional landscapes to xeric landscapes increase the ambient temperature. This increase in temperature will result in an increased use of air conditioning. According to Tamim Younos, a professor of water resources at Virginia Tech, it can take an average of 25 gallons of water to produce 1 kilowatt-hour of electricity (IEEE 2008). While not considered in this analysis, this could increase the average per capita per day indoor water use, reducing the benefits of this form of conservation. Because local water projects and conservation together will not meet demand over time, it is essential that an additional supply is developed.

In addition, given risks posed by drought, climate change and the demand hardening that accompanies conservation, the ability to tap into Lake Powell, an on-stream reservoir that gathers water from the entire upper basin of the Colorado River, would add important diversity of supply not available from the off-stream reservoirs that currently tap the Virgin River to supply Washington County. Furthermore, the long range reliability of the Lake Powell supply avoids the drastic economic losses that can occur if businesses see a risk of unstable water supplies and cease to maintain and invest in the area.

The WCWCD operates in compliance with state and federal law and regulations pertaining to system design, capacity and water quality, and the WCWCD's water deliveries are constrained by factors imposed by the Endangered Species Act. Its plans take into account data and studies prepared by the state and relied upon by its professional consultants with expertise in the area of study. The plans set forth by its municipal customers are an important basis for estimating reasonable demand expectations. Thus, WCWCD seeks to respond to the will of the residents of the county as represented by elected public officials.

In 2006, the WCWCD adopted a unique approach to water sales, designed to enhance conservation opportunities for its municipal customers (WCWCD 2006). The Regional Water Supply Agreement (RWSA), in contrast to the take-or-pay contracts traditionally relied upon by utilities, is an "all-requirements" contract serving the following Washington County cities (see Figure ES-1 for locations):

- St. George
- Washington
- Hurricane
- Ivins
- LaVerkin
- Toquerville
- Santa Clara
- Leeds

Conservation is emphasized through several contract provisions.

- The RWSA requires municipal customers to pay only for the water that is delivered to them, eliminating disadvantages to conservation caused by traditional "take-or-pay" contracts that require blocks of water to be paid for whether or not they are used.
- Impact fees, paid by new development for capital costs of facilities necessary to supply water, are increased with increasing irrigated area, thus encouraging new development to minimize outdoor use of water. Lots in excess of 10,000 square feet pay for the additional area unless a water conservation agreement is recorded to limit irrigated landscape.
- A conservation provision requires municipal customers to maintain or implement
    - water conservation plans,
    - water conservation rate structures,
    - time of day water use ordinances,
    - landscape ordinances.
- Municipal customers are also required to
    - promote secondary untreated water irrigation systems,
    - participate in planning to ensure maximum use of reuse water and
    - use secondary untreated water on all municipal facilities for which such use is feasible.

The RWSA requires the WCWCD to acquire, construct, and operate its water system to meet anticipated municipal demand. The RWSA pays for water through three different charges. Impact fees are paid by new growth to address demand for new public water facilities. Municipal customers pay a wholesale delivery charge based on metered delivery and a water development surcharge to ensure a steady funding mechanism during economic fluctuations.

Municipal customers retain their existing water resources, rights and facilities, except to the extent they choose to integrate them with WCWCD's water supplies, which requires additional contracts with the District. The wholesale delivery charge covers operation, maintenance, repair and replacement. The District's Capital Facilities Plan (CFP), which is approved by the municipal customers, determines the components of the system necessary to provide adequate water to meet the current and future needs of the customers. The CFP includes the LPP as a future system component.

The only source available to augment Virgin River basin groundwater supplies traditionally relied upon for municipal use has been development of Virgin River basin surface water, requiring the construction of storage and transmission facilities. The WCWCD's first project, the Quail Creek diversion and off-stream reservoir, was completed in 1985. The construction of Sand Hollow reservoir in 2002, integrated with the Quail Creek project, brought the average annual yield of Virgin River water of the reservoirs to 24,922 ac-ft per year. In addition Sand Hollow Reservoir operates as a groundwater recharge system, currently storing over 100,000 ac-ft, available as a drought reserve.

The WCWCD's ability to develop water in the Virgin River basin is limited by several factors:

- Water quality is compromised by the LaVerkin hot springs, coming in at about 10 cubic feet per second at 10,000 parts per million of total dissolved solids (TDS).
- The district is faced with water quality issues such as arsenic and brackish water (geology).
- Due to the contamination of the Virgin River by the hot springs water, the district's diversion structure is located several miles upstream from the springs and the water is delivered to the off-stream reservoirs through several miles of pipeline.
- The capacity of the pipeline limits the amount of water that can be diverted from the river.
- Diversion must be avoided when the natural flows are compromised by mud and debris during floods that might damage facilities or negatively impact water quality in the system. As a result of these limitations on diversions from the Virgin River, the river has maintained virtually the same hydrograph including flood stage flows for the past 100 years.
- The district's water use is subject to the major, primary agricultural diversion rights on the Virgin River, dating between 1890 and 1904, belonging to the St. George and Washington Canal Company (1890-1900), the Hurricane Canal Company (1904) and LaVerkin Canal Company (1891). These three companies combined are entitled to about 190 cfs of Virgin River flow, which exceeds the typical summer flows in this stretch of river emphasizing the challenge faced by having only one water source, the Virgin River Basin.
- The district also allocates water for riparian habitat and wildlife conservation demands, including instream flow protection.

Because water quality issues have prevented use of Virgin River water downstream of the La Verkin hot springs for culinary or potable water use, the WCWCD and its municipal partners have developed secondary untreated water systems to maximize the use of this water supply for outdoor irrigation. Many secondary untreated systems were constructed years ago, with limited delivery pipe sizes, and are often used continuously to make the most use of this water. Golf courses in Washington County rely on secondary untreated water.

1.3.2 Kane County Water Conservancy District

KCWCD was formed in 1992. It has a limited customer base and limited supply sources at present. The KCWCD boundary encompasses all of Kane County. The county extends from Lake Powell and the Colorado River on the east to Washington County on the west. The main communities can be seen in Figure ES-1 and include:

- City of Kanab
- Orderville Town
- Alton Town
- Glendale Town
- Big Water
- Johnson Canyon

Although KCWCD encompasses all of Kane County, much of the county will not be served by the Lake Powell Pipeline. Existing KCWCD water supply customers include rural developments located in the Cedar Mountain and Johnson Canyon areas. KCWCD owns and operates wells in the Johnson Canyon area to meet these demands. KCWCD has a connection to the Kanab City water supply and intends to use Lake Powell Pipeline supplies to meet future demands there and in the Johnson Canyon subbasin. This document includes a brief assessment of four groups in Kane County primarily based on the four major subbasins. Kanab City is grouped with the Johnson Canyon subbasin in this Assessment and Alton Town is represented alone in the Kanab Creek subbasin. Throughout this document, when referring to the four subbasins, Kanab City and Johnson Canyon subbasin are included along with Alton Town and the East Fork and Wahweap subbasins.

The Utah State Institutional Trust Lands Administration (SITLA) administers a large tract of land in east Kane County within the KCWCD service area. The eastern part of KCWCD, including Big Water, drains to Lake Powell. It is therefore in the Southeastern Colorado River Basin as defined by the State of Utah, and is in the Upper Colorado Basin as defined by the Colorado River Compact.

1.4 Summary Description of the Lake Powell Pipeline Project

In 2006 the Utah State Legislature passed the Lake Powell Pipeline Development Act (Utah Code Ann. § 73-28-101 *et seq*.), which authorized the Board of Water Resources to build the LPP to meet a portion of southwestern Utah’s future water demands. The Act specifies the powers of the state Board of Water Resources, which is charged with construction of the project, establishes a management committee to consult with the board and approve expenditures, establishes contractual requirements, allocates the water to specified entities, establishes terms for delivery and payment and authorizes transfer of title under specified conditions.

The LPP would transport a portion of Utah’s Colorado River water from Lake Powell to Washington and Kane counties. The pipeline would consist of approximately 140 miles of buried 69-inch diameter pipe from Lake Powell to Sand Hollow Reservoir near Hurricane and St. George. Pumping facilities near Glen Canyon Dam and booster pumping stations along the pipeline alignment would provide the approximately 2,000-foot lift needed to transport the water over the high point in the pipeline. The 2,630-foot drop between the high point and end of the pipeline would be utilized to generate hydropower by new hydroelectric generation facilities. The power sales from the hydroelectric generation facilities would offset a portion of the pumping costs. The Districts have requested allotments of water from the LPP project based on their own assessments of future water needs. These requests are summarized as follows.

- **WCWCD –** 82,249 ac-ft/yr
- **KCWCD –** 4,000 ac-ft/yr

Chapter 2 – Methodology

2.1 Introduction

This chapter describes the data and methodology used in this Assessment, including:

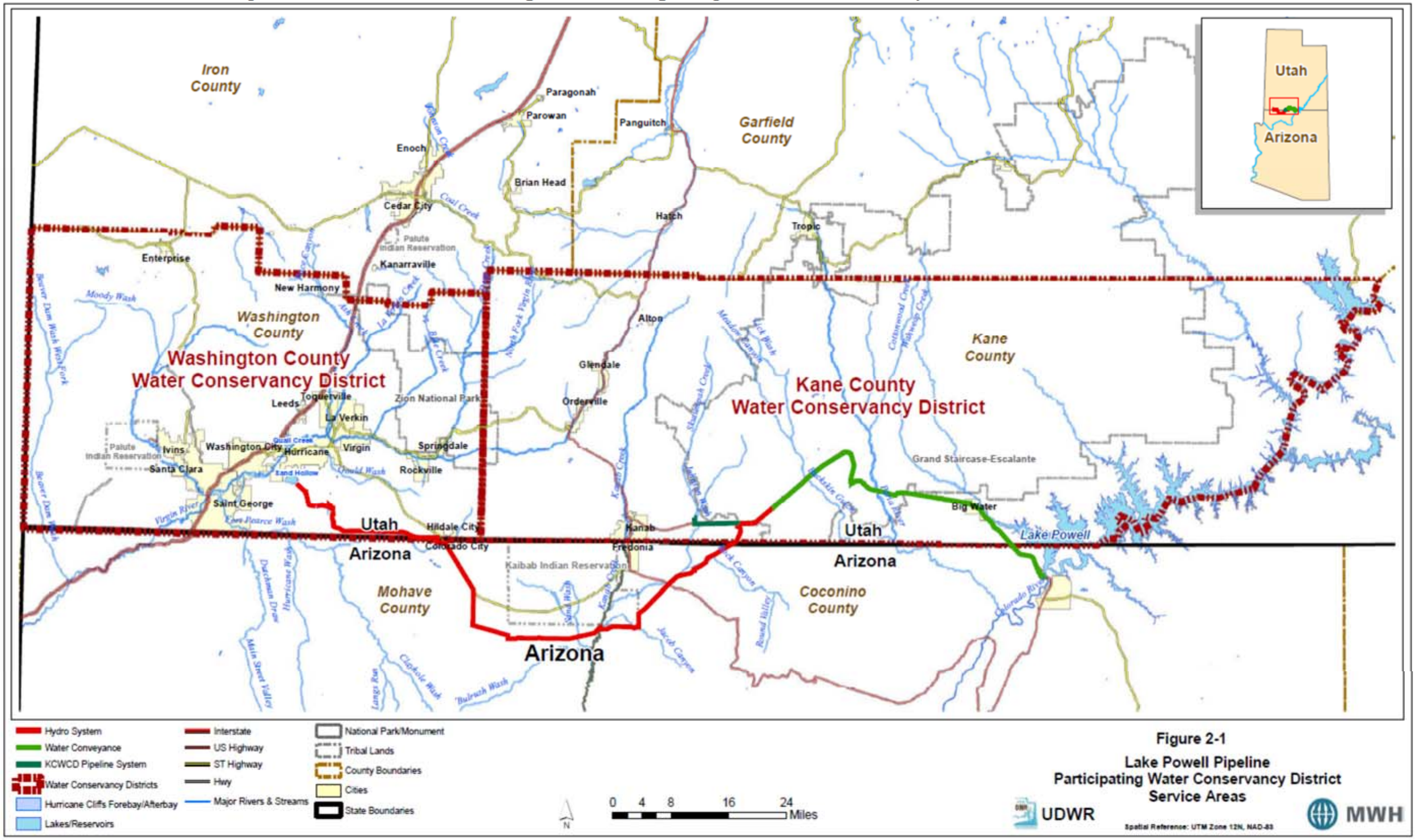
- Determination of potential LPP service areas.
- Water demand forecasts based on
  - Population forecasts, based on officially adopted forecasts provided by the Utah Governor's Office of Management and Budget (GOMB).
  - Forecasts of per capita water use and total water needs to 2060, the adopted study period.
- Estimates of reliable yields of existing and future water supply projects.
- Confirmation by Maddaus Water Management (MWM) that conservation goals are attainable
- Integrated water resources plans
- Coordination efforts with stakeholders.

2.2 Service Areas

This Assessment evaluated which portions of the Districts' service areas could be provided water from the LPP. Figure 2-1 is a map showing the boundaries of the two districts and the proposed alignment of the LPP.

Because portions of the Districts' service areas are distant from the proposed LPP alignment, there may be economic and engineering limitations to supplying project water to all areas. However, indirect use of LPP water may be possible in some seemingly remote areas through exchanges and substitute supply agreements. As a result of these potential partnerships, the majority of each district's service area was evaluated in this assessment. WCWCD and KCWCD demands and water supply projects were evaluated independently.

Figure 2-1 Lake Powell Pipeline Participating Water Conservancy District Service Areas



2.2.1 Washington County Water Conservancy District

The majority of WCWCD system water is delivered to municipal customers who serve over 85 percent of the population of the county. In this Assessment, 33 retail water systems were evaluated in WCWCD's service area. Enterprise was not included in the analysis because of its distance from the LPP and unlikeliness of exchange agreements involving LPP water taking place.

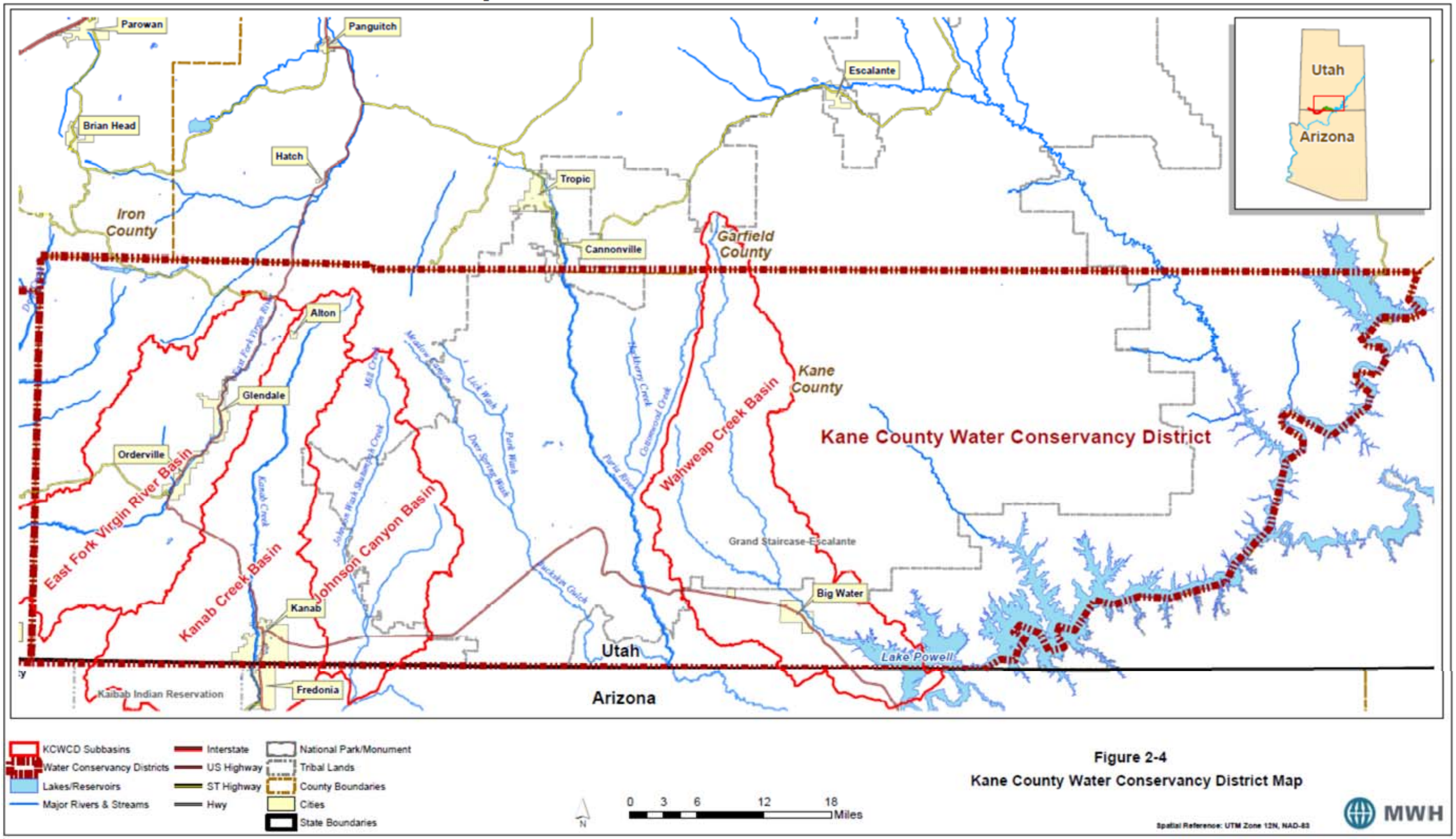
2.2.2 Kane County Water Conservancy District

KCWCD's service area encompasses all of Kane County. The county extends from Lake Powell and the Colorado River on the east to Washington County on the west. This document includes a brief assessment of four groups in Kane County primarily based on the four major subbasins. While the entire county is considered part of KCWCD's service area, the district currently only serves residences in the Johnson Canyon subbasin and areas between Kanab City and Johnson Canyon. KCWCD also provides backup water and has a supply connection to Kanab City, which can be used to deliver additional water in the future as needed. The Duck Creek and Cedar Mountain area has several residences that are used as second homes. Because of its location, water use in this area does not return to the Kanab/Virgin River basin or the Colorado River basin and was therefore excluded from analysis in this document. The KCWCD pipeline proposed as part of the Lake Powell Pipeline would terminate at the mouth of Johnson Canyon, where it would be connected to the existing KCWCD and the Kanab City treatment and distribution systems. For this reason, Kanab City is grouped with the Johnson Canyon subbasin in this Assessment and Alton Town is represented alone in the Kanab Creek subbasin.

Strictly speaking, the four subbasins analyzed in this assessment within Kane County, Figure **2-2,** include:

- East Fork Virgin River – Orderville, Glendale and Alton
- Kanab Creek – Alton Town and Kanab City
- Johnson Canyon – Johnson Canyon
- Wahweap Creek – Church Wells and Big Water

Figure 2-2 Basins in KCWCD's Service Area



2.3 Water Demand Forecast Methodology

In 2014, the Utah Division of Water Resources (DWRe) published population and water use projections for each water basin in Utah. With the exception of Enterprise, all of WCWCD's service area was included in the Kanab Creek/Virgin River Basin. KCWCD's service area encompasses portions of the East Fork Virgin River, Kanab Creek, Johnson Canyon and Wahweap Creek Basins.

2.3.1 Projecting Population

The Utah Governor's Office of Management and Budget (GOMB; formerly the Governor's Office of Planning and Budget) has developed population projections for southwest Utah since the late 1960s. These forecasts are sanctioned for use by state and other agencies for planning purposes. The most recent projections, issued in 2012, use the estimated 2010 populations as a baseline to predict populations every decade to 2060. The projections are provided by county and also by listed cities and towns within each county. DWRe compared city and town boundaries used in the GOMB projections to the municipal service area boundaries for which they collect water usage data and adjusted the baseline populations to reflect the population within these municipal service area boundaries. DWRe applied the GOMB growth rates to the baseline populations in the adjusted area boundaries.

Because future population depends on birth rate, mortality, immigration, and emigration, each of which are affected by many factors, there is a high degree of uncertainty in population models, especially those projecting beyond just a few years. In **Figure 2-3** and **Figure 2-4**, ten historical population projections made by GOMB are plotted with actual population data estimated by the Census Bureau for Washington and Kane counties, respectively (GOMB 2005, GOMB 2008, GOMB 2012a, GOMB 2012b, & U.S. Census 2015). The GOMB projections have frequently underestimated, and in 2005 and 2008 overestimated, population growth for Washington County. The projections for Kane County, likewise, have failed to accurately estimate actual population. Although inaccuracy is inherent to all population models, projections which under or overestimate population can have detrimental consequences for the entities using them for long-term planning.

Figure 2-3 Historical Population Projections for Washington County

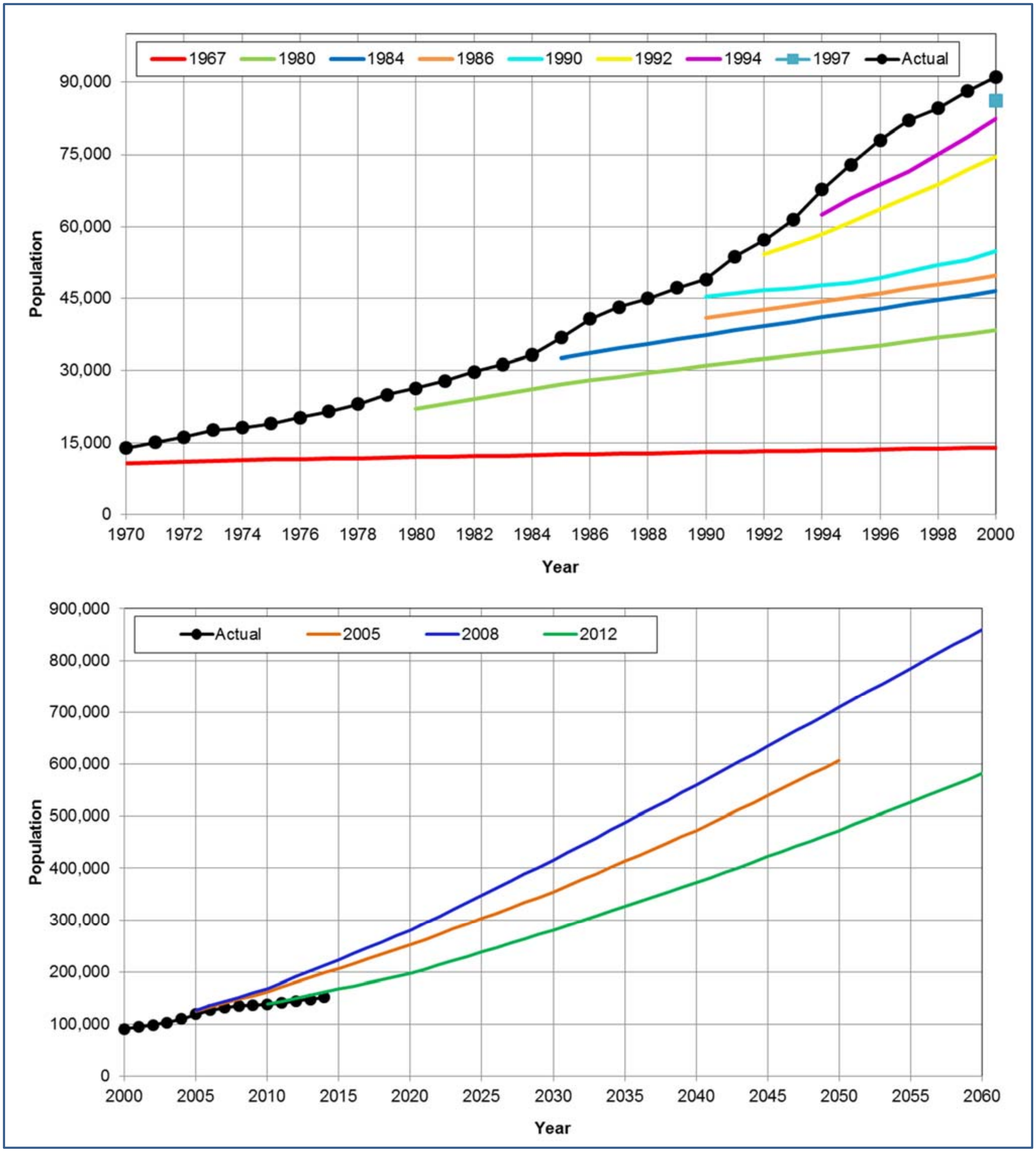
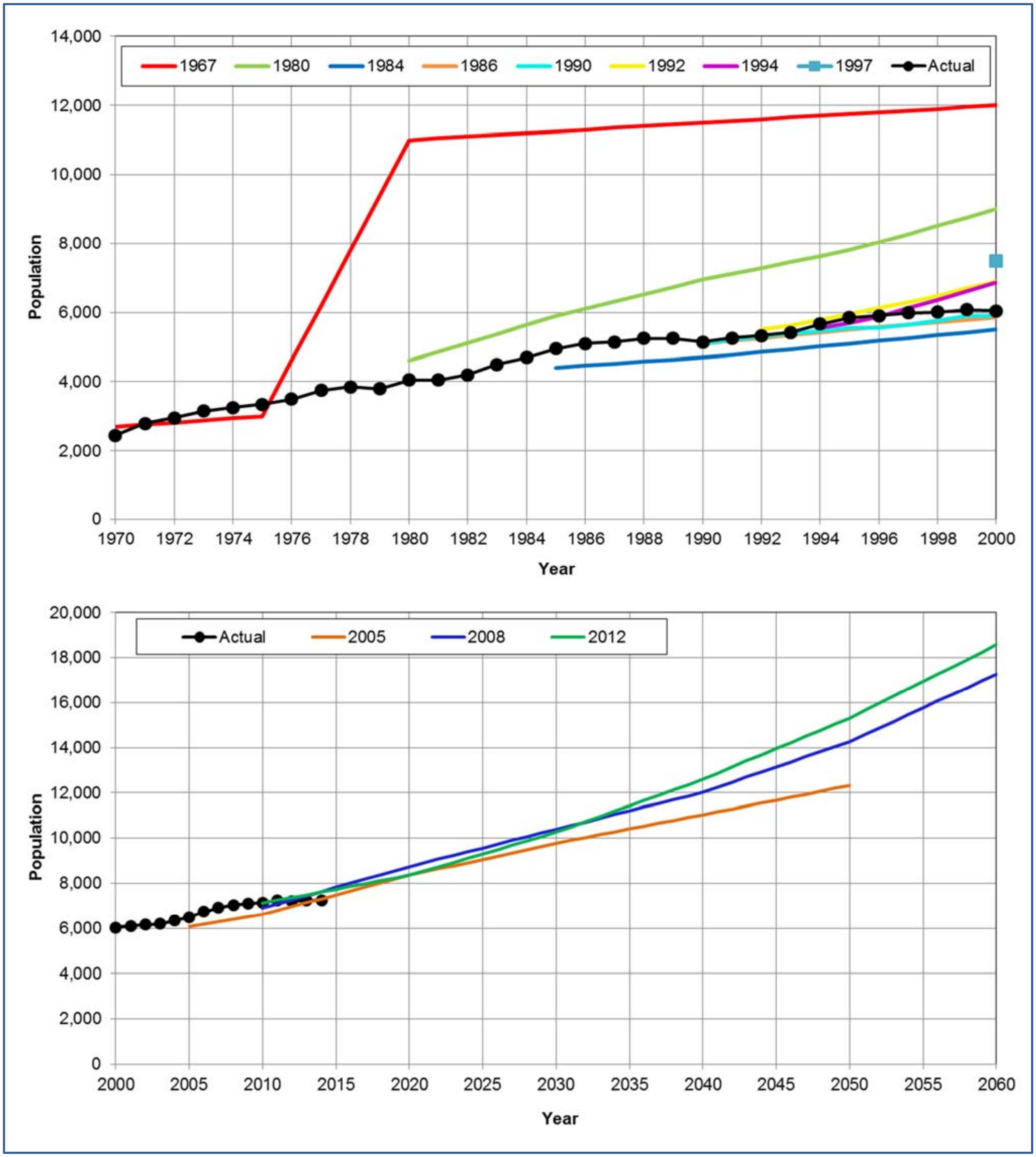


Figure 2-4 Historical Population Projections for Kane County



2.3.2 Estimating Per Capita Water Use

Per capita water use is essentially the amount of water used by a given population. The per capita usage outlined in this report is intended to help state and local entities plan for the future, taking into account the unique circumstances they face.

The following assumptions were made in determining the base per capita water use for the entities within the Districts' service areas:

- Water use by both permanent and non-permanent residents was divided by the permanent resident population to calculate per capita use.
- This Assessment reports all customer level water use consistent with State of Utah policy, whereas communities in other states often do not include commercial, institutional, industrial or secondary water use, and may also subtract return flows from wastewater to calculate per capita water use.
- This Assessment reports all municipal and industrial (M&I) water use, including customer level residential, commercial, institutional and industrial culinary and secondary water use, whereas other communities report only residential water use.
- This Assessment reports both culinary and secondary untreated water use; whereas other communities report only culinary water use.
- Per capita water use includes M&I use but not agricultural use.
- Water use forecasts were developed for total, culinary or potable, and secondary untreated use.
- WCWCD – Average per capita water use for Washington County was assumed to be representative of per capita water use for WCWCD. Enterprise was not included because it is located in the Cedar/Beaver Basin and would not be served by Lake Powell Pipeline project because of its remote location.
- KCWCD – Average per capita water use for Kanab City and the Johnson Canyon subbasin was assumed to be representative of per capita water use for the KCWCD as this is the only area that will be served by KCWCD facilities. Per capita water use for three other groups is provided for informational purposes.

DWRe separated 2010 M&I water use estimates into residential, commercial, institutional and industrial use categories. Residential water use was further broken down by indoor and outdoor use. Secondary untreated water systems are not available in all areas, so many homes and businesses use culinary water to meet outdoor watering needs. Reliable use records are available for culinary water because cities meter and bill customers for this water. However, while some secondary untreated water use is metered, most is not; and therefore, DWRe estimated secondary untreated use using available lot size, efficiency and climate data.

2.3.3 Factors Influencing Per Capita Use

Local climate, culture and economic makeup influence water consumption. The pioneer culture of home gardening has persevered over time. The warm climate in southwest Utah provides a long growing season for shade trees, home vegetable gardens and other landscaping. Precipitation occurs outside of much of the summer growing season. System demands in southwest Utah are increased by the growing season coupled with a high evapotranspiration (ET_o) rate and minimal offsetting precipitation. Annual per capita water use data were analyzed to determine trends in water use considering net evapotranspiration data from Coral Canyon (DWRe 2013e) as an indicator of annual weather conditions.

The pleasant climate, plentiful recreational opportunities, and the scenic beauty of southwest Utah attract millions of tourists each year. During their stays, these tourists consume water and contribute to the calculated per capita usage in both WCWCD and KCWCD. Washington County has a large tourism population associated with conventions, golfing, athletic events, and visits to nearby national parks and recreation areas. Washington and Kane County share the world renowned Zion National Park. Kane County is a gateway to Lake Powell, Bryce Canyon, and the Grand Staircase-Escalante National Monument. Average annual tourist visits for the two counties exceed six million per year. The Washington County Convention and Tourism Office (WCCTO) estimates 5.6 million tourists visit Washington County each year (WCCTO 2015). This estimate was derived by multiplying the number of hotel rooms with the average occupancy rate and an estimate of three people per room. Using that methodology, Kane County likely receives 440,000 tourists per year. There are 155 new hotel rooms in Kanab City currently under construction and scheduled for opening in early 2016 (KCWCD 2015). Kane County also has about 2.5-3 million people that 'pass through' the county on the way to and from tourist destinations such as Zion, Bryce, Grand Canyon, and Lake Powell.

Dixie State University (DSU) and Dixie Applied Technology College (DXATC) are within WCWCD's service area. Some students at these two institutions are permanent residents of Washington County, and consequently are included in the population data for the county, but the many are not. In 2007, over 2,000 DSU students, or 36 percent, were not residents of Washington County. The net non-permanent student population for Washington County will inflate commercial, institutional and industrial (CII) per capita water use compared to locations without student populations. The student population in Kane County is negligible and will have minimal effect on calculated per capita water use.

Although estimates of per capita water use only consider the permanent population, there are a number of part-time, second home owners that reside during the winter months in both districts. Second-home owners make up approximately 30 percent of Washington County's total parcels, and most second-homes are within major city limits and could potentially be served by the LPP (Washington County Assessor 2015). These properties maintain outdoor landscaping year round, equipped with timer-controlled irrigation systems, creating an irrigation demand that is attributed to permanent population in the per capita numbers. DWRe estimates that water use by second homes contributes an additional 36.4 gpcd in WCWCD. Second home use is included in the CII water use category in the DWRe per capita estimates. Kane County has more second homes than primary with 56 percent of the residents being classified as second homes (Kane County Assessor 2015). The majority of Kane County second-home owners live in the Cedar Mountain area, which is outside the study area. This area is not analyzed in this assessment. The DWRe estimates an additional 15.7 gpcd of second home water use in KCWCD (Kanab City and Johnson Canyon; DWRe 2013d). This use is also grouped in the CII water use category in the per capita estimates.

2.3.4 Conservation

The historical conservation achieved in the Districts' service areas has been based on water use data provided by DWRe (DWRe 2014c). Annual per capita water use data were analyzed to determine trends in water use. Future water conservation efforts were evaluated in a detailed water conservation study, conducted for each of the districts by Maddaus Water Management (Appendix B, MWM 2015a, MWM 2015b). This analysis reviewed water use data (billing data), evaluated existing water conservation measures, considered potential future water conservation measures and selected a program considered likely to be implemented in the future. The analysis relied on a model developed by MWM that analyzes water use at the end-use level (e.g., individual appliances and fixtures) and considers factors such as individual unit water savings, year of implementation, unit costs, and market penetration. Meetings with local water user representatives were held to select preferred conservation measures.

2.3.5 Forecasting Water Demand

Total projected water demand was determined for the two Districts for the period from 2010 to 2060 by multiplying the projected population for each of the Districts by the projected total per capita water use with conservation. Separate culinary and secondary untreated water use demands were estimated to determine the potential secondary untreated supply that could be utilized by the Districts.

2.4 Water Supplies

The best estimate of reliable supply represents the approximate annual volume of water that is reliably available to meet peak demands, reported in the DWRe Water Use Projections (WCWCD 2014; DWRe 2014c). Reliable yield for future projects was based upon information provided by the Districts. Reliable yield for the Virgin River was based upon the Virgin River Daily Simulation Model prepared by DWRe 2014a.

Key documents that were reviewed to determine existing water supplies included:

- Capital facilities plans for the Districts and cities within the Districts;
- Basin plans developed by the Utah Board of Water Resources for the Kanab Creek/Virgin River Basin; and
- DWRe municipal and industrial water use reports (DWRe 2013b; DWRe 2013g; WCWCD 2014).

When different references reported different values for yields of existing water supplies, in general the most recent report was considered to provide the most reliable information.

Water supplies that meet the EPA's secondary untreated Maximum Contaminant Level (MCL) for drinking water of Total Dissolved Solids (TDS) less than 500 mg/L are deemed usable for culinary purposes in this Assessment. The EPA's secondary untreated MCLs are guidelines which address aesthetic concerns in culinary water, such as taste, color and odor. The EPA does not establish MCLs for secondary untreated water; therefore, an upper limit of 1,000 mg/L TDS was assumed for

M&I secondary untreated water use in this report, which is the maximum TDS level for the least salt tolerant residential ornamental landscape.

Water supply planning typically uses the estimated reliable yield for a water supply. In particular, the hydrology of surface water supplies in the Virgin River reveals that averages rarely occur and most years yield well below average supplies. Reliance on average or maximum yields or flows would significantly overestimate supplies and underestimate shortages. Reliable yield estimated by the DWRe was used to estimate yield for the existing water supplies within the Districts.

2.4.1 Surface Water Sources

WCWCD relies heavily on surface water supplies. For WCWCD, average annual yield with a maximum annual surface water shortage of 10 percent using the critical historical drought period was used to represent reliable surface water supplies. In other words, the WCWCD would have to address a water shortage in 1 out of every 10 years.

Kane County primarily relies on groundwater; however, the supply for the Kanab Irrigation Company water, providing water to the Kanab City irrigation and secondary water users, comes from surface water streamflow from the Kanab Creek. These flows are affected dramatically by drought conditions and have a direct impact on Kanab City groundwater demands, as residents use these sources when irrigation flows are reduced.

A recent study by the U.S. Bureau of Reclamation, in coordination with the DWRe describes the potential impact of climate change on future streamflow in the Virgin River (Reclamation 2014). This study evaluated 112 streamflow projections at the Virgin River at Littlefield USGS streamflow gauge, developed using global General Circulation Model output of 112 future projections of temperature and precipitation data. The results of the study display statistics representing the range of variability among the 112 climate change projections. **Table 2-1** below shows the projected future simulated monthly percent changes in flow for the Virgin River at Littlefield. This analysis was incorporated into the Virgin River Daily Simulation Model for estimating reliable supply at the WCWCD diversion structure (DWRe 2014a). As shown, future flows during the summer months (May through August) are projected to be lower while the fall and winter months are projected to be similar or greater than the base period. Furthermore, due to warmer temperatures, the future climate is anticipated to shift the seasonal runoff one month earlier, have more severe storm events and cause winter precipitation in the West to fall more as rain than snow (see **Study Report 19**), which will all affect surface water flows. While a decrease in flow hurts the system, a shift in the runoff and a shift from snow to rain may cause an even greater loss to supply.

Table 2-1 Projected Future Period Virgin River Flow

	10th percentile (1)	30th percentile (1)	50th percentile (1)	70th percentile (1)	90th percentile (1)	Mean
January	88%	98%	104%	117%	136%	110%
February	83%	98%	109%	139%	167%	123%
March	80%	103%	126%	161%	226%	141%
April	58%	79%	100%	124%	158%	107%
May	41%	59%	72%	91%	119%	77%
June	51%	59%	66%	75%	98%	70%
July	75%	83%	90%	95%	104%	90%
August	79%	86%	93%	98%	119%	95%
September	84%	92%	97%	105%	123%	100%
October	88%	93%	97%	104%	118%	101%
November	90%	94%	98%	102%	111%	100%
December	89%	94%	99%	104%	114%	101%
Annual Sum	72%	86%	97%	114%	141%	104%

Notes:
(1)Percentiles are relative to the distribution of the 112 climate change simulations
(2)Monthly percentages are Future Period (2025-2054) relative to Base Period (1950-1999)

2.4.2 Groundwater Sources

Reliable yields of groundwater supplies were assumed to be equal to those estimated in the DWRe reports regarding M&I water supply and uses, which are 50 percent of the maximum pumping capacity of wells, when pump capacity is the limiting factor (unless otherwise indicated by the well owner) (DWRe 2013g). Springs are equal to their respective reliable yields.

2.4.3 Planning Reserves

Planning reserves provide water districts protection against variations in supply and demand. Although not reflected in either the supply or demand in this analysis, WCWCD has a goal of maintaining a planning reserve equal to the estimated supply for 15 years into the future, so that new projects are brought online in advance of need. This allows for time that might be needed for planning, obtaining approvals, final design and construction of large water projects.

A 10 percent planning reserve was added to the existing reliable groundwater supplies for Kane County entities to avoid using water supplies up to the maximum and to provide a buffer against annual variability in water supplies affected by precipitation runoff and groundwater aquifer recharge. This reserve is applied to the reliable supply estimates after the climate change reductions are considered and results in a 10 percent decrease in reliable supply.

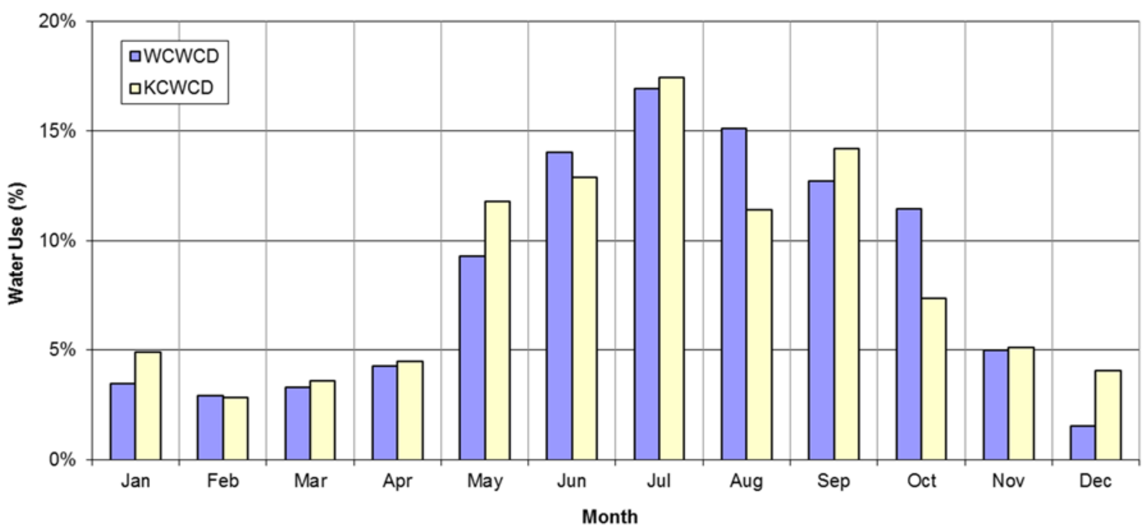
2.4.4 Demand Timing

Water use is not constant from month to month. Monthly M&I water use patterns for each District, as a percentage of total annual use, are presented in Figure **2-5**. For both districts, the largest amount of water is used from April through October, during the irrigation season. Throughout the rest of the year water use is fairly constant.

Total annual secondary untreated water use was distributed monthly throughout the irrigation season (April through October) using data obtained from the cities (St. George Water Services Department 2004; Alpha Engineering 2006). **Figure 2-6** shows the monthly secondary untreated water use pattern, estimated assuming no outdoor water use in January through March, November, and December.

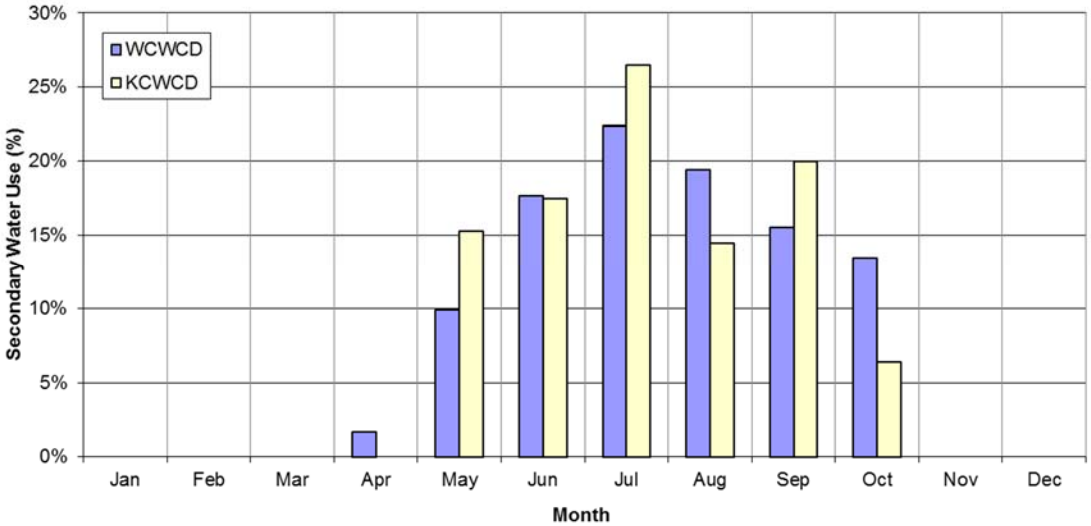
Monthly secondary untreated demand variations were used to estimate the portion of potential secondary untreated supply that could be used without storage capacity. Potential secondary untreated supply is generated throughout the year as treated wastewater, but the secondary untreated demand occurs only during the irrigation season. Without storage of potential wintertime secondary untreated supply, wastewater generated during winter months could not be utilized to meet secondary untreated demands. Monthly water use patterns were used to estimate potential secondary untreated supplies described in **Chapter 4**.

Figure 2-5 Monthly M&I Water Use Pattern (Percentage of Total Annual Use)



Source: St. George Water Services Department, 2004; Alpha Engineering, 2006.

Figure 2-6 Monthly M&I Secondary Untreated Water Use Pattern (Percentage of Total Annual Secondary Untreated Use)



Source: St. George Water Services Department, 2004; Alpha Engineering, 2006.

2.5 Agricultural Conversion for M&I Supply

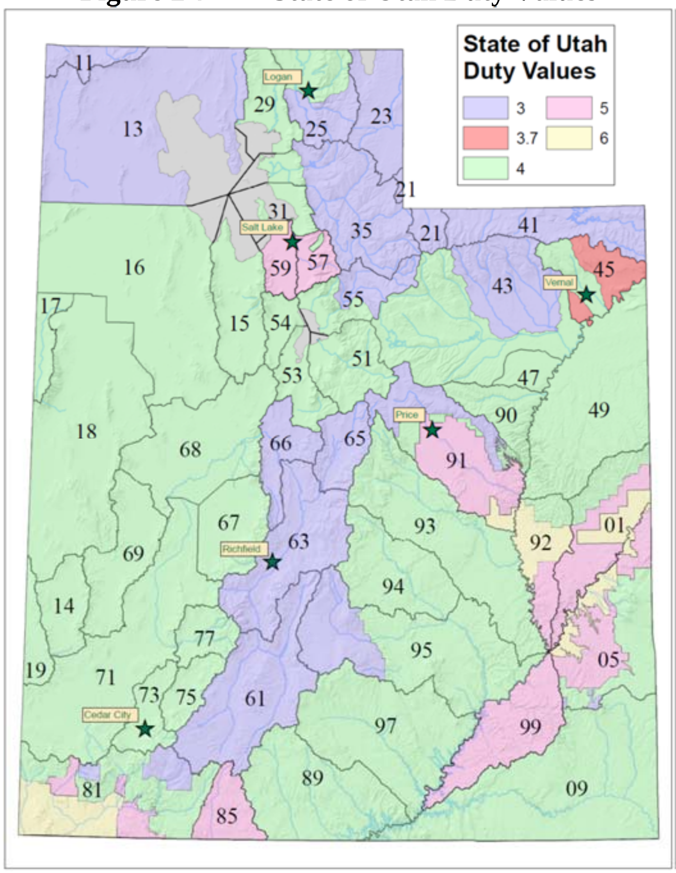
As municipal development occurs over existing agricultural lands, water will be converted from agricultural to municipal uses. To estimate the amount of water that might be obtained from these conversions, the State of Utah duty of water values were used. Water quality concerns and groundwater sustainability were not considered in this computation.

None of the agricultural water in the Kanab and Johnson Canyon area can be planned on for future conversion to M&I. Most all of the agriculture water supplies in the Kanab City area are provided by the Kanab Irrigation Company who holds title to the water rights. This unique situation is created because most of the water available in the area being irrigated is not available from surface or ground water on or nearby the property as there are no surface flows and the groundwater is extremely brackish. As a result, the irrigation water is piped from streamflows about ten miles north of the area being served. Kanab irrigation company water rights are held for irrigation purposes and individuals cannot change uses as they hold shareholder rights only. Kanab Irrigation Company policy is not to allow for any conversions to M&I as properties are developed, but to transfer irrigation to other parcels which are readily available. The Irrigation Company and Kanab City culinary water compete for the same resources and irrigation water reduces the residential demands for the culinary water so conversions will not likely provide any net gain in the system.

Additionally both Kane County and Kanab City general and land use plans give strong support to preserving and strengthening agriculture and open space preservation associated with agricultural uses. Current trends have shown an increase in agricultural lands by approximately 20% over the last five years. There are no estimated reductions in agricultural lands as both plans and local production needs for these resources will continue to increase rather than decrease.

The duty of water multiplied by the irrigated acreage determines anticipated irrigation water use. The duty of water is established by the Utah State Engineer for irrigated agricultural land, as shown in **Figure 2-7** (DWRi 2008b). The Virgin River Basin and the Kanab Creek Basin are depicted in the figure as numbers 81 and 85, respectively. As shown, the Virgin River Basin is a combination of duty values of 3, 4, 5 and 6. The portion of Washington County most likely to be developed has a duty value of 6 ac-ft per year per acre of irrigated land.

Figure 2-7 State of Utah Duty Values



2.6 Calculating Water Conservation

Information on the water conservation programs currently being implemented by the Districts and the cities within their service areas was obtained from published water conservation plans submitted to the DWRe and from interviews with water conservation coordinators and water resource planners at the various entities. No effort was made to field-verify the implementation of specific conservation measures described in the water conservation plans.

Documentation of recent water use reductions that could be attributed to state and local water conservation programs was expressed in terms of per capita water use rates as determined from review of information provided by the entities or the state. The historical conservation achieved in the Districts' service areas was based on water use data provided by DWRe (DWRe 2014c).

Projected conservation for the two districts was based on water conservation projections by the Utah Division of Water Resources (DWRe 2014c). Water conservation demand management alternatives, general and site-specific conservation programs, and other water efficiency measures targeted to achieve these projections were developed by Maddaus Water Management (MWM), in close cooperation with MWH and each District (Appendix B, MWM 2015a, MWM 2015b). Results of the conservation studies were compared to the State's water conservation goals.

Studies of potential future water savings resulting from implementation of conservation programs were performed for each District independently. The studies included collecting billing data to analyze actual water use at the customer level; selecting potential conservation measures suitable for the community; combining selected measures into comprehensive water conservation programs; and coordinating with the communities in the selection of conservation measures likely to succeed in this area and the overall desired program. MWM's Demand Side Management Least Cost Planning Decision Support System (DSS Model) prepares long-range water demand and conservation water savings projections. The DSS Model is an end-use model that separates total water production (i.e., water demand in the service area) into specific water end uses (e.g., toilets, faucets, irrigation). Development of the model was based on extensive experience with conservation programs in other communities, published information on conservation measure effectiveness, and locally specific information provided by the water users. Conservation programs were developed for each District, and the local stakeholders selected the program they felt was most reasonable for their conditions. The impacts of the water conservation programs on water demand were evaluated from 2016 through 2025 with respect to the targets, and from 2016 to 2060 for long-term planning.

In MWM's Technical Conservation Analysis for Kane County (MWM 2015a), the water conservation projections include use from the Duck Creek and Cedar Mountain areas. This assessment does not include these areas. Because of this, the current and future per capita water use estimates are much higher than is reported by DWRe and shown in this document. The programs to be followed to achieve conservation and the feasibility of achieving the stated percent reductions apply to the areas analyzed in this assessment as well as the entire Kane County as analyzed by MWM.

Conservation is essential in meeting future water needs. Changes in technology, demographics, community values, and other factors may have unanticipated effects on water use. Conservation above the levels used in these reports is encouraged by WCWCD; however, the conservation goals used are prudent for planning. These goals have been vetted by Division of Water Resources, each district, community participants, and Maddaus Water Management. They exceed current state goals, utilize available technologies, and, importantly, are believed to be achievable within the timeframe that additional water supplies will be needed in Washington County.

2.6.1 Demand Hardening

Water providers currently rely on demand management – or emerging conservation measures – to get through drought periods when water supplies are well below normal. When conservation measures have consistently reduced water use to the point it has become “normal” use, there are fewer short term options for reducing non-essential uses to save water for essential uses. This decrease in flexibility of water use is referred to as “demand hardening.” Demand hardening requires that reliable yield estimates are factored to meet all projected demands, because there is little potential to reduce demands when actual yields are less than the estimated yield.

2.7 Integrated Water Resources Plans

Integrated water resources plans consist of integrating demand forecasts with existing and potentially available supplies in a strategic manner. New supply sources were added sequentially in priority when demand exceeds supply based on factors such as qualitative unit cost, current status of project development, and preferences expressed by the Districts. Because detailed cost estimates for future water supply projects were not developed for this analysis, any cost comparisons between water supply sources were qualitative only.

There are a number of factors that introduce significant uncertainty into integrated water resource plans. These include:

- Actual future conservation efforts may exceed or fall short of the goals assumed in this study. A conservation analysis conducted by Maddaus Water Management evaluated the potential for implementing specific conservation measures in the study area.
- Changes from traditional landscapes to xeric landscapes increase the ambient temperature. This increase in temperature will result in an increased use of air conditioning which could result in an increase in the average per capita per day indoor water use, reducing the benefits of this form of conservation.
- The rate at which urban development occurs in areas of existing irrigated agriculture will affect the rate at which agricultural supplies are converted to M&I supplies without buy and dry programs. This in turn could affect the timing of other new supplies including LPP.
- The existing mix of culinary and secondary untreated water use was assumed to change in the future. Complex economic factors, outdoor landscaping practices, and regional and local water use policies will probably affect the ratio of secondary untreated water use to total water use substantially.
- Advanced water treatment processes (e.g., reverse osmosis) are currently financially and environmentally prohibitive to provide culinary water from local surface waters. Technological breakthroughs in treatment processes or brine disposal methods could make advanced water treatment feasible for southwestern Utah in the future and may allow use of some secondary untreated water resources currently planned to offset culinary demand available for direct culinary use.
- The conservation goals of each district were applied to 2010 per capita usage to project future demand. While this estimation method is appropriate for a 50-year projection, per capita use is affected by several factors, such as economic makeup, infrastructure design, and climate, which are likely to deviate from current conditions.
- The economic composition of each district is likely to change as population increases thus varying the residential to CII usage ratio. As cities grow, commercial, industrial and institutional uses often increase. It is likely that southwest Utah will remain a popular location

for second homes and tourism, but it is unknown if either component will increase as more and more baby boomers retire or taper off as the area becomes more populated.

- Possible effects of climate change on demand, such as an increase in per capita water use with decreased precipitation, were not included in this analysis because of uncertainties in effects of climate change on use.

2.8 Coordination with Local Stakeholders

Several meetings were held to involve local stakeholders in the development of the first draft of this assessment. In May 2007, stakeholder meetings were held with representatives from the public (e.g., cities within the Districts' service areas, local citizens, and environmental groups), and additional meetings were held with the Districts in July 2007, September 2007, and January 2008. These meetings informed stakeholders on the Districts' current water supply operations and issues associated with current and future supplies.

For the conservation assessment performed by MWM (MWM 2010a, MWM 2010b, MWM 2015a, MWM 2015b), meetings were conducted to collect water use and reuse data and existing conservation program information. The initial meetings occurred in 2010 and an update of the conservation technical analysis was completed in 2015. The update included additional meetings with the WCWCD Water Conservation Plan Update Work Group and several meetings and communications with KCWCD. KCWCD also held meeting with all municipalities in the county to participate in the development of the KCWCD conservation plan. MWM presented several potential conservation measures that could be considered for implementation in each community and the stakeholders screened the potential conservation measures to a short list of specific conservation measures that were further evaluated in the conservation assessment. The conservation coordinators and water resource planners for each entity selected the preferred conservation program in a workshop with MWM.

Chapter 3 – Water Demand

3.1 Introduction

As southwestern Utah's population steadily continues to grow, demand for water will consequently increase, approaching an estimated 189,435 acre-feet per year by 2060 in LPP service areas. Increased conservation efforts are expected to reduce per capita usage, but both districts must be capable of supplying enough water to meet Utah design standards for source sizing. In Chapter 3, population and per capita water use projections are used to predict future water demands for WCWCD and KCWCD.

Per capita water use in WCWCD's service area is expected to decrease by 35 percent from 2000 to 285 gpcd total and 136 gpcd residential by the end of the study period (2060) with conservation. Even with this per capita use reduction, overall water demand will approach 184,250 ac-ft per year in WCWCD's service area by 2060 (DWRe 2014c).

The four KCWCD subbasins are projected to have a total population of 17,074 by 2060. Per capita water use is expected decrease 30 to 35 percent from 2000 baseline levels to 271 gpcd by the end of the study period (2060) with conservation. Thus, water demand will approach 5,185 ac-ft per year within the four subbasins of KCWCD by 2060 (DWRe 2013b; DWRe 2014c).

3.1.1 WCWCD Projected Population

The average annual growth rate in Washington County is projected to be 3.6 percent until 2030 when it is expected to gradually decrease. By 2060, WCWCD's service population is anticipated to exceed 575,000. Population projections for WCWCD and the six largest cities in their service area are shown in Table 3-1.

Table 3-1 WCWCD Population Projections

City/District	Population					
	2010	2020	2030	2040	2050	2060
Hurricane	13,300	18,950	27,020	35,800	45,510	56,020
Ivins	6,410	9,130	13,020	17,250	21,930	27,000
La Verkin	4,060	5,780	8,250	10,930	13,890	17,100
Santa Clara	6,500	9,260	13,200	17,500	22,240	27,380
St. George	72,750	103,640	147,780	195,810	248,920	306,420
Washington	18,760	26,730	38,110	50,490	64,190	79,020
WCWCD	**138,530**	**196,480**	**279,270**	**369,370**	**468,990**	**576,850**
Annual Growth Rate	-	3.6%	3.6%	2.8%	2.4%	2.1%
Source: DWRe 2014c.						

3.1.2 KCWCD Population Projections

Population projections for the four groups within KCWCD boundaries are summarized in **Table 3-2**. Only Kanab City and Johnson Canyon is expected to be served by the Lake Powell Pipeline. The other groups are shown for informational purposes only. Cities and towns within each of the four groups were previously described in **Section 2.2.2**.

Table 3-2 Population Projections for KCWCD Groups

Group	Parameter[2]	Year						2010 to 2060 AGR
		2010	2020	2030	2040	2050	2060	
East Fork Virgin River Subbasin	Pop.	960	1,130	1,380	1,700	2,060	2,500	-
	AGR	-	1.59%	2.05%	2.06%	1.95%	1.93%	1.92%
Alton Town	Pop.	120	140	170	210	260	310	-
	AGR	-	1.59%	2.05%	2.06%	1.95%	1.93%	1.92%
Kanab City and Johnson Canyon	Pop.	4,780	5,610	6,890	8,460	10,290	12,480	-
	AGR	-	1.60%	2.05%	2.06%	1.95%	1.94%	1.92%
Wahweap Creek Subbasin	Pop.	680	800	980	1,200	1,460	1,770	-
	AGR	-	1.59%	2.05%	2.06%	1.95%	1.93%	1.92%

Notes:
(1)Source DWRe 2013a, DWRe 2013b, DWRe 2014c
(2)Pop. = population projection; AGR = annual growth rate.

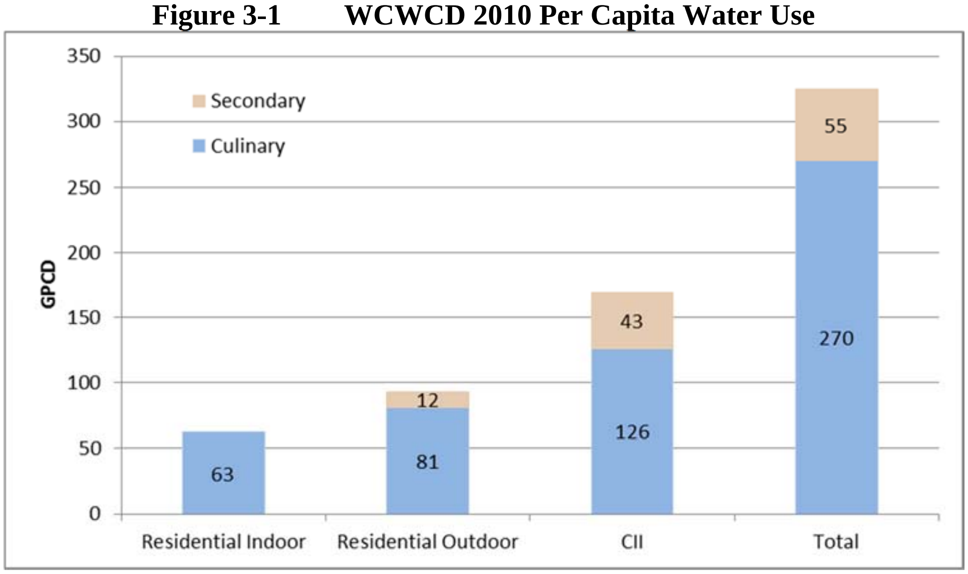
3.2 Per Capita Water Use

The 2010 estimated per capita water use of both districts was used as the baseline to project future water demands. As described in **Section 2.3**, DWRe calculates per capita water use by dividing the total water use in an area by the permanent population. Water usage is also divided into culinary or potable and secondary untreated categories.

3.2.1 WCWCD 2010 Per Capita Water Use

In 2010 the per capita water use in the WCWCD service area was estimated to be 325 gpcd. **Figure 3-1** shows that 270 gpcd was culinary water and 55 gpcd was secondary untreated water (DWRe 2013a; DWRe 2013d). Residential use contributed 156 gpcd, and commercial, institutional and industrial (CII) use contributed 169 gpcd. CII includes use from second homes.

Figure 3-1 WCWCD 2010 Per Capita Water Use



3.2.2 KCWCD 2010 Per Capita Water Use

In 2010 the per capita water use in the KCWCD service area (Kanab City and Johnson Canyon subbasin) was estimated to be 287 gpcd (DWRe 2014c). **Figure 3-2** shows that 272 gpcd was culinary water and 15 gpcd was secondary untreated water. Residential use contributed 153 gpcd, and CII use contributed 133 gpcd. The per capita water use for the four subbasins in Kane County (all groups) was estimated to be 309 gpcd (DWRe 2013b; DWRe 2013d; DWRe 2014c). **Figure 3-3** shows that 260 gpcd was culinary water and 49 gpcd was secondary untreated water. Residential use contributed 177 gpcd, and CII use contributed 133 gpcd. CII includes use from second homes.

Figure 3-2 KCWCD (Kanab City and Johnson Canyon) 2010 Per Capita Water Use

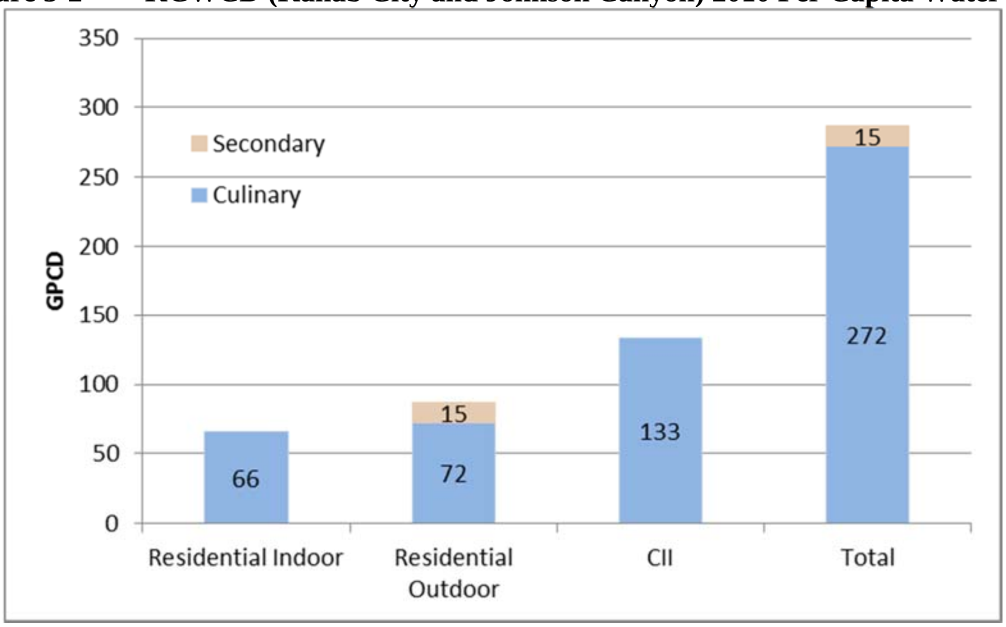
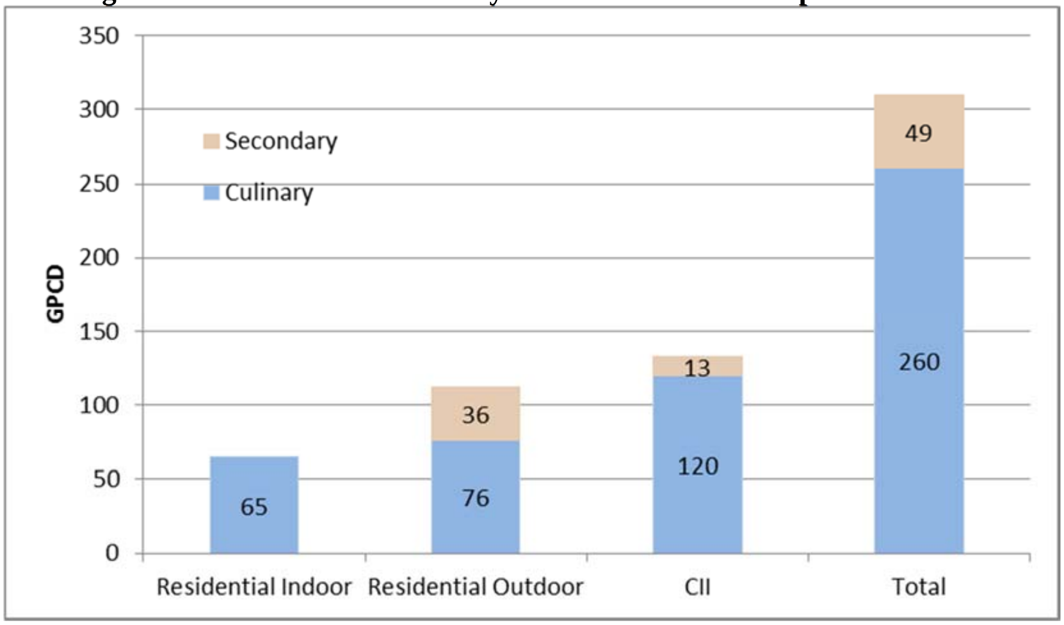


Figure 3-3 Four Kane County Subbasins 2010 Per Capita Water Use



3.3 Projected Water Demand

Annual water demand was calculated by DWRe using population projections and anticipated per capita water usage assuming 30 to 35 percent conservation by 2060. Projections were given for WCWCD and each of its major water systems as well as for the entities of Kane County that reside within the Kanab/Virgin River Basin. The annual demand was forecast in 10-year increments out to 2060 and includes a breakdown of culinary and secondary untreated use (DWRe 2014c). Demand was forecast using the currently mandated design standards per equivalent residential connection (ERC), as described in **Section 3.3.2**.

3.3.1 Required Source-Sizing Standards

Per capita water use is anticipated to decline resulting from increased conservation, but ultimately, the quantity of water municipalities must be capable of providing their customers is dictated by design standards for source sizing. Utah Division of Drinking Water (DDW) requires sources to meet both average and peak day demands (DDW citation, R309-510). A minimum of 0.45 ac-ft per year of source water is required per equivalent residential connection (ERC) statewide to meet indoor demands. The ERC could influence the demand needs in the future as the requirement may be more than the per capita use after conservation measures have been taken.

The current rule requires extensive data collection of both average and peak flows before DDW will consider reducing the quantity of source water supplied per ERC. DDW is evaluating current indoor and outdoor requirements across the state, but unless requirements are reduced, both Districts must provide enough source water to meet the DDW standard.

3.3.2 WCWCD Water Demand Forecast

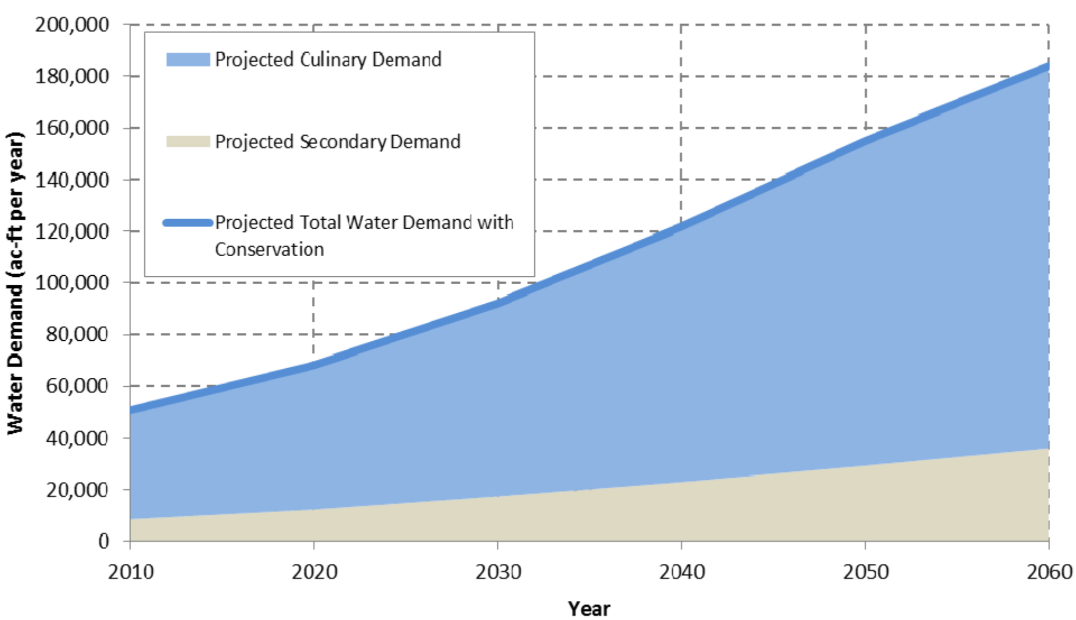
Water demand forecasts for total M&I water use for WCWCD are shown in

Table 3-**3** (DWRe 2014c). **Figure 3-4** projects both secondary untreated and culinary demands out to 2060

Table 3-3 WCWCD Total M&I Water Demand Forecast

Year	Population	Per Capita Use with Conservation (gpcd)	Total Projected Water Demand with Conservation (ac-ft/yr)
2010	138,530	325	50,380
2020	196,480	311	68,450
2030	279,270	295	92,220
2040	369,370	295	122,010
2050	468,990	295	154,940
2060	576,850	285	184,250
Source: DWRe 2014c			

Figure 3-4 WCWCD Projected Demand



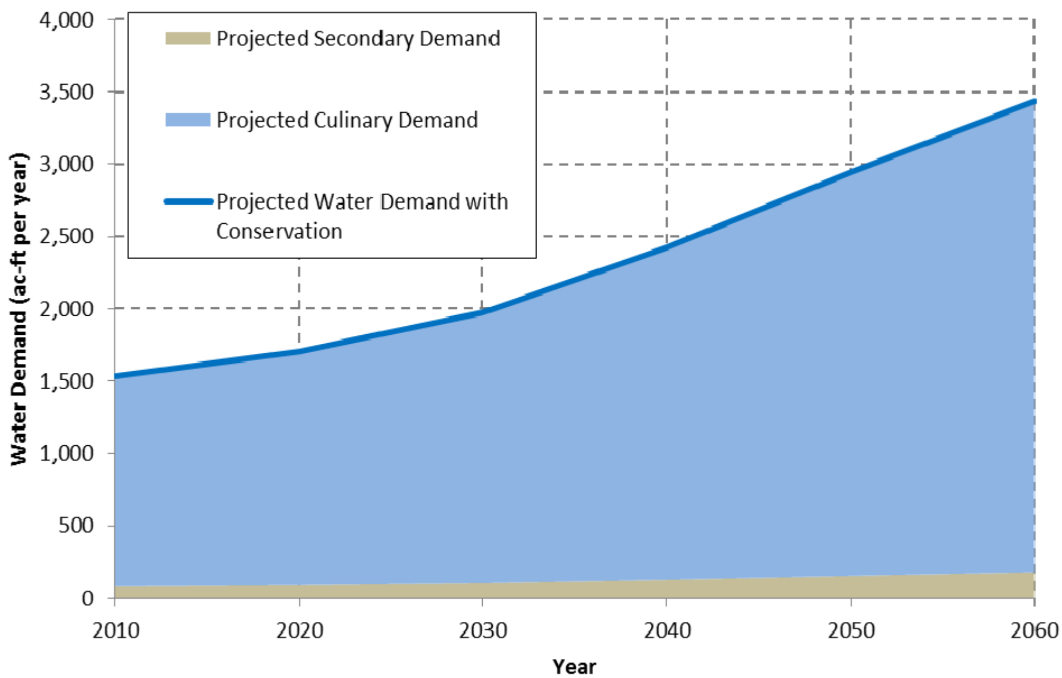
3.3.3 KCWCD Water Demand Forecast

Water demand forecasts for total M&I water use are shown in **Table 3-4** and plotted for KCWCD (Kanab City and Johnson Canyon subbasin) in **Figure 3-5**. KCWCD currently serves only the Johnson Canyon subbasin but anticipates serving this area as well as Kanab City with water from the Lake Powell Pipeline in the future.

Table 3-4 KCWCD (Kanab City and Johnson Canyon) M&I Water Demand Forecast

Year	Population	Per Capita Use with Conservation (gpcd)	Total Projected Water Demand with Conservation (ac-ft/yr)
2010	4,780	287	1,535
2020	5,609	272	1,709
2030	6,888	256	1,971
2040	8,463	256	2,422
2050	10,287	256	2,944
2060	12,484	246	3,445
Source: DWRe 2014c			

Figure 3-5 KCWCD (Kanab City and Johnson Canyon) Projected Demand



Water demand forecasts for total M&I water use are plotted for the three other groups in Kane County in **Figure 3-6** through **Figure 3-8**. The approximate total M&I water demands for each of the groups throughout the study period with conservation is shown in **Table 3-5.**

Table 3-5 Kane County Groups M&I Water Demand with Conservation Forecast

Group	Projected Water Demand (ac-ft/yr)					
	2010	2020	2030	2040	2050	2060
East Fork Virgin River Subbasin	467	538	641	786	954	1,137
Alton Town	28	32	39	47	57	68
Wahweap Creek Subbasin	238	267	311	382	464	544
Source: DWRe 2013b; DWRe 2014c						

Figure 3-6 East Fork Virgin River Subbasin Total M&I Water Demand Forecast

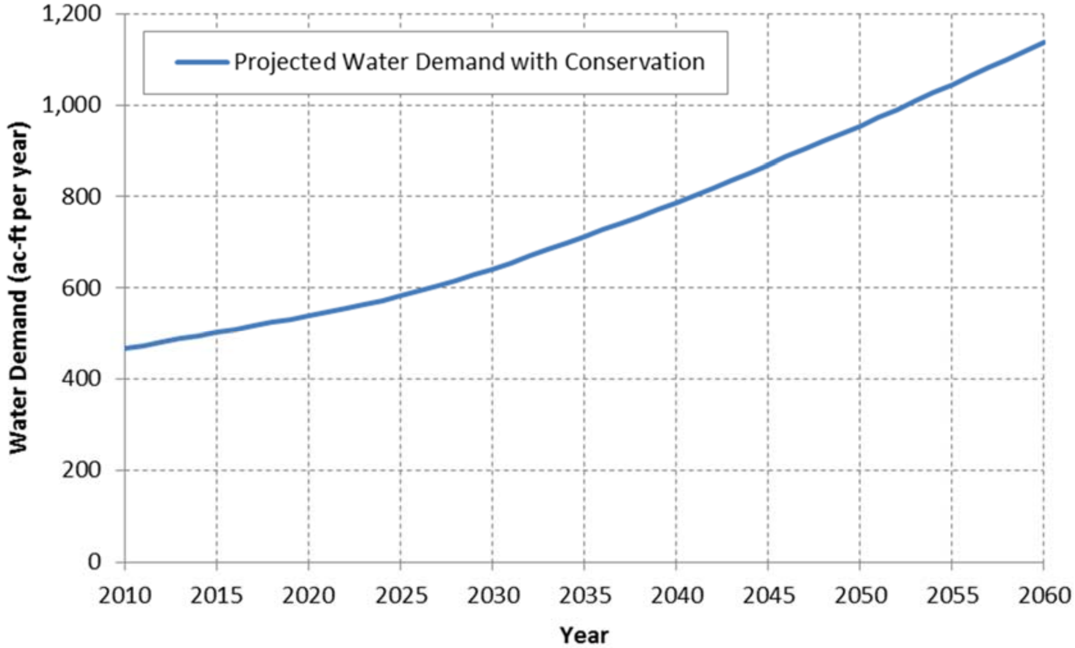


Figure 3-7 Alton Town Total M&I Water Demand Forecast

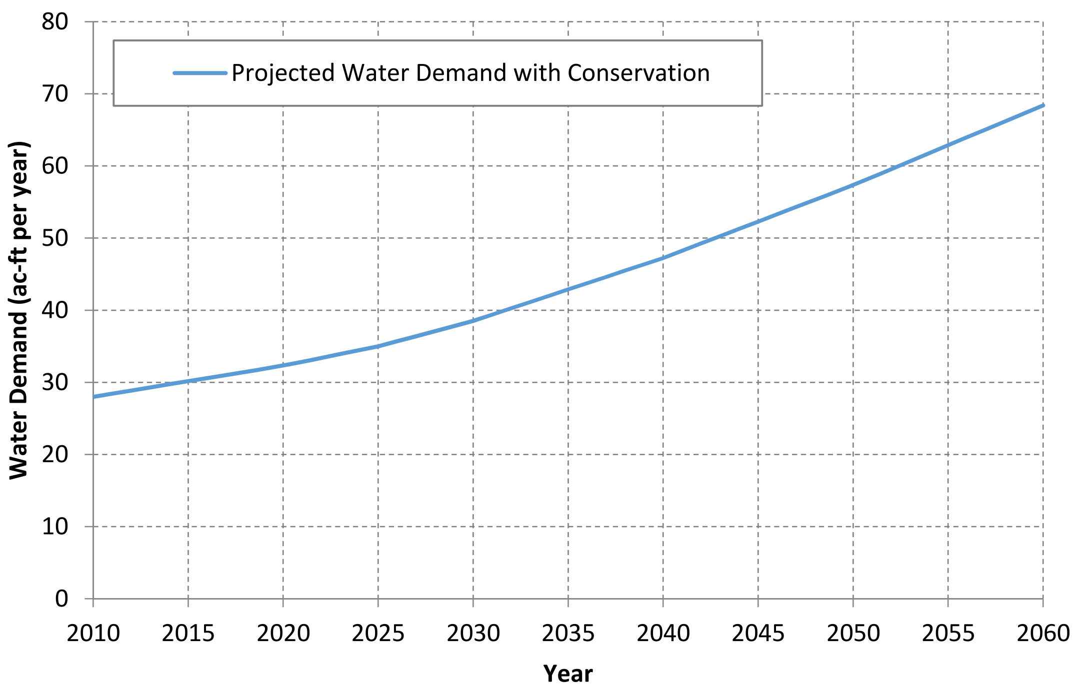
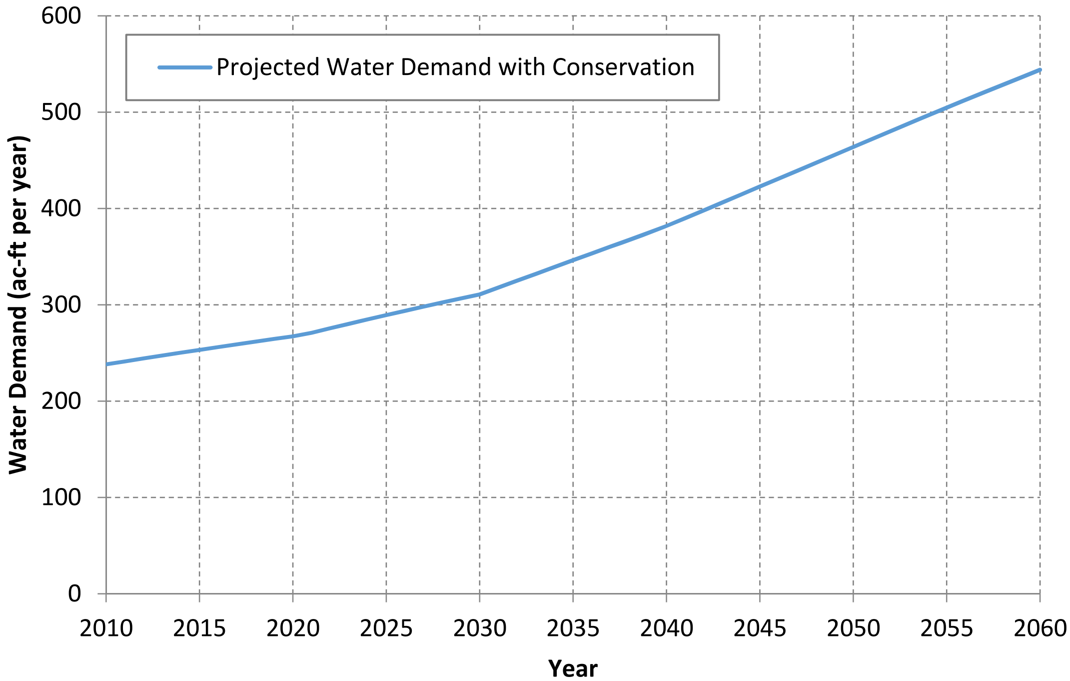


Figure 3-8 Wahweap Creek Total M&I Water Demand Forecast



Chapter 4 – Water Supply Conditions

4.1 Introduction

Existing supplies are currently used to meet water needs and are assumed to be available on a sustainable basis in the future. Planned supplies are projects now in the planning or implementation process. Projects identified in this chapter include both culinary or potable and secondary untreated supplies that have previously been evaluated by the Districts or by DWRe. The LPP project is included because it is considered to be a key potential component of future water supply plans for the Districts. WCWCD has requested 82,249 ac-ft per year of LPP water and KCWCD has requested 4,000 ac-ft per year.

In Washington County, water quality of the Virgin River below the LaVerkin hot springs is a significant issue affecting potential supplies, which are therefore not planned for implementation within the study period; these supplies could be part of a longer term water supply portfolio if identified problems are resolved. Certain sources not feasible for development in Washington County are discussed in **Section 4.2.6**.

Groundwater supplies in the Johnson Wash area (KCWCD service area) are of poor quality and are not likely to be suitable for culinary purposes (Appendix A, MWH 2015). Some ground water is potentially available in the East Fork Virgin River subbasin and the Wahweap Creek subbasin. The quality of this water is assumed to be suitable for future needs.

Agricultural water supplies are considered only as potential M&I sources through transfers and conversions. Irrigated acreage and agricultural water use are not expected to increase in the future based on the Virgin River Basin Plan and Kanab Creek Basin Plans (DWRe 1993).

4.2 Washington County

4.2.1 WCWCD Water Supply Overview

Washington County water supplies come from a combination of groundwater (springs and wells) and surface water (direct diversions and reservoirs). The Navajo Sandstone Aquifer and shallow alluvial aquifers provide groundwater resources. Surface water sources consist of the Virgin River and its tributaries. In 2010, approximately 20 percent of the developed culinary water supplies for public community water systems in Washington County were from groundwater sources and 80 percent were from surface water sources (DWRe 2013a). Groundwater supplies developed by public drinking water systems are generally of high quality and can be used directly for culinary uses after disinfection. Surface water supplies are used directly to meet secondary untreated water demands or are treated to meet culinary demands. The cities and towns in Washington County have historically developed independent water collection and treatment systems; however, since WCWCD's first project in the mid-1980s, the major municipal water systems have become increasingly integrated.

Groundwater sources within the WCWCD service area are considered to be fully appropriated and closed to further appropriations at this time by the State Engineer (DWRi 2008a), with the exception of the Canaan Gap drainage east of the Hurricane Cliffs and the Beaver Dam Wash drainage, which are open to small underground water appropriations for domestic filings. New diversions and uses must be accomplished by change applications filed on previously approved water rights. Changes between surface and underground sources are reviewed for hydrologic connection to avoid interference with existing water rights.

4.2.2 Water Quality Effects on WCWCD Future Supplies

Water quality, primarily arsenic and dissolved solids concentration, limits current and future use of a substantial portion of Washington County's water supplies. Arsenic concentrations of groundwater in the Navajo Sandstone Aquifer often exceed the maximum contaminant level (MCL) set by EPA, and many groundwater sources must be either treated or blended with low arsenic concentration water in order to be used for culinary purposes. The concentration of total dissolved solids (TDS) of a water source also limits what uses are appropriate. A large portion of Virgin River water is unsuitable for culinary and even landscape irrigation use because of the high TDS discharge from the La Verkin hot springs.

In 2000, EPA lowered the primary MCL for arsenic in drinking water from 50 micrograms per liter (µg/L) to 10 µg/L. Many local wells that recover water from the Navajo Sandstone Aquifer naturally exceed this limit. Consequently, several high-production, culinary wells in Washington County were converted to secondary untreated wells because of the new arsenic limit. Other wells require blending with waters containing less arsenic in order to comply with the new MCL. Because future recharge and recovery projects will likely occur in the Navajo Sandstone Aquifer, arsenic concentration will continue to be a challenge, and additional treatment processes will be needed to use the affected groundwater for culinary purposes.

La Verkin hot springs discharge water with 10,000 mg/L concentration of TDS at a rate of about 10 cubic feet per second into the Virgin River near the La Verkin Bridge, thus rendering all downstream water unsuitable for culinary use or landscape irrigation. Virgin River water, diverted by the St. George and Washington Canal Company at the Washington Fields agricultural diversion, has an average TDS of approximately 1,500 mg/L due to the La Verkin hot springs discharge (USEPA 2008). Because TDS at the agricultural diversion exceeds 2,500 mg/L when base river flows are low, agricultural users of this water must utilize flood irrigation to prevent salts from building up in the soil, an approach unsuitable for M&I purposes.

The high cost, high energy demand, and lack of an environmentally sound alternative for disposal of the waste brine stream is a deterrent to reverse osmosis (RO) treatment of the Virgin River water supply. As technology improves over time and the costs of water treatment decline, it may become economically feasible to treat high TDS water for culinary use without the adverse environmental effects currently of concern. The proposed LPP project would import higher quality water much more economically and would avoid the environmental impacts associated with RO treatment.

The TDS and hardness concentrations in Lake Powell water are similar to those of the existing WCWCD supplies, and addition of the water as a new supply would likely have a minimal effect on overall water quality in the area. Current TDS concentrations of the water supply in the WCWCD service area ranges from 100 to 800 mg/L, with average of about 450 mg/L. TDS concentrations of untreated Lake Powell water within the top 100 feet ranges from 350 to 600 mg/L, depending on seasonal fluctuations in water quality. Total hardness of the water supply in the WCWCD service area ranges from approximately 100 to 400 mg/L as calcium carbonate, compared to the hardness of untreated Lake Powell water of 240 to 320 mg/L as calcium carbonate. The design and operation of the Lake Powell Pipeline intake at Lake Powell would allow water diversion from the top 100 feet of Lake Powell to optimize water quality of the supply that would be conveyed through the pipeline.

If adequate storage and additional water supplies were available, it may become possible to blend high TDS Virgin River water with a lower TDS supply from another source (e.g., reuse water and excess Santa Clara Project Water) to create water suitable for secondary untreated M&I purposes.

An increase in the use of highly saline water for secondary untreated water use purposes may still have a detrimental effect on the water quality of local surface and groundwater supplies as a result of return flows and infiltration of a portion of the water used for irrigation. These effects must be carefully considered in connection with use of high TDS water as a future supply so as not to decrease the quality of the culinary supply or cause adverse environmental effects in receiving waters.

4.2.3 WCWCD Existing Supplies

Because most of the readily available water in the county has been developed and most of the county is closed by the State Engineer to the acquisition of new water rights, the municipalities are generally relying upon the District for future water supplies, most of which will be provided through large water projects that require a regional funding base.

Reliable supply for surface water sources was calculated with the Virgin River Daily Simulation Model (DWRe 2015a, DWRe 2015b) for a 90 percent reliability level (i.e., maximum surface water shortage of 10 percent in any given year that would be made up with groundwater supply). The Virgin River Daily Simulation Model was run with climate change reductions on supply based on the 50^{th} percentile climate change scenario as defined by Reclamation (Reclamation 2014) and described in **Section 2.4.1**. Reliable secondary untreated supply is assumed to be equivalent to current secondary untreated use (DWRe 2013a). The yield estimates used for Washington County are considered reliable because recharged groundwater supplies can be used to supplement surface water supplies to fully meet demands during extreme drought years. Additionally, operational flexibility is continually being enhanced by the District in order to avert water supply shortages.

Climate change may have a larger impact on WCWCD's supplies than is seen by the predicted streamflow reductions in Reclamation 2014. Due to warmer temperatures, the future climate is anticipated to shift the seasonal runoff one month earlier, have more severe storm events and cause winter precipitation in the West to fall more as rain than snow (see **Study Report 19**). While a decrease in flow hurts the system, a shift in the runoff and a shift from snow to rain may cause an even greater loss to supply. WCWCD's water rights dictate that water is stored in the winter and spring, when the agriculture water rights are not being used for irrigation. Winter and spring water discharge in the system is based on snowmelt in the mountains. If snow precipitation is limited then the potential for storage is limited. The Quail Creek Pipeline's capacity also limits the ability to capture and move water into storage. If snow melts quickly, the period of time to capture water in a fixed capacity pipeline is limited. If precipitation comes in abrupt rain events causing streamflow to exceed the pipeline capacity, that water is lost and the system's storage is not improved.

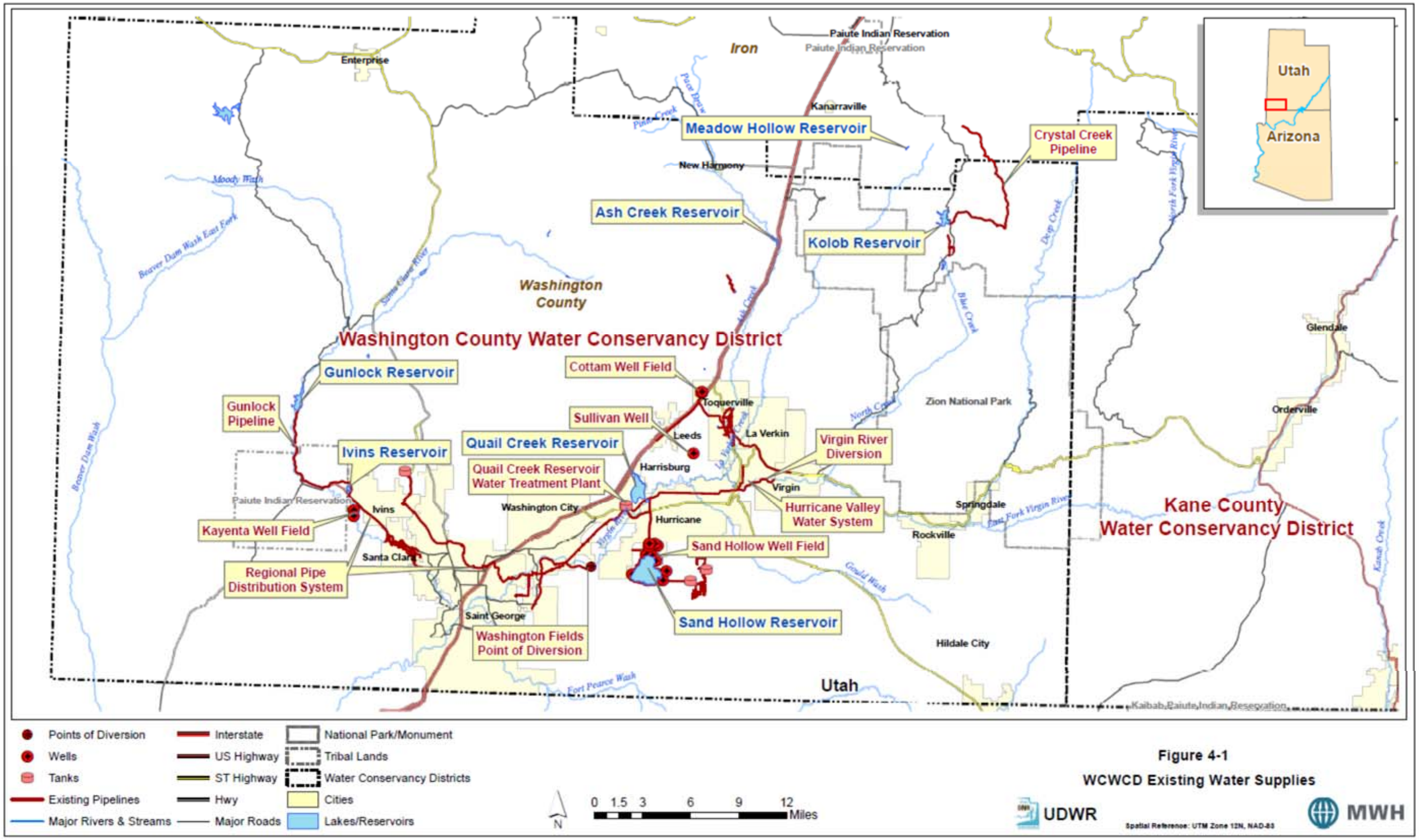
Table 4-1 summarizes the reliable yield for WCWCD projects for culinary and secondary untreated purposes. Culinary supplies can also be used to meet secondary untreated water demands if necessary. **Figure 4-1** shows the general location of water supply projects described below.

Table 4-1 WCWCD Existing Projects and Water Uses

Project	Reliable Culinary Quality Water Yield (ac-ft/yr)(1)	Reliable Secondary untreated Quality Water Yield (ac-ft/yr)(4)
Quail Creek and Sand Hollow Reservoirs(2)	24,922	0
Sand Hollow Non-Recharge Groundwater(3)	4,000	0
Cottam Well Field	875	0
Kayenta Water System (Ence Wells)	250	0
Crystal Creek Pipeline	2,000	0
Toquerville Secondary untreated Water System	0	178
Total	**32,047**	**178**

Notes:
(1)Source of data: WCWCD 2008a; WCWCD 2014.
(2)Reliable yield for Quail and Sand Hollow Reservoirs includes yields from Kolob and Meadow Hollow Reservoirs. (DWRe 2014a).
(3)Supply utilizes water rights and natural basin recharge.
(4)DWRe 2013a. Assumed reliable supplies are equivalent to current secondary untreated water use.

Figure 4-1 WCWCD Existing Water Supplies



4.2.3.1 WCWCD System Facilities

Quail Creek and Sand Hollow System. Quail Creek and Sand Hollow reservoirs are a combined system, receiving Virgin River water from the Quail Creek Diversion structure through a pipeline network. Water delivery to these off-stream reservoirs is limited by the capacity and operational requirements of the diversion structure and pipeline system. Quail Creek Reservoir has a capacity of 40,000 ac-ft and supplies raw water to the Quail Creek Water Treatment Plant. Sand Hollow Reservoir has a 50,000 ac-ft capacity with an active pool of about 30,000 ac-ft and a drought pool of 20,000 ac-ft reserved for extreme drought. The drought pool is included in the reliable yield for Sand Hollow Reservoir. In addition, the reservoir serves as a groundwater recharge facility to the Navajo Sandstone Aquifer which currently stores about 100,000 ac-ft with an estimated future capacity of about 300,000 ac-ft. Water may be delivered from Sand Hollow to Quail Creek Reservoir or directly to the Quail Creek Water Treatment Plant.

Kolob Reservoir. Kolob Reservoir, 5,585 ac-ft, on a tributary of the Virgin River, was built in 1957 and later acquired by WCWCD. Water from the reservoir is released to the Virgin River for diversion at the Quail Creek diversion structure.

Crystal Creek Pipeline. Water is diverted from Crystal Creek and conveyed through a 12-mile pipeline to Kolob Reservoir to augment deliveries to Quail Creek and Sand Hollow reservoirs. The yield for the Crystal Creek Pipeline was assumed to be "new water" that would otherwise not be diverted from the Virgin River because it utilizes excess capacity in Kolob Reservoir.

Gunlock Reservoir. Gunlock Reservoir, 10,884 ac-ft, was built on the Santa Clara River in 1970 for storage and delivery to irrigation companies in Gunlock, Santa Clara and Ivins. Most of the water stored in Gunlock Reservoir is diverted through the Gunlock to Santa Clara Pipeline to meet secondary untreated water demands. The Gunlock to Santa Clara Pipeline is described in **Section 4.2.3.4**.

Meadow Hollow Reservoir. Meadow Hollow Reservoir, 600 ac-ft, is located on Spring Creek and La Verkin Creek in Iron County and was built in 1948 for irrigation purposes.

Ash Creek Reservoir. Ash Creek Reservoir receives snowmelt and peak flow runoff from the Ash Creek drainage basin. The reservoir seldom fills, does not retain water, and the storage capacity has been restricted significantly because of dam safety concerns by the Utah State Engineer. The Ash Creek Pipeline is currently being built to convey water from Ash Creek Reservoir to the proposed Toquer Reservoir near Anderson Junction.

4.2.3.2 Culinary Water Systems

Quail Creek Water Treatment Plant. The Quail Creek Water Treatment Plant is an integral component of WCWCD's water system. This 60 million gallon per day (mgd) plant can receive water from three sources: Quail Creek Reservoir, Sand Hollow Reservoir and the Virgin River and delivers culinary water to RWSA municipal customers described in **Section 1.3.1.** Located just below Quail Creek Reservoir, this conventional filtration plant will eventually be expanded to treat 80 mgd

Sand Hollow Wells. The Sand Hollow well field includes 13 wells that draw water from pre-reservoir groundwater rights and from water recharged to the Navajo Sandstone Aquifer by Sand Hollow Reservoir. Water is chlorinated and pumped to two storage tanks with a total of 3 million gallons of storage capacity prior to delivery to RWSA municipal customers and Sky Ranch and Cliff Dwellers retail customers.

An evaluation of aquifer storage and recovery at Sand Hollow is presented in the Groundwater Resources Technical Report, (DWRe 2016). Currently it is estimated that there is approximately 106,000 ac-ft stored in the aquifer that could be used for this purpose (USGS 2013). Most of the recharged water stored in the Navajo Sandstone Aquifer would be reserved for use during dry periods to compensate for any deficit between annual supply and demand.

Cottam Wells System. The Cottam Well system delivers water from two wells via pipeline to Toquerville, La Verkin and Virgin and, if needed, to Hurricane and Leeds. This system also supplies water to about 20 customers in WCWCD's retail system, Casa de Oro, near Leeds.

Kayenta (Ence Wells) Water System. The Kayenta Wells (also known as the Ence Wells) are two wells with a total pumping capacity of 310 gallons per minute located within the incorporated boundary of Ivins. They provide water to the residential community of Kayenta.

Regional Pipeline Transmission System. The Regional Pipeline transmission system (pipeline, 500,000 gallon tank and two pump stations) conveys water from the Quail Creek Water Treatment Plant and Sand Hollow Wells to St. George, Santa Clara, Washington and Ivins.

Retail Water Systems. The WCWCD delivers retail water to the residential communities of Sky Ranch and Cliff Dwellers, south of Hurricane, the Casa de Oro subdivision near Leeds and certain areas on Kolob plateau.

4.2.3.3 Secondary Untreated Water Systems

Secondary untreated water is non-potable water that may be used for outdoor landscape irrigation. Secondary untreated water is a significant factor in assessing WCWCD service area supplies because of the significant amount of untreated water that cannot be economically used any other way. Water quality is compromised by the LaVerkin hot springs, as described in **Section 4.1.2**. Historically secondary untreated water was available in certain communities based upon surface water diversions developed by irrigation companies. Today, secondary untreated water deliveries may be provided from these untreated water sources and from treated municipal reuse water. In all cases, infrastructure, including main delivery lines and lateral pipelines, can limit the ability to deliver secondary untreated water to neighborhoods and communities. Meeting outdoor irrigation or industrial demands with secondary untreated water allows higher quality potable supplies to be reserved for culinary purposes. Because of the value of secondary untreated water in offsetting demand on culinary systems, and because of the limited infrastructure, secondary untreated water is delivered to public parks, golf courses and other areas over the entire 24 hour period the water is available regardless of time of day water restrictions.

4.2.3.3.1 Toquerville Secondary Untreated Water System

WCWCD, Toquerville City and the Toquerville Irrigation Company created the Toquerville Secondary Water System (TSWS) by contract in 1998, relying upon the water available from Toquerville Springs. WCWCD purchased irrigation company water rights (except those belonging to the municipality) and converted the open ditch irrigation system to a pressurized system that distributes water to residents of the Toquerville area. The secondary untreated supply of TSWS was assumed to be equal to the reliable use of the system in 2010 which was 178 ac-ft per year (DWRe 2013d).

4.2.3.3.2 Gunlock to Santa Clara Pipeline

Secondary untreated water on the Santa Clara River is stored in the Gunlock and Ivins Reservoirs and delivered through the Gunlock to Santa Clara pipeline. The Gunlock to Santa Clara Project, constructed in 2004, replaced four previous diversions and converted the old flood irrigation system to a pressurized system, with a pipeline from Gunlock Reservoir to Ivins Reservoir and beyond to deliver secondary untreated water in Ivins and Santa Clara and to the Shivwits Band of Paiute Indians. Ivins Reservoir also stores reuse water. The pipeline provides secondary untreated M&I water to golf courses, parks and residences. The Santa Clara secondary untreated system is supplemented by the wells. The Santa Clara River constitutes an abrupt hydrology that is highly variable thereby making it difficult to accurately estimate reliable supply, but WCWCD estimates reliable yield of the system to be approximately 2,500 ac-ft per year of secondary untreated water supply (WCWCD 2008a).

4.2.3.3.3 St. George Secondary Untreated Systems

St. George has a wastewater treatment plant, reuse plant, and an extensive secondary untreated distribution system.

St. George Wastewater Treatment Plant

The St. George Wastewater Treatment Plant (WWTP) produces Type II effluent using an extended aeration treatment process that uses physical and biological processes to treat sewage (City of St. George 2009b). The current design capacity of the WWTP is about 17 million gallons per day (mgd). The wastewater effluent is either treated by the reuse plant or discharged to the Virgin River.

St. George Reuse Treatment Plant

St. George completed a reuse plant in 2006 that treats water from the WWTP for reuse as secondary untreated water, in conjunction with the Shivwits Band of Paiute Indians water rights settlement on Santa Clara River water, under which St. George agreed to deliver 2,000 ac-ft of reuse water annually to the Band. Utah water law specifies that original water rights owners retain ownership after the first-use water has been treated for reuse so the St. George treatment plan relies upon agreements reached with WCWCD and municipal entities to distribute the reclaimed water.

The reuse plant filters and chlorinates WWTP water producing Type I effluent that can be used for secondary untreated purposes where human exposure is likely. Current capacity of the reuse plant is 7 mgd with two filters treating 3.5 mgd each. The plant is designed to expand to 10.5 mgd capacity with the addition of a third filter. The typical effluent of the WWTP is good quality which enhances efficiency of the reuse plant. The average water quality of the reuse effluent in comparison to the Utah's water quality limits are displayed in **Table 4-2** below.

Table 4-2 Water Quality of St. George Reuse Effluent and Utah Water Quality Limits

Constituent	Reuse Effluent[(1)]	Utah Constituent Limit[(2)]
Turbidity (NTU)	0.5-0.8	2
pH	7.7	6-9
Residual Chlorine (mg/L)	1.7-2.4	<1
E Coli (#/L)	1	0
BOD (mg/L)	2.0-2.6	5
TSS (mg/L)	1.3-2.4	5
Notes: [(1)]City of St. George 2009b. [(2)]DAS 2014.		

Demand for reuse water exists only during the irrigation season; as a result the reuse plant is only operated from late March to late October. There is currently no storage for reuse water. When supply exceeds secondary untreated demand, the reuse plant is shut down, and wastewater effluent is discharged to the Virgin River. Because of this limitation, the current maximum annual yield from the reuse facility is approximately 5,800 ac-ft per year, with 3,900 ac-ft per year committed to Shivwits Band of Paiute Indian Reservation and area golf courses. In 2007, approximately 2,460 ac-ft of reuse water was treated and distributed (City of St. George 2009a).

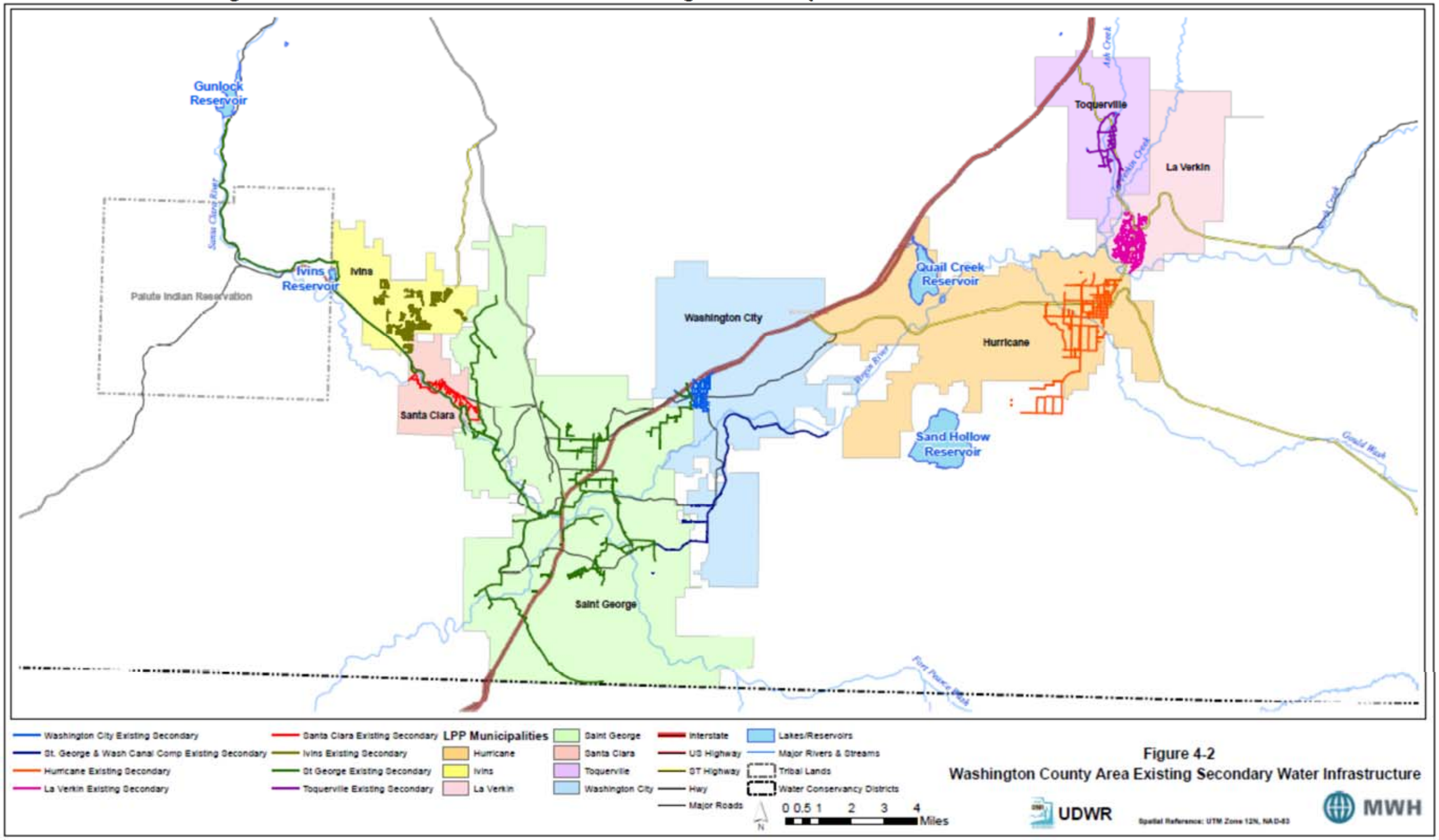
Currently reuse water has better water quality (approximately 1,200 ppm TDS) than the Virgin River water available for secondary untreated use (approximately 2,500 ppm TDS) and thus would improve secondary untreated water quality. But over time, increases in total dissolved solids and other constituents in the return flows, after repeated reuse treatment, could degrade water quality where reuse water is used or stored.

Secondary Untreated Distribution Sources

Secondary untreated water from the St. George and Washington Canal Company system and the Gunlock to Santa Clara pipeline system is currently being used to offset demand on culinary supplies in certain areas of St. George. In 2010, WCWCD worked with the Canal Company to replace 22.6 miles of the St. George and Washington Canal and its laterals, which had a long history of leakage and evaporation losses, with pipeline. The pipe can facilitate pressurization for residential sprinkler system in the Washington Fields area. Springs located northeast of downtown called the East/West City Springs feed a small ditch system in downtown St. George. This system primarily serves residential customers. Secondary untreated water and reuse water are intermixed in Santa Clara secondary untreated systems. Springs in western Washington City supply water for a private secondary untreated system called the Sandburg System, serving 3 schools, 2 parks, and a ball field in northeast St. George and western Washington City.

Most of the secondary untreated water delivery system is pressurized and interconnected with the exception of the small ditch system in downtown St. George and the Sandburg system mentioned above. The network of distribution lines within the system runs from Gunlock Reservoir to Washington Fields as can be seen in **Figure 4-2**.

Figure 4-2 WCWCD Owned and St. George Secondary Untreated Sources and Infrastructure



Secondary Untreated Customers

Several churches, golf courses, parks, and schools are served by the secondary untreated systems. Approximately eight golf courses, ten parks, sixteen schools, six churches and eight subdivisions, an RV park, the St. George WWTP, and the city power yard are all supplied with secondary untreated water.

Two private ditch companies also provide water in the St. George service area. Bloomington Water Company provides water to residential lots near the Bloomington Hills golf course. Cottonwood Irrigation supplies water to Dixie State College.

Secondary untreated customers are generally charged based on a water rate structure that is intended to encourage use of this supply to offset culinary demand, rather than to recover full cost of delivery.

4.2.3.3.4 Hurricane City Secondary Untreated System

The original Hurricane canal diversion was merged into WCWCD's Quail Creek diversion in 1985. The district is responsible to transmit water rights belonging to the Hurricane Canal Company, 12,000 to 15,000 ac-ft of water per year, based upon its 1890 water right priority.

4.2.3.3.5 La Verkin City Secondary Untreated System

The original La Verkin diversion was merged into WCWCD's Quail Creek diversion in 1985 and the WCWCD is responsible to transmit the associated 2,650 ac-ft of water rights. In February 2007 the City of La Verkin acquired these water rights along with the La Verkin Bench Canal Company secondary untreated water system. The original pressurized irrigation distribution system was installed around 1985 and facilities are being used at or near capacity, although there are sufficient water rights to support an expanded infrastructure.

4.2.3.3.6 Ivins City Secondary Untreated System

The Ivins Irrigation Company system receives water from the Santa Clara project and delivers within Ivins City and to agricultural users in the area. Ivins City owns shares in the company and seeks to maximize the distribution and efficiency of this source to offset culinary demand. The city has required new developments to install dry secondary untreated lines for a future secondary untreated system.

4.2.3.3.7 Santa Clara City Secondary Untreated System

The Santa Clara Canal Company and St. George Clara Canal Company are private companies in which WCWCD, St. George City, Ivins Irrigation Company and Santa Clara City own shares. A city park and cemetery are served by the secondary untreated system.

4.2.3.3.8 Washington City Secondary Untreated System

Washington City owns and operates a secondary untreated irrigation system within the "old" section of town north of the Virgin River. The secondary untreated system is comprised of irrigation districts which utilize different sources of secondary untreated water. The irrigation infrastructure consists of a network of small, unconnected low pressure ditches, pipes, gates, and valves. None of the existing infrastructure would be usable for a pressurized irrigation system.

4.2.4 Total Washington County Municipal and Industrial Water Supplies

Total reliable existing and near-term supply for Washington County is approximately 67,677 ac-ft per year, made up of culinary (potable) and secondary untreated (non-potable) supplies.

4.2.4.1 Culinary Water Supplies

The total reliable culinary water supply in Washington County, including WCWCD, is approximately 59,172 ac-ft per year. **Table 4-3** shows the reliable culinary water supplies developed by each public community water system in Washington County.

Table 4-3 Reliable Culinary Water Supplies – Washington County

Water Supplier	Reliable Culinary Water Supply (ac-ft/yr)			
	Springs	Wells	Surface	Total(1)
Angell Springs SSD	40	17	0	57
Apple Valley Water Company	0	160	0	160
Cedar Point Water Company	0	123	0	123
Central Culinary Water(3)	0	100	0	100
Dammeron Valley Water Works(2)	0	426	0	426
Diamond Ranch Academy	28	56	0	84
Diamond Valley Acres Water Co.	0	465	0	465
Dixie Deer SSD	0	110	0	110
Gunlock SSD	43	32	0	74
Harmony Farms Water Users	0	145	0	145
Harmony Heights	0	42	0	42
Hildale/Colorado City	42	1,362	0	1,404
Homespun Village Water Company	0	11	0	11
Hurricane City Water System(3)	1,614	1,854	0	3,468
Ivins City(3)	48	177	0	226
Kayenta Water Users Association(3)	0	0	0	0
La Verkin City(3)	661	0	0	661
Leeds Domestic Water Users Assoc.	80	339	0	418
Mountain Springs Water Co.	0	124	0	124
New Harmony Town Water	28	724	0	752
Pine Valley Irrigation Co.	91	24	0	114
Pine Valley Mt. Farms Water Co. (2)	0	185	0	185
Rockville Pipeline Co.	31	41	0	72
Santa Clara Municipal Water System(3, 4)	97	1,274	0	1,371
Springdale Culinary Water	205	129	498	832
St. George, City of(3, 5)	1,200	11,113	0	12,313
Toquerville Water Dept. (3)	363	0	0	363
Veyo Culinary Water Association	240	41	0	280
Virgin Water Department(3)	0	0	0	0
Washington County WCD(6)	0	5,125	26,922	32,047

Water Supplier	Reliable Culinary Water Supply (ac-ft/yr)			
	Springs	Wells	Surface	Total[1]
Washington County WCD-Hurricane Valley Retail	0	0	0	0
Washington Municipal Water System[3]	0	1,904	0	1,904
Winchester Hills Water Company[2]	0	267	0	267
Zion Canyon Water System	540	33	0	573
Totals	**5,350**	**26,402**	**27,420**	**59,172**

Notes:
[1]Wells are limited to 50% of their maximum capacity for reliable supply when well/pump capacity is the limiting factor. Springs and surface water supplies are equal to their respective maximum capacities.
[2]Reliable water supply is considered to be equal to calculated water use.
[3]Has contract with WCWCD for additional water supply
[4]Reliable well supply is calculated based on Santa Clara's 24.7% ownership of wells in Snow Canyon Compact yield.
[5]Reliable well supply is calculated based on St. George's 63.3% ownership of wells in Snow Canyon Compact yield. However, St. George has more well water rights available for additional supply, if needed.
[6] See Table 4-2
Source: DWRe 2014c.

4.2.4.2 Secondary Untreated Water Supplies

A number of irrigation companies deliver secondary untreated water to M&I systems in Washington County. While these 2010 secondary untreated water use data are considered reliable due to the significant validation process followed by DWRe, reliable data for previous years are not available with enough frequency to assess possible trends in use within the county or on a per capita basis. Total secondary untreated use in Washington County, including systems owned by WCWCD, is approximately 8,505 ac-ft per year (DWRe 2013a, **Table 4-4**).

Table 4-4 Washington County Secondary Untreated Use 2010 – Reliable Supply

Washington County Water Supplier	Residential Use	Commercial Use	Institutional Use	Industrial Use	Total Secondary Untreated Use
Central Canal & Irrigation Co.	15	0	0	0	15
Gunlock Irrigation Co.	30	0	0	0	30
Hurricane City Water System	136	1,079	901	45	2,161
Ivins Irrigation	81	0	0	0	81
La Verkin Bench Canal Co.	243	0	0	0	243
Leeds Water Company	50	0	0	0	50
New Harmony Town Water	15	0	8	0	23
Pine Valley Irrigation Company	20	0	0	0	20
Rockville Ditch Co.	60	0	2	0	62
Santa Clara Municipal Water System	15	0	0	0	15
Springdale Culinary Water	82	0	20	0	102
City of St. George, Various Irrigation Companies	760	1,080	2,850	0	4,690
Toquerville Secondary System[1]	175	0	3	0	178
Virgin Canal Company	40	0	2	0	42
Washington Municipal Water System	100	314	378	0	792
County Totals	**1,822**	**2,473**	**4,164**	**45**	**8,505**

Washington County Water Supplier	Residential Use	Commercial Use	Institutional Use	Industrial Use	Total Secondary Untreated Use
Notes: (1) Included in WCWCD reliable supply (2) Source: DWRe 2013a					

4.2.5 WCWCD Planned Water Supplies

While municipal customers of the district may make improvements to their individual systems to improve efficiencies, major future water supplies will be developed by WCWCD. This section briefly describes water development projects currently planned or being implemented by WCWCD.

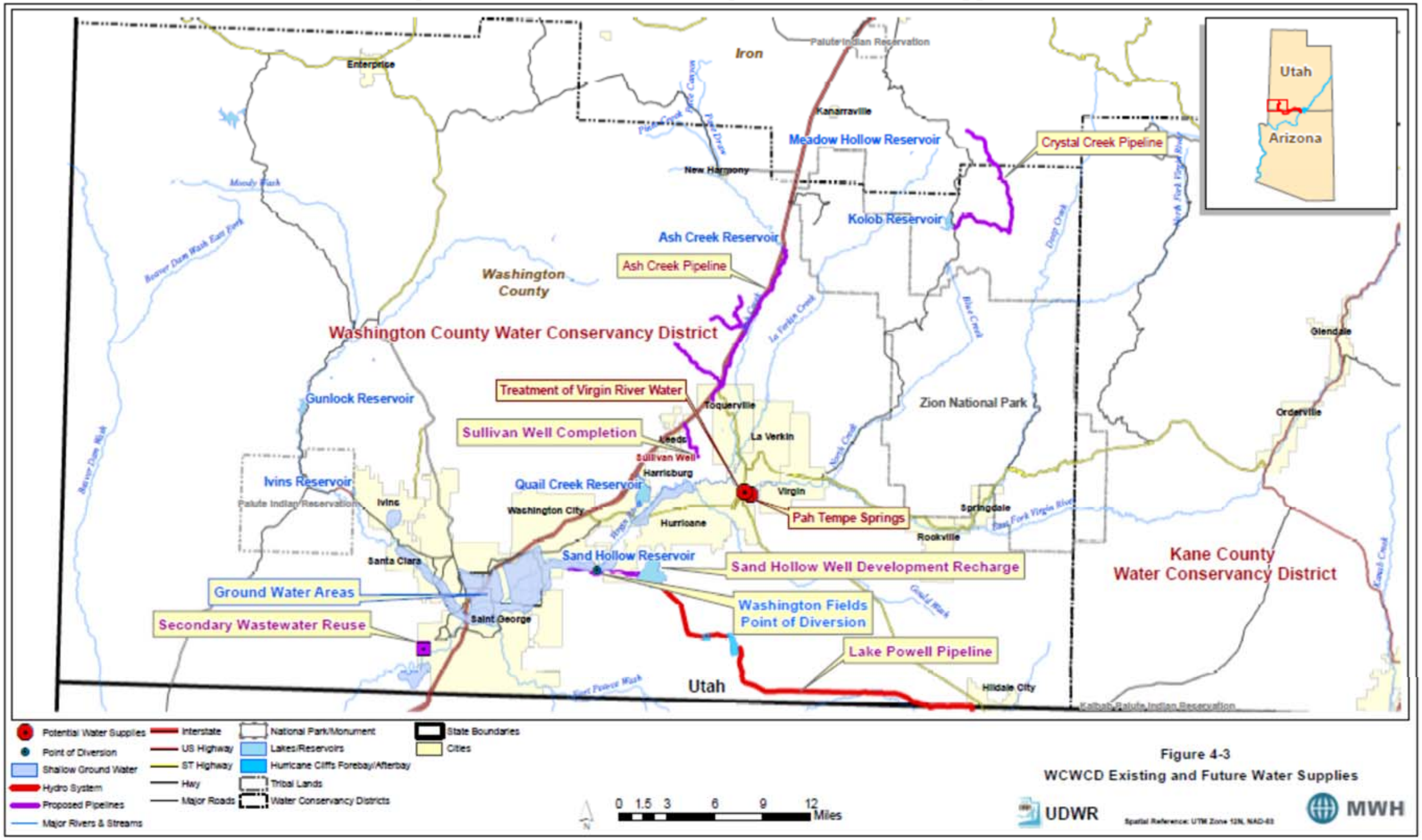
4.2.5.1 Culinary Water System Expansion

The Lake Powell Pipeline project is considered a planned source of future water supplies. **Figure 4-3** shows the general location of the planned projects. Direct wastewater reuse delivery for culinary water supply is not considered to be a viable option in this study because of limitations in treatment technology, treatment cost, permit-ability and public acceptance.

4.2.5.1.1 Ash Creek Pipeline/Toquer Reservoir

The Ash Creek Project will be completed in the near term. A collection system is being planned and constructed to replace the current open ditches on Leap Creek (partially complete), Wet Sandy Creek (complete) and South Ash Creek (planned). Water will be carried from the existing points of diversion and the Ash Creek Reservoir to the proposed 3,640 ac-ft Toquer Reservoir near Anderson Junction. Water stored in the reservoir will be delivered through a pipeline to the Toquerville Secondary untreated Water System, offsetting demand on the high quality Toquerville Spring water, thus maximizing its availability for culinary use. Water from the Ash Creek Pipeline also could be integrated into the Quail Creek Pipeline. Water developed by the Ash Creek Project would be a new water resource because the source water currently infiltrates into the ground to unknown locations. The Ash Creek Pipeline will be sized to meet full demands during the summer irrigation period, but yield will be limited by secondary untreated demand levels. The simulated yield of the pipeline would be 2,840 ac-ft per year with 90 percent reliability according to the Virgin River Daily Simulation Model from 50th percentile climate change scenario results (DWRe 2014a). The supply is categorized as culinary supply due to offset of demand for culinary quality water.

Figure 4-3 WCWCD Existing and Future Water Supplies



4.2.5.1.2 Well Field Expansions

Sand Hollow Recharge/Recovery. Additional local groundwater will be developed at the Sand Hollow well field to achieve the maximum allowable yield capacity, although the major portion of the recharged groundwater will be reserved as a drought buffer. The Sand Hollow recharge and recovery source will need arsenic treatment or blending and transmission upgrades for use as a culinary supply.

Cottam Wells. The system will be optimized with additional wells for maximum yield over time.

Sullivan Well Field. The Sullivan Well field will be developed to tie into the Cottam well system or deliver to developments in the Leeds area in the future.

Ash Creek Recharge/Recovery and Toquer Wells. The first Toquer Well was drilled in September 2015. Other wells will be developed in the area to take advantage of existing water rights and aquifer recharge provided by the Ash Creek Project.

Pintura Wells, Diamond Valley Wells and Kayenta (Ence) Wells. The WCWCD is planning groundwater development in the Pintura area, along the Ash Creek Corridor and in Diamond Valley area, to be completed before construction of the Lake Powell Pipeline. Additional yield from the Kayenta (Ence) Well system is anticipated to be developed after the Lake Powell Pipeline.

4.2.5.1.3 Additional Conveyance Infrastructure

WCWCD anticipates completion of additional water supply pipelines that will not generate new yield, but will increase the flexibility of the water supply portfolio. For example, the Sand Hollow Regional Pipeline will distribute water taken out of the Sand Hollow well field. This pipeline is part of a regional water supply project that will tie into existing water lines to provide water to the cities of St. George and Washington and will provide a redundant water supply to existing city facilities.

4.2.5.1.4 Warner Valley Reservoir

Warner Valley Reservoir will store water to serve secondary systems. A capacity of 55,000 ac-ft has been assumed based on preliminary planning work. The reservoir will store water diverted from the Virgin River at the Washington Fields Diversion, water from the St. George reuse plant and available water from the Gunlock to Santa Clara Pipeline. The reservoir will firm the yields from Virgin River diversions that may otherwise be lost downstream, facilitate use of reclaimed water and allow for blending of high TDS water with better quality water. The storage provided by Warner Valley Reservoir would be especially important in light of the anticipated reduced yields from the Virgin River caused by projected climate change (DWRe 2014a). Environmental review for the Warner Valley Reservoir has not yet formally commenced, so the project may be constructed prior to or after completion of the LPP.

4.2.5.1.5 Lake Powell Pipeline

WCWCD has requested the delivery of 82,249 ac-ft of water per year from the LPP project. Approximately 13,200 acre-feet of the LPP water would be diverted from the pipeline in Apple

Valley and treated for future M&I use in the Apple Valley area. Approximately 69,000 acre-feet of the LPP water would flow into Sand Hollow Reservoir at full demand and use. The LPP water from Sand Hollow Reservoir would be treated and distributed to the District's municipal customers. Water from LPP is fully consumable so wastewater generated from LPP water use would be treated and stored for reuse in secondary untreated supply systems.

4.2.5.2 Additional Secondary Untreated Water System Expansion

WCWCD and the several cities within the WCWCD service area propose to expand secondary untreated systems in their communities to offset culinary water use. Expansion of secondary untreated water infrastructure, including water distribution pipelines and storage tanks, would allow greater use of reuse water. It is prohibitively expensive to add secondary untreated delivery systems in already-developed communities. Expansion may be justified where trunk lines can meet large secondary untreated demands at golf courses, cemeteries, parks, and other large outdoor irrigation needs. Some cities are requiring secondary untreated water systems to be installed in new developments where it may be practicable to deliver secondary untreated water in the future. The following sections discuss the potential for further development of the secondary untreated systems in the study area.

4.2.5.2.1 St. George City

The St. George wastewater reuse plant could be maximized to its 10 mgd design capacity (11,200 ac-ft per year). The plant's current reuse capacity is 7.0 mgd or 7,800 ac-ft per year, but due to lack of storage, this supply can only be used to meet secondary untreated demands during the irrigation season from April through October. Thus, the usable supply is 50 percent, or 3,900 ac-ft per year. Assuming storage facilities would be implemented, a future maximized 10 mgd plant capacity would result in an additional 7,300 ac-ft per year of future supply.

Any reuse capacity above the 10 mgd design capacity would require new treatment facilities. In theory, wastewater reuse could be increased to approximately 40,000 ac-ft per year in 2060 (including the 11,200 ac-ft per year given above). This estimate is based upon the wastewater effluent rate for communities served by the St. George wastewater treatment plant (St. George, Washington, and Santa Clara) using the indoor water use projections and assumes 15% losses in the collection system and a 90% plant recovery. This estimate may be high as it does not consider limitations placed by return flow commitments, secondary untreated demand timing and the infrastructure available to store and deliver the supply.

Storage capacity is a significant limiting factor in maximizing reuse water supplies because demand sets the limit on the amount that can be used at any one time without storage for the excess supply. The existing reuse line extends southeast from the treatment plant along the Southern Corridor to the intersection with River Road and will be extended eastward as the Southern Corridor is extended. Reuse water may serve the Ledges common areas and golf course on Highway 18 once additional pump stations are installed. This assessment assumes that St. George will require all new development to install secondary untreated water systems, where feasible, by 2020.

4.2.5.2.2 Hurricane City

The City, in cooperation with the Hurricane Canal Company contracted to create a Pressurized Water Master Plan in 2007 to expand the secondary untreated system in the Hurricane Valley area. The canal system is gradually being replaced with pipe as agricultural uses change and residential areas develop in this area. Another 3 MG reservoir adjacent to the existing reservoir is proposed for additional storage. Hurricane is expected to require all new development to install secondary untreated water systems, where feasible.

4.2.5.2.3 Ivins City

All subdivisions constructed since the 1990s in Ivins City have been required to install secondary untreated irrigation pipelines to connect to a future municipal irrigation system. Ivins City currently owns shares in the Ivins Irrigation Company, St. George Clara Canal Company and the Santa Clara Field Canal Company, which own rights for secondary untreated water. It is unclear how this system will be phased into the City, whether by transferring the Ivins Irrigation Company system to the city or by development of an independent system. Future municipal irrigation system demands at 2060 are projected to be 3,100 ac-ft per year, with a peak day demand of 4,700 ac-ft per year.

4.2.5.2.4 La Verkin City

The City of La Verkin Secondary Water Master Plan (LaVerkin City 2010a) discusses the future secondary untreated system needs. The Plan outlines recommendations for improvements to the secondary water system to meet secondary untreated water demands through buildout conditions. According to the Plan, secondary untreated water right usage at buildout would be 1,070 ac-ft per year. Secondary untreated water use projections at 2060 are 1,024 ac-ft per year (DWRe 2014c).

4.2.5.2.5 Toquerville City

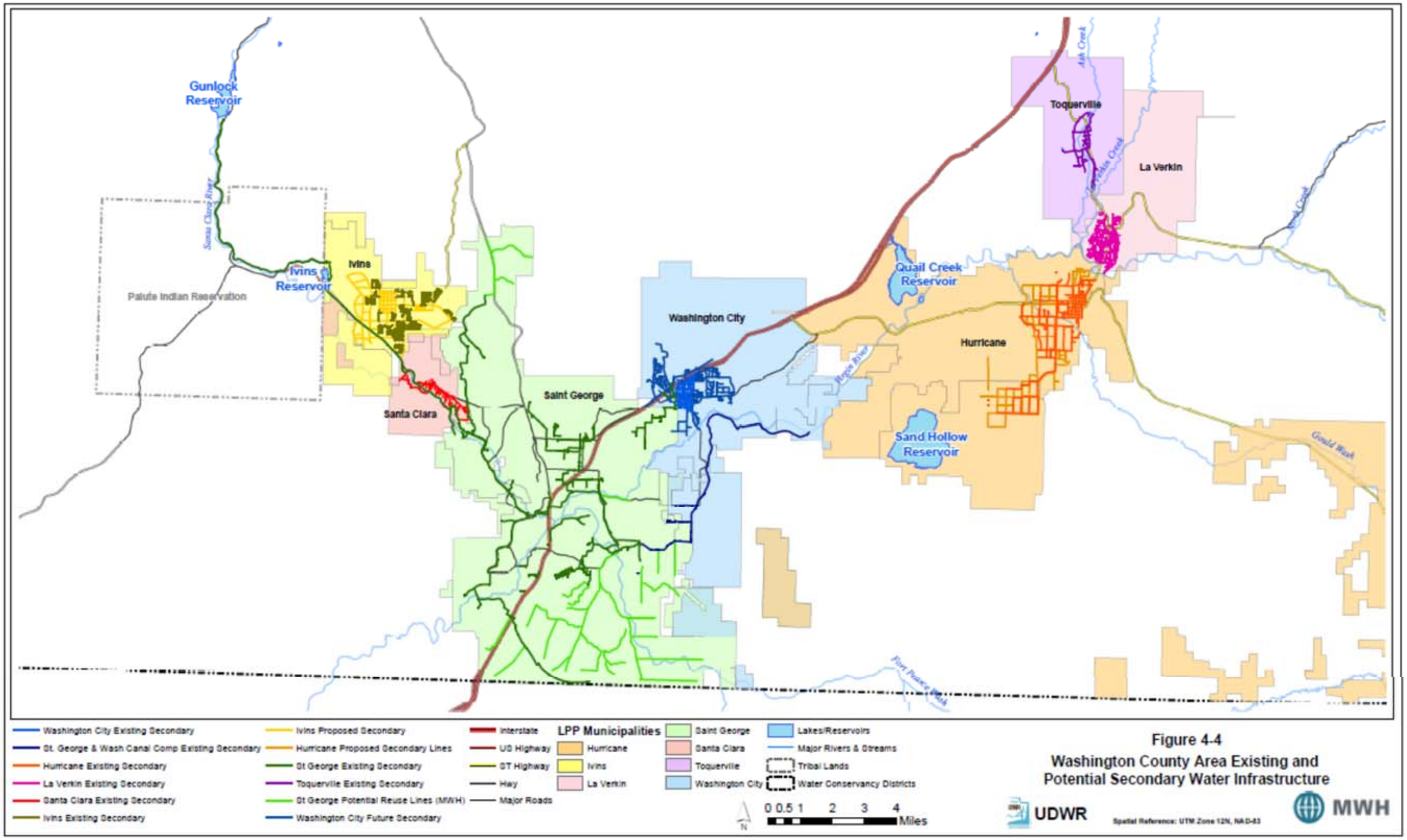
By 2060 the existing TSWS secondary untreated system could be used to full capacity, which could be as much as 2,063 ac-ft per year, the total original water rights of the system.

4.2.5.2.6 Washington City

Washington City’s 2005 Secondary Water Master Plan (Washington City 2005) estimates potential secondary untreated water demand through 2025 and recommends a future pressurized secondary untreated water system. The Plan considered water resource recovery facilities (WRRFs) also known as scalping plants in conjunction with their wastewater system improvements. Preliminary calculations show that on average the amount of water recovered from the scalping plant could take care of the secondary untreated irrigation needs of the community. In October 2006 the City adopted an ordinance requiring all new development within the city to install distribution infrastructure within new developments. The projected secondary untreated demand in 2060 is 3,343 ac-ft per year (DWRe 2014c)

The locations of future secondary untreated lines were estimated conceptually for this assessment based on areas of potential development that may include secondary untreated pipeline infrastructure, which can be seen in **Figure 4-4**. Potential secondary untreated water customers include any future developments.

Figure 4-4 WCWCD Existing and Potential Secondary Untreated Infrastructure and Customers



4.2.5.3 Agricultural Conversion for M&I Supply

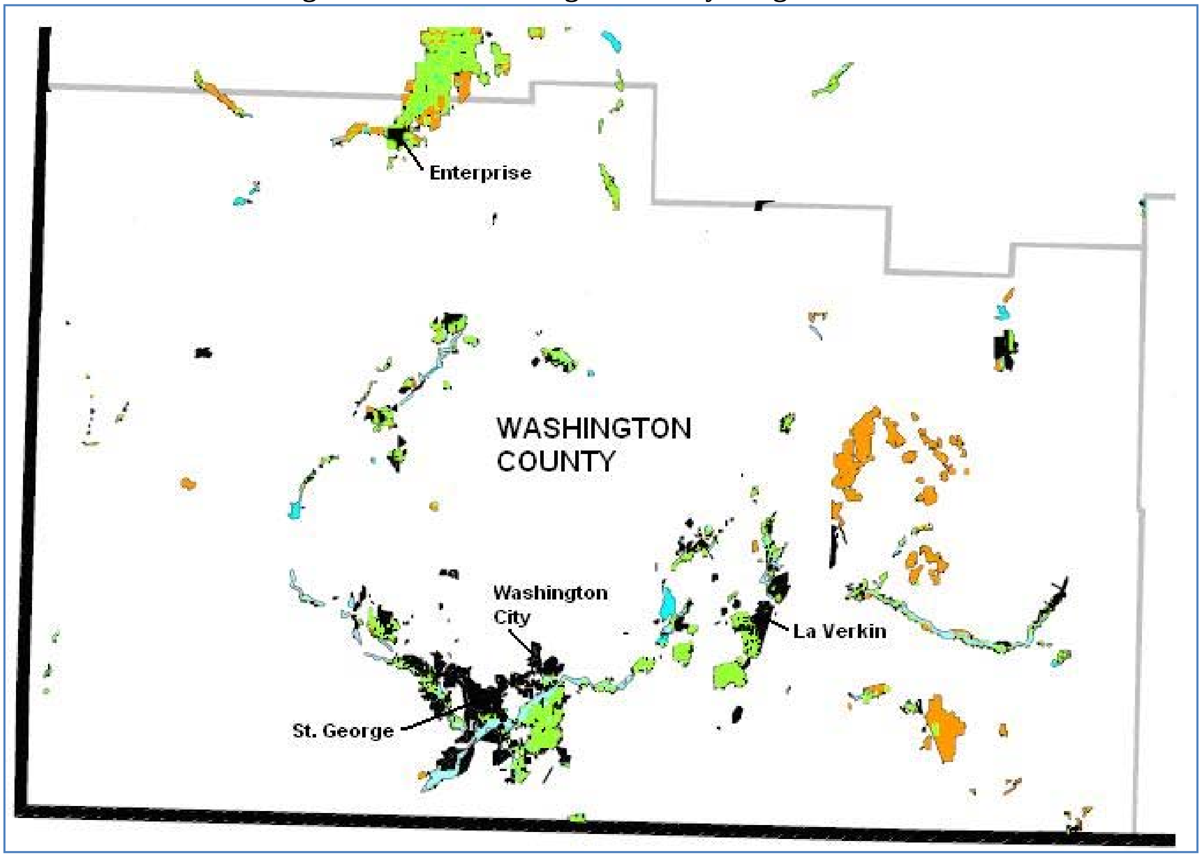
As agricultural lands are developed, water will be converted from agricultural to municipal uses. No "buy and dry" programs have been established by WCWCD. Approximately 90 percent of irrigated agricultural water supply in the Kanab Creek/Virgin River Basin originates from surface water sources (DWRe 1993), and as described in **Section 4.2.2**, poor water quality limits cost-effective use of this water by secondary untreated systems. **Figure 4-5** outlines the relative location of irrigated croplands to urban areas to help gain a better understanding of the acreage that could potentially be converted from agricultural to municipal uses.

Within Washington County, most conversion of agricultural water use to M&I would likely occur within the Washington Fields area south of St. George and Washington cities. DWRe (2011a) performed an analysis of the Virgin River basin which included an estimate of the Washington Fields agricultural water that could be converted to M&I use, following historical trends. The study estimated that 12,880 ac-ft per year could be converted for secondary untreated M&I purposes with a 90 percent reliability. This value includes some existing irrigation supplies that have already been converted. Using the M&I Water Use Report data (DWRe 2013g) for secondary untreated water supplies, it was estimated that about 2,800 ac-ft per year of Washington Fields was included in the 12,880 ac-ft per year value. Thus, the remaining irrigation water available for conversion to secondary untreated M&I use is about 10,080 ac-ft per year.

The majority of agricultural supply that would be converted to M&I supply as a result of development has high TDS concentrations that would either require blending with lower TDS supplies or very costly (RO) treatment to reduce overall TDS. In the future, water from agricultural conversions made in the Washington Fields area could be placed in a future storage facility, allowing efficient management of this water for secondary untreated and other purposes in the area. Blending with reuse water and Santa Clara River stored water could reduce the overall TDS.

WCWCD intends to use stored water for use in M&I pressurized secondary untreated supply systems in the future. Water could also be managed for environmental uses such as providing target flows in the Virgin River for the endangered woundfin minnow and Virgin River chub.

Figure 4-5 Washington County Irrigated Lands



Source: Modified from (DWRe 1999)
Map Color Code: Green = Irrigated Cropland, Orange = Non-Irrigated Cropland, Blue = Water, Black = Urban

Lake Powell water in the top 100 feet ranges from 350 to 600 mg/L TDS. As described in **Section 4.2.2,** blending untreated Lake Powell water with agricultural water (1,500 mg/L) at about 2:1 would result in an overall supply with 735-900 mg/L TDS, which is assumed to be acceptable for secondary untreated use in this report.

RO treatment is not under consideration at this time for secondary untreated use because of environmental, technical, and economic feasibility issues. For purposes of discussion, assuming a TDS concentration of 1,500 mg/L for the agricultural supply and 100 percent removal of TDS, 2,470 ac-ft per year of the total 7,400 ac-ft per year supply would have to be treated with RO to meet 1,000 mg/L, leaving an average annual yield of 6,900 ac-ft per year for secondary untreated use.

The following issues affect the feasibility of advanced treatment of agricultural conversions.

- High cost of advanced water treatment options such as reverse osmosis
- High energy requirements associated with reverse osmosis
- Lack of an environmentally acceptable alternative for disposal of brine created from the reverse osmosis process

- High TDS of water supply may require substantial portions of the water supply to be treated to achieve the final desired TDS for secondary untreated M&I uses

4.2.6 WCWCD Water Sources not Feasible for Development

The projects described in this section are not currently part of the long-term water supply portfolio of WCWCD, largely because of practical, economic and environmental reasons. The technical and environmental challenges are discussed below.

4.2.6.1 Virgin River Water

After numerous studies by various state and federal agencies, the DWRe and WCWCD have concluded there is no additional Virgin River water available to be developed for water supply in Washington County because of variable streamflow, poor water quality, lack of current storage options, minimum streamflow requirements, and the potential for sedimentation of possible reservoir sites. An evaluation was completed for this analysis to confirm the above conclusion that there is no additional Virgin River water available for development.

The studies described here have looked for additional water downstream from existing diversions. A large portion of the available water supply occurs during short periods of high streamflow, which cannot be economically diverted with standard river diversion and conveyance facilities. Even if an alternative diversion structure and conveyance system could be built, the high TDS would disqualify the supply for M&I use (including secondary untreated water use) as discussed in **Section 4.2.2**. Another factor, the lack of available storage sites, is discussed below.

Simulated daily streamflow for the Virgin River downstream of the Washington Fields diversion from 1941 to 2006 is shown in **Figure 4-6**. Streamflow exceedance information for the same location and period of record is summarized in **Table 4-5** and **Figure 4-7** (DWRe 2008b), which shows the frequency of various streamflow values. For example, **Table 4-5** and **Figure 4-7** indicate that 50 percent of daily streamflow values are greater than or equal to 25 cfs. The majority of annual flow volume occurs during infrequent higher flows, which decreases the potential for capturing these flows and developing additional Virgin River water. The simulated historical daily streamflow ranges from 0 to 21,100 ac-ft per day (0 to 10,600 cfs), with higher flows generally occurring during spring runoff and in response to short intense rainfall events. The variability of streamflow would require a large diversion structure and storage facility to give a reliable annual supply and thus eliminates this source of Virgin River water as a technically and economically feasible project.

Table 4-5 Virgin River below Washington Fields – Percent Exceedance for Daily Streamflow, 1940-2006

Percent Exceedance	Streamflow (cfs)
1	1,280
5	403
10	175
20	43
30	43
40	43
50	25
60	13

Percent Exceedance	Streamflow (cfs)
70	7.3
80	7.1
90	0.0
100	0.0

Figure 4-6 Daily Streamflow for Virgin River below Washington Fields

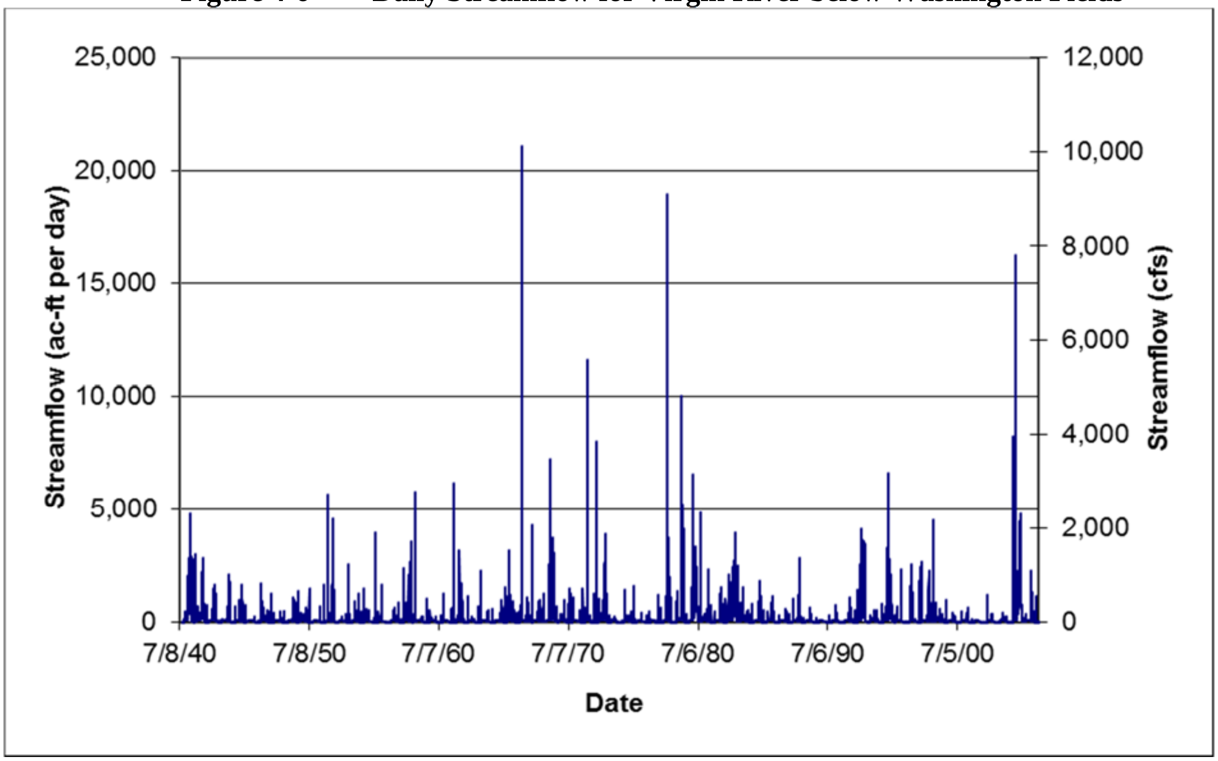
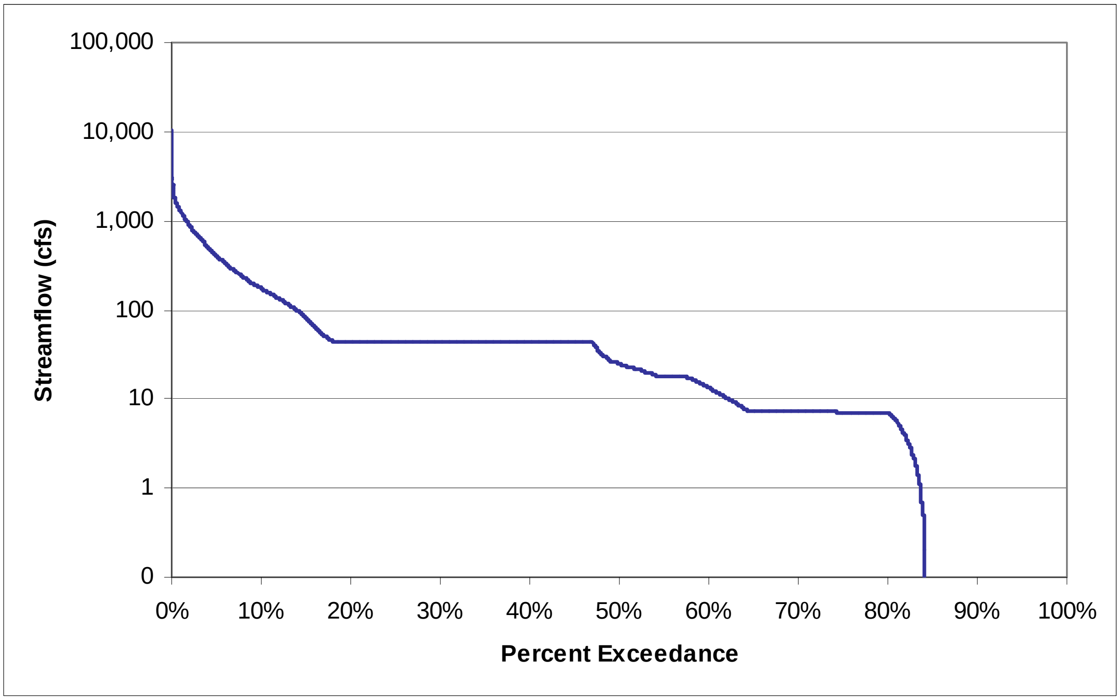


Figure 4-7 Virgin River below Washington Fields Flow Exceedance Curve



Potential storage locations within the Virgin River Basin were investigated by the DWRe (DWRe 1988; DWRe 1992). Of the 96 potential sites considered, DWRe screened out all but 16 sites based on geologic flaws, potential storage capacity, onsite field reviews, and detailed characteristics such as cost and environmental considerations. An on-stream dam would have a detrimental effect on aquatic habitat at the location of the reservoir, and would also have serious sedimentation and erosion issues. Of the 16 sites remaining after DWRe's analysis, only two of the reservoir sites were deemed to be potentially feasible sites for storage of additional Virgin River water. DWRe yield modeling of the Virgin River indicates that reservoir capacity for Virgin River water would need to be about 5 ac-ft of reservoir storage capacity per 1 ac-ft of reliable yield, because of the variability of streamflow in the Virgin River.

4.2.6.2 Groundwater Development

The Virgin River groundwater basin in Washington County (the Navajo Sandstone aquifer) is considered to be over-appropriated by the Utah Division of Water Rights (DWRi 2008a). The groundwater budget for the Navajo Sandstone aquifer presented in the Virgin River Basin Plan (DWRe 1993) was updated with current groundwater pumping information from the Virgin River M&I Use Report for municipal demands (DWRe 2013g), and with projected agricultural groundwater pumping for 2005 from the Virgin River Basin Plan (DWRe 1993). The updated groundwater budget confirmed the aquifer is fully utilized and there are no new supplies available for development.

The USGS has completed modeling for WCWCD in the Sand Hollow area, including an analysis of natural infiltration to the Sand Hollow Basin. The USGS concluded natural recharge to the Sand

Hollow groundwater is 790 ac-ft per year, which has already been accounted for in the Sand Hollow groundwater yield described in **Section 4.2.3.1** (USGS 2013).

4.2.7 Summary of Planned and Potential WCWCD Water Supply Projects

Table 4-6 summarizes the water supply projects currently planned by WCWCD to meet the demands of existing and future water users in Washington County and those that could be considered potential long-term projects if certain technical, environmental or cost concerns were resolved. Individual projects would supply either culinary or secondary untreated water to District customers. Each project would have limitations in the areas it could deliver water to economically.

Table 4-6 Future Planned and Potential WCWCD Water Supply Projects

Project	Estimated Reliable Culinary Supply (ac-ft/yr)	Estimated Reliable Secondary untreated Supply (ac-ft/yr)
Ash Creek Pipeline[(1)]	2,840	0
Sand Hollow Recharge and Recovery[(2)]	3,000	0
Cottam Well Maximization	600	0
Sullivan Wells	750	0
Pintura Well	600	0
Diamond Valley Well	400	0
Kayenta (Ence) Wells[(3)]	480	0
Westside Arsenic Treatment[(4)]	5,000	0
Maximize Existing Wastewater Reuse[(3,5)]	0	7,300
Agricultural Conversion from Development[(3,6)]	0	10,080
Lake Powell Pipeline	82,249	0
Potential Future LPP Reuse[(3)]	0	28,830
Total Potential Yield from Future Projects	**95,919**	**46,210**

Notes:
[(1)] Ash Creek Pipeline yields 2,840 ac-ft/yr based on Virgin River Modeling (DWRe 2014a).
[(2)]Arsenic Treatment or blending and transmission upgrades must first occur.
[(3)]To be implemented post-Lake Powell Pipeline
[(4)]Includes Gunlock to Santa Clara Pipeline and Snow Canyon Wells. Moved to future reliable supply due to extent of treatment needed for culinary supply.
[(5)]See Section 4.2.5.2.1.
[(6)]The estimated supply is 12,880 ac-ft/yr with 90% reliability (DWRe 2011a). However, it was estimated that approximately 2,800 ac-ft/yr of this supply is currently in use and has been accounted for in the reliable secondary untreated supply.
[(7)]Source of data DWRe 2014c

4.3 Kane County Water Conservancy District

This section describes existing and future planned and potential water supplies for entities within the Kane County.

4.3.1 Kane County Water Supply Overview

KCWCD is a relatively new water conservancy district, formed in 1992. It has a limited customer base and limited supply sources at present. While the entire county is considered part of KCWCD's service area, existing KCWCD customers are rural developments located in the Cedar Mountain and Johnson Canyon areas. KCWCD owns and operates its own wells in the Johnson Canyon area to meet these demands. The only substantial community in Kane County – the City of Kanab – has developed its own water supply system over time, and may continue to meet the needs of M&I customers within its current city boundaries, and within future annexation areas as well.

All existing M&I supplies in Kane County are derived from groundwater resources (wells and springs). Most existing water supplies in Kane County are derived from groundwater from the Navajo Sandstone Aquifer. This groundwater is of high quality, and is used directly for culinary purposes after disinfection. Because of its proximity to Zion National Park and the Grand Staircase – Escalante National Monument, Kane County is a partner in an agreement with WCWCD and others that limits its well production and groundwater development by prohibiting removal of water supplies from the Monument.

Kane County encompasses parts of four different watershed basins: (1) Kanab Creek/Virgin River, (2) Southeastern Colorado River, (3) Western Colorado River, and (4) Sevier River. Surface and groundwaters are considered to be fully appropriated at this time in the Kanab Creek/Virgin River and Southeastern Colorado River Basins. New diversions and uses must be accomplished by change applications filed on owned or acquired existing rights.

The Navajo Sandstone Aquifer is the primary water source for the Kanab and Johnson Wash drainages. The water from the Navajo Sandstone Aquifer is usually of good quality. However, throughout the Kanab Creek and Johnson Wash drainage areas both good and poor water quality is found. The groundwater at lower elevations of the basins tends to have poorer quality due to soluble minerals that are discharged from some geological formations (DWRe 1993). Available data suggest that groundwater quality in wells drilled in the Johnson Wash area is of poor quality and generally not favorable for culinary use (Appendix A, MWH 2015). As a result, the water from the lower elevations of the basins can only be used as secondary untreated water unless treated by advanced processes such as RO.

Both surface water and groundwater supplies are anticipated to be affected by climate change in the future. As discussed at the beginning of **Chapter 4**, existing supply yields are anticipated to decline from 3 percent in 2020 to 7.2 percent in 2060 based on the statistical analysis of streamflow projections conducted by the U.S. Bureau of Reclamation (Reclamation 2014).

Water supply is of the utmost importance to Kane County. The Kane County Resource Management Plan (Kane County 2011) states that "Water is the life blood of Kane County. Water quality and availability has historically determined the level, type, and location of existing growth. This pattern would continue into the future except for the fact that new distribution systems have made water more available throughout the county. The county encourages and supports the efficient management and use of its water resources. The future of the county is completely dependent on available water. The county not only needs a county-wide distribution system to assist any area in time of need, but a redundant supply to avoid simply running out of water at some future date."

4.3.2 Kane County Existing Water Supplies

A summary of the reliable culinary water supply sources for all of Kane County is provided in **Table 4-7** and existing reliable supplies are described separately for each of the four groups. Fredonia, Arizona, receives its water supply from Kane County, but it is not located within the county and is not included in the population or water demand values reported in Chapter 3. Therefore, Fredonia supplies are not included in the existing reliable culinary supply total for Kane County. The National Park Service Bullfrog Recreation Site and the Cedar Mountain residential area would not be served by the Lake Powell Pipeline and are not located within any of the four subbasins considered. Therefore it is also not included as reliable culinary water supplies for KCWCD. There is currently no aquifer recharge in Kane County recovered for water supply (DWRe 2011b). The reliable supplies will reduce with time based on climate change projections. Also, a ten percent planning reserve is incorporated into the future reliable supply quantities in the integrated water resource plans discussed in **Chapter 6**. The planning reserve helps to avoid using water supplies up to the maximum and to provide a buffer against annual variability in water supplies affected by precipitation runoff and groundwater recharge. Those shown in this section have not yet been reduced and do not include a reduction to accommodate the planning reserve.

Table 4-7 Reliable Culinary Water Supplies – Kane County

Water Supplier	Reliable Culinary Water Supply (ac-ft/yr)			
	Springs	Wells[1]	Surface	Total[1]
Alton[2]	34	0	0	34
Church Wells Special Service District[3]	0	225	0	225
Glen Canyon Special Service District #1 (Big Water) [3]	0	506	0	506
Glendale Town Corp.[2]	105	15	0	120
Kanab Municipal Water System[2,4]	105	2,182	0	2,287
Kane County WCD (Johnson Canyon) [2,4]	0	150	0	150
Orderville Town Water System[2]	79	384	0	463
Total Kane County Reliable Supply	**323**	**3,462**	**0**	**3,785**

Notes:
[1]Wells are limited to 50% of their “maximum” capacity for reliable supply when well/pump capacity is the limiting factor. Springs and surface water supplies are equal to their respective “maximum” capacities.
Sources: [2]DWRe 2013b; [3]DWRe, 2014b
[4]Kanab City and Johnson Canyon would be served by KCWCD LPP supplies in the future

4.3.2.1 East Fork Virgin River Subbasin

Public community water systems in the East Fork Virgin River subbasin include the towns of Glendale and Orderville. Reliable culinary and secondary untreated water supplies for the basin are summarized in **Table 4-8**. The total reliable water supply for the basin is the combined culinary and secondary untreated supply of 842 ac-ft per year (DWRe 2013d). Annual total culinary use for 2010 was 208 ac-ft per year or 36 percent of the reliable culinary water supply.

Table 4-8 Reliable Water Supplies – East Fork Virgin River

Water Source	Reliable Supply (ac-ft/yr)		
	Culinary	Secondary Untreated	Total
Glendale Town Corp.	120	89	209
Orderville Town Water System	463	170	633
Total	**583**	**259**	**842**

4.3.2.2 Alton Town

Reliable culinary and secondary untreated water supplies for Alton Town is summarized in **Table 4-9**. The total reliable water supply is the combined culinary and secondary untreated supply of 50 ac-ft per year (DWRe 2014c). Annual total culinary use for 2010 was 28 ac-ft per year or 56 percent of the reliable culinary water supply. Fredonia, AZ and Kanab City are in the same hydrologic subbasin as Alton Town. However, while Fredonia receives its water supply from Kane County, it is not located within the county and is not included in the population or water demand values reported in **Chapter 3**. Further, Kanab City will be served by KCWCD LPP water supply in the future and was therefore grouped with Johnson Canyon. Therefore, Fredonia and Kanab City supplies are not included in the existing reliable culinary supply total for Kanab Creek Subbasin, and only Alton Town is listed.

Table 4-9 Reliable Water Supplies – Alton Town

Water Source	Reliable Supply (ac-ft/yr)		
	Culinary	Secondary Untreated	Total
Alton Town	34	16	50
Total	**34**	**16**	**50**

4.3.2.3 KCWCD (Kanab City and Johnson Canyon Subbasin)

The two public community water systems to be served LPP water in the future by KCWCD are Kanab City and the Johnson Canyon subbasin. Reliable culinary and secondary untreated water supplies for this group are summarized in **Table 4-10**. The total culinary reliable water supply for the basin is 2,437 ac-ft per year and secondary untreated supply of 80 ac-ft per year (DWRe 2014c). Annual total culinary use for 2010 was 1,535 ac-ft per year or 61 percent of the reliable culinary water supply.

Table 4-10 Reliable Water Supplies – KCWCD

Water Source	Reliable Supply (ac-ft/yr)		
	Culinary	Secondary Untreated	Total
Kanab City	2,287	80	2,367
Johnson Canyon	150	0	150
Total	**2,437**	**80**	**2,517**

4.3.2.4 Wahweap Creek Subbasin

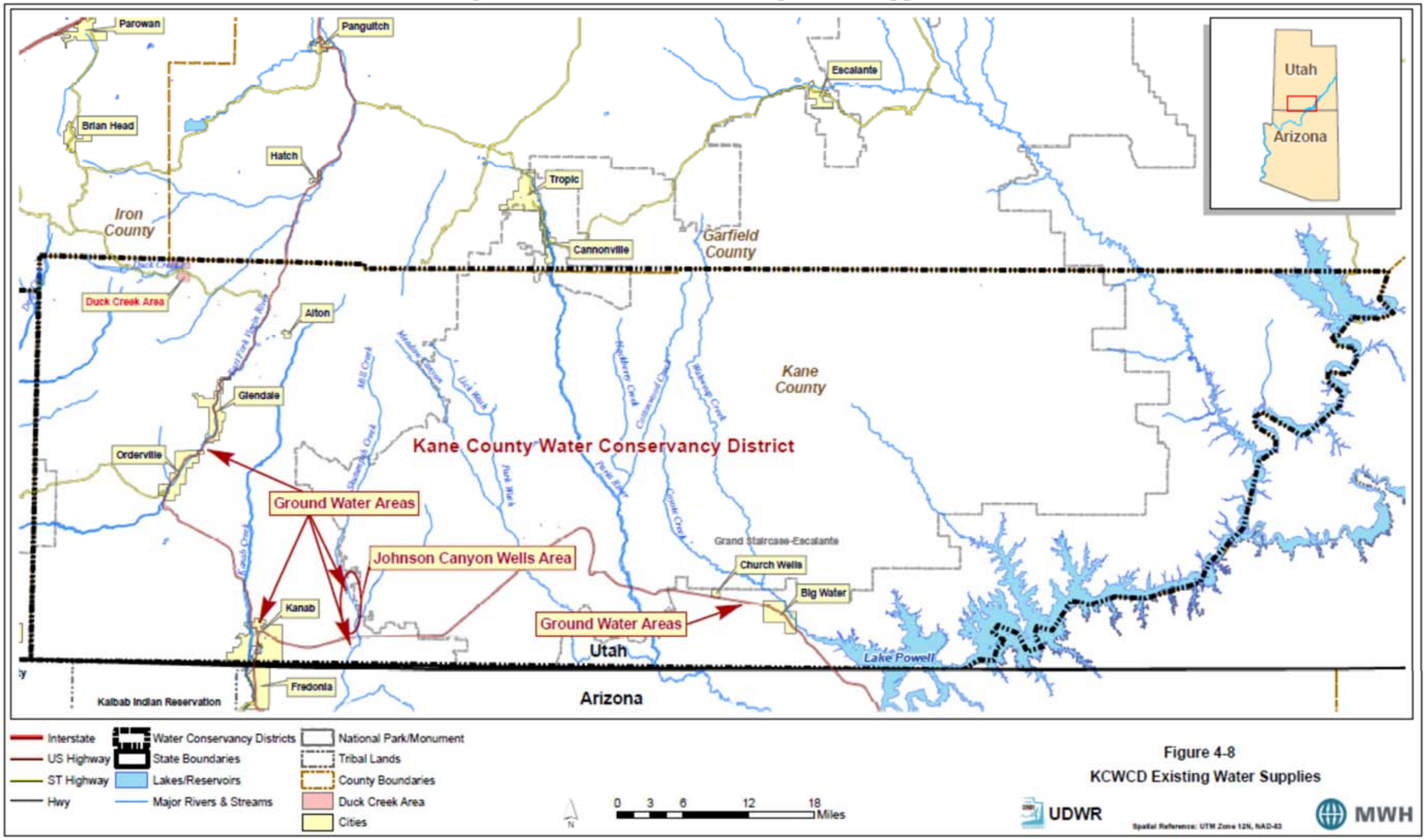
Public community water systems in the Wahweap Creek subbasin include two public community water systems. Reliable culinary and secondary untreated water supplies for the basin are summarized in **Table 4-11**. The total reliable water supply for the basin is the combined culinary and secondary untreated supply of 736 ac-ft per year (DWRe 2013b). Annual total culinary use for 2010 was 233 ac-ft per year or 32 percent of the reliable water supply.

Table 4-11 Reliable Water Supplies – Wahweap Creek

Water Source	Reliable Supply (ac-ft/yr)		
	Culinary	Secondary Untreated	Total
Glen Canyon Special Service District #1 (Big Water)	506	5	511
Church Wells Special Service District	225	0	225
Total	**731**	**5**	**736**

Figure 4-8 shows the general location of the existing Kane County supply sources.

Figure 4-8 KCWCD Existing Water Supplies



4.3.3 KCWCD Future Supplies – Planned

4.3.3.1 Groundwater

M&I water suppliers in Kane County anticipate using additional groundwater production to meet increased future water demands. The State Engineer has determined that no new groundwater permits will be issued within the project area in Kane County. A review of existing records determined that the total of adjudicated municipal groundwater rights in the four subbasins within Kane County is approximately 13,990 ac-ft per year (MWH 2013). Total reliable culinary supply from wells for Kane County in the Kanab Creek/Virgin River Basin (minus Fredonia, AZ) and the Southeast Colorado Basin was reported to be 3,460 ac-ft per year in 2010 (**Table 4-12**). Thus, municipal well users could increase their supply by approximately 10,530 ac-ft per year and remain within their permitted withdrawal rates. Groundwater quality data from wells in the Johnson Wash area near the mouth of Johnson Canyon have shown that most wells in this area are not suitable for culinary use. The wells that have acceptable quality penetrate below alluvial deposits. These wells are of low to moderate production potential (Appendix A, MWH 2015). Therefore, while the water right may be available, the quality of the water or production of the wells may not be sufficient to fulfill the right. The Kanab City Water Conservation Plan (Kanab City 2013) states that there is potential for additional groundwater development in all of Western Kane County by drilling wells at favorable locations. Care must be taken to avoid discharging more groundwater than can be recharged over time. If overdrafts would occur, the Department of Water Rights would curtail the amount of well water rights shown in the table below, preventing them from being fully realized. **Table 4-12** depicts the groundwater potentially available by study area group. Alton Town did not have any groundwater data in the sources reviewed.

Table 4-12 Municipal Groundwater Supplies Potentially Available for Development

Group	Municipal Groundwater Rights (ac-ft/yr)(1)	Current Reliable Culinary Supply from Wells (ac-ft/yr)(2)	Legally Available for Development (ac-ft/yr)
East Fork Virgin River Subbasin	985	400	585
Alton Town	0	0	0
KCWCD (Kanab City and Johnson Canyon Subbasin)	10,250	2,330	7,920
Wahweap Creek Subbasin	2,755	730	2,025
Total	**13,990**	**3,460**	**10,530**
Notes: (1)MWH 2013 (2)See **Table 4-7**; DWRe 2013b			

There are substantial water quality issues that would limit the use of any additionally available groundwater supply. Water quality diminishes from the upper portions of the four subbasins to the lower portion of the subbasins. For example, TDS concentrations increase in the lower part of the Kanab Creek subbasin to an extent that any available additional supplies near the City of Kanab would only be of sufficient quality for secondary untreated use. An analysis of published online water quality data showed that wells within the Johnson Wash area produce groundwater that exceed the State of Utah's Secondary untreated Maximum Contaminant Levels (MCL) for drinking water in total dissolved solids (TDS), electrical conductivity (EC), sulfate (SO_4) associated with gypsum, and sodium (Na). Sediments derived from erosion of Johnson Canyon are likely to include deposits originating from the Moenkopi Formation exposed in the lower (southerly) extent of the canyon. These exposures include the Shnabkaib Member, which are high in soluble gypsum and evaporites, and could be the source of high TDS, SO_4, and Na concentrations in the Johnson Wash area groundwater (Appendix A, MWH 2015).

4.3.3.2 Lake Powell Pipeline

KCWCD has requested delivery of 4,000 ac-ft of water annually from the LPP. The planned delivery point for Lake Powell Pipeline water to KCWCD would be to a proposed water treatment plant in Johnson Canyon. From this point, LPP water could be delivered into the Kanab City water supply system. KCWCD would be allowed 4,000 ac-ft per year of depletions to the Upper Colorado River Basin based on Colorado River Compact requirements and the agreement between KCWCD and DWRe for diversion of Lake Powell water supply.

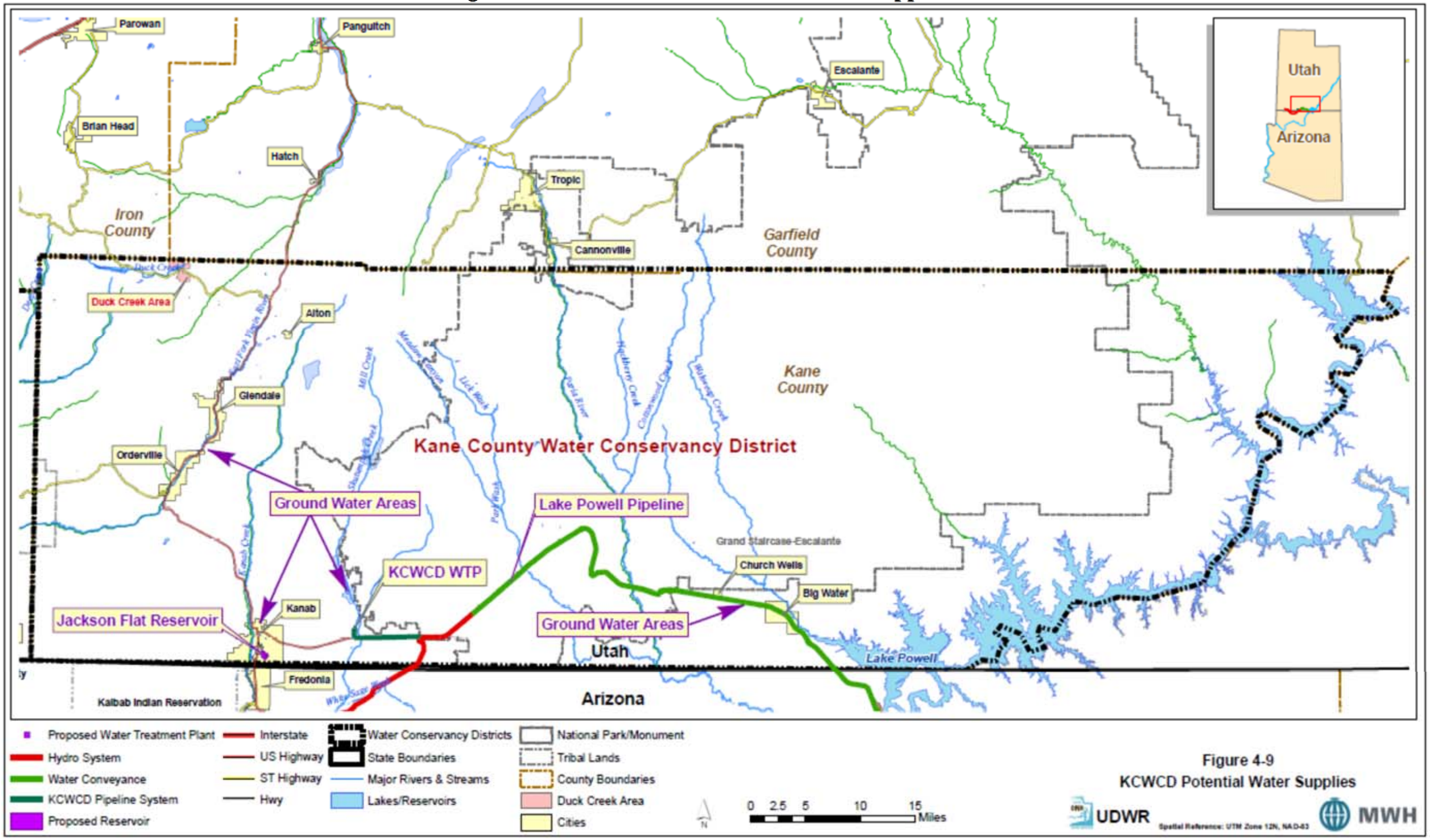
The proposed Lake Powell Pipeline would have a limited service area within KCWCD. Although KCWCD has no current intention of doing so, the proposed pipeline alignment is conveniently located to also serve the Big Water, and SITLA areas. Big Water currently has its own groundwater-based supplies, yet KCWCD could agree to provide LPP water in the future, either in addition to groundwater development when demand exceeds the allowable groundwater supply, or in lieu of groundwater development to allow additional groundwater resources to be developed in communities that are not located near the LPP. In this way LPP water would free up use of additional groundwater in the more remote and rural parts of Kane County. Although extremely unlikely, KCWCD could conceivably construct a pipeline from the LPP to the Orderville/Glendale area to meet future demands in that region of the County. The Lake Powell Pipeline would never serve the Sevier River Basin because of its remote location relative to the pipeline alignment.

KCWCD would either store LPP water in a new surface reservoir for treatment in a future water treatment facility or use it to recharge groundwater aquifers such as in the Johnson Canyon area to extend the life of the groundwater basin. Lake Powell water would have lower TDS (approximately 350 to 600 milligrams per liter) relative to groundwater in the lower portions of the Kanab Creek and Johnson Canyon subbasins (up to 1,200 milligrams per liter TDS). Consequently, if Lake Powell water was used to recharge the aquifers at these points of currently high TDS groundwater, the Lake Powell water may improve the local groundwater quality at the recharge locations.

4.3.3.3 Jackson Flat Reservoir

KCWCD completed Jackson Flat Reservoir south of Kanab in spring 2012. Jackson Flat Reservoir is a 4,228 ac-ft facility to supply secondary untreated and agricultural irrigation water to commercial, institutional and industrial (CII) users that are currently served by well water. The reservoir stores surface water diversions that had typically been used by the Kanab Irrigation Company (approximately 7,500 ac-ft per year) in order to maximize the efficiency of the use of these agricultural diversions. Diversions are being stored in the reservoir throughout the year and are available during irrigation season when demands are highest. Locations of potential future water supplies for KCWCD are shown in **Figure 4-9**.

Figure 4-9 KCWCD Potential Water Supplies



4.3.4 Kane County Future Supplies – Potential

In addition to development of new groundwater, existing agricultural water supplies could be converted to M&I use, either through growth over currently irrigated lands or through “buy and dry” programs. Agricultural land exists in Kane County. There is no agricultural water use in the Wahweap Creek subbasin which is located in the Southeast Colorado River Basin. Most of the agricultural in the Kanab Creek subbasin is occurs near Kanab City. However, as previously mentioned in **Section 2.5,** none of the agricultural water in the Kanab City or Johnson Canyon area will likely be available for conversion toe M&I in the future. The Kanab irrigation company water rights are held for irrigation purposes only. Kanab Irrigation Company policy is not to allow for any conversions to M&I as properties are developed, but to transfer irrigation to other parcels which are readily available. Therefore, the irrigated lands and diversions attributed to the KCWCD group have a 0 percent agricultural water potentially developable for M&I use. Alton Town had no data in the sources reviewed. There is agriculture around Alton Town. For the purposes of this study it was assumed a minimal amount of irrigated land could be converted near Alton Town in the future if no other supply were available, resulting in 50 ac-ft per year of water supply.

There were a total of approximately 19,167 acres of agricultural land in 2013 within Kane County, of which 5,755 were irrigated acres and 13,412 were non-irrigated agricultural acres (DWRe 2014b). Irrigated agricultural acreage in 2013 and the associated agricultural water use (based a duty of water 5.0 ac-ft per year per acre; **Section 2.5**) are shown in **Table 4-13.** In order to calculate the amount of water available from potential agricultural water rights conversions to M&I use, it was assumed that the entire agricultural diversion right would be able to be transferred to M&I use (i.e., not just the consumptive use portion). The consumptive use for the new M&I water right was assumed to be no greater than the existing agricultural consumptive use. Although **Table 4-13** indicates that there is a total of 13,052 ac-ft per year of agricultural water use, it would not be reasonable to assume that all agricultural water use would be transferred to M&I. It was assumed that 20 percent of existing irrigated agricultural land could potentially be either developed for M&I purposes of purchased through “buy and dry” programs in the East Fork Virgin River Subbasin and that none would be available in the Kanab City and Johnson Canyon group. Thus, there would only be a total of approximately 1,153 ac-ft per year of water supply available to M&I from existing irrigated agricultural.

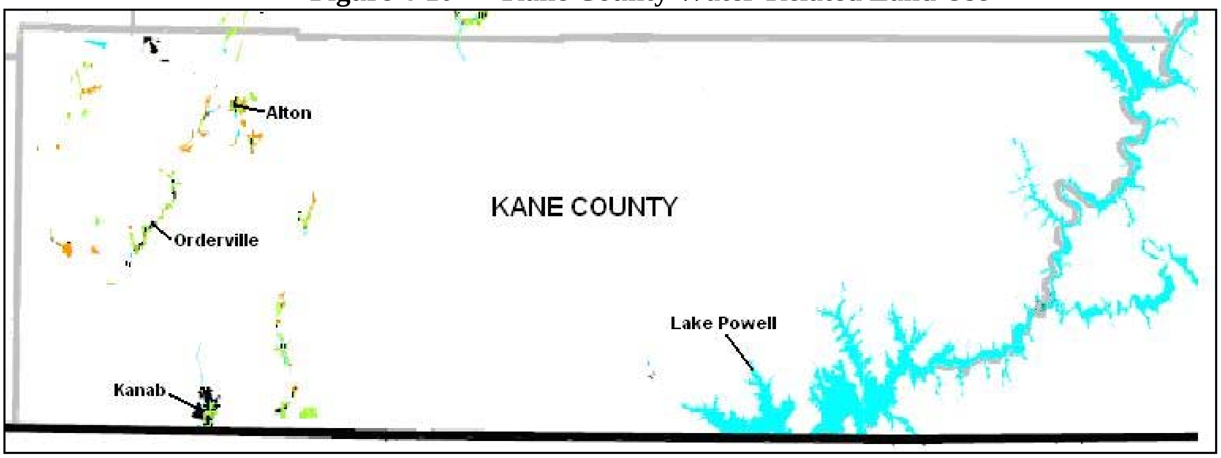
Table 4-13 Kane County Groups – 2007 Estimated Agricultural Water Use

Group	Irrigated Lands (acres)[1]	Agricultural Water Diversions (ac-ft/yr)[2]	20% Agricultural Water Potentially Developable (ac-ft/yr)
East Fork Virgin River Subbasin	1,150	5,750	1,150
Alton Town	50	250	50
KCWCD (Kanab City and Johnson Canyon Subbasin)	1,460	7,300	0
Wahweap Creek Subbasin	--	--	--

Notes:
(1)Source of irrigated land data: DWRe 2008c; DWRe 2013f; DWRe 2014b
(2)Based on duty of water of 5.0 ac-ft/yr per acre of irrigated agricultural land (DWRi 2008b, Section 2.5). Also assumed that the entire agricultural water right would be able to be converted (diversions) and not just the consumptive use portion (depletions) and 20% could be transferred to M&I.

Figure 4-10 outlines the relative location of irrigated croplands to urban areas. Irrigated croplands are represented by the areas shaded in green, while urban areas are colored black. The significant irrigated lands are located in the Johnson Wash and East Fork Virgin River floodplains. Agricultural conversions in the East Fork Virgin River area could supply future M&I demands in Orderville and Glendale. While no irrigated lands are shown for Alton Town in **Table 4-13, Figure 4-10** shows that some of the area around Alton Town would be available for agricultural conversion. This water would be needed for future supply once demand exceeds current reliable supplies.

Figure 4-10 Kane County Water-Related Land Use



Source: Modified from DWRe, 1999.
Notes: Map Color Code: Green = Irrigated Cropland, Orange = Non-Irrigated Cropland, Blue = Water, Black = Urban

4.3.5 Summary of Potential Developable Kane County Water Supplies

Table 4-14 summarizes the potential developable supplies to meet future demands in Kane County. KCWCD previously owned approximately 30,000 ac-ft per year of additional water rights referred to as the Andalex water rights. However, the District recently leased these rights to a proposed nuclear power plant project in Emery County off the Green River. The water rights were leased on a 40-year term with a 30-year renewal option. The lease payment for the rights is planned to be used by the District to help pay for the District's portion of the cost for the Lake Powell Pipeline project.

Table 4-14 Developable KCWCD Supplies

Source	Maximum Potential Yield (ac-ft/yr)				Comments
	East Fork Virgin River Basin	Alton Town	KCWCD (Kanab City and Johnson Canyon)	Wahweap Creek Basin	
New Groundwater Production	585	0	7,920	2,025	
Agricultural Water Conversion	1,150	50	0	--	Assumed 20% of irrigated agricultural water use could be transferred to M&I. Estimate is based on full conversion of agricultural diversions to M&I diversions assuming no increase in consumptive use. No agriculture is expected to transfer to M&I in the KCWCD group and a minimal amount was assumed for Alton Town.
Lake Powell Pipeline	0	0	4,000	0	KCWCD has requested 4,000 ac-ft from LPP Supply and plans to serve Johnson Canyon and Kanab City.
Total Potential Yield	**1,735**	**100**	**11,920**	**2,025**	

Chapter 5 – Water Conservation Programs

5.1 Introduction

Water conservation is an important component of any future water supply plan, particularly for communities in the arid southwest United States. Utah is one of the five fastest growing states in the nation and is the second driest state in the country (only Nevada is drier). The population growth rate coupled with the semi-arid climate makes water conservation vital to maximize the benefits of Utah's limited water resources. This chapter describes existing water conservation plans adopted by the Districts and the cities within their service areas and their recent effectiveness in reducing per capita water use and conservation programs adopted for future implementation. For the purpose of this report, water conservation is defined as reductions in municipal, commercial, and industrial per capita water use, because these are the demand sectors that would be served by supplies from the Lake Powell Pipeline. The information in this chapter is the basis for the assumptions for future water conservation used in the water needs forecast analysis described in **Chapter 3**.

In 1998 and 1999 the Utah legislature passed and then revised the Water Conservation Plan Act, requiring water agencies with more than 500 drinking water service connections to submit water conservation plans to the Utah Division of Water Resources by April 1999. The water conservation plans are intended to outline conservation goals, programs and methods for implementing the programs and guide the water agencies in their water conservation activities for the next five years (DWRe 2003). Water conservation plans evaluated in this document include:

- Kane County (KCWCD 2007)
- Kanab City (Kanab City 2013)
- Santa Clara (Santa Clara City 2009)
- Hurricane City (Hurricane 2009)
- LaVerkin (LaVerkin City 2010b)
- St. George (City of St. George 2008)
- Washington City (Washington City 2010)
- Ivins City (Ivins City 2008)
- Washington County Water Conservancy District (WCWCD 2010)

In 2000 the state of Utah set a statewide water conservation goal of reducing the 1995 per capita water demand from public community systems by at least 25 percent before 2050 (DWRe 2003). Then, in 2002, the state revised the goal to be at least a 25 percent reduction by the year 2050 from the baseline year 2000. DWRe estimates that an 8 percent reduction occurred from 1995 to 2000. In 2013, the state again revised its conservation goal to a 25 percent reduction of 2000 water use by 2025. DWRe estimated that the state of Utah achieved an 18 percent water use reduction between 2000 and 2010 (DWRe 2010).

5.1.1 Historical Conservation and Goals

From 2000 to 2010, total per capita water use decreased 26 percent in WCWCD's service area. In the KCWCD service area of Kanab City and the Johnson Canyon subbasin a reduction of 24 percent has been obtained (DWRe 2014c). Together, the four subbasins in Kane County have conserved 21 percent during the same time period. Both districts aspire to reduce 2000 per capita use 30-35 percent by 2060, exceeding the state goal of 25 percent reduction by 2025. The programs they have included in their water conservation plans have been evaluated and shown to be a practical method for achieving these goals.

Maddaus Water Management (MWM) concluded that 30 to 35 percent reduction by 2060 is attainable if additional conservation measures are implemented in each district's service area. Descriptions of these measures and results of the model are discussed in depth in the following sections. Based on this analysis, and the notable conservation already realized by both districts, the total per capita use reduction goals listed in **Table 5-1** are assumed when calculating future water demands.

Table 5-1 Conservation Goals[1]

Year	WCWCD	KCWCD (Kanab City and Johnson Canyon)	All Subbasins Combined
2010	26%	24%	21%
2025	33%	32%	28%
2060	35%	35%	31%
(1) Percent reduction in total per capita water use from 2000. (2)Source: DWRe 2014c.			

5.2 Washington County

Water use in the WCWCD service area reflects a strong trend towards increased conservation. The older parts of communities reflect the pioneer lots established at the time of settlements with gardens and trees, forming a narrow ribbon of green in the valleys. New developments have limited irrigated area, less turf and more desert-wise landscaping. From 2000 to 2010, conservation savings are estimated at about 26 percent (DWRe 2014c).

Given the long growing season, the annual precipitation of about 8 inches (WRCC 2013), with little falling during the peak demand season, the ever-increasing reduction in water use reflects the substantial efforts devoted to water conservation in Washington County. This achievement is magnified when considering that about 27 percent of the homes in Washington County are second homes, whose use is attributed to the resident population. Additional uses that are uniquely combined in the county include millions of tourists each year and Dixie State University's nonresident students, which add a substantial water use factor onto the relatively small local population (**Section 2.3.3)**. Per capita water use numbers will continue to decline as development density increases with urbanization.

As the first water conservancy district in Utah to adopt a water conservation plan, WCWCD has been a leader in conservation in Utah and continues to enhance its conservation programs. Seven cities have also adopted water conservation plans: St. George, Santa Clara, Washington, Hurricane, Ivins, Toquerville and LaVerkin. Additionally, WCWCD's 2006 Regional Water Supply Agreement described in **Section 1.3.1**, includes a number of conservation requirements for its municipal customers.

In August of 1993, WCWCD approved a "Long Term Framework for Water Resource Management, Development, and Protection Plan" stating the District's intent to develop a water conservation plan. The same month the District formed a Water Conservation and Drought Management Committee, comprised of realtors, landscape professionals, irrigators, and concerned citizens, with the objective of examining water conservation practices that could be implemented within the County. This committee's recommendations were incorporated into the Washington County Water Management and Conservation Plan (WCWMCP) which was adopted in May 1996. In 1998, the state of Utah imposed a water conservation plan requirement on water districts and retailers, currently codified at Utah Code Ann. § 73-10-32 (2014). The WCWMCP was revised in 2003 and again in 2010. The most recent conservation plan update occurred in 2015.

Between 1996 and 2010, WCWCD spent $12.6 million on water conservation efforts, and the district currently budgets about $250,000 per year for water conservation programs directly, in addition to a full-time water conservation manager and two full-time horticulturists for its demonstration gardens.

5.2.1 Washington County Water Conservancy District Programs

Conservation activities began in Washington County with the first Water Fair in 1995. After the adoption of the original WCWMCP in 1996, WCWCD hired a conservation coordinator and began implementing additional water conservation programs. The goal of each conservation plan is to conserve water through the improvement of surface water quality, seepage and evaporation reduction, drought management, watershed enhancement, irrigation practice improvements, public education, and conservation ordinance establishment.

Table 5-2 gives a list of the various water conservation measures WCWCD has implemented since 1996 (WCWCD 2007; WCWCD 2008b; WCWCD 2010). Each measure is described in more detail below.

Table 5-2 WCWCD Water Conservation Programs (WCWCD 2007; WCWCD 2008b; WCWCD 2010)

Category
Water Conservation Demonstration Gardens
Media
Education and Outreach
Conservation Education and Certification
Weather Station Link and Website
New Arrival Water Survival Kit
Rebates and Grants
Irrigation Upgrade Rebate Program
WaterSense Toilet Rebate Program
Water Efficient Technology Assistance Program (WETAP)
Turf Replacement for Public Athletic Fields
Water Checks
On-going Studies to Maximize Use of Highly Saline Water
Water-Wise Plant List and Tagging (State Program)
Watershed Management and Enhancement
Secondary Untreated Water Systems
Conversion of Open Canals to Pipelines
Telemetry Project
Ordinances
Impact Fee
Water Rates

5.2.1.1 Water Conservation Demonstration Gardens

The Garden at Tonaquint Park. To educate the public and landscape professionals on water-efficient landscaping, WCWCD, in cooperation with the City of St. George, constructed its first demonstration garden in the fall of 2002 at Tonaquint Park. Self-guided tours, with the assistance of pamphlets and kiosks, allow visitors to learn about the importance of soil composition and fertilization; weather and climate; irrigation practices and technology; and plant design and selection. The garden also displays five distinct landscaping themes: Desert Highlands; Urban Desert; Desert Shrublands; a Native Garden; and Desert Oasis. To further assist the public with water-efficient landscaping, a list of water-wise plants developed by WCWCD and Utah State University Extension, is available at the garden and online. Monthly workshops are hosted at the garden to give the public an opportunity to learn about water-wise practices from community experts. This garden has received many local donations and grants from the Bureau of Reclamation.

Tonaquint Community Garden. Local St. George residents grow a variety of fresh produce in a one-acre garden organized in 44 plots in this community garden. This community garden is designed to provide education to residents on how to nurture, maintain and protect a healthy landscape. An onsite horticulturist along with volunteer master gardeners offer hands-on instruction on how to plant and maintain food-producing plants in an arid, water limited environment. This garden is a partnership with St. George City and WCWCD. It was built with a 75/25 percent grant from Natural Resource Conservation District. Education is coordinated with Utah State University Extension.

Red Hills Desert Garden. Opened in May of 2015 in partnership with the City of St. George and the Virgin River Program, this interactive garden focuses on desert landscapes, with more than 170 plant varieties demonstrating the beauty of water smart landscapes. The 4.5-acre garden area uses, on average, five million gallons of water less per year than traditional turf. The garden provides information on designing, installing and maintaining a desert landscape that's compatible with the local climate and also offers views of endangered fish species and prehistoric dinosaur tracks.

5.2.1.2 Media

WCWCD launched its first conservation media campaign in 2000. Current efforts include print, broadcast and online advertising campaigns, a district website, brochures, fact sheets, flyers, and newsletters, with water saving tips and other water conservation information. WCWCD participates in the Governor's Conservation Team SlowtheFlow media campaign, started in 2002 to instill a conservation ethic state-wide, using a unified conservation message. WCWCD also engages in conservation related activities for "Water Week," designated by the state in 2007 as the first full week in May.

5.2.1.3 Education and Outreach

WCWCD organizes an annual water fair that reaches approximately 1,900 elementary school students annually. The fair is hosted at Dixie State University where the students participate in presentations and a water jeopardy game in which classes compete on knowledge about water treatment, water properties, water infrastructure and water conservation. This program began in 1995.

USU and St. George worked with Irrisoft to create a website that reports ET_o values based on data from three weather stations. ET_o values are used by landscape professionals and homeowners to gauge the landscape irrigation needs.

Other educational outreach programs implemented by WCWCD include a garden fair, facility tours and a water walk, in cooperation with the City of St. George. District staff members also serve as resources to educators in a school outreach program. Using these events and activities, the district educates people on the value of water, the importance of conservation and water issues facing the state. WCWCD also partners with the United States Environmental Protection Agency (EPA) in the WaterSense Program.

Qualified Water Efficient Landscaper (QWEL) classes are offered to train professional landscapers and homeowners to implement water conservation practices. This course covers 12 sections on landscape management involving design, plant selection, irrigation installation, irrigation scheduling and irrigation audit. WCWCD hosts an annual Irrigation Association certification courses to train and certify landscape professionals

5.2.1.4 New Arrival Water Survival Kit

Municipal customers of the WCWCD are given water conservation packets to hand out to new water utility customers. The packets contain information about programs offered, water-wise landscaping principles, local conservation resources and contact information for the water conservation specialist.

5.2.1.5 Rebates and grants

Rebates for water saving irrigation upgrades have been offered to all water use categories to encourage the use of Smart Water Applied Technology (SWAT) devices and high efficiency technology. SWAT devices update irrigation controllers based on plant water needs, weather information and soil moisture sensors. WaterSense-labeled-toilet rebates are offered to homeowners and commercial properties. Rebates are given for replacing clothes or dish washers with water efficient appliances. The Water Efficient Technical Assistance Program (WETAP) offers a rebate to businesses upgrading equipment to water efficient types. Also, WCWCD has offered matching grants for public athletic fields irrigated by culinary or potable water when retrofitted with artificial turf.

5.2.1.6 Water Checks

Water Checks were first offered by WCWCD in 2005 along with the state-wide "SlowtheFlow" program. A WCWCD technician performs tests on the irrigation system, evaluates system efficiency and application rate and provides appropriate recommendations to customers, including an irrigation schedule.

5.2.1.7 Ongoing Studies to Maximize Use of Highy Saline Water

WCWCD is working with Brigham Young University and the state to identify water-wise plants and irrigation practices that will thrive when irrigated with highly saline Virgin River water. Identification of plants that can tolerate the saline water and also survive on low water consumption could extend the use of a large quantity of water in secondary untreated water systems.

5.2.1.8 Water-Wise Plant List and Tagging (State Program)

WCWCD was a sponsor of the state's Water-Wise Plant Tagging Program. This program assists Utah citizens in identifying water-wise plants at participating plant nurseries. The plants must be 1) water-wise, 2) adaptable to Utah's arid climate and cold winters, 3) available in the industry, 4) relatively easy to maintain in the landscape and 5) have desirable landscape characteristics which function under limited water availability. Tags are placed on plants that meet the five specified criteria to assist in identifying appropriate plants for use in the region.

5.2.1.9 Watershed Management and Enhancement

The Virgin River Watershed Management Plan (VRWAC 2006) addresses watershed concerns of water quality and water quantity as they affect drinking water supplies, threatened/endangered/native species and riparian corridor health. WCWCD was a major partner and contributor to the Plan and assisted in its development by working with Utah Department of Environmental Quality (UDEQ) to address water quality impairments through Total Max Daily Loads (TMDL) for the Virgin River and its tributaries. They were also influential in several programs to improve streamflow within the watershed including the Virgin River management and Recovery Program as well as contributing to the integrated approach of managing water supply and watershed health put forth in the Plan.

5.2.1.10 Secondary Untreated Water Systems

Municipalities and WCWCD, pursuant to the RWSA, are maximizing the use of secondary untreated water systems to serve new development, thus offsetting demands on culinary water sources (WCWCD 2006). One conservation method that reduces irrigation water use is the conversion of open canals and flood irrigation to pipelines and pressurized systems. This reduces water losses from seepage and evaporation in secondary untreated systems. The Toquerville Secondary untreated Water System was the first open ditch system to be connected to a piped system. WCWCD purchased water rights from the Toquerville Irrigation Company's shareholders and converted the open-ditch irrigation system to a pressurized system which distributes irrigation water from Toquerville Springs to Toquerville residents. The Gunlock to Santa Clara pipeline has replaced four diversions and converted flood irrigation to a pressurized system. The pipeline delivers irrigation water to Ivins, Santa Clara, and the Shivwits Band of Paiute Indian Reservation. Also, WCWCD was instrumental in converting the largest and longest open canal system in the county, the St. George and Washington Canal system, from approximately 22.6 miles of open ditch to enclosed pipeline (including main canal and laterals). Finally, upon completion of the district's Ash Creek Project, another 6.3 miles of open ditch will have been converted to enclosed pipelines (including the ditch from South Ash Creek to Pintura and the Wet Sandy Ditch.

5.2.1.11 Telemetry Project

To minimize water loss, aid in water management, and enhance the accuracy of measuring water right allocations, a telemetry project that monitors diversions along the Santa Clara River and Virgin River has been implemented (WCWCD 2008b). The project monitors diversions along both rivers to minimize water loss and enhance the accuracy of measuring water right allocations.

5.2.1.12 Ordinances and Impact fees

All municipal customers of the district have time-of-day watering restrictions to discourage excessive water use. Impact fees, applicable to all new development (new platted lots and building permits) within the service areas of municipal customers, are based on the size of the irrigable portion of the lot, with a pro rata increase for irrigated areas over a certain size (WCWCD 2008b).

5.2.1.13 Water rates

To encourage the reduction of water consumption, many cities have adopted inclining block-rate structures. Block rate structures consist of fixed amounts of water sold at a unit price. Increased block rate structures are based on the idea that consumers will use less water if the unit rate of water increases with increased volume consumption. Inclining block-rate structures are more effective in encouraging customers to reduce their water use when there is a significant price difference between each tier. WCWCD and the following cities have adopted increasing block rate structures: Springdale, Hurricane Valley, La Verkin, Ivins, Washington, Santa Clara, St. George, Enterprise, and Hurricane, where the price of water is stepped up based upon increased usage. In addition, WCWCD completes a water budget for each of its golf course customers and charges a 50 percent surcharge for usage in excess of the budget amount.

5.2.2 Programs Offered by Cities in Washington County

The conservation efforts of the individual cities in Washington County are consistent with those of WCWCD with a primary focus on public awareness and education. St. George City employs a water conservation coordinator and the seven major cities in Washington County have written conservation plans. These plans implement a wide range of conservation measures, several in partnership with WCWCD. To encourage water conservation, Washington County municipalities are:

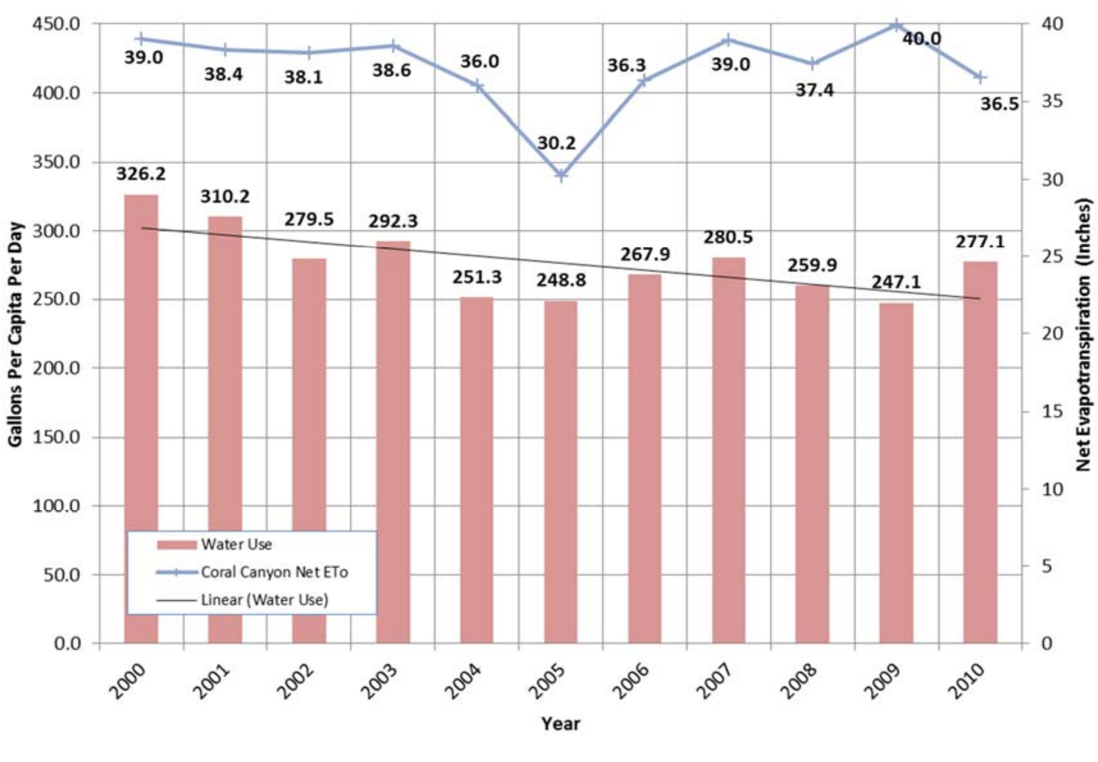
- Charging increasing block-rate structures to encourage efficient water use
- Implementing time-of-day watering ordinances to discourage irrigation water waste
- Restricting use of culinary water for large irrigators and homeowners
- Prohibiting use of culinary water for washing paved areas, non-commercial car washing, filling of private swimming pools, and irrigation of city parks or schools
- Offering free residential outdoor water audits
- Providing water audit programs for commercial and industrial users
- Integrating drought management plans into rate schedules
- Offering rebates for water efficient toilets and washing machines
- Giving rebates to coin-operated laundromats and multi-family housing complex laundries that upgrade to water efficient washing machines
- Promoting of indoor water-saving fixtures
- Offering incentives for efficient landscape/irrigation installations or rehabs
- Rebating pressure regulating valve installations on irrigation systems
- Converting of public facility irrigation systems to secondary untreated water where feasible
- Installing additional meters and radio read systems to better account for water losses
- Replacing old pipes and meters to significantly reduce water loses
- Upgrading SCADA systems to better manage and identify water losses
- Purchasing leak detector to decrease water loss
- Educating students, teachers and scout troops about water conservation, water quality, water supplies, and water shortages
- Participating in WCWCD's annual water fair
- Presenting to Chamber of Commerce and service clubs on water conservation
- Teaching customers to read and understand their water bills
- Providing water use comparisons and water savings tips with customer's water bills
- Distributing conservation information by newsletters, public awareness programs, conservation pamphlets, checklists, and lawn water guides
- Publishing lists of low water plant species to promote more efficient of landscape design
- Providing training on efficient irrigation systems
- Offering awards for water-conserving landscape
- Hosting workshops for industry professionals such as landscapers, builders, plumbers, and irrigation contractors
- Increasing public awareness of conservation practices through radio and newspaper education
- Identifying effective conservation programs with Alliance for Water Efficiency's Water Conservation Tracking Tool
- Promoting xeriscape, especially in new developments
- Requiring installation of secondary untreated water irrigation systems in new developments

- Implementing water conservation principles in planning, development and management of new projects

5.2.3 Conservation Savings

As previously shown in **Table 5-**1, total per capita water use decreased 26 percent in WCWCD's service area between 2000 and 2010 (DWRe 2014c). The overall culinary water conservation savings for WCWCD from 2000 to 2010 was determined by DWRe to be 15 percent utilizing actual data for the 6-cities between 2000 and 2010 (DWRe 2013c). Reduction in regional per capita water use can result from conservation actions, changes in housing density, housing types, landscaping, lot sizes, climate, water pricing, drought policies, regional economic conditions (e.g., recessions), percentage of non-permanent residents, hotel occupancy, and commercial, institutional and industrial (CII) uses. ET_o data were analyzed to help determine the effects weather may have had on water use in a particular year. High ET_o in hot and dry years could result in increased water demands for outdoor irrigation. The opposite is true for wet and cool years when water use can decline. **Figure 5-1** shows the relationship between net ET_o and per capita culinary water use for the six cities, as monitored by the Governor's Water Conservation Team.

Figure 5-1 Culinary Per Capita Water Use for WCWCD (6 Cities; DWRe 2009b, DWRe 2013c, DWRe 2013e)



5.2.4 Future Goals and Water Conservation Programs

Future water conservation savings were estimated through a detailed water conservation study, originally conducted for WCWCD by Maddaus Water Management in 2010 (MWM 2010b) and updated in 2015 (Appendix B, MWM 2015a). This analysis reviewed water use data (billing data), evaluated existing water conservation measures, considered potential future water conservation measures and selected a program considered likely to be implemented in the future. The analysis relied on a model developed by MWM that analyzes water use at the end-use level (e.g., individual appliances and fixtures) and considers factors such as individual unit water savings, year of implementation, unit costs, and market penetration. Meetings with local water user representatives were held to select preferred conservation measures.

Twenty-eight conservation measures were selected for evaluation in the DSS Model. Based on water savings potential and cost-effectiveness, 23 of these conservation measures were included in the 2015 conservation plan update. The details of the study and each conservation measures are included in Appendix B, MWM 2015a. **Table 5-3** lists the measures selected for implementation.

Table 5-3 WCWCD Conservation Programs

Measure Name	Category
Real Water Loss Reduction	General Measures
Conservation Pricing	General Measures
Public Information Program	General Measures
Water Budgeting/Monitoring	General Measures
Billing Report Educational Tool	General Measures
Efficient Outdoor Use Education and Training Program	General Measures
Distribute Retrofit Kits	Residential Measures (Indoor)
Single Family (SF) Water Surveys	Residential Measures (Indoor)
Toilet Leak Detection	Residential Measures (Indoor)
Multifamily Washer Rebate	Residential Measures (Indoor)
High Efficiency Toilet (HET) Rebates	Residential Measures (Indoor), Commercial Measures (Indoor)
CII Surveys	Commercial Measures (Indoor)
CII Rebates to Replace Inefficient Equipment	Commercial Measures (Indoor)
Replace Spray Nozzles	Commercial Measures (Indoor)
High Efficiency Urinal Rebate (<.5 gallon)	Commercial Measures (Indoor)
School Building Retrofit	Commercial Measures (Indoor)
Install High Efficiency Fixtures in Government Buildings	Commercial Measures (Indoor)
Irrigation Water Surveys (Water Checks)	Irrigation Measures (Outdoor)
Xeriscape Demonstration Gardens	Irrigation Measures (Outdoor)
Train Landscape Maintenance Workers	Irrigation Measures (Outdoor)
Financial Incentives for Irrigation Upgrades	Irrigation Measures (Outdoor)
Smart Irrigation Controller Rebates	Irrigation Measures (Outdoor)

Table 5-4 summarizes the projected GPCD reductions and percent conservation anticipated with the selected program. Results show that by 2060 WCWCD could reduce its 2010 GPCD levels by 12 percent by 2060. The estimated water savings include those anticipated from enforcement of current plumbing codes that require use of low-flow plumbing fixtures in new homes and remodels. The conservation savings shown in **Table 5-4** were factored into the demand projections used to compare future supply and demand in **Chapter 6**.

Table 5-4 Conservation Program Projected GPCD Reduction Percentage to Year 2060

Year	Conservation Plan with Plumbing Code (GPCD)	Conservation Plan with Plumbing Code (% Reduction)
2010	325	0%
2020	306	6%
2025	298	8%
2030	294	10%
2040	291	10%
2050	288	11%
2060	285	12%

5.3 Kane County

The Kane County Water Conservancy District and the City of Kanab have developed conservation plans for the Johnson Creek and Kanab Creek areas. The goal of these plans is to make sure that future culinary water needs are met. As with other parts of Utah, many of the homes in Kane County are secondary untreated homes. As a result, water use increases during the summer months, holidays, and weekends.

The City of Kanab adopted a water conservation plan in 1999 and revised it in 2009. The water conservation plan addresses past water conservation measures, opportunities to develop and implement management conservation measures, and short and long term goals for efficient water use.

5.3.1 Current Conservation Program

5.3.1.1 KCWCD (Kanab City and Johnson Canyon)

The Johnson Canyon area has year-round residence with both outside and inside usage. The conservation efforts in this area focus on management, household usage and outside usage. Management conservation measures include the facilitation of water rights transfers and acquisition of new water rights (KCWCD 2011). The efficiency of KCWCD's culinary water distribution system will be sustained through maintenance and system upgrades. The Johnson Canyon system is currently monitored by employees of KCWCD, but the installation of a SCADA system is possible in the future to automate and monitor the system (KCWCD 2011).

KCWCD is educating the public on water conservation methods that can be implemented to reduce household water use. KCWCD has adopted an inclining block-rate structure in their Johnson Canyon area. Inclining block rate structures are based on the idea that consumers will use less water if the unit rate of water increases with increased volume consumption. **Table 5-5** shows the increasing block rate structures that are used to discourage excessive water use in the Johnson Canyon area (KCWCD 2011).

Table 5-5 KCWCD Increasing Block Rate Structure for Residential Customers

Water System	Level	Consumption	Rate
Johnson Canyon	--	Residential Standby	$15.00
Johnson Canyon	1 - Base Minimum Fee	0-15,000 gal/mo	$35.00
Johnson Canyon	2	15,001-25,000 gal/mo	$1.00/1,000 gal
Johnson Canyon	3	25,001-45,000 gal/mo	$1.25/1,000 gal
Johnson Canyon	4	45,001+ gal/mo	$1.50/1,000 gal

Kanab City's conservation approach has primarily been to provide an efficient culinary water supply system to its customers, and the city has completed system upgrades to improve the efficiency including completion of a pressurized irrigation system. Kanab City's short and long term goals for efficient water use include public education, maintenance and upgrades of the culinary water system, use of reclaimed municipal wastewater for irrigation of parks, golf courses and other large turf areas, source protection zones and well management. Other conservation implementations include residential water saving devices and practices for consumers, requirements of new residential construction to meet landscape or xeriscape ordinances, and impact fees and water rates based on usage and best management practices on golf courses and parks. **Table 5-6** lists the conservation programs in greater detail.

Table 5-6 KCWCD (Kanab City and Johnson Canyon) Conservation Programs

Category	Title	Description
Education and Outreach	Public Education	Teach children and adults about conservation methods to minimize water use.
Water Distribution System	Maintenance	Maintain an efficient culinary water system through maintenance and system upgrades.
Residential Water Systems	Water Saving Devices	Flow restrictors for showers and faucets, toilet dams, leak protection kits, and lawn watering guides.
Residential Water Systems	New Construction Requirements	New residential construction must meet model landscape or xeriscape ordinances.
Water Rates	Impact Fees, Increasing Block Rate Structure	Impact fees and water rates based on water usage are used in Kanab City. An increasing block rate structure is currently used in the Johnson Canyon area.
Commercial and Industrial Water Systems	Best Management Practices	Best Management Practices for golf courses and parks including bubblers on trees, timed night watering, upgrade in sprinkler efficiency, use of low-pressure nozzles, minimization of well overflow, and immediate fixing of water leaks.
Water Source	Protection	Maintain source protection zones and protect recharge and watershed areas.
Source: Kanab City 2013; KCWCD 2011		

Kanab City also has a four stage conservation approach, with the four stages of conservation based on four levels of water shortages or reduction in supply from drought or equipment failure. Kanab City has a conservation management plan, with detailed requirements and restrictions for each of the four levels of water shortages. The management plan describes conservation requirements for indoor and outdoor water practices for each of the four levels of shortages, which are generally described in **Table 5-7**.

Table 5-7 Kanab City Conservation Management Plan

Conservation Stage	Supply/Demand Relationship	Conservation Action
Stage 1	Supply 2-3% greater than total daily demand, or drought or equipment failure results in 2-3% reduction in supply	Voluntary restrictions on nonessential water use, with reduction goal of 2-3% of daily peak use.
Stage 2	Culinary demand greater than supply by 1-3%, or drought or equipment failure results in 5% reduction in supply	Mandatory restrictions on nonessential water use, with reduction goal of 5-10% of daily peak use.
Stage 3	Culinary demand greater than supply by 5%, or drought or equipment failure results in 10% reduction in supply	Mandatory restrictions on nonessential water use, with reduction goal of 10-25% of daily peak use.
Stage 4	Culinary demand greater than supply by 10%, or drought or equipment failure results in 25% reduction in supply	Water rationing plan for all available culinary water resources, with reduction goal of 25-60% of daily peak use.
Source: Kanab City 2013		

5.3.2 Conservation Savings

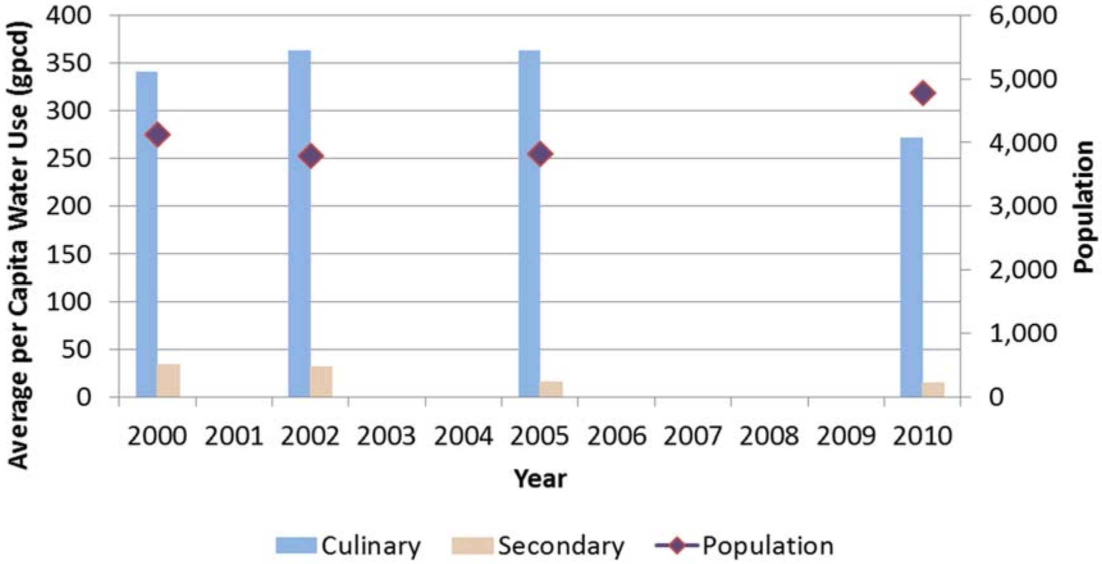
The historical water use patterns for Kane County were analyzed based on water production and consumption data provided by KCWCD. However, much of the water use data available to KCWCD contains many errors. The best assumptions have been made to include all water uses, with knowledge that in some areas the water numbers are being reported in multiple data sets. Current population data also is limited to the census records that do not account for the actual use by Kane County's large transient tourist and second home users. As a result the current measures of GPCD are not fairly comparable to other areas.

For the purposes of this document, estimates of past water use were made based on the Kanab Creek/Virgin River Basin M&I water supply and use reports from the Utah Division of Water Resources. These were used to estimate the trend in per capita water use in KCWCD (Johnson Canyon and Kanab City).

5.3.2.1 KCWCD (Kanab City and Johnson Canyon)

Between 2000 and 2010, the time period in which KCWCD began providing culinary water to the Johnson Canyon area, the total water use decreased by 24 percent (DWRe 2014c). Culinary water use dropped 20 percent and secondary untreated water use dropped 56 percent. Average per capita water use for the KCWCD service area (Kanab City and Johnson Canyon) is shown in **Figure 5-2** (DWRe 2006a, DWRe 2009a, DWRe 2014c).

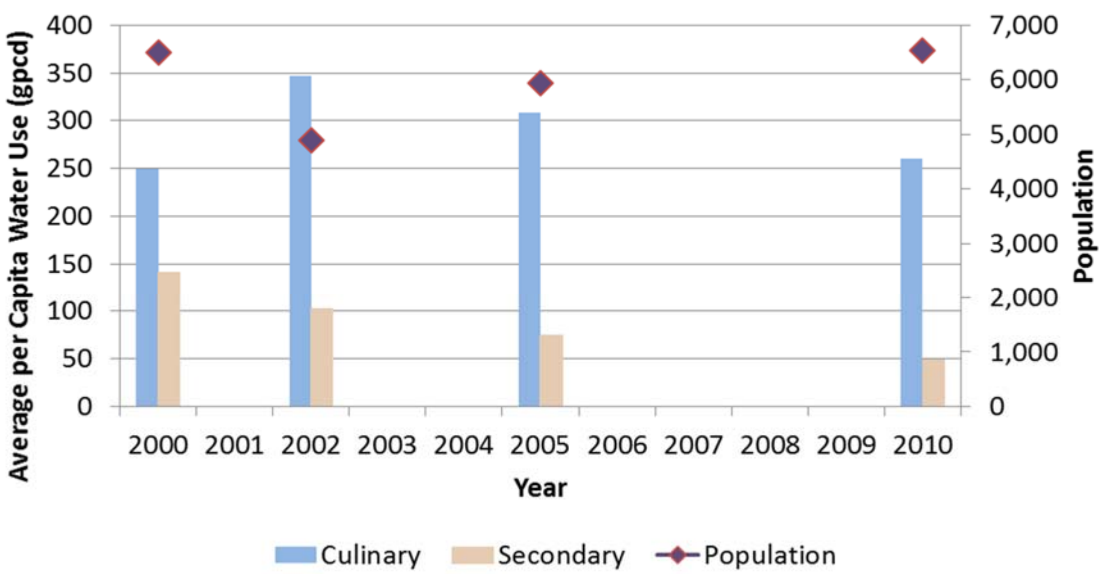
Figure 5-2 KCWCD (Kanab City and Johnson Canyon) Average per Capita Water Use from 2000 to 2010



5.3.2.2 Four Subbasins

Between 2000 and 2010, the total water use for the four subbasins combined decreased by 21 percent (DWRe 2014c). Average per capita water use for the four subbasins combined is shown in **Figure 5-3** (DWRe 2006a, DWRe 2006b, DWRe 2008a, DWRe 2009a, DWRe 2014c)

Figure 5-3 Four Subbasins Average per Capita Water Use from 2000 to 2010



5.3.3 Future Goals

Kanab City, Johnson Canyon and the remainder of Kane County have begun to make significant conservation savings in recent years. Future community-wide conservation savings will be achieved by implementing both passive and active measures. Passive measures are codes and standards that force consumers to update appliances and fixtures to increase conservation savings. Active measures are those in which KCWCD will invest to promote conservation, such as incentives and educational programs.

MWM completed a Conservation Technical Analysis Memorandum (Appendix B, MWM 2015a) to identify programs and projects to most effectively improve water use efficiency. This Conservation Technical Analysis builds on the 2010 Water Conservation Technical Analysis prepared by MWM and MWH (MWM 2010a). In this analysis, MWM included uses from all of Kane County, including the Duck Creek and Cedar Mountain area. For this reason, the estimates of gallons per capita day are higher than what is shown by the DWRe and used in this analysis. A study of the potential conservation measures readily available to Kane County entities yielded three potential water conservation programs. Of these, Program B was selected by KCWCD for future implementation.

MWM (2015a) performed an analysis of potential conservation measures and programs for Kane County. This task included a review of KCWCD's current water conservation measures, identification of current and new measures that may be appropriate for the local entities, and screening of these measures to a short-list for detailed evaluation (benefit-cost analysis). The short-list was further evaluated and scored during screening workshops based on water use characteristics, economies of scale, demographics, and other factors that are unique to Kane County.

To more precisely estimate Kane County's water use, Maddaus Water Management (MWM) employed its DSS Model. Using data provided by KCWCD for population and demand in 2013 and the historical and projected water use estimates provided by the State (DWRe 2014c), MWM was able to estimate water use projections for multiple water use categories and develop conservation strategies to help the district achieve its water use goals (Appendix B, MWM 2015a).

A total of 24 individual measures were evaluated using the DSS Model. Based on the modeling results from Maddaus Water Management's DSS model. Program B was chosen as the only cost-effective combination of measures. To achieve the desired level of water efficiency county-wide, all utilities must participate in Program B and implement the applicable measures with their share of the overall customer participation rates assumed in the DSS model. **Table 5-8** lists the ten conservation measures selected under Program B. Measures are categorized as education, or incentives.

Table 5-8 KCWCD Conservation Measures Considered

Measure Name	Category
Distribute Retrofit Kits	Incentives
Toilet Leak Detection	Incentives
Public Information Program	Education
Rotating Sprinkler Nozzle Rebates	Incentives
Replace Spray Nozzles	Incentives
Xeriscape Demonstration Gardens	Education
Billing Report Educational Tool	Education
Educate Builders on New Home Water Sense Standards	Education

Measure Name	Category
Twenty Gallon Challenge	Education
Efficient Outdoor Use Education and Training Programs	Education

5.4 Conclusions

WCWCD has been a leader in water conservation for many years. It developed its water conservation program in 1996 before it was required by the State of Utah and has continued to expand the program and add measures to increase water conservation. Based on a review of historical water use, total per capita water use decreased from 2000 to 2010 by 26 percent (DWRe 2014c). WCWCD has exceeded the state goal of 25 percent reduction by 2025 and aims to reduce 2000 per capita use 35 percent by 2060. Maddaus Water Management (MWM) concluded that this reduction is attainable if additional conservation measures are implemented in the district's service area (Appendix B, MWM 2015b).

Kane County has also had significant conservation savings for the 2000-2010 period with a reduction of 24 percent within the KCWCD service area of Kanab City and Johnson Canyon (DWRe 2014c) and 21 percent for the four subbasins in Kane County combined. MWM (2015a) performed an analysis of potential conservation measures and programs for Kane County. This task included a review of KCWCD's current water conservation measures, identification of current and new measures that may be appropriate for the local entities, and screening of these measures to a short-list for detailed evaluation (benefit-cost analysis). The short-list was further evaluated and scored during screening workshops based on water use characteristics, economies of scale, demographics, and other factors that are unique to Kane County. KCWCD intends exceed the State goal of 25 percent by 2025 and to further reduce 2000 per capita use 30 percent by 2060 through these conservation measures.

Chapter 6 – Water Resources Planning

6.1 Introduction

The integrated water resources plans for each district define the magnitude and timing of future water project development in relation to future water demands. They show a likely scenario of how supplies could be developed in a logical sequence to meet demands. These plans are designed to determine whether the Lake Powell Pipeline Project would be needed within the planning horizon (present to 2060), and if so, when.

WCWCD: It is estimated the LPP would need to be brought online in 2028 when the projected demand with conservation nears 81,273 ac-ft, exceeding the total reliable supply. Total reliable supply for WCWCD is 67,677 ac-ft per year with an additional 13,670 ac-ft per year of culinary or potable supply projects planned for completion prior to 2060. A portion of the culinary supplies can be used to meet secondary untreated demands as necessary until their full yield is needed to fulfill culinary requirements.

KCWCD: The KCWCD (Kanab City and Johnson Canyon) reliable supplies are projected to be in deficit by 2035 when they would be exceeded by total water use. Supplies are projected by DWRe (2014b), reduced by the Reclamation projected climate change median streamflow reductions (Reclamation 2014) and again reduced to account for a 10 percent planning reserve buffer.

Criteria for bringing new water projects online, and the strategies for implementing new projects, vary among water utilities and can change substantially over time in response to many factors including hydrology, economics, and politics. The evaluation in this study is necessarily simplified and is intended primarily to assess the need for the Lake Powell Pipeline Project in the context of long-term growth. Each district’s short-term planning objectives and priorities may change from the concepts outlined in this study over time, but the effects of any short-term changes in local water development would not affect the need for the LPP within the planning horizon (2010 – 2060).

The following general assumptions were used in preparing integrated water resource plans for each district.

- **Service Area.** The districts’ service areas include cities that have developed their own water supplies. These cities have various policies – formal and informal – on how they want to participate with their water conservancy district in meeting future demands. Some plan to rely entirely on the district to meet all increased demands in the future (e.g., RWSA municipal customers of the WCWCD), while others currently anticipate meeting increased future needs on their own. For purposes of this study, total supplies and demands throughout Washington County and within Kanab City and the Johnson Canyon subbasin of Kane County have been considered when determining the need for and timing of new water sources, based upon the following assumptions:

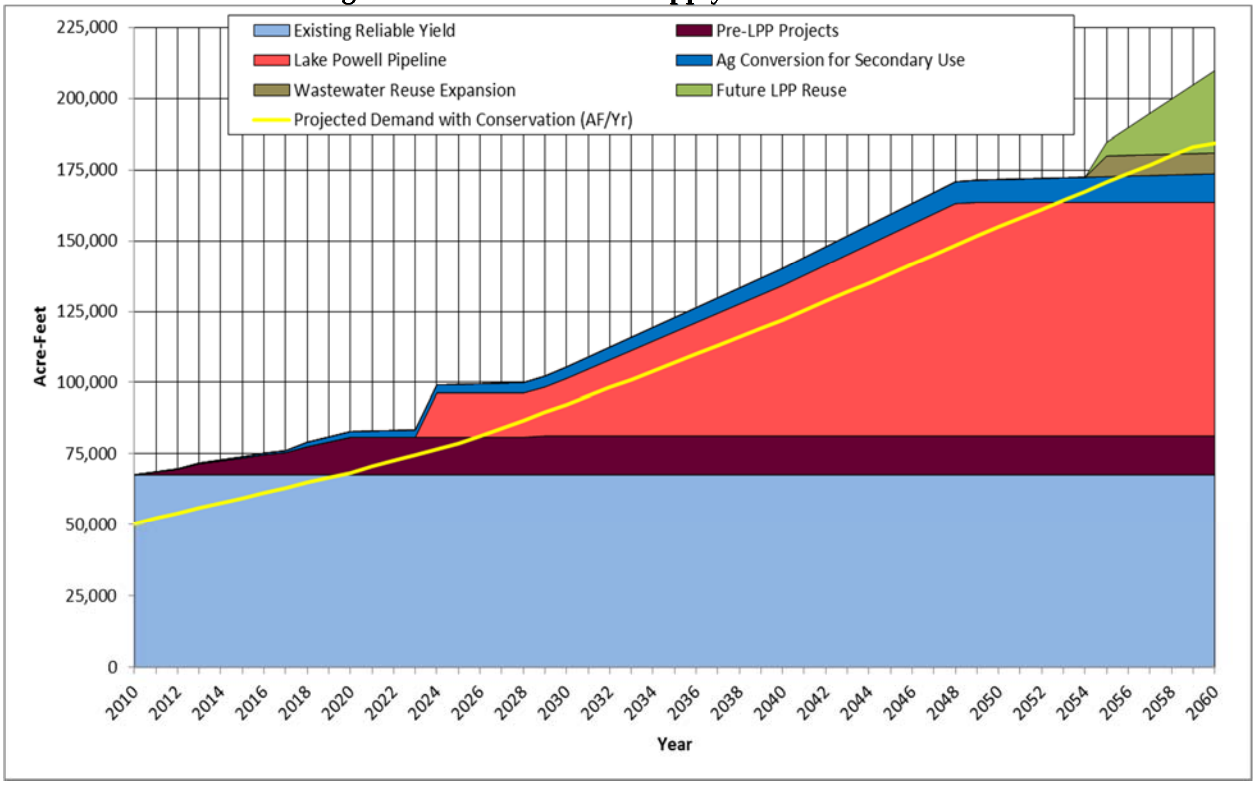
    - The benefits of regionalization in seeking new water sources will encourage water suppliers to work together rather than individually
    - Local projects implemented by individual water suppliers in already over-appropriated basins (e.g. virtually all of the Virgin River basin) will increase the need for regional supplies.
- **Unconstrained Distribution Systems.** The required infrastructure would be provided to distribute new water sources to the areas of need.
- **Total Water Use.** Total water use (culinary and secondary untreated) has been used to forecast water demand timing.
- **Sequential, Prioritized Project Implementation.** Although districts could simultaneously implement multiple projects, the uncertainties of timing cannot be addressed in this analysis. New projects have been sequenced based on current capital facility plans, qualitative unit cost, current status of project development, ease of implementation, and stated preferences of the districts.
- **Supply Reductions.** The U.S. Bureau of Reclamation projected climate change median streamflow reductions (Reclamation 2014) were incorporated into WCWCD water supply modeling and applied to the reliable supply estimates for Kane County. Also, a ten percent planning reserve is incorporated into the reliable supply quantities to avoid using water supplies up to the maximum and to provide a buffer against annual variability in water supplies affected by precipitation runoff and groundwater recharge.
- **Project Certainty.** Future water projects have a reasonable certainty of being implemented within the study period. More speculative or uncertain projects, due to technical, cost or environmental concerns, have not been included.
- **Lake Powell Pipeline Supplies.** LPP requests have been used as LPP supplies (82,249 ac-ft per year for WCWCD and 4,000 ac-ft per year for KCWCD).

Assumptions specific to each individual district are described in the following sections.

6.2 WCWCD Integrated Water Resources Plan

Figure 6-1 shows the timing of supply and demand. LPP would be needed in approximately 2028. The full yield of secondary untreated supply projects would be available to meet any M&I demand (i.e., both culinary and secondary untreated demand) when the projects are complete. The portion of the culinary supplies above the demand line would be needed when the demand line crosses the supply line, so this portion of culinary supply could be used to meet secondary untreated demand until the entire culinary supply is needed to meet culinary demands.

Figure 6-1 WCWCD Supply and Demand – Total



More details regarding the yields of these supplies are summarized in **Table 6-1**. Specific assumptions used to develop the integrated water resources plan are presented in **Table 6-2**. The difference between the projected 2060 demand of 184,250 ac-ft per year and reliable supplies (67,677 ac-ft per year) is about 116,573 ac-ft per year. Approaches for meeting this projected demand are discussed below and include planned projects. The suggested order of implementation of all planned and potential projects is based on a comparison of conceptual unit cost, current status of project development, and preferences expressed by the WCWCD during meetings held with the district for the analyses completed for this report.

The total yield of WCWCD culinary projects planned before bringing the LPP online is 13,670 ac-ft per year. These projects are described in detail in **Section 4.2.5**. The Ash Creek Project is the first culinary water supply source because it makes culinary-grade quality water available that currently is used to meet secondary untreated demands. Other future culinary supplies include well field expansions and upgrades.

Another source of water available to WCWCD to meet total water demands would be agricultural water conversions from M&I development (10,080 ac-ft/yr). This potential project has substantial feasibility or economic constraints that preclude it as a viable option as a culinary M&I supply. However, water from agricultural conversions could supply secondary untreated demands. It was assumed that agricultural conversions would begin immediately and continue to increase annually until the full yield is attained. Conversions made in the Washington Fields area would need to be stored in a future storage facility to attain maximum yield. For planning purposes, it is assumed that this storage can be permitted, designed, and constructed in about 6 years, prior to the LPP.

Water reuse up to the existing St. George reuse plant capacity is the next increment of secondary untreated supply. Assuming storage facilities would be implemented, a future maximized 10 mgd plant capacity would result in 7,300 ac-ft per year of future supply. Additional reuse plant expansion beyond existing plant capacity could be implemented as another source of secondary untreated supply and would accommodate reuse of LPP water. Plant expansion could be phased in over time to meet demand in response to population growth and water use, improvements in treatment technologies, and improved public acceptance of water reuse.

Timing for new secondary untreated water sources assumes demand along with construction of separate secondary untreated water distribution systems. A portion of the culinary supplies can be used to meet secondary untreated demands as necessary until their full yield is needed to fulfill culinary requirements.

Table 6-1 WCWCD Summary of Existing and Future Supplies

Existing Project	Reliable Culinary Quality Water Yield (ac-ft/yr)[2]	Reliable Secondary untreated Quality Water Yield (ac-ft/yr)[2]
Quail Creek and Sand Hollow Reservoirs[3]	24,922	0
Sand Hollow No-Recharge Groundwater[4]	4,000	0
Cottam Well Field	875	0
Kayenta (Ence Wells) Water System[8]	730	0
Crystal Creek Pipeline	2,000	0
Toquerville Secondary untreated Water System[5]	0	178
Ash Creek Pipeline[6]	2,840	0
Sand Hollow Recharge and Recovery[7]	3,000	0
Cottam Well Maximization	600	0
Sullivan Wells	750	0
Pintura Well	600	0
Diamond Valley Well	400	0
Westside Arsenic Treatment[9]	5,000	0
Other Washington County Providers	27,125	8,327
Maximize Existing Wastewater Reuse[8,10]	0	7,300
Agricultural Conversion from Development[8,11]	0	10,080
Lake Powell Pipeline	82,249	0
Potential Future LPP Reuse[8]	0	28,830
Total	**155,091**	**54,715**

Notes:

[1]Source of data: WCWCD 2014; DWRe 2013a; DWRe 2013d. Average yield with up to 10 percent shortage assumed to represent reliable yield for WCWCD projects.

[2]Culinary quality water was assumed to be able to meet culinary demands first, and then secondary untreated demands with any portion of the culinary supply that is not fully utilized.

[3]Reliable yield model for Quail and Sand Hollow Reservoirs includes yields from Kolob and Meadow Hollow Reservoirs. Current supply from 50th percentile climate change scenario with 10% shortage (DWRe 2014a).

[4]Supply utilizes existing water rights and natural basin recharge.

[5]DWRe 2013d. Assumed reliable supplies are equivalent to current secondary untreated water use.

[6] Ash Creek Pipeline yields 2,840 ac-ft/yr based on a 90% reliability level under the 50th percentile climate change scenario.

[7]Arsenic Treatment or blending and transmission upgrades must first occur.

[8]To be implemented post-Lake Powell Pipeline (Ence Well post-LPP portion equal to 480 ac-ft/yr)

[9]Includes Gunlock to Santa Clara Pipeline and Snow Canyon Wells. Moved to future reliable supply due to extent of treatment needed for culinary supply.

[10 See Section 4.2.5.2.1.

[11]The estimated supply is 12,880 ac-ft/yr with 90% reliability (DWRe 2011a). However, it was estimated that approximately 2,800 ac-ft/yr of this supply is currently in use and has been accounted for in the reliable secondary untreated supply.

Table 6-2 WCWCD Integrated Water Resources Plan Data

Supply Source	Average Annual Yield in 2060 (ac-ft/yr)	Type of Supply (Culinary or Secondary untreated)	Timing	Start Date	Comments
Existing Supplies	67,677[1]	Culinary and Secondary untreated		-	Combined culinary and secondary untreated supply.
Future Supplies					
Agricultural Conversions from Development	10,080[2]	Secondary untreated	Begin when needed; phase in over time	2010	Consists of multiple projects and water rights changes. Linear annual increase to meet secondary untreated demand; full yield requires additional storage.
Ash Creek Pipeline and Well Improvements	13,670[4]	Culinary	As needed Pre-LPP, 480 ac-ft Kayenta Wells post-LPP	2010	Culinary supply indirectly by supplying secondary untreated supply grade water to offset current culinary use.
Lake Powell Pipeline	82,249	Culinary	When needed	2028	Can be used to meet culinary and/or secondary untreated supply as needed. 82,249 ac-ft/yr used in 2060.
Maximize Existing Wastewater Reuse Capacity of 10 mgd	7,300[3]	Secondary untreated	When needed	2055	Treatment capacity and distribution system can be phased as needed to meet secondary untreated demand; requires additional storage.
Future LPP Reuse	28,830[4]	Secondary untreated	When needed	2055	Phased in as needed to meet secondary untreated demand; requires additional storage.

Notes:
(1)Includes WCWCD reliable water supply based on WCWCD 2014 which includes WCWCD existing projects and water uses. Includes other existing municipal supplies.
(2)The estimated supply is 12,880 ac-ft/yr with 90% reliability (DWRe 2011a). However, it was estimated that approximately 2,800 ac-ft/yr of this supply is currently in use and has been accounted for in the reliable secondary untreated supply. It was assumed that agricultural conversions from development would be developed moderately until additional storage is available.
(3) See Section 4.2.5.2.1.
(4) WCWCD 2014

6.3 KCWCD Integrated Water Resources Plan

KCWCD’s service area encompasses all of Kane County. This document includes a brief assessment of four groups in Kane County primarily based on the four major subbasins. Although KCWCD encompasses all of Kane County, much of the county will not be served by the Lake Powell Pipeline. Existing KCWCD water supply customers include rural developments located in the Cedar Mountain and Johnson Canyon areas. KCWCD owns and operates wells in the Johnson Canyon area. KCWCD has a connection to the Kanab City water supply and intends to use Lake Powell Pipeline supplies to meet future demands there and in the Johnson Canyon subbasin. For this reason, Kanab City is grouped with the Johnson Canyon subbasin in this Assessment and Alton Town is represented alone in the Kanab Creek subbasin. Throughout this document, when referring to the four subbasins, Kanab City and Johnson Canyon subbasin are included along with Alton Town and the East Fork and Wahweap subbasins.

Kane County reliable water supplies were discussed in **Section 4.2**. The Reclamation projected climate change median streamflow reductions were interpolated for the years 2010 to 2060 to give a downward sloping reduction in streamflow based on the future period projections (Reclamation 2014). The reductions were applied to the reliable supply for the four Kane County subbasins. Furthermore, a 10 percent planning reserve was added to the reliable supply estimates, based on similar planning reserves used by water districts in western states, to avoid using water supplies up to the maximum and to provide a buffer against annual variability in water supplies affected by precipitation runoff and groundwater aquifer recharge. **Table 6-3** shows the yield of the current reliable and future supplies when the climate change median streamflow reductions are applied to the existing reliable supply and the 10 percent planning buffer is applied. The future groundwater rights shown for KCWCD is assumed to be available in the future, however care will have to be taken to drill in favorable locations throughout Western Kane County so that withdrawals do not exceed recharge rates. If drawdowns become evident, the Department of Water Rights would limit these rights.

The KCWCD (Kanab City and Johnson Canyon subbasin) deficit would likely occur in 2035 as total use would exceed the reliable supply. KCWCD shows a 2040 deficit of 266 acre-feet. **Figure 6-2** shows the supply and demand for KCWCD where the lines of the graph cross in approximately 2035, indicating KCWCD would need a new supply starting in 2035. The LPP would traverse Kane County on its way to Washington County. Therefore, there is an opportunity for KCWCD to participate in the LPP simply out of convenience. Tapping into the pipeline would add a reliable supply to their system that would stretch local supplies further into the future. LPP deliveries could be used for culinary supplies, saving local groundwater for use as secondary untreated water and preserving aquifer levels within the county. KCWCD has also considered using LPP deliveries to recharge aquifers supporting local well fields to sustain natural supplies and keep water levels high.

Table 6-3 Kane County Integrated Water Resources Plan Data

Supply Source	Average Annual Yield in 2060 (ac-ft/yr) East Fork Virgin River Subbasin	Alton Town	KCWCD (Kanab City and Johnson Canyon	Wahweap Creek Subbasin
Existing Supplies	703	42	2,102	615
Future Supplies[1]				
New Groundwater	489	0	6,615	1,690
Agricultural Conversion	960	42	0	0
Lake Powell Pipeline	0	0	3,341	0

Notes:
(1)Climate Reduction (7.2%) + 10% Planning Reserve
(2)Combined culinary and secondary untreated supply
(3)KCWCD requested 4,000 ac-ft/yr from LPP

Figure 6-2 through **Figure 6-5** show graphically the relationship between supply and demand, and the sequential timing of new projects brought on line to meet the forecasted total water demand in each of the four groups. A combination of existing and new supplies is sufficient to meet all future needs within the planning horizon for each group.

The KCWCD (Kanab City and Johnson Canyon subbasin) reliable supplies are projected to be in deficit by 2035 when they would be exceeded by total water use. As previously discussed, KCWCD will use LPP water to meet future demands beyond the reliable supply due to the poor quality of groundwater available.

Figure 6-2 KCWCD Supply and Demand – Kanab City Johnson Canyon

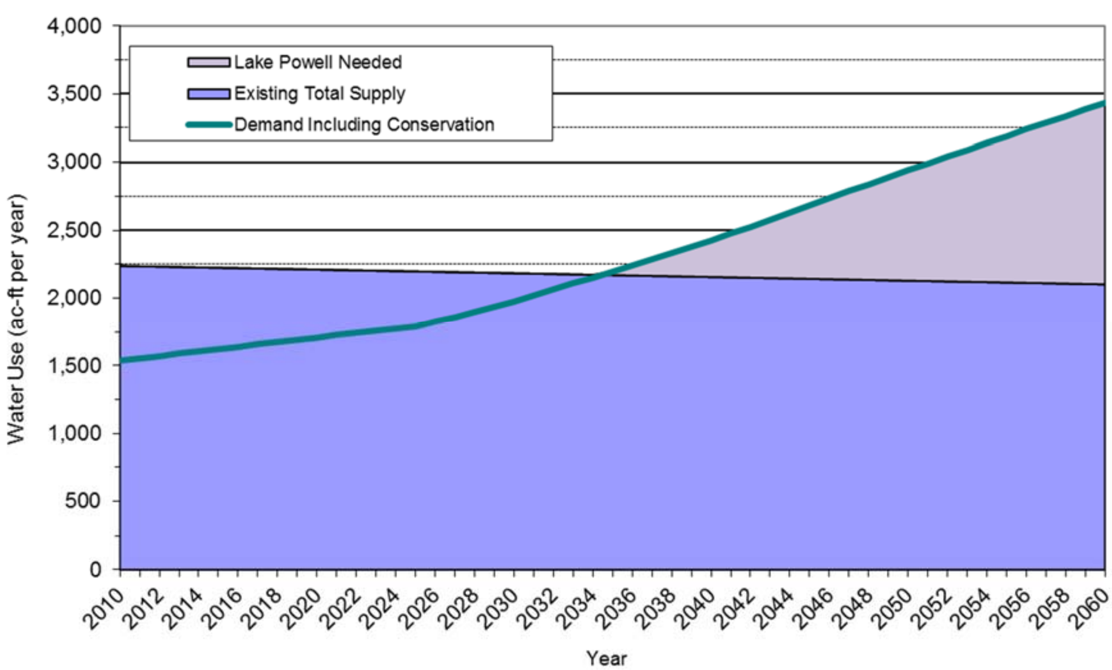


Figure 6-3 East Fork Subbasin Supply and Demand – Orderville Town and Glendale

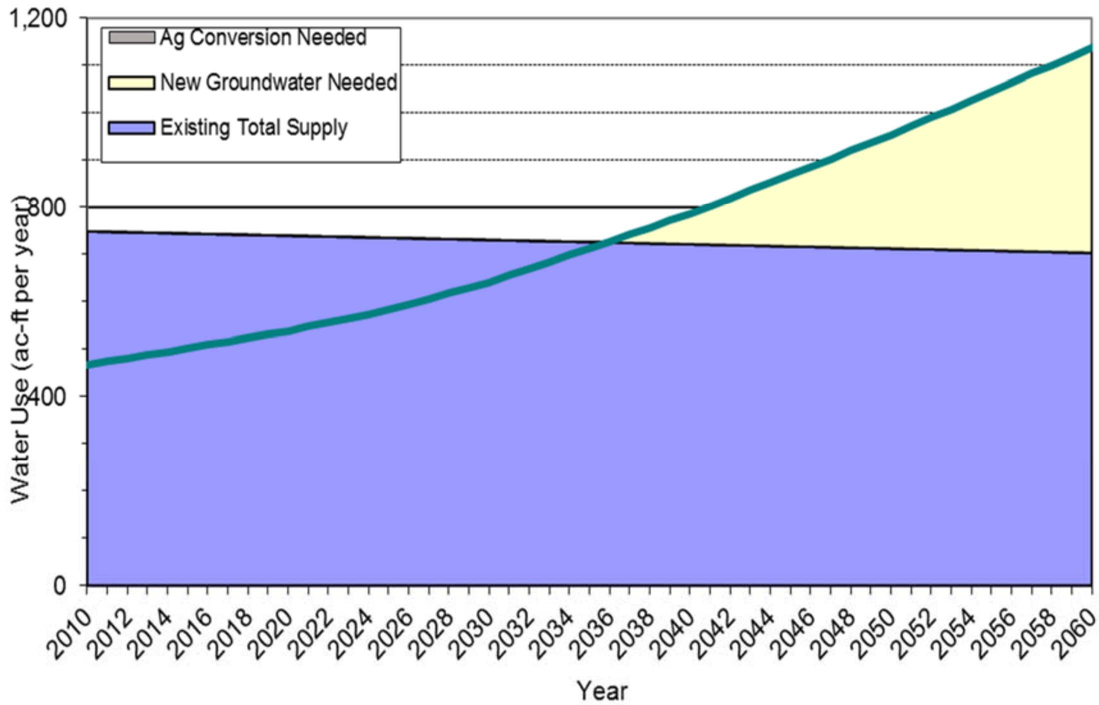


Figure 6-4 Alton Town Supply and Demand

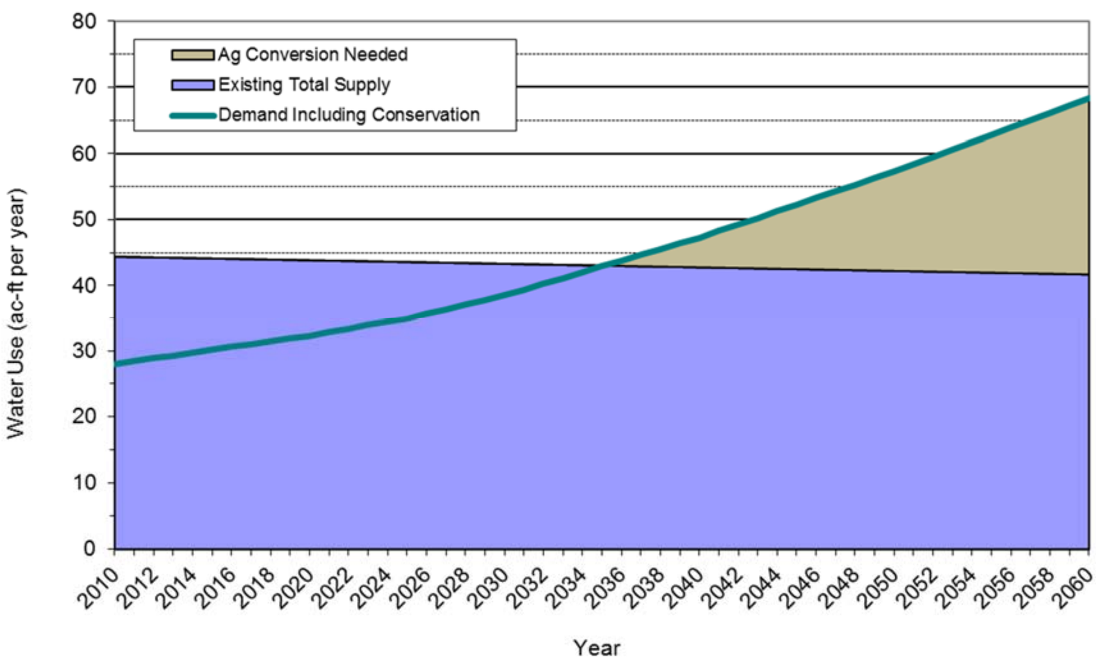
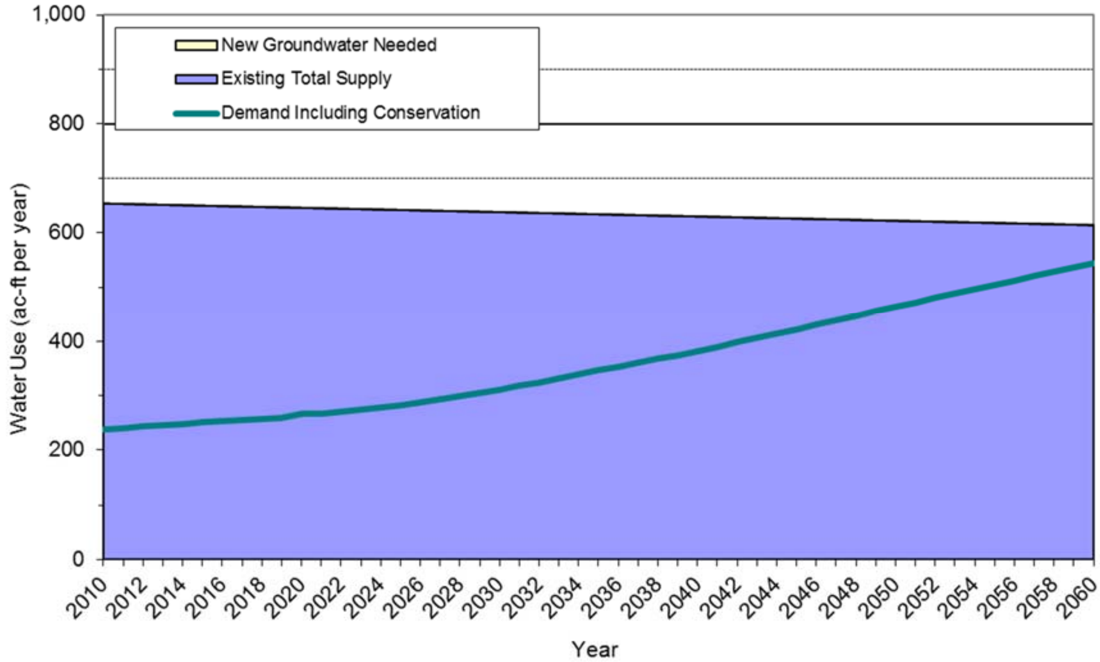


Figure 6-5 Wahweap Creek Subbasin Supply and Demand



6.4 Conclusion

Demand projections to 2060 for each county were provided by the State of Utah Department of Water Resources (DWRe 2014c). Entities in both counties are implementing conservation measures and have committed to future programs developed through a detailed water conservation study conducted by Maddaus Water Management (Appendix B; MWM 2015 a; MWM 2015b). Each district is expected to exceed the State of Utah's water conservation goal of reducing per capita use from 2000 usage by 25 percent by year 2025. Existing reliable supplies for each water district have been evaluated and it is determined that they are being efficiently and fully utilized. The future of the climate in the area is expected to change in ways that are unfavorable to the estimated yields of the reliable supplies. Given the available information, the results shown in this report are suitable for long-range regional water supply planning purposes. This Assessment shows that in the near future, projected water demands will exceed existing supplies for WCWCD and KCWCD and as water suppliers, they will be required to employ a variety of approaches to meet these demands. Conservation will play a vital role in minimizing the need for additional water, but development of new water sources, including Colorado River water from the Lake Powell Pipeline, will be critical in maintaining a safe and reliable supply of water for communities in Southern Utah. The no project alternative is not a good use of water resources and is not appropriate for water supply planners.

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Glossary

Acre-foot – a volumetric unit of water used in water supply planning, which is equivalent to water spread over an acre of area with a depth of 1 foot (325,851 gallons)

Annual Growth Rate – the yearly compounding increase in a value, used in this report to represent the yearly rate of growth for population projections

Aquifer – an underground water-bearing geologic formation

Buy and Dry – the conversion of agricultural water rights for other uses, typically through purchase by municipal and industrial water providers, with a resulting dry-up of irrigated land

Conservation – reduction in per capita water use typically achieved through water savings measures such as water reuse, efficient lawn watering practices, and low flow water fixtures

Culinary Water – water supply that meets drinking water quality standards and can be used to meet all water demands (synonymous with potable water)

Groundwater – water contained in an aquifer, and sometimes extracted for water supply (typically extracted through a groundwater well)

Integrated Water Resources Plan – a balance of forecasted water demands and existing and future water supply projects, typically prepared for planning the timing and volume of future potential water supplies

Maximum Annual Supply – the yearly volume of water that could be delivered at the maximum daily flow rate of a given water supply

Maximum Contaminant Level (MCL) – the greatest level of a particular contaminant within a water source that is considered to be a threshold for making the water source available for beneficial use (e.g., a drinking water MCL for total dissolved solids)

Non-Potable Water – water supply that does not meet drinking water standards, which can be used to meet demands that do not require drinking water quality (e.g., irrigation and lawn watering) (synonymous with secondary untreated water)

Per Capita Water Use – the average rate of water consumption per person, typically calculated in gallons per person per day

Permanent Population – the number of residents living in an area that occupy their residences year-round (i.e., not including tourists or part-time residents)

Potable Water – water supply that meets drinking water standards, which can be used to meet all water demands (synonymous with culinary water)

Prior Appropriation Doctrine – a water administration system typically used in the western United States, which prioritizes water rights by the date that the rights were first administered (i.e., through seniority of the rights)

Reliable Annual Supply – the annual volume of water that is readily available to meet peak demands (in this report, reliable supply is based on the Utah Division of Water Resources definition – the portion of the maximum potable water supply that can be used to meet annual water demands)

Secondary Untreated Water – water supply that does not meet drinking water standards, which can be used to meet demands that do not require drinking water quality (e.g., irrigation and lawn watering) (synonymous with non-potable water)

Sustainable Yield – the volume of groundwater that can be withdrawn from an aquifer on an average annual basis without depleting the long-term storage of the aquifer, which is generally equal to the amount of recharge to the aquifer

Water Reuse – the use of treated wastewater for a beneficial use, such as lawn and golf course irrigation or industrial water; potable water reuse refers to the use of treated wastewater to meet culinary demand

Yield – the amount of water can be delivered from a particular supply, typically given in terms of annual supply

Abbreviations and Acronyms

BOD	Biochemical oxygen demand
CFP	Capital Facilities Plan
CII	Commercial/Industrial/Institutional
DATC	Dixie Applied Technology Courses
DWRe	Utah Division of Water Resources
DWRi	Utah Division of Water Rights
ET	Evapotranspiration
GOMB	Utah Governor's Office of Management and Budget (formerly GOPB)
GOPB	Utah Governor's Office of Planning and Budget
GPCD	Gallons per capita per day
KCWCD	Kane County Water Conservancy District
LPP	Lake Powell Pipeline
M&I	Municipal and Industrial
MCL	Maximum contaminant level
MG	Million gallons
mgd	Million gallons per day
mg/l	Milligrams per liter
MWM	Maddaus Water Management
NEPA	National Environmental Policy Act
RWSA	Regional Water Supply Agreement
SITLA	Utah State Institutional Trust Lands Administration
SWAT	Smart Water Applied Technology
TDS	Total dissolved solids
TMDL	Total Maximum Daily Load
TSS	Total suspended solids
USGS	United States Geological Survey
WCWCD	Washington County Water Conservancy District
WCWMCP	Washington County Water Management and Conservation Plan

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