# Lake Powell Pipeline

## Final Study Report 22
## Alternatives Development

**April 2016**

# Alternatives Development Study Report
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# Executive Summary

## ES.1 Introduction

The Lake Powell Pipeline Study Report 22, Alternatives Development, was prepared to determine a range of alternatives for the Lake Powell Pipeline (LPP) in the Environmental Impact Statement (EIS) that will be performed by the Federal Energy Regulatory Commission (Commission) in accordance with the National Environmental Policy Act (NEPA). The LPP participants are the Washington County Water Conservancy District (WCWCD) and the Kane County Water Conservancy District (KCWCD). The district's service areas are shown in Figure ES-1. The alternatives for each district were developed and evaluated separately; the alternatives of one district were not compared with the alternatives of the other district.

## ES.2 Methodology

The conceptual project alternatives consisted of a No Action Alternative and No Lake Powell Water Alternative for each district. Conceptual project alternatives were developed based on water supply sources available for future development by each district. Certain water development activities currently being pursued or planned by the districts were combined into a set of existing and planned activities that were assumed to be part of the No Action and No Lake Powell Water alternatives. The alternatives were evaluated on their ability to meet the equivalent population water needs with and without implementing the LPP Project. Alternatives meeting this requirement were subjected to a screening process based on ability to meet water demand, technical feasibility, total conceptual cost opinion, environmental considerations, and land use considerations.

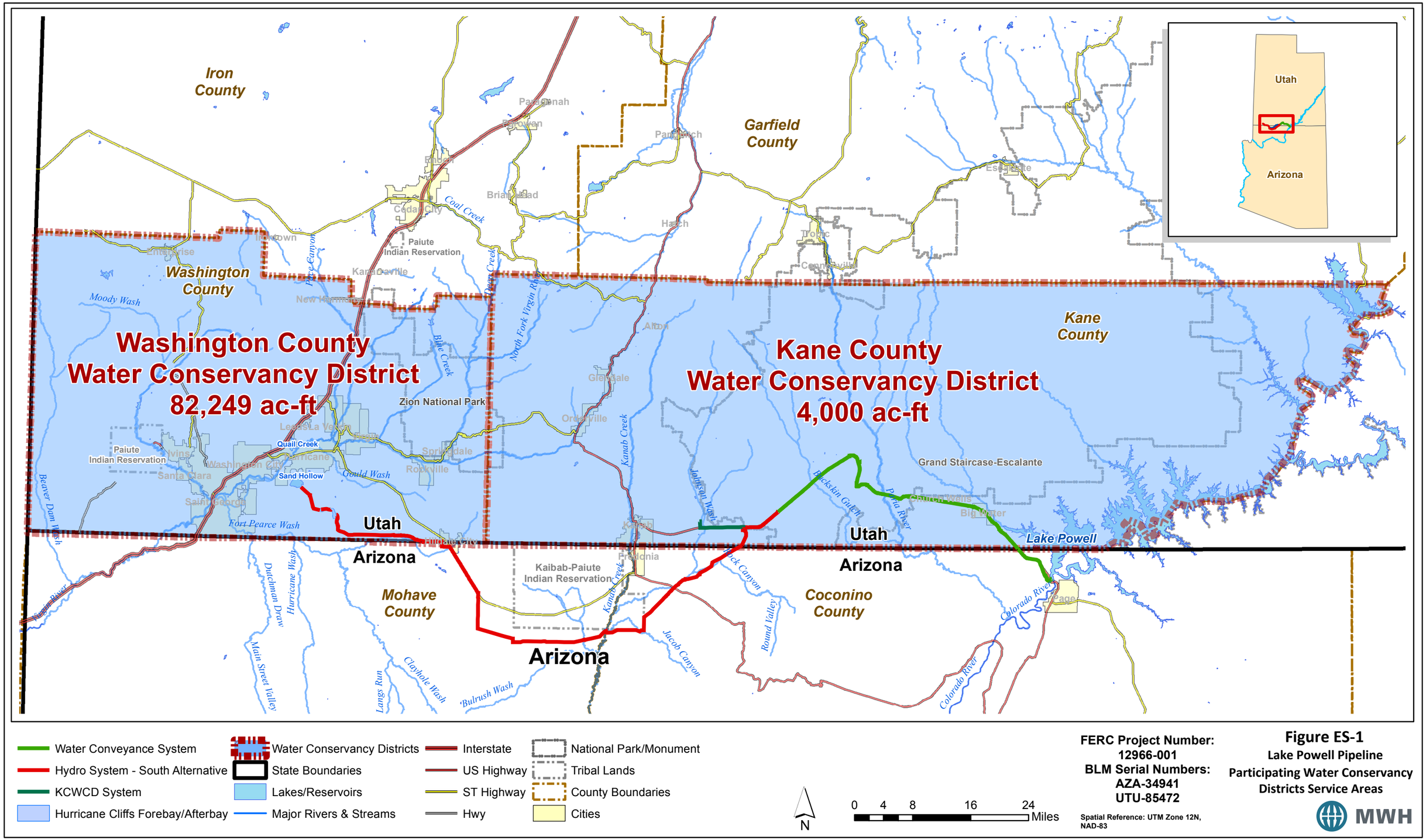
## ES.3 No Lake Powell Water Alternatives

### ES.3.1 WCWCD

The WCWCD No Lake Powell Water Alternative would meet the LPP equivalent population demand beginning in 2025. It would ultimately need to provide approximately 82,249 acre-feet per year of supply by 2052. Two potential alternatives were developed and evaluated for WCWCD.

- Treatment of Virgin River water supplies and wastewater reuse effluent by reverse osmosis (RO) and eliminating residential outdoor irrigation with potable water

- Treatment of Virgin River water supplies and wastewater reuse effluent by reverse osmosis (RO) and eliminating residential outdoor irrigation with potable water, and conveying available groundwater from Kane County to Washington County by pipeline




FERC Project Number: 12966-001
BLM Serial Numbers: AZA-34941 UTU-85472

Spatial Reference: UTM Zone 12N, NAD-83

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

MWH

### ES.3.2 KCWCD

The KCWCD No Lake Powell Water Alternative would require agricultural water conversion to M&I raw water supply and treatment for potable use. The KCWCD No Action Alternative meets the LPP equivalent population demand of approximately 3,440 acre-feet per year in 2060, with existing supplies and implementation of its "baseline" water development activities.

## ES.4 Recommended Alternatives for NEPA Analysis

### ES.4.1 WCWCD

Based on the screening process identified in Section ES.2, the recommended No Lake Powell Water Alternative for NEPA analysis is treatment of Virgin River water and wastewater reuse effluent supplies by RO and eliminating residential outdoor irrigation with potable water. The WCWCD No Lake Powell Water Alternative will be analyzed along with the No Action Alternative, the Proposed Action (South Alternative), the Southeast Corner Alternative and the Existing Highway Alternative.

### ES.4.2 KCWCD

Based on the screening process described above, the recommended No Lake Powell Water Alternative for NEPA analysis involves agricultural water conversion to M&I raw water supply and treatment for potable use. The KCWCD No Lake Powell Water Alternative will be analyzed along with the No Action Alternative, the Proposed Action (South Alternative), the Southeast Corner Alternative and the Existing Highway Alternative.

# Chapter 1
# Introduction

## 1.1 Introduction

This report documents the development of reasonable range of alternatives to the proposed Lake Powell Pipeline (LPP) Project for each participating water district. The LPP Project and these alternatives will be analyzed in an environmental impact statement (EIS) to be prepared by the Federal Energy Regulatory Commission (Commission) in compliance with the National Environmental Policy Act (NEPA). The requirements for this study report are described in Study Plan 22, Alternatives Development, approved by the Commission's January 21, 2009, Study Plan Determination.

The implementing regulations for NEPA (40 CFR 1500 through 1508) require federal agencies to consider alternatives to a Proposed Action (U.S. GPO, 2005). The alternatives must meet water needs for the same projected population as the Proposed Action. The LPP Project would deliver 86,249 acre-feet per year to two participating water conservancy districts, the Washington County Water Conservancy District (WCWCD) and Kane County Water Conservancy District (KCWCD). The LPP Project would use a portion of the State of Utah's unallocated Colorado River water rights to deliver water to Washington County from Lake Powell and includes the Kane County Pipeline (KCP). Figure ES-1 shows each district's service area. The LPP Project water would meet the needs of growing populations in communities served by WCWCD through 2052, and in KCWCD through 2060. The No Action alternative would not meet the water needs of the projected future population.

## 1.2 Summary of Projected Population and Water Use

This analysis must develop alternatives that will meet water demands for the LPP participants. Table 1-1 provides the projected population levels and the projected water demand, with and without conservation, for WCWCD and KCWCD from 2010 to 2060. The population projections, initially developed by the Utah Governor's Office of Management and Budget (GOMB), are based on 2012 population estimates. Utah Division of Water Resources (UDWRe) adjusted the GOMB population estimates to include population served within municipal service area boundaries and applied GOMB projected growth rates.

### 1.2.1 WCWCD

WCWCD's service area includes all of Washington County, with a population that is projected to grow at an annual rate of 3.1 percent, while the state's population is expected to grow at an annual rate of 1.7 percent during the next 50 years. The Washington County population, estimated at 138,115 in 2010 is projected to reach 581,731 in 2060 (an increase of 321 percent) (GOMB 2013). About 55 percent of population increase between 2010 and 2060 would be from an increase in net migration projection (about 243,734 persons). Among 29 counties in the state, Washington County is projected to have the third largest population increase during the projections period. Therefore, WCWCD is expected to increase its service area population accordingly. St. George, which is the largest city in Washington County, is projected to increase from 72,897 in 2010 to 307,037 by 2060.

The State of Utah has initiated a state-wide water conservation program with the goal of a 25 percent reduction in per capita consumption by 2025. WCWCD instituted a water conservation program in 1995 consisting of appliance replacement, restaurant washing device replacement, smart landscape watering techniques, pricing strategies, and other programs. UDWRe estimates WCWCD has achieved

approximately 26 percent reduction in per capita consumption since 2000, and WCWCD plans on reducing water consumption a total of 35 percent by 2060.

### 1.2.2 KCWCD

It is projected that Kane County's population will grow at an annual rate of 1.9 percent over the next 50 years. The county's population, which is estimated at 7,125 in 2010, is projected to reach 18,583 by 2060 (an increase of 161 percent). About 25 percent of the projected population increase between 2010 and 2060 is attributed to an increase in net migration (about 2,896 persons).

Based on GOMB population projections, the county's share of the state's total population will increase from 0.26 percent in 2010 to 0.31 percent by 2060, which implies that the county is projected to grow at faster rate than the state average.

The KCWCD 2010 per capita baseline use in the Kanab municipal and Johnson Canyon areas was approximately 287 gallons per day. The Kanab municipal and Johnson Canyon areas are estimated to serve approximately 73 percent of the KCWCD service area permanent population.

**Table 1-1**
**Projected Population and Water Demands**

**Page 1 of 2**

| 2012 Population Projections[4] | | | WCWCD | | KCWCD[1] | |
|---|---|---|---|---|---|---|
| Year | WCWCD | KCWCD | Demand (ac-ft/yr) | Demand w/ Cons.[3] (ac-ft/yr) | Demand (ac-ft/yr) | Demand w/ Cons.[3] (ac-ft/yr) |
| 2010 | 138,530 | 6,540 | 52,644 | 50,380 | 1,484 | 1,535 |
| 2011 | 145,325 | 6,654 | 56,070 | 52,187 | 1,497 | 1,548 |
| 2012 | 151,120 | 6,768 | 59,496 | 53,994 | 1,510 | 1,566 |
| 2013 | 156,915 | 6,882 | 62,922 | 55,801 | 1,523 | 1,584 |
| 2014 | 162,710 | 6,996 | 66,348 | 57,608 | 1,536 | 1,602 |
| 2015 | 168,505 | 7,110 | 69,774 | 59,415 | 1,549 | 1,620 |
| 2016 | 174,300 | 7,224 | 73,200 | 61,222 | 1,562 | 1,638 |
| 2017 | 180,095 | 7,338 | 76,626 | 63,030 | 1,575 | 1,656 |
| 2018 | 185,890 | 7,452 | 80,052 | 64,838 | 1,588 | 1,674 |
| 2019 | 191,685 | 7,566 | 83,481 | 66,646 | 1,601 | 1,692 |
| 2020 | 196,480 | 7,680 | 86,905 | 68,450 | 1,615 | 1,709 |
| 2021 | 204,759 | 7,854 | 90,411 | 70,466 | 1,687 | 1,725 |
| 2022 | 213,038 | 8,028 | 93,917 | 72,482 | 1,759 | 1,740 |
| 2023 | 221,317 | 8,202 | 97,423 | 74,498 | 1,831 | 1,755 |
| 2024 | 229,596 | 8,376 | 100,929 | 76,515 | 1,903 | 1,771 |
| 2025 | 237,875 | 8,550 | 104,435 | 78,537 | 1,975 | 1,788 |
| 2026 | 246,154 | 8,724 | 107,941 | 81,273 | 2,047 | 1,824 |
| 2027 | 254,433 | 8,898 | 111,447 | 84,009 | 2,119 | 1,860 |
| 2028 | 272,712 | 9,072 | 114,953 | 86,745 | 2,191 | 1,896 |

## Table 1-1
## Projected Population and Water Demands



| 2012 Population Projections[4] | | | WCWCD | | KCWCD[2] | |
|---|---|---|---|---|---|---|
| Year | WCWCD | KCWCD[1] | Demand (ac-ft/yr) | Demand w/ Cons.[3] (ac-ft/yr) | Demand (ac-ft/yr) | Demand w/ Cons.[2, 3] (ac-ft/yr) |
| 2029 | 270,991 | 9,246 | 118,459 | 89,482 | 2,263 | 1,933 |
| 2030 | 279,270 | 9,420 | 121,968 | 92,220 | 2,334 | 1,971 |
| 2031 | 288,280 | 9,635 | 125,868 | 95,199 | 2,387 | 2,015 |
| 2032 | 297,290 | 9,850 | 129,768 | 98,178 | 2,400 | 2,060 |
| 2033 | 306,300 | 10,065 | 133,668 | 101,157 | 2,493 | 2,105 |
| 2034 | 315,310 | 10,280 | 137,568 | 104,136 | 2,546 | 2,150 |
| 2035 | 324,320 | 10,495 | 141,468 | 107,115 | 2,599 | 2,195 |
| 2036 | 333,330 | 10,710 | 145,368 | 110,094 | 2,652 | 2,240 |
| 2037 | 342,340 | 10,925 | 149,268 | 113,073 | 2,705 | 2,285 |
| 2038 | 351,350 | 11,140 | 153,168 | 116,052 | 3,758 | 2,330 |
| 2039 | 360,360 | 11,355 | 157,068 | 119,031 | 3,811 | 2,375 |
| 2040 | 369,370 | 11,570 | 160,968 | 122,010 | 2,867 | 2,422 |
| 2041 | 379,332 | 11,820 | 165,286 | 125,303 | 2,929 | 2,472 |
| 2042 | 389,294 | 12,070 | 169,604 | 128,596 | 2,991 | 2,524 |
| 2043 | 399,256 | 12,320 | 173,922 | 131,889 | 3,053 | 2,576 |
| 2044 | 409,218 | 12,570 | 178,240 | 135,182 | 3,115 | 2,628 |
| 2045 | 419,180 | 12,820 | 182,558 | 138,475 | 3,177 | 2.680 |
| 2046 | 429,142 | 13,070 | 186,876 | 141,768 | 3,239 | 2,732 |
| 2047 | 439,104 | 13,320 | 191,194 | 145,061 | 3,301 | 2,784 |
| 2048 | 449,066 | 13,570 | 195,512 | 148,354 | 3,363 | 2,836 |
| 2049 | 459,028 | 13,820 | 199,830 | 151,647 | 3,425 | 2,888 |
| 2050 | 468,990 | 14,070 | 204,150 | 154,940 | 3,485 | 2,944 |
| 2051 | 479,776 | 14,369 | 208,400 | 157,871 | 3,553 | 2,990 |
| 2052 | 490,562 | 14,668 | 212,650 | 160,802 | 3,621 | 3,040 |
| 2053 | 501,348 | 14,967 | 216,900 | 163,733 | 3,689 | 3,090 |
| 2054 | 512,134 | 15,266 | 221,150 | 166,664 | 3,757 | 3,140 |
| 2055 | 522,920 | 15,565 | 225,400 | 169,595 | 3,825 | 3,190 |
| 2056 | 533,706 | 15,864 | 229,650 | 172,526 | 3,893 | 3,240 |
| 2057 | 544,492 | 16,163 | 233,900 | 175,457 | 3,961 | 3,290 |
| 2058 | 555,278 | 16,462 | 238,159 | 178,388 | 4,029 | 3,340 |
| 2059 | 566,064 | 16,761 | 242,400 | 181,319 | 4,096 | 3,390 |
| 2060 | 576,850 | 17,060 | 246,648 | 184,250 | 4,160 | 3,445 |

**Note:** ac-ft/yr = acre-feet per year
[1] KCWCD total population shown; Kanab municipal and Johnson Canyon service area population is approximately 73% of KCWCD total; Fredonia, AZ population included in total, not included in Kanab municipal and Johnson Canyon service area population.
[2] KCWCD M&I Water Demand for Kanab municipal and Johnson Canyon service areas
[3] Demand w/Cons. = Demand with Water Conservation
[4] UDWRe compared city and town boundaries used in GOMB projections to municipal service area boundaries for which they collect water usage data and adjusted GOMB baseline projections to reflect the population within these municipal service area boundaries. GOMB growth rates were applied to the baseline populations in these adjusted area boundaries.

# Chapter 2
# Planned and Potential Future Water Supply Projects

## 2.1 Introduction

Both of the participating water conservancy districts have existing plans for water supply projects to be executed in the short term and has identified future water supply and development projects within the LPP planning horizon (UDWRe 2016). These projects are described in the following sections.

### 2.1.1 WCWCD

WCWCD plans on maximizing its use of the available local water supply. The Ash Creek Project will consist of constructing a pipeline system to replace open ditches on Leap Creek, South Ash Creek and Wet Sandy Creek, and to bring water from the existing Ash Creek Reservoir to a new 3,640 acre-foot storage reservoir to be constructed near Anderson Junction. At full development, the project is expected to supply 2,840 acre-feet per year of secondary water to the WCWCD service area. The 2,840 acre-feet per year of culinary quality spring water previously used to meet these secondary water demands will then be available to meet culinary demands.

WCWCD plans on maximizing use of available water rights by developing new wells and treating existing wells to culinary quality. This groundwater development is anticipated to yield 10,830 acre-feet per year and includes the expansion and arsenic treatment of the Sand Hollow well field and arsenic treatment of the Gunlock well field by St. George City.

Treated effluent from the St. George Wastewater Treatment Plant (WWTP) currently contributes 3,900 acre-feet per year to the secondary water supply in the WCWCD's service area. Additional existing wastewater could be treated to an acceptable standard and reused, adding 7,300 acre-feet per year to secondary supply. Full utilization of existing wastewater would require expansion of reuse plant capacity to 10 million gallons per day (mgd), installation of a separate network of secondary water pipelines and pump stations to serve customers from the main reuse water trunk line in St. George, and additional treated water storage. Wastewater reuse could make additional culinary supply available by offsetting secondary demand currently being met with culinary water. The maximum, theoretical quantity of wastewater reuse available in 2060 is projected to be approximately 40,000 acre-feet per year, assuming there is sufficient capacity to store and beneficially use all available return flows. Reduction of indoor water use beyond the current conservation goals would reduce the amount of water available for reuse.

Agricultural conversions could augment future water supply for WCWCD. Additional water supplies could be made available through urban development of existing agricultural lands. An additional 10,080 acre-feet per year is projected to be available as reliable M&I secondary water from converting agricultural lands to municipal development by 2060.

The proposed Warner Valley Reservoir project would consist of a 55,000 acre-foot storage reservoir near the Washington Fields Diversion that could store water from WCWCD and St. George and Washington Canal Company water rights, as well as, reuse and Santa Clara Project water that exceeds existing storage demands. This project would provide for more efficient storage and management of water from wastewater reuse and agricultural conversion.

### 2.1.2 KCWCD

KCWCD intends to fully develop existing, adjudicated groundwater rights within the Kanab Creek and Johnson Canyon subbasins to provide future water supplies. The current reliable groundwater supply of the Kanab Creek and Johnson Canyon subbasins is approximately 2,517 acre-feet per year. The KCWCD future groundwater supply legally available for development is 10,270 acre-feet per year. Groundwater supplies near the mouth of Johnson Canyon have total dissolved solids (TDS) concentrations exceeding the drinking water standards, which excludes the future development of groundwater from this area.

KCWCD completed construction of the 4,228 acre-foot capacity Jackson Flat Reservoir south of Kanab. The reservoir stores and supplies secondary and agricultural irrigation water to commercial/industrial/institutional (CII) users that are currently served by well water. The reservoir will annually store approximately 7,500 acre-feet per year of surface water diversions that have typically been used by the Kanab Irrigation Company to maximize the efficiency of those diversions.

In addition to developing new groundwater supplies, existing agricultural water supplies could be converted to M&I use, either through M&I conversion over currently irrigated lands or through "buy and dry" programs. It is estimated that approximately 1,460 acre-feet per year is available for conversion to M&I uses from existing irrigated agricultural land, based on the amount of agricultural land in general proximity to urban areas.

# Chapter 3
# Conceptual Project Alternatives

## 3.1 Introduction

The conceptual project alternatives for the two water conservancy districts are comprised of variations of the No Lake Powell Water Alternative, which entails a combination of actions to increase culinary supply, reduce culinary usage, increase secondary usage and undertake wastewater reclamation/reuse programs. The conceptual alternatives are evaluated to determine their ability to meet the equivalent population water needs of the districts under the LPP Project Proposed Action.

### 3.1.1 Equivalent Population Water Needs

The equivalent population of each district is the population level at which no additional water supplies are available to meet water needs. This assumes all conservation goals have been met, all water rights have been fully developed, planned agricultural water conversions have been fully completed, pending storage projects have been fully developed, identified wastewater reclamation/reuse opportunities have been fully exploited, and finally, all secondary water conversions have been made.

#### *3.1.1.1 WCWCD Equivalent Population Water Needs*

The equivalent population of WCWCD if the LPP Project is not constructed (i.e., no LPP Project equivalent population) is 237,875. It is estimated that this population would occur in 2025 and corresponds to a combined culinary and secondary water demand of 78,537 acre-feet per year. If the LPP Project is constructed, the WCWCD equivalent population is 576,850 and is estimated to occur in 2060. This corresponds to a potable and secondary water demand of 184,250 acre-feet per year with water conservation implemented and achieved (35 percent reduction in per capita use between 2000 and 2050).

#### *3.1.1.2 KCWCD Equivalent Population Water Needs*

The KCWCD equivalent population of the Kanab municipal and Johnson Canyon areas if the LPP Project is not constructed is 7,347. It is estimated that this population would occur in 2033 with a corresponding potable and secondary water demand of 2,105 acre-feet per year. If the LPP Project is constructed, the KCWCD equivalent population is greater than 12,454 and is estimated to occur beyond 2060. This corresponds to a potable and secondary demand greater than 3,445 acre-feet per year.

## 3.2 Existing Supply, Planned Projects and Future Demand

### 3.2.1 WCWCD

The conceptual project alternatives for WCWCD include the following projects identified in Section 2.1.1: completion of the Ash Creek Project, development of groundwater supplies, maximum utilization of wastewater reuse supplies and agricultural conversion supplies, and the potential completion of the Warner Valley Projection (MWH, 2015). Existing and planned water conservation activities and programs are assumed to continue. These form the existing and planned projects, activities and programs that WCWCD anticipates pursuing.

Table 3-1 shows the existing water supplies for Washington County (including WCWCD), along with the water supplies made available from the development of the planned projects, which combine to equal the total future M&I water supply. The total future M&I water demand compared to the total future M&I water supply indicates an 8 to 12 percent higher supply than demand to account for variable annual hydrology conditions and water demands. The WCWCD conceptual No Lake Powell Water Alternatives are evaluated on their ability to meet future M&I water demands.

**Table 3-1**
**Washington County M&I Water Supply and Demand Summary[1]**

| Washington County (includes WCWCD) | Existing Potable M&I Supply ac-ft/yr | Planned Projects ac-ft/yr | Waste-water Reuse Expansion to Existing 10 mgd Capacity ac-ft/yr | Other Secondary Water ac-ft/yr | Agricultural Conversion (secondary water) ac-ft/yr | LPP Project Supply Delivered to WCWCD ac-ft/yr | Additional Wastewater Reuse Expansion Beyond Existing Capacity – LPP Water Reuse ac-ft/yr | Total Future M&I Supply ac-ft/yr | Total Future M&I Demand ac-ft/yr |
|---|---|---|---|---|---|---|---|---|---|
| **2025** | 59,172 | 13,190 | 0 | 8,505 | 0 | 4,030[b] | 0 | 84,897 | 78,537[a] |
| **2052**[a] | 59,172 | 13,190 | 7,300[c] | 8,505 | 5,530 | 82,249 | 7,800[d] | 183,745 | 160,802 |
| **2060** | 59,172 | 13,190 | 7,300[c] | 8,505 | 10,080 | 82,249 | 28,830 | 209,266 | 184,250 |

**Notes:**
[1]All M&I water included (potable water and secondary untreated water)
[a]Year when all LPP Project water diverted from Lake Powell would be used by WCWCD; reuse of LPP Project associated water would extend supply of secondary untreated water beyond 2052.
[b]WCWCD use of LPP Project water through 2025.
[c]3,900 acre-feet per year wastewater reuse included as Other Secondary Water; total reuse would be 11,200 acre-feet per year.
[d]Additional wastewater reuse only available with LPP Project, which would supply return flow.
ac-ft/yr = acre-feet per year

Figure 3-1 shows the water demand for Washington County, including WCWCD, from 2010 through 2060 without water from Lake Powell. The figure illustrates the need for additional water sources beginning in 2025 if the Lake Powell Pipeline is not constructed and operated.

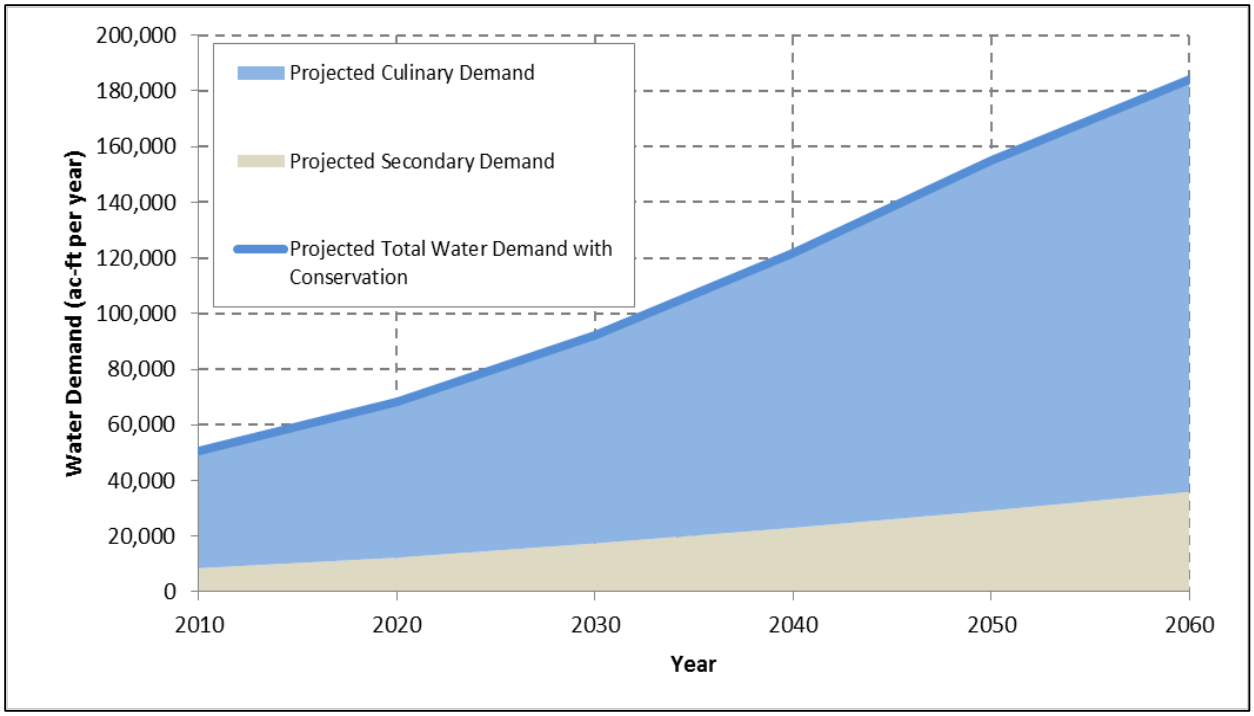



**Figure 3-1**
**WCWCD Projected Water Demand**

### 3.2.2 KCWCD

The conceptual project alternative for KCWCD includes the full development of existing groundwater rights (see Section 2.1.2). Existing water conservation activities and programs would continue. The full development of existing groundwater rights and ongoing water conservation activities and programs serve as the existing and planned projects for KCWCD, and the same is assumed to occur under the LPP Proposed Action (MWH, 2015).

Table 3-2 shows the existing water supplies for KCWCD, along with the water supplies made available from the development of the planned projects, activities and programs, which combine to equal the total future M&I water supply. The total future M&I water demand compared to the total future M&I water supply indicates a 14 to 16 percent higher supply than demand to account for variable annual hydrology conditions and water demands. The KCWCD conceptual No Lake Powell Water Alternatives are evaluated on their ability to meet future M&I water demands.

**Table 3-2**
**KCWCD M&I Water Supply and Demand Summary[1]**

| KCWCD | Existing Reliable M&I Supply ac-ft/yr | Full Development of Existing Groundwater Rights ac-ft/yr | Agricultural Conversion (secondary water) ac-ft/yr | LPP Project Water Delivered to KCWCD ac-ft/yr | Total Future M&I Supply ac-ft/yr | Total Future M&I Demand ac-ft/yr |
|---|---|---|---|---|---|---|
| **2033** | 2,517 | 0 | 0 | 0 | 2,517 | 2,105 |
| **2060** | 2,101 | 1,810[c] | 1,460 | 1,334 | 4,895 | 3,445 |

**Notes:**
[1]Kanab City and Johnson Canyon Subbasin only portions of KCWCD evaluated.
[a]Without construction and operation of the LPP; includes 10 percent operating reserve
[b]With construction and operation of the LPP; includes 10 percent operating reserve
[c]10,250 acre-feet per year legally developable; however, the groundwater has high TDS concentrations exceeding drinking water standards. No additional groundwater development is included in total future M&I supply.
ac-ft/yr = acre-feet per year

Figure 3-2 shows the water demand for KCWCD from 2010 through the year 2060 without water from Lake Powell. The figure shows the district's need for additional water supplies beginning in approximately 2033.

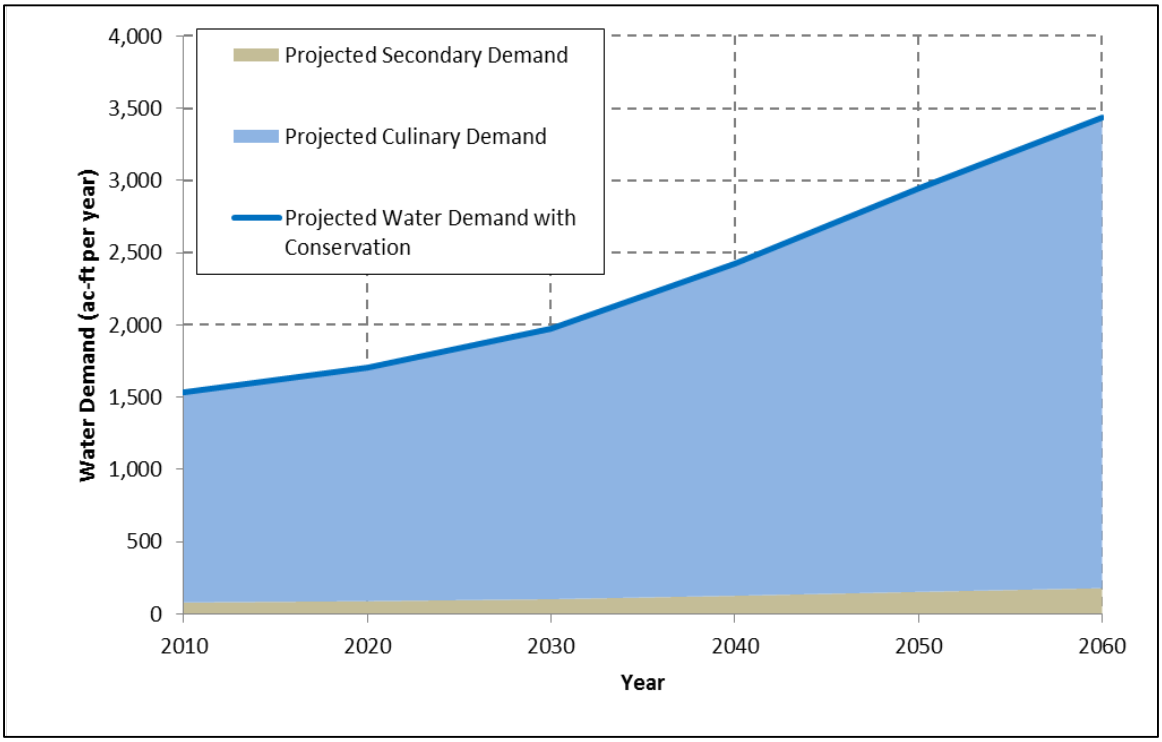



**Figure 3-2**
**KCWCD Projected Water Demand**

## 3.3 Description of the Conceptual No Lake Powell Water Alternatives

The conceptual No Lake Powell Water Alternatives would vary, depending on each participating Districts available options, but would involve combinations of options, such as developing remaining available surface water and groundwater supplies, developing reverse osmosis treatment of existing low quality water supplies in the WCWCD service area, and eliminating residential outdoor watering in the WCWCD service area. These alternatives must meet the LPP Proposed Action equivalent population water need without diverting the State of Utah's water from Lake Powell. Existing and planned projects identified in Section 3.2 would continue to be implemented.

### 3.3.1 WCWCD Conceptual No Lake Powell Water Alternatives

WCWCD would not receive any of the State of Utah's Colorado River water from Lake Powell under the conceptual No Lake Powell Water Alternatives. WCWCD would implement currently planned future water development projects (baseline projects) and continue to implement currently mandated conservation goals. Beginning in 2025, WCWCD's existing and planned project supplies would total 80,867 acre-feet of water supply per year, and demand would be 78,537 acre-feet per year. The WCWCD water supply shortage in 2052 would be approximately 81,140 acre-feet per year, and the growing water demand would exceed the WCWCD share of LPP Project water (82,249 acre-feet per year) during 2052. Therefore, the WCWCD conceptual No Lake Powell Water Alternatives must develop approximately 82,249 acre-feet of water per year to meet the comparable water supply that would be provided under the LPP Project. The following subsections describe components of the WCWCD conceptual No Lake Powell Water Alternatives.

#### *3.3.1.1 Reverse Osmosis Treatment of Virgin River Water*

To address the water supply shortages beginning in 2025, WCWCD could develop a reverse osmosis (RO) advanced water treatment facility to treat up to approximately 50,000 acre-feet per year of Virgin River water that contains high total dissolved solids (TDS) concentration. Approximately 28,400 acre-feet per year of available Virgin River is agricultural water and would need to be purchased from water right owners and canal company shareholders. The RO advanced water treatment facility would produce up to 45,000 acre-feet of water per year suitable for M&I use (MWH 2015). The WCWCD's Warner Valley Reservoir would be available to deliver raw water to the RO advanced water treatment facility. The 5,000 acre-feet per year of brine by-product from the RO treatment process would require evaporation and disposal meeting State of Utah water quality regulations.

#### *3.3.1.2 Reverse Osmosis Treatment of Future Reclaimed Wastewater Effluent*

The existing St. George WWTP sends a portion of its treated effluent to the St. George Regional Water Reclamation Facility for additional treatment and reuse as secondary irrigation water. The maximum capacity of the existing reuse plant is 7,300 acre-feet per year. The reuse water is used as a secondary irrigation water supply from April through October, and currently is not stored during the winter months. The City of St. George has received approvals to construct two storage reservoirs to store the reuse water during the winter months and increase the annual reuse of treated effluent. The reuse water could also be stored in the proposed Warner Valley Reservoir. The maximum projected wastewater treatment plant effluent available for reuse in 2060 is projected to be 40,000 acre-feet per year. This projected water reuse supply is estimated using the following assumptions: 1) continued conservation would result in a reduction of 35 percent total per capital water use based on year 2000 usage; 2) indoor water use is 40 percent of total per capita water use; 3) indoor water use from St. George, Washington, and Santa Clara

would be treated at the St. George WWTP; 4) 15 percent of water would be lost in the collections system; and 5) the wastewater and reuse plants would recover 90 percent of the water for use as reuse. The maximum projected wastewater treatment plant effluent available for reuse in 2025 is projected to be 17,110 acre-feet per year, increasing to 34,940 acre-feet per year by 2052. Of this supply, 3,900 acre-feet is currently being used as secondary untreated water, so 31,040 would be new supply. Evaporation losses from a 69,030 acre-foot Warner Valley Reservoir are estimated to be 4,717 acre-feet per year (MWH 2015). RO treatment of the remaining26,320 acre-feet per year wastewater reuse effluent could yield approximately 23,690 acre-feet of product water and 2,630 acre-feet of brine for evaporation and disposal. The RO treated effluent could then be disinfected and delivered for culinary use. This potential component of the No Lake Powell Water Alternative would require a new RO treatment facility or increasing the capacity of an RO facility treating water stored in Warner Valley Reservoir, and also could face a significant public acceptance challenge as well as regulatory approvals.

### *3.3.1.3 Eliminating Potable Water Use for Outdoor Residential Watering*

The No Lake Powell Water Alternative would permanently eliminate residential outdoor water use in Washington County, re-purposing the portion of potable water used for residential outdoor watering to indoor potable use. Projections of future water use through 2060 account for population growth, climate change (projected 6 percent reduction of Virgin River flows by 2050), and water conservation (35 percent reduction in per capita water use from 2000 to 2060).

Gradual elimination of residential outdoor potable water use starting in 2025 would provide the growing population with potable water for indoor use through 2045; however, re-purposing residential outdoor potable water use to indoor use would not increase the water supply and would have to be accompanied by adding another water supply to meet the growing demand. By 2045, all potable water would be used for indoor purposes, including residential indoor, commercial, institutional and industrial uses. Re-purposing residential outdoor potable water use to indoor potable use would require converting traditional residential outdoor landscapes and uses to desert landscapes compatible with the local climate or non-irrigated landscapes. Xeriscapes would not be permitted as desert landscape. Residential water users would be responsible for converting their traditional outdoor landscapes to non-irrigated landscapes or desert landscapes. Secondary water use in Washington County, totaling 8,505 acre-feet per year, would be converted to commercial, institutional and industrial use. This conceptual alternative could potentially reduce potable demand by 52,160 acre-feet per year by 2060.

Eliminating outdoor residential watering throughout the WCWCD service area would require several other related actions, all of which would be viewed as draconian by existing residents. The WCWCD would have to adopt procedures to ensure elimination of residential outdoor watering. Such a policy would be highly unpopular with residents in the WCWCD service area, in part because existing residential users would be required to give up the water previously allocated for their use in order to accommodate future residential users and also because the impacts on the quality of the surrounding environment would be significant. Elimination of outdoor watering would result in conversion to desert landscapes that would have the same vegetation as surrounding desert areas. Existing landscapes may have to be hardscaped, in the form of rock cover, concrete or other surface protection, to avoid perpetuation of dust and weeds. Converting existing landscapes would impose substantial costs, unless property owners decided to allow landscapes to dry up and inevitably turn to dust and weeds. Some options might include a turf buy-back program and credits and/or payments to residents for removing existing landscaping from residential yards and replacing it with hardened landscaping. Xeriscaping would not be an option, and the ornamental shrubs and plants that currently comprise much of the residential landscaping throughout the greater St. George metropolitan area would not survive. Residential swimming pools would be prohibited. No vegetative shade or vegetable gardening would be allowed to occur. WCWCD and their municipal subscribers would have to develop and maintain a

program to enforce restrictions on use of culinary water for residential outdoor watering. Such a program would involve mandatory inspections and audits of residential properties to verify outdoor water use, investigations of violations, fines for violations, and other activities to make sure potable water distributed to residential water users is used for indoor purposes only. The costs of eliminating outdoor water use, re-landscaping, enforcement, monitoring, and other related actions would be borne by the existing and future water users within the WCWCD service area.

#### *3.3.1.4 Importing Available Groundwater from Kane County*

Another conceptual No Lake Power Water Alternative for WCWCD would to use available groundwater imported into the WCWCD service area from Kane County. KCWCD could provide up to 10,270 acre-feet per year of its undeveloped existing groundwater rights with high TDS concentrations to meet the LPP Project equivalent population water need through 2060. This water would be conveyed by a new pipeline to the WCWCD service area to offset its unmet demand. In addition to developing and maintaining the water conveyance system (pump stations, pipelines and energy recovery), WCWCD would have to develop the groundwater supply wells and negotiate agreements with KCWCD to transfer the water into the WCWCD service area. This project also would face a significant public acceptance challenge in Kane County. The imported water would have to be treated by RO processes before being used for M&I supply.

#### *3.3.1.5 Summary of WCWCD Conceptual No Lake Powell Water Alternatives*

The conceptual No Lake Powell Water Alternatives for WCWCD would consist of several components to yield an 82,249 acre-foot annual water supply equivalent to the WCWCD portion of the LPP Project. One combination of components would involve eliminating water use for outdoor landscape watering (24,366 acre-feet per year re-purposed to indoor use only), RO treatment of wastewater reuse effluent (12,883 acre-feet of product water) and RO treatment of Virgin River water (45,000 acre-feet of product water) to provide the 82,249 acre-feet of water equivalent to the LPP Project. The total potable water demand of 130,245 acre-feet per year (including 52,160 acre-feet of residential outdoor potable water use) would be required to meet WCWCD indoor potable water demand.

Another combination of components would involve RO treatment of Virgin River water and a smaller amount of wastewater reuse facility effluent, eliminating residential outdoor use of potable water, and importing high TDS water from KCWCD. The 45,000 acre-feet per year of RO product water from treating high TDS Virgin River water, 3,640 acre-feet per year of RO product water from wastewater reuse facility effluent, 9,243 acre-feet per year of RO product water from treating imported high TDS groundwater from Kane County, and 24,366 acre-feet per year resulting from eliminating residential outdoor use of culinary water would equal 82,249 acre-feet per year of M&I water to help meet WCWCD demands through 2052. The total potable water demand of 130,245 acre-feet per year (including 52,160 acre-feet of residential outdoor potable water use) would be required to meet WCWCD indoor potable water demand.

### 3.3.2 KCWCD Conceptual No Lake Powell Water Alternative

The KCWCD conceptual No Lake Powell Water Alternative would rely on existing water supplies, water conservation measures resulting in reduced water use, and future water development projects consisting of new groundwater production. Reliable water supplies (projected to be 2,170 acre-feet per year in 2035) for the area served by KCWCD (Kanab City and Johnson Canyon), adjusted for projected stream flow reductions (4.2 percent in 2035) resulting from climate change and a planning reserve (10 percent), would be exceeded by projected M&I water demands by 27 acre-feet per year within the KCWCD service area

in 2035. KCWCD projected potable water demand in 2060 would be 3,435 acre-feet per year, with a potable water deficit of 1,334 acre-feet per year. Additional groundwater in the Kanab Creek drainage basin could be developed to provide up to 6,615 acre-feet per year of potable water within the aquifer's estimated safe yield. The low quality of this water would likely require advanced water treatment. The developed groundwater from the Kanab Creek drainage basin would be pumped and conveyed through an eight-mile long pipeline to the Johnson Canyon drainage basin. The Johnson Canyon drainage basin comprises the potable water supply service area served by KCWCD in the area that could be served by the LPP Project.

## 3.4 Description of No Action Alternative

No new intake, water conveyance or hydroelectric features would be constructed or operated under the No Action Alternative. FERC would not issue a license for the LPP Project. The Utah Board of Water Resources' Colorado River water rights consisting of 86,249 acre-feet per year would not be diverted from Lake Powell and would continue to flow into the lake until the water is used for another State of Utah purpose.

### 3.4.1 WCWCD No Action Alternative

Under the No Action Alternative, WCWCD would complete the Ash Creek Project, planned groundwater development and continue to implement planned conservation programs. Wastewater reuse would be utilized to the maximum extent storage allows. Existing and future water supplies totaling 72,840 acre-feet per year potable and 8,505 acre-feet per year secondary would meet projected M&I water demand within the WCWCD service area through approximately 2028, exhausting all water planning reserves. Each supply source would be phased in to meet the M&I potable and secondary water demand associated with the forecasted population.

The No Action Alternative would not provide WCWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses). The No Action Alternative would not provide adequate water supply to meet projected water demands beyond 2028. There would be a projected water shortage of approximately 102,903 acre-feet per year in 2060 within the WCWCD service area under the No Action Alternative.

### 3.4.2 KCWCD No Action Alternative

KCWCD would use existing water supplies to meet potable water demands through 2035. Reliable water supplies are projected to be 2,101 acre-feet per year in 2060.

The No Action Alternative would not provide KCWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses). The No Action Alternative would not provide adequate water supply to meet projected water demands beyond 2035. There would be a projected water shortage of approximately 1,334 acre-feet per year in 2060 within the KCWCD service area under the No Action Alternative.

# Chapter 4
# Evaluation of the Conceptual No Lake Powell Water Alternatives

## 4.1 Introduction

The conceptual No Lake Powell Water Alternatives are evaluated for technical feasibility, total conceptual cost, environmental, and land use considerations. All of the identified components of the conceptual No Lake Powell Water Alternatives are technically feasible. Total conceptual cost opinion should be considered preliminary because of the limited knowledge of the scope of work, bidding environment at time of construction, and the variable timing on when construction could occur. Environmental and land use considerations of the conceptual No Lake Powell Water Alternatives are based on preliminary analyses.

The existing and planned projects are included in the No Action, LPP Project Proposed Action and conceptual No Lake Powell Water Alternatives; therefore, the estimated costs and environmental and land use considerations of these projects are not discussed further and are not used for comparison in this evaluation.

### 4.1.1 Technical Feasibility

#### *4.1.1.1 WCWCD Technical Feasibility*

The WCWCD conceptual No Lake Powell Water Alternatives would be technically feasible. The RO water treatment facility could be designed, constructed and operated beginning in 2025 to produce the needed product water and dispose of the brine from the RO process. Although RO treatment of reclaimed wastewater is technically feasible, it is not a reasonable alternative component at this time because it could not be permitted by regulatory agencies. An enlarged Warner Valley Reservoir would be required to store 69,030 acre-feet per year of raw water to account for evaporation losses and raw water storage to supply the RO treatment facility. The enlarged Warner Valley Reservoir would be technically feasible. Eliminating residential outdoor landscape irrigation with potable water could be implemented to meet the projected water supply need beginning in 2025. Hardening existing and future residential landscapes would be challenging but technically feasible. All trees, ornamental shrubs, grass and other existing "non-desert" vegetation would have to be removed from existing residential landscapes to accomplish the conversion. Eliminating residential outdoor landscape irrigation would reduce the ability of WCWCD to absorb water supply variables such as extended droughts because temporary reductions in outdoor water use could no longer provide a water system buffer. Conveyance of available groundwater from Kane County to Washington County would meet significant opposition but is technically feasible, involving water wells, pumping stations, and a pipeline.

#### *4.1.1.2 KCWCD Technical Feasibility*

The KCWCD would require converting agricultural water and treatment in addition to the baseline projects to meet the LPP equivalent population water need. The potential future agricultural water conversions and treatment are technically feasible.

### 4.1.2 Total Conceptual Cost Opinions

#### *4.1.2.1 WCWCD Total Conceptual Cost Opinion*

The reverse osmosis (RO) treatment of Virgin River water and reclaimed wastewater to eventual potable water use, including brine evaporation and management, all associated infrastructure, enlarged Warner Valley Reservoir, a pipeline to Apple Valley, and operations and maintenance (O&M), is estimated to have a present worth (27 years, in $2016) total conceptual cost opinion of $3,306,260,000 without financing costs. This would also include the costs associated with eliminating residential outdoor water use the District and municipal subscribers would incur to develop, issue and enforce regulations and the costs associated with changing landscaping practices. The community costs of eliminating residential outdoor water use and removing lawns and plants, shrubs, and trees and replacing them with non-irrigated landscaping or desert landscaping, turf removal rebates, dust control, and heat island effects increasing air conditioning costs would result in a present worth (27 years, in $2016) total conceptual cost opinion of $5,787,760,000.

Purchasing and conveying available groundwater from Kane County to Washington County by pipeline would have a total conceptual cost opinion of $155,000,000 without financing costs. This alternative would convey water with high TDS concentration to the St. George metropolitan area. The water would require RO treatment before being used as M&I supply.

The total conceptual cost opinion (present worth 27 years, in $2016) for the WCWCD conceptual No Lake Powell Water Alternative would be $2,545,030,000 for RO treatment of Virgin River water and reused wastewater effluent, the enlarged Warner Valley Reservoir, Apple Valley pipeline, and associated infrastructure to meet the 82,249 acre-foot demand in 2052. The total conceptual cost opinion (present worth 27 years, in $2016) for the WCWCD conceptual No Lake Powell Water Alternative plus turf removal rebates and regulatory functions for enforcing no residential outdoor watering would be $3,306,260,000. This does not include costs estimated to be incurred by homeowners from the elimination of residential outdoor watering.

#### *4.1.2.2 KCWCD Total Conceptual Cost Opinion*

KCWCD would have a total conceptual cost opinion of $15,210,000 to implement a water treatment facility to treat agricultural water converted to M&I use. The water treatment facility would be located near the mouth of Johnson Canyon.

### 4.1.3 Environmental Considerations

#### *4.1.3.1 WCWCD Environmental Considerations*

Environmental considerations associated with the WCWCD conceptual No Lake Powell Water Alternatives include potential impacts on Virgin River hydrology and water quality, shallow subsurface water movement, geology and soils, listed aquatic and wildlife species and their designated critical habitat, riparian and wetland areas, wildlife associated with the Virgin River riparian corridor and throughout the St. George metropolitan area, aquatic resources in the Virgin River, vegetation communities, air quality, noise, archaeological resources and historic-era resources, soil resources, visual resources, energy resources, and socioeconomics. The following sections describe the environmental considerations of eliminating residential outdoor watering related to water use, geology and soils, shallow subsurface water and evapotranspiration, water quality, and the resulting impacts on resources associated with the Virgin River from LaVerkin to the Utah-Arizona state line.

**4.1.3.1.1 Water Use and Return Flow Analysis.** The municipalities in Washington County have agreements with WCWCD to purchase potable water for distribution to their residential, commercial, institutional and industrial customers. The potable water is treated by WCWCD for human consumption at the Quail Creek Water Treatment Plant in Hurricane, Utah and supplied to the cities of St. George, Washington, Hurricane, LaVerkin, Santa Clara, and Ivins. The supplied potable water, along with secondary untreated water supplied to some water users in Washington County cities, comprise the M&I water supply of the county. The secondary untreated water totals 8,505 acre-feet per year and is used for outdoor watering throughout the county's urban and semi-urban areas. Potable water is consumed for indoor uses and outdoor watering throughout Washington County by residential, commercial, institutional, and industrial users. The 2010 total potable water use in Washington County was 41,875 acre-feet (UDWRe 2014a). The potable water use is divided into use categories and documented by UDWRe (2014a). Two methods have been used to estimate residential outdoor potable water use and total outdoor potable water use to quantify the estimated effect of residential outdoor watering on non-sewered return flows to the Virgin River.

The first method of estimating residential outdoor potable water use begins with the UDWRe documented residential potable indoor water use, along with potable water use by commercial, institutional and industrial (CII) categories (CII uses include indoor and outdoor use) (UDWRe 2014a). The residential potable indoor use is added to the CII water use to obtain the total potable water use for indoor residential and CII. This value is then subtracted from the total potable water use to estimate the residential outdoor potable water use. The estimated CII outdoor use of potable water is estimated by UDWRe (2014a) using a factor of 0.2 times commercial use and 0.8 times institutional use. The estimated commercial outdoor use and estimated institutional outdoor use of potable water are added the estimated residential outdoor potable water use to develop the estimated total outdoor potable water use. UDWRe (2014a) estimates that 50 percent of the 2010 outdoor potable water use becomes non-sewered return flow to the Virgin River. The remaining 50 percent of the 2010 total outdoor potable water use is estimated to be consumed through evapotranspiration and stored as soil moisture. UDWRe's estimate of 50 percent of outdoor water use is applied to the estimated total outdoor potable water use and the estimated residential outdoor potable water use to determine the non-sewered return flows. UDWRe's Kanab/Virgin River Basin Municipal and Industrial Depletion analysis projects the 50 percent of outdoor water use as non-sewered return flow will decrease to 30 percent by 2050 (UDWRe 2014a). The difference between the total estimated residential non-sewered return flows in acre-feet per year and cfs represent the projected impact of eliminating residential outdoor watering on subsurface return flows to the Virgin River. The UDWRe data and estimates developed in this first method of analysis have been extrapolated from 2010 to 2060 using the UDWRe Kanab/Virgin River Basin Use Projections 2010 – 2060 (UDWRe 2014b). Table 4-1 shows the results of the first method of estimating the effect of residential outdoor watering on non-sewered return flows to the Virgin River.

**Table 4-1**
**Estimated Residential Outdoor Water Use and Associated Non-Sewered Return Flow to the Virgin River**
**Method 1**

| Year | 2010 Action and Projected Future Residential Potable Indoor Use ($R_i$) | 2010 Actual and Projected Future Commercial Potable Use (C) | 2010 Actual and Projected Future Institutional Potable Use (I) | 2010 Actual and Projected Future Industrial & Stock Water Potable Use ($I_s$) | Estimated Total Potable Use for $R_i$+C+I+$I_s$ | Total Potable Use ($T_p$) | Estimated Residential Outdoor Potable Use ($R_o$=$T_p$-$R_i$-C-I-$I_s$) | Estimated Outdoor Use of Potable Commercial and Institutional Use ($P_{ci}$) | Estimated Total Outdoor Potable Water Use ($T_{po}$) | 2010 Actual and Projected Secondary Water Use (S) | Estimated Total Outdoor Water Use Return Flow (Non-Sewered) to Virgin River ($TR_{vr}$) | Estimated Total Outdoor Water Use Return Flow (Non-Sewered) to Virgin River (in cfs) ($TR_{vr}$) | Estimated Residential Outdoor Potable Use Return Flow (Non-Sewered) to Virgin River ($RR_{vr}$) | Estimated Residential Outdoor Potable Use Return Flow (Non-Sewered) to Virgin River (in cfs) ($RR_{vr}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All water use values in acre-feet per year except where noted | | | | | | | | | | | | | |
| 2010 | 9,621 | 10,503 | 2,876 | 542 | 23,542 | 41,875 | 18,333 | 4,401 | 22,734 | 8,505 | 11,367 | 15.7 | 9,167 | 12.7 |
| 2020 | 12,900 | 14,090 | 3,858 | 727 | 31,575 | 56,175 | 24,600 | 5,904 | 30,505 | 8,505 | 13,727 | 19.0 | 11,070 | 15.3 |
| 2025 | 14,622 | 15,973 | 4,374 | 824 | 35,793 | 63,684 | 27,891 | 6,694 | 34,584 | 8,505 | 14,698 | 20.3 | 11,854 | 16.4 |
| 2030 | 17,205 | 18,760 | 5,137 | 968 | 42,070 | 74,795 | 32,725 | 7,862 | 40,587 | 8,505 | 16,235 | 22.4 | 13,090 | 18.1 |
| 2040 | 22,756 | 24,826 | 6,798 | 1,281 | 55,661 | 98,981 | 43,320 | 10,404 | 53,723 | 8,505 | 18,803 | 26.0 | 15,162 | 20.9 |
| 2050 | 28,893 | 31,534 | 8,635 | 1,627 | 70,689 | 125,725 | 55,036 | 13,215 | 68,250 | 8,505 | 20,475 | 28.3 | 16,511 | 22.8 |
| 2052 | 30,222 | 32,668 | 8,945 | 1,686 | 73,521 | 130,245 | 56,724 | 13,690 | 70,414 | 8,505 | 21,124 | 29.2 | 17,017 | 23.5 |
| 2060 | 35,538 | 37,203 | 10,187 | 1,920 | 84,848 | 148,327 | 63,479 | 15,590 | 79,069 | 8,505 | 23,721 | 32.8 | 19,044 | 26.3 |

**Notes:**

1. All water use values used from UDWRe source tables are for Washington County, Utah.

Sources:

UDWRe. 2014a. Kanab/Virgin River Basin Municipal and Industrial Depletion. Salt Lake City, UT. September.

UDWRe. 2014b. Kanab/Virgin River Basin Use Projections 2010 – 2060. Salt Lake City, UT. November.

The second method of estimating residential outdoor potable water use begins with the UDWRe 2010 Kanab/Virgin River Basin Municipal and Industrial Depletion analysis of Washington County total potable residential outdoor use and projects proportional values from 2010 using the Kanab/Virgin River Basin Use Projections 2010 – 2060 to estimate values through 2060 (UDWRe 2014a; UDWRe 2014b). Second home outdoor potable use is added to the residential outdoor potable use to obtain total residential outdoor potable use, projected from 2010 through 2060 using the same proportional values based on the 2010 value from the Kanab/Virgin River Basin Municipal and Industrial Depletion analysis along with the Kanab/Virgin River Basin Use Projections 2010 – 2060 (UDWRe 2014a; UDWRe 2014b). Estimated total potable outdoor use is then calculated for CII outdoor use of potable water using a factor of 0.2 times commercial use and 0.8 times institutional use (UDWRe 2014a) and projected from 2010 through 2060 using the Kanab/Virgin River Basin Use Projections 2010 – 2060 (UDWRe 2014b). The CII outdoor potable use is added to the total residential outdoor potable use to estimate the total potable outdoor use. UDWRe's estimate of 50 percent of outdoor water use is applied to the estimated total outdoor potable water use and the estimated residential outdoor potable water use to determine the non-sewered return flows to the Virgin River. UDWRe's Kanab/Virgin River Basin Municipal and Industrial Depletion analysis projects the 50 percent of outdoor water use as non-sewered return flow will decrease to 30 percent by 2050 (UDWRe 2014a). The difference between the total estimated residential non-sewered return flows in acre-feet per year and cfs represent the projected impact of eliminating residential outdoor watering on subsurface return flows to the Virgin River. Table 4-2 shows the results of the second method of estimating the effect of residential outdoor watering on non-sewered return flows to the Virgin River.

The two methods utilized to estimate the residential outdoor water use and associated non-sewered return flow to the Virgin River result in slightly different values as shown in Tables 4-1 and 4-2. Method 1 shown in Table 4-1 estimates the non-sewered return flows to the Virgin River from residential outdoor water use are 80 percent of the total outdoor water use resulting in non-sewered return flows to the Virgin River. Method 2 shown in Table 4-2 estimates the non-sewered return flows to the Virgin River from residential outdoor water use are 77 percent of the total outdoor water use resulting in non-sewered return flows to the Virgin River. The Table 4-1 estimated total outdoor potable water use non-sewered return flows range from 0.8 to 1.5 cfs higher than the Table 4-2 estimated total outdoor potable water use non-sewered return flows. The Table 4-1 estimated residential outdoor potable water use non-sewered return flows range from 1.2 to 2.1 cfs higher than the Table 4-2 estimated residential outdoor potable water use non-sewered return flows.

The estimated residential outdoor water use non-sewered return flows represent the amount of return flow water that would not flow into the Virgin River between LaVerkin and the Utah-Arizona state line resulting from eliminating residential outdoor water use as part of the No Lake Powell Water Alternative. The analysis estimates that in 2052, the reduction in non-sewered return flows to the Virgin River would range from 21.4 to 23.5 cfs (77 to 80 percent reduction) resulting from eliminating residential outdoor watering. The remaining non-sewered return flow to the Virgin River from CII outdoor water use in 2052 is estimated to range from 6.4 to 5.7 cfs (23 to 20 percent remaining) resulting from eliminating residential outdoor watering. The effect of the secondary water use of 8,505 acre-feet per year is not included in the Table 4-1 and Table 4-2 calculations because this water would be diverted from the Virgin River as part of the RO treatment raw water supply under the No Lake Powell Water Alternative.

UDWRe modeled 72 years of daily stream flow data for the Virgin River using the Virgin River Daily Simulation Model (VRDSM) (UDWRe 2015). The base case model assumes future conditions with climate change hydrology reducing Virgin River basin stream flows by six percent and full utilization of existing water rights using existing facilities. The Virgin River reaches with lower modeled stream flows occur downstream of the Washington Fields Diversion and continue to the Utah-Arizona state line (Figure 4-1). During low flow conditions in the Virgin River in the months of June through February in the reach

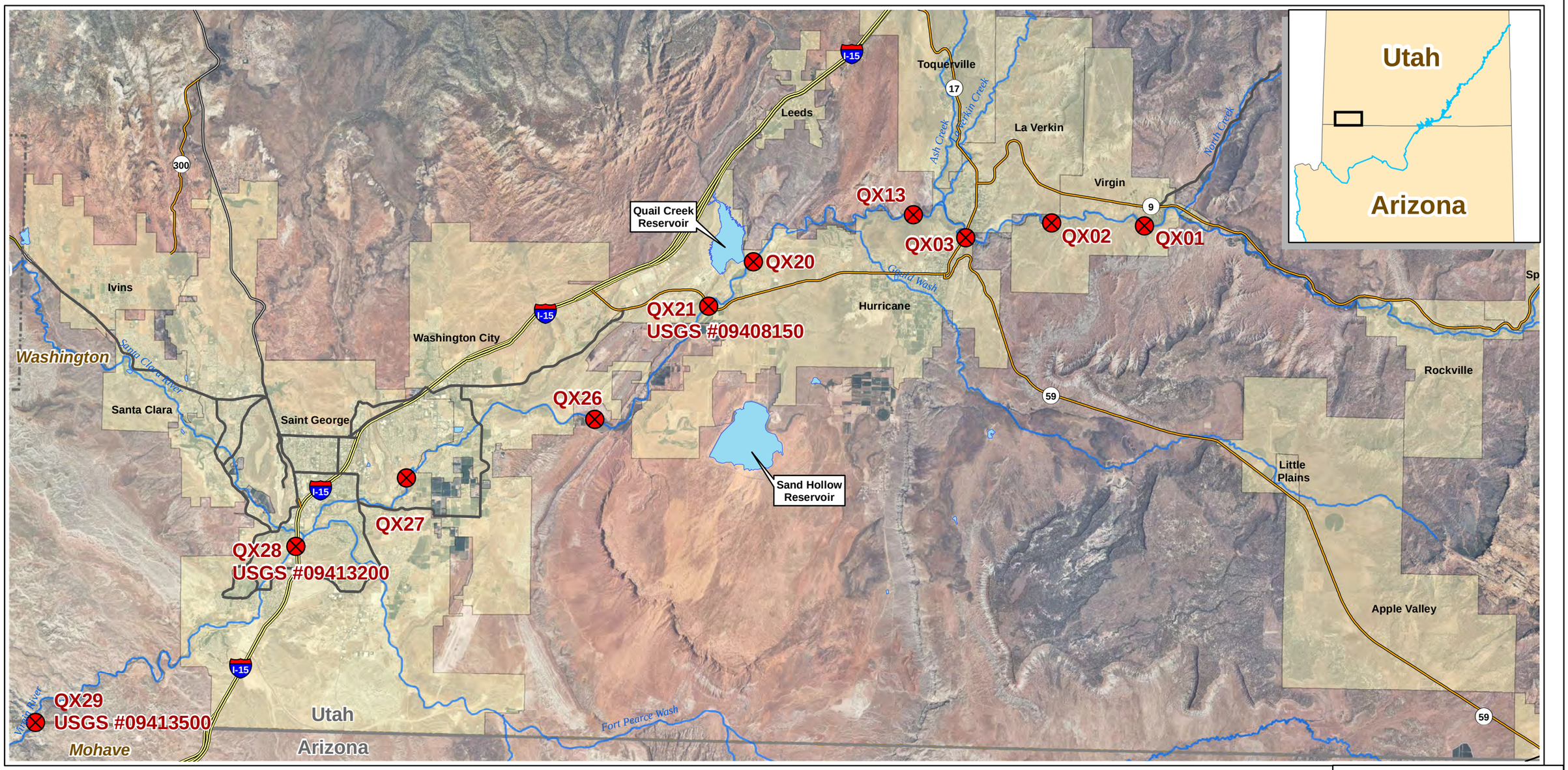
**Table 4-2**
**Estimated Residential Outdoor Water Use and Associated Non-Sewered Return Flow to the Virgin River**
**Method 2**

| Year | All water use values in acre-feet per year except where noted | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2010 Actual and Projected Future Potable Residential Outdoor Use ($R_o$) | 2010 Actual and Projected Future Second Home Outdoor Potable Use ($SH_o$) | Estimated Total Residential Outdoor Potable Use ($R_o + SH_o$) | Estimated Total Potable Outdoor Use ($T_{po}$) | 2010 Actual and Projected Future Outdoor Return Flow (Non-Sewered) Factor Interpolated | Estimated Total Outdoor Water Use Return Flow (Non-Sewered) to Virgin River ($TR_{vr}$) | Estimated Total Outdoor Water Use Return Flow (Non-Sewered) to Virgin River (in cfs) ($TR_{vr}$) | Estimated Residential Outdoor Potable Use Return Flow (Non-Sewered) to Virgin River ($RR_{vr}$) | Estimated Residential Outdoor Potable Use Return Flow (Non-Sewered) to Virgin River (in cfs) ($RR_{vr}$) |
| 2010 | 12,598 | 4,012 | 16,610 | 21,553 | 0.5 | 10,777 | 14.9 | 8,305 | 11.5 |
| 2020 | 16,900 | 5,382 | 22,282 | 28,914 | 0.45 | 13,011 | 18.0 | 10,027 | 13.9 |
| 2025 | 19,159 | 6,101 | 25,261 | 32,779 | 0.425 | 13,931 | 19.2 | 10,736 | 14.8 |
| 2030 | 22,502 | 7,166 | 29,668 | 38,498 | 0.4 | 15,399 | 21.3 | 11,867 | 16.4 |
| 2040 | 29,778 | 9,483 | 39,261 | 50,946 | 0.35 | 17,831 | 24.6 | 13,742 | 19.0 |
| 2050 | 37,824 | 12,046 | 49,870 | 64,712 | 0.3 | 19,414 | 26.8 | 14,961 | 20.7 |
| 2052 | 39,184 | 12,479 | 51,663 | 67,038 | 0.3 | 20,111 | 27.8 | 15,499 | 21.4 |
| 2060 | 44,624 | 14,211 | 58,835 | 76,345 | 0.3 | 22,904 | 31.6 | 17,650 | 24.4 |

**Notes:**

1. All water use values used from UDWRe source tables are for Washington County, Utah.

Sources:
UDWRe. 2014a. Kanab/Virgin River Basin Municipal and Industrial Depletion. Salt Lake City, UT. September.
UDWRe. 2014b. Kanab/Virgin River Basin Use Projections 2010 – 2060. Salt Lake City, UT. November.




Virgin River Daily Simulation Model Node
Lakes & Reservoirs
Major Rivers & Streams
Tribal Lands
State Boundaries
County Boundaries
Cities
Interstate
US Highway
ST Highway
Highway
Major Road

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

0 0.5 1 2 3 4 Miles

**Lake Powell Pipeline Project**

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 4-1** MWH

**Virgin River Daily Simulation Model Nodes**

downstream from the Washington Fields Diversion (QX26), mean monthly flows are simulated to range from 6 to 46 cfs, including residential outdoor water use. Eliminating residential outdoor water use during these months would potentially reduce average Virgin River flows to zero June through November, 8.6 cfs in December, 4.6 cfs in January, and 24.6 cfs in February. The estimated reductions in stream flows resulting from reduced non-sewered return flows are averaged across the year (a conservative assumption) and likely would be greater during the summer irrigation months when more water is used for residential outdoor watering. The Virgin River downstream of Bloomington Bridge is represented by the next downstream VRDSM node (QX27) from the Washington Fields Diversion (QX26) (Figure 4-1). The VRDSM node downstream of Bloomington Bridge has mean monthly stream flows ranging from 31 to 46 cfs during the months June through November. This river reach receives more return flow, including non-sewered return flows from Washington City and the Washington Fields area, than the reach immediately downstream from the Washington Fields Diversion. The estimated reductions in stream flows resulting from reduced non-sewered return flows (averaged across the year) would potentially reduce Virgin River flows to between 7.5 cfs in July to 24.6 cfs in June and November. The next downstream VRDSM node (QX28) is on the Virgin River downstream of the confluence with the Santa Clara River (Figure 4-1). This river reach receives increasing return flows, including non-sewered return flows compared to the reach below the Bloomington Bridge (QX27). The lowest flow months downstream of the confluence with the Santa Clara River are July and August, with mean monthly flows ranging from 47 to 52 cfs. This Virgin River reach receives return flows from St. George, Santa Clara and Ivins. The estimated reductions in stream flows resulting from reduced non-sewered return flows (averaged across the year) would potentially reduce Virgin River flows to between 23.5 cfs in July and 30.6 cfs in August. The most downstream VRDSM node (QX29) is at the Utah-Arizona state line and corresponds with USGS gage 09413500 (Figure 4-1). The lowest flow months in the reach ending at QX29 are July and August, which have the same mean monthly flows during these months as the reach downstream of the Santa Clara River confluence. The estimated reductions in stream flows resulting from reduced non-sewered return flows would be the same at the QX28 reach downstream from the Santa Clara River confluence (UDWRe 2015).

Flow duration curves generated by the VRDSM represent the probability of flows in the Virgin River from 0 to 100 percent of the time based on the 72 years of daily stream flow data simulated by the model (UDWRe 2015). The estimated reduced non-sewered return flows resulting from eliminating residential outdoor watering would reduce the percent of time stream flows would occur at QX26, representing the reach downstream from the Washington Fields Diversion, from 27 to 15 percent probability. The flow duration curves for the downstream VRDSM model nodes (QX27, QX28, and QX29) would maintain some stream flow 100 percent of the time, even with the effect of the estimated reduced non-sewered return flows. This indicates gaining flow the Virgin River experiences as it flows through the St. George metropolitan area resulting from various return flows.

**4.1.3.1.2 Geology and Soil Conditions.** The Virgin River basin geology is primarily comprised of sandstone, limestone, conglomerate, and basalt (USDA-SCS 1977). Approximately 21 percent of Washington County is exposed bedrock, and 62 percent of the soil types in the developed urban areas of the St. George metropolitan area are shallow with depths less than five feet to bedrock (USDA-SCS 1977). Table 4-3 summarizes the total number of soils and the depths to bedrock of soils in the St. George metropolitan area.

| Table 4-3<br>Summary of St. George Metropolitan Area Soil Depths to Bedrock | | | | | |
|---|---|---|---|---|---|
| **Total Soil Types** | **Depth to Bedrock (feet)** | | | | |
| | **1 to 2** | **2 to 3** | **3 to 4** | **4 to 5** | **>5** |
| 58 | 20 | 8 | 4 | 4 | 23 |
| Percent of Total | 62% | | | | 38% |
| Source: USDA – Soil Conservation Service. 1977. Soil Survey of Washington County Area, Utah. | | | | | |

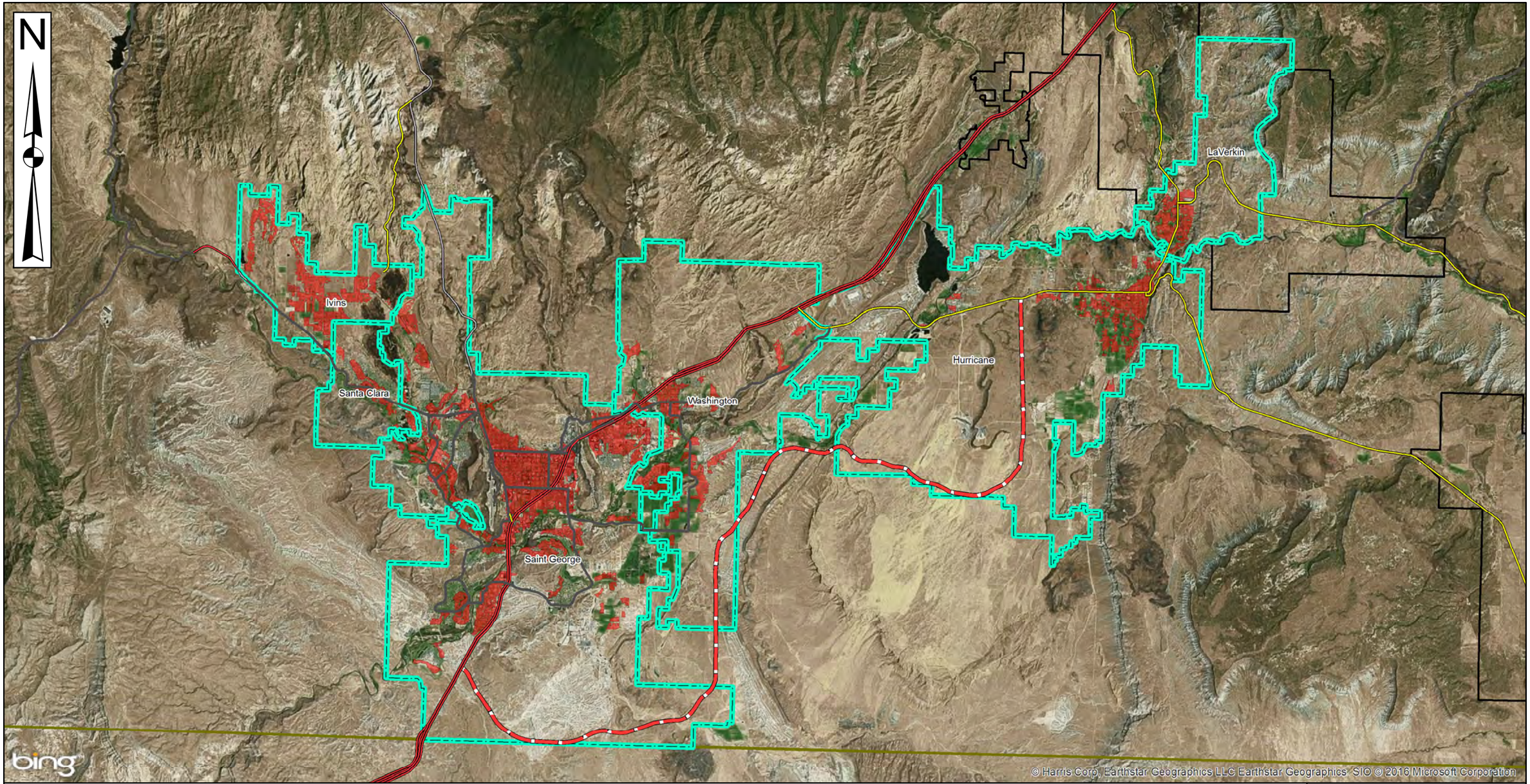
The six cities comprising the St. George metropolitan area are St. George, Washington, Hurricane, LaVerkin, Santa Clara, and Ivins. GIS analysis was performed to determine the urban and suburban development areas within the municipal boundaries of these six cities. The soils data within the boundaries of these six cities were analyzed and matched to the urban and suburban developed areas as of 2015, using data from the Soil Survey of Washington County Area, Utah (USDA-SCS 1977). Soils with depths to bedrock greater than five feet were identified and mapped in areal extent (acres) across the developed areas of the six cities. Soils with depths to bedrock less than five feet were identified and mapped in areal extent in the developed areas within the municipal boundaries. Table 4-4 displays the results of the GIS analysis of soil depths throughout the developed areas of Washington County. Figure 4-2 shows the Washington County urban areas with soil depths greater than five feet, based on the soils data and the areal extent and location relative to the Virgin River.

**Table 4-4**
**Washington County Urban Area Soil Depth Analysis**

| | **Washington County Cities (acres)** | | | | | | **Total Area** |
|---|---|---|---|---|---|---|---|
| | **St. George** | **Washington** | **Hurricane** | **Ivins** | **Santa Clara** | **LaVerkin** | |
| **Urban Area** | 15,114 | 3,850 | 4,487 | 1,773 | 1,083 | 722 | **27,029** |
| **Soil Depth Area >5 feet** | 5,930 | 1,517 | 1,266 | 1,419 | 353 | 543 | **11,028** |
| **Percent of Urban Area** | 39% | 39% | 28% | 80% | 33% | 75% | **41%** |
| **Soil Depth Area <5 feet** | 9,184 | 2,333 | 3,221 | 354 | 730 | 179 | **16,001** |
| **Percent of Urban Area** | 61% | 61% | 72% | 20% | 67% | 25% | **59%** |

The Washington County urban area soil depth analysis shown in Table 4-4 indicates that 59 percent of the soils within the urban areas comprised by the six cities have soils with depths to bedrock less than five feet. Soils with depths to bedrock greater than five feet comprise 41 percent of the urban area. All of the soils within the urban area are classified as well-drained or excessively well-drained, which means they are permeable to rapidly permeable, water flows through the soils quickly, and the soils have low available water holding capacity (USDA-SCS 1977). Therefore, water used for outdoor watering of landscapes that is not consumed by evapotranspiration or lost through evaporation flows quickly through the shallow soils to the bedrock or other impervious layer. The bedrock in the Washington County urban areas is characterized as being relatively flat and gently sloping toward the south (USDA-SCS 1977). The Virgin River is the low point in the valley and surface water, shallow subsurface water, and discharging

groundwater all flow to the Virgin River through the St. George metropolitan area. Water applied to outdoor landscapes drains quickly through the relatively shallow soils to the bedrock, where it flows laterally across the bedrock surface toward the Virgin River.




City Boundaries
Soil greater than 5 feet deep
Cities
State Boundaries
Interstate
US Highway
ST Highway
Hwy
Major Road
Southern Corridor

**FERC Project Number:**
**12966-001**
**BLM Serial Numbers:**
**AZA-34941**
**UTU-85472**

N

0 2 4 6 Miles

**Lake Powell Pipeline Project**

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 4-2** MWH

**Washington County**
**Urban Areas with**
**Soil Greater than 5 Feet Deep**

**4.1.3.1.3 Shallow Subsurface Water and Evapotranspiration.** Water applied to outdoor landscapes in the St. George metropolitan area is consumed by vegetation as evapotranspiration, evaporates into the atmosphere, and becomes part of the shallow subsurface water that moves vertically and horizontally through the soils. The shallow subsurface water flows by gravity through the soils to bedrock or other low-permeability earth materials. When the shallow subsurface water reaches the bedrock, then it flows laterally by gravitational force through the well-drained to excessively well-drained soils toward the Virgin River. The shallow subsurface water is discharged as non-sewered return flow from the soil-bedrock interface into the Virgin River. The non-sewered return flows discharging to the Virgin River occur along its banks throughout the St. George metropolitan area. These shallow subsurface discharges contribute to the gaining reaches of the Virgin River.

Evapotranspiration in the St. George metropolitan area is estimated to average 37.9 inches of water per year (3.16 feet per year average) for turfgrass, with a range from 35.5 to 50 inches annually as measured by lysimeter (UAES 2011). Evapotranspiration from gardens is estimated to average 22.2 inches per year. Evaporation from shallow open water is estimated to average 51.3 inches per year (UAES 2011).

The 2015 residential outdoor watering area in urban Washington County as analyzed using GIS data is estimated at 3,371 acres. Using the estimated residential outdoor water use from Table 4-1 and projecting the proportionate 2015 residential outdoor water use at 21,466 acre-feet per year, the total water use in feet (21,466 acre-feet per year/3,371 acre) yields an estimated value of 6.37 feet per year of residential outdoor water use. The evapotranspiration (including evaporation) is estimated to consume 3.16 feet per year. Therefore, the estimated value of residential outdoor water use returning as non-sewered return flow to the Virgin River is 3.21 feet per year (approximately 50 percent of the total water applied), which equals the UDWRe estimate of 50 percent of outdoor water use returning as non-sewered return flow to the Virgin River.

**4.1.3.1.4 Water Quality.** Water applied to residential outdoor landscapes in the St. George metropolitan area that discharges to the Virgin River as non-sewered return flow is affected by soil temperatures. The Natural Resources Conservation Service (NRCS) classifies the St. George metropolitan area as having thermic soil characteristics, where the mean annual soil temperature is 15 ºC (59 ºF) or higher but lower than 22 ºC (71 ºF), and the difference between mean summer and mean winter soil temperatures is more 5 ºC (41 ºF) at a depth of approximately 20 inches (NRCS 2016). The temperature of water delivered from Quail Creek Water Treatment Plant during the outdoor irrigation season (March through October) ranges from 11.1 ºC (52 ºF) to 25.9 ºC (79 ºF) and is not expected to increase during distribution through underground piping. When the potable water is applied to vegetation during the outdoor irrigation season, the temperature increases upon contact with the vegetation and near surface soil. Outdoor water use that infiltrates into the soil and becomes shallow subsurface water during the high air temperature months (June through September) is cooled by the lower soil temperatures (<22 ºC, <71 ºF), especially in soils deeper than 15 to 20 inches. When the shallow subsurface water is discharged as non-sewered return flow to the Virgin River, it helps cool the river water when surface flow temperatures are higher than 22 ºC (71 ºF). Virgin River water temperature data at USGS gage 09413500 (Virgin River near St. George, Utah) show a range of 17.9 ºC (64 ºF) to 28.0 ºC (82 ºF) during the months June through September (USGS 2016). The non-sewered return flow of residential outdoor water use during these months would cool the shallow subsurface water to between 15 ºC (59 ºF) and 22 ºC (71 ºF). When this water discharges to the Virgin River, it cools the river flow through mixing, especially during periods when the river water temperatures are above 22 ºC (71 ºF).

Elimination of residential outdoor watering under the No Lake Powell Water Alternative would reduce the non-sewered return flow to the Virgin River by an estimated 77 to 80 percent, and the resulting effect on river water temperatures would be an increase in river water temperatures compared to baseline conditions. The temperature increases would be highest in the reach downstream from the Washington

Fields Diversion where the river flow would be zero to <3 cfs. As the Virgin River water temperature increases, the dissolved oxygen concentration decreases because the solubility of oxygen decreases with increasing temperature (Sawyer and McCarty 1978). An increase in water temperature from 20 ºC (68 ºF) to 25 ºC (77 ºF) decreases the dissolved oxygen saturation concentration by approximately 1 mg/L to a maximum of 8 mg/L. Dissolved oxygen concentrations recorded by the USGS at gage 09413500 (Virgin River near St. George, Utah) range from 7.0 to 7.6 during the months of June through September. Reducing the non-sewered return flows to the Virgin River by eliminating residential outdoor watering would reduce dissolved oxygen concentrations by an estimated 1 mg/L.

**4.1.3.1.5 Resulting Impacts on Virgin River Resources.** The No Lake Powell Water Alternative, incorporating elimination of residential outdoor watering and RO treatment of Virgin River water diverted at the Washington Fields Diversion would have potential adverse effects and impacts on the resources associated with the Virgin River corridor. Reductions in non-sewered return flows to the Virgin River flows resulting from eliminating residential outdoor watering and associated changes in water quality would adversely affect listed aquatic and wildlife species and their designated critical habitats in and along the Virgin River. Riparian and wetland areas along the Virgin River would be affected by the reduced Virgin River flows, which in turn could adversely affect wildlife resources that inhabit the riparian and wetland areas. Wildlife resources also would be directly affected by operation of the brine evaporation ponds associated with the RO treatment system resulting from loss of 2,000 acres of upland habitat. Aquatic resources in the Virgin River would be affected by the reductions in stream flows and associated changes in river water temperatures. Vegetation communities in the St. George metropolitan area would be affected by the conversion from traditional residential landscapes to hardened landscapes with desert vegetation. Air quality would be temporarily affected by pipeline and pump station, RO treatment facility and desert landscape construction activities. Air quality could be permanently affected by the conversion to desert landscapes, resulting in increased airborne particulate matter generated from increased exposed soil areas. Noise levels would temporarily increase during construction activities. Archaeological and historic-era resources could be affected by construction of pipelines, pump stations, the RO treatment facility and brine evaporation ponds. Soil resources could be eroded during facility construction and during conversion from traditional residential landscapes to hardened surfaces with desert landscapes. Depending on the amount of funds made available for landscape conversions, long-term soil erosion could occur from desert landscapes through wind and precipitation runoff erosional processes. The elimination of existing landscapes through either intentional replacement with desert landscapes, which are more susceptible to weeds, or through lack of water, would result in increased weed production. Visual resources within the St. George metropolitan area would be affected by the conversion of traditional residential landscapes to hardened surfaces with desert landscapes in terms of color, texture, line and form, plus visibility could decrease during windstorms from increased airborne particulates. The temperature amelioration offered by existing landscaping would be lost, leading to higher temperatures and more power demands as use of air conditioning increases. This impact is known as the heat-island effect and would significantly increase air conditioning during the cooling season (May through October) when temperature in indoor spaces would increase up to 6 ºC and range from 3.9 ºC to 6.0 ºC higher than baseline conditions (Myrup 1969). More water would be consumed in connection with power production, although the source water may be located in a different area. Significant energy resources would be permanently consumed to power the RO water treatment facility, and a commitment of energy would be made to pump available groundwater and convey it from Kane County to Washington County. Socioeconomic resources would be affected by converting traditional residential landscapes to desert landscapes through changing property values, significantly increased water rates, enforcement of residential outdoor watering restrictions and concomitant social costs as residents lose their sense of community and pride and as resentment of new residents grows. Residential yards would be uninhabitable during the hot summer months. Residential vegetable gardens would be eliminated. Construction and operation of the RO water treatment facility would significantly increase water rates for all water users.

#### *4.1.3.2 KCWCD Environmental Considerations*

The KCWCD environmental considerations include potential groundwater depletion from local aquifers and reduction of groundwater recharge from agricultural water conversion to M&I raw water supply. Groundwater depletion would only be a concern if the withdrawal of groundwater from an aquifer exceeds the aquifer recharge rate. It appears the aquifers identified for KCWCD future development of groundwater supplies are adequate to meet the identified water needs and they receive recharge in excess of future withdrawals. Portions of the groundwater aquifer have high TDS concentrations and the groundwater extracted from these areas could not be used for M&I supply.

### 4.1.4 Land Use Considerations

#### *4.1.4.1 WCWCD Land Use Considerations*

Land use considerations associated with the WCWCD conceptual No Lake Powell Water Alternatives would include loss of grazing land from constructing and operating the RO water treatment facility, evaporation ponds and brine disposal, and the enlarged Warner Valley Reservoir. Converting traditional residential landscapes to hardened surfaces with desert landscape features would alter the vegetation composition on land parcels, but would not change the residential land use designations or classifications. Constructing and operating a water conveyance pipeline from Kane County to Washington County would restrict future land use along the pipeline right-of-way.

#### *4.1.4.2 KCWCD Land Use Considerations*

Agricultural land use would be converted to other uses including housing and municipal infrastructure near Kanab under the KCWCD conceptual No Lake Powell Water Alternative.

# Chapter 5
# Conceptual No Lake Powell Water Alternatives Screening

## 5.1 Introduction

The conceptual No Lake Powell Water Alternatives are screened in this chapter using criteria established to evaluate the relative merits of each alternative. The screening process involves systematic rating of the conceptual No Lake Powell Water Alternatives using five screening criteria: 1) ability to meet projected water demands; 2) technical feasibility; 3) total conceptual cost opinion; 4) environmental considerations; and 5) land use considerations. The screening methodology allows the alternatives to be consistently evaluated according to established criteria to determine each District's No Lake Powell Water Alternative for analysis in the other study reports and the Commission's draft Environmental Impact Statement (EIS).

### 5.1.1 Screening Criteria Definitions and Screening Evaluations

The screening criteria defined in the following subsections allow for consistent evaluation of the conceptual No Lake Powell Water Alternatives. Summary screening evaluations of the conceptual No Lake Powell Water Alternatives are included for WCWCD. The KCWCD No Lake Powell Water Alternative meets the LPP equivalent population water needs, therefore no alternatives are evaluated or screened for KCWCD.

#### *5.1.1.1 Ability to Meet Projected Water Demands*

The ability to meet projected water demands is defined as having the quality or state of being able to reliably perform at a level meeting the future water demand. A No Lake Powell Water Alternative with the ability to meet projected water demands would provide a reliable water supply comparable to the LPP Proposed Action.

The WCWCD conceptual No Lake Powell Water Alternatives would meet the projected water demand through 2052. This is the same year through which the LPP Project would meet the projected water needs of the population served by the WCWCD.

#### *5.1.1.2 Technical Feasibility*

Technical feasibility is defined as being able to use available technology to successfully achieve established performance objectives. A No Lake Powell Water Alternative with technical feasibility would be capable of being completed using available technology to achieve water quantity and quality objectives comparable to those provided under the LPP Project.

Although each component of the conceptual No Lake Powell Water Alternatives is technically feasible, significant regulatory hurdles may make some difficult to implement. The advanced treatment of reclaimed wastewater to culinary quality using RO by WCWCD is the most technically challenging component and the most likely to be challenged by regulatory agencies. No "toilet to tap" treatment plants have been approved in the state of Utah, and therefore, it is uncertain whether or not this component of the alternative would be approved. Developing and operating RO advanced water treatment of Virgin River water would be technically challenging and could be approved by regulatory agencies. Design and operation of a pipeline to convey available Kane County groundwater to Washington County would face similar technical challenges. Restricting residential outdoor water use to reduce water consumption by

converting traditional residential landscaping practices to hardened surfaces with desert landscapes is the least technically challenging alternative, provided, however, that the actions necessary to accomplish the change would be extremely challenging as a practical matter because of social opposition and the challenges posed by eliminating shade trees that have existed since the first pioneers arrived in Washington County, vegetable gardens, turf and other people-friendly landscape, and convincing residents to perform the tasks necessary to achieve these changes.

#### *5.1.1.3 Total Conceptual Cost Opinion*

Total conceptual cost is defined as the total present worth probable cost of an alternative. The total conceptual cost opinion of the No Lake Powell Water Alternative is $3,306,260,000. With the addition of importing Kane County groundwater, the total conceptual cost opinion of the No Lake Powell Water Alternative is $3,461,260,000.

For the WCWCD, using RO advanced water treatment of Virgin River water and wastewater reuse effluent, and restricting residential outdoor watering with culinary grade water would have the most favorable relative cost rating and would be the most cost effective No Lake Powell Water Alternative. The total conceptual cost opinion includes the costs that would be incurred by WCWCD and its municipal partners to convert traditional residential landscapes to desert landscapes, but the costs that would be incurred by homeowners are not.

#### *5.1.1.4 Environmental Considerations*

Environmental considerations are defined as broadly assessed environmental impacts on physical, biological and socioeconomic resources that could result from implementing an action. A No Lake Powell Water Alternative with fewer potential environmental impacts and less intense projected effects on other resources receives a higher rating for environmental considerations compared to an alternative with numerous potential environmental impacts and significant projected effects on other resources.

The WCWCD conceptual No Lake Powell Water Alternatives vary in their potential effects on environmental resources. Both alternatives would involve treating Virgin River water using a RO advanced water treatment process, which could affect Virgin River hydrology, water quality, listed aquatic and wildlife species and their designated critical habitats, riparian and wetland areas, wildlife, aquatic resources, archaeological resources and historic-era resources, energy resources and socioeconomic resources. The RO advanced water treatment of reclaimed wastewater effluent would have additional effects on all of the same resources, with increased impact intensity because of the incremental treatment requirements. Eliminating residential outdoor watering could affect Virgin River hydrology, water quality, groundwater levels, listed aquatic and wildlife species and their designated critical habitats, riparian and wetland areas, wildlife, aquatic resources, vegetation communities, air quality, soil resources, visual resources, and would have significant adverse impacts on socioeconomic resources. Developing and conveying available groundwater from Kane County to Washington County could affect groundwater levels, vegetation communities, wildlife, listed wildlife and plant species, archaeological resources and historic-era resources, soil resources, visual resources, energy resources and socioeconomic resources. The conceptual No Lake Powell Water Alternative with the least potential effect on environmental resources would involve RO advanced water treatment of Virgin River water and wastewater reuse effluent, and eliminating residential outdoor irrigation. The WCWCD conceptual No Lake Powell Water Alternative involving developing and conveying available Kane County groundwater to Washington County would cause additional impacts on resources that would not be offset by treating additional wastewater reuse effluent. The No Lake Powell Water Alternative involving RO advanced water treatment of Virgin River water and RO advanced water treatment of reclaimed wastewater effluent and

development of an enlarged Warner Valley Reservoir would have the greatest potential effect on environmental resources because the RO treatment facilities would increase in area and direct effects on resources.

### *5.1.1.5 Land Use Considerations*

Land use considerations are defined as broadly assessed changes in land use that could result from implementing an action. A No Lake Powell Water Alternative with little or no change in land use receives a higher rating for land use considerations compared to an alternative with large changes in land use.

Converting traditional residential landscaping to hardened landscape with desert vegetation within the WCWCD service area would radically alter vegetation composition on residential land parcels, although it would not change the residential land use designation of the parcels. This component of the No Lake Powell Water Alternatives would have the least effect on land use. Constructing and operating RO advanced water treatment facilities would change land uses over a large area and would permanently commit existing agricultural land to brine evaporation ponds and the enlarged Warner Valley Reservoir. The RO treatment of the combined Virgin River water and reclaimed wastewater effluent sources, associated brine evaporation ponds, and an enlarged Warner Valley Reservoir would have a significant impact on public and private land use. Constructing and operating a water conveyance pipeline from Kane County to Washington County could change existing land use and permanently restrict future land use along the pipeline corridor. This component of a No Lake Powell Water Alternative would have a moderate impact on land use.

## 5.2 Screening Process Summary

The screening process involved developing and using a numeric rating scale to represent the ratings for each screening criterion. The conceptual No Lake Powell Water Alternatives are assigned a numeric rating score from 0 to 5 representing the screening criteria defined and screening evaluations provided in Section 5.1. An assigned numeric rating score of 0 represents the lowest possible rating in the screening process. An assigned numeric rating score of 5 represents the highest possible rating in the screening process. The total numeric rating for each conceptual alternative represents a composite, un-weighted numeric rating for the screening criteria. The highest possible total numeric rating in the screening process is 25. The conceptual No Lake Powell Water Alternative with the highest total numeric rating is the recommended No Lake Powell Water Alternative for analysis in the study reports and the draft environmental impact statement that will be prepared by the Commission to meet NEPA compliance requirements.

### 5.2.1 WCWCD No Lake Powell Water Alternatives Screening Process Results

Table 5-1 shows the screening results for the WCWCD conceptual No Lake Powell Water Alternatives.

**Table 5-1**
**WCWCD Conceptual No Lake Powell Water Alternatives Screening**

| WCWCD No Lake Powell Water Alternative | Screening Criteria | | | | | Total Rating |
|---|---|---|---|---|---|---|
| | Ability to Meet Water Demand | Technical Feasibility | Total Conceptual Cost Opinion | Environmental Considerations | Land Use Considerations | |
| Virgin River & Wastewater RO & Residential Watering Elimination | 5 | 4 | 0.1 | 2 | 3 | 14.1 |
| Virgin River & Wastewater RO & Kane County Pipeline & Residential Watering Elimination | 5 | 4 | 0 | 2 | 3 | 14.0 |

The No Lake Powell Water Alternative with the highest total numeric rating is the combination of RO advanced water treatment of Virgin River water and wastewater reuse effluent, and eliminating residential outdoor irrigation, which would require issuing regulations and converting traditional residential landscapes to desert or non-irrigated landscapes to meet the projected future water demand.

### 5.2.2 KCWCD No Lake Powell Water Alternatives Screening Process Results

The agricultural water conversion and treatment alternative meets the LPP equivalent population water need for KCWCD. No additional alternatives were evaluated.

# Chapter 6
# Recommended No Lake Powell Water Alternatives for NEPA Analysis

The recommended No Lake Powell Water Alternatives for WCWCD and KCWCD consist of the following components to meet each district's projected water demand without the Lake Powell Pipeline project. These recommended No Lake Powell Water Alternatives are analyzed in the LPP Project study reports and will be analyzed in the draft environmental impact statement prepared by the Federal Energy Regulatory Commission to meet their NEPA compliance requirements.

## 6.1 Recommended No Lake Powell Water Alternative for WCWCD

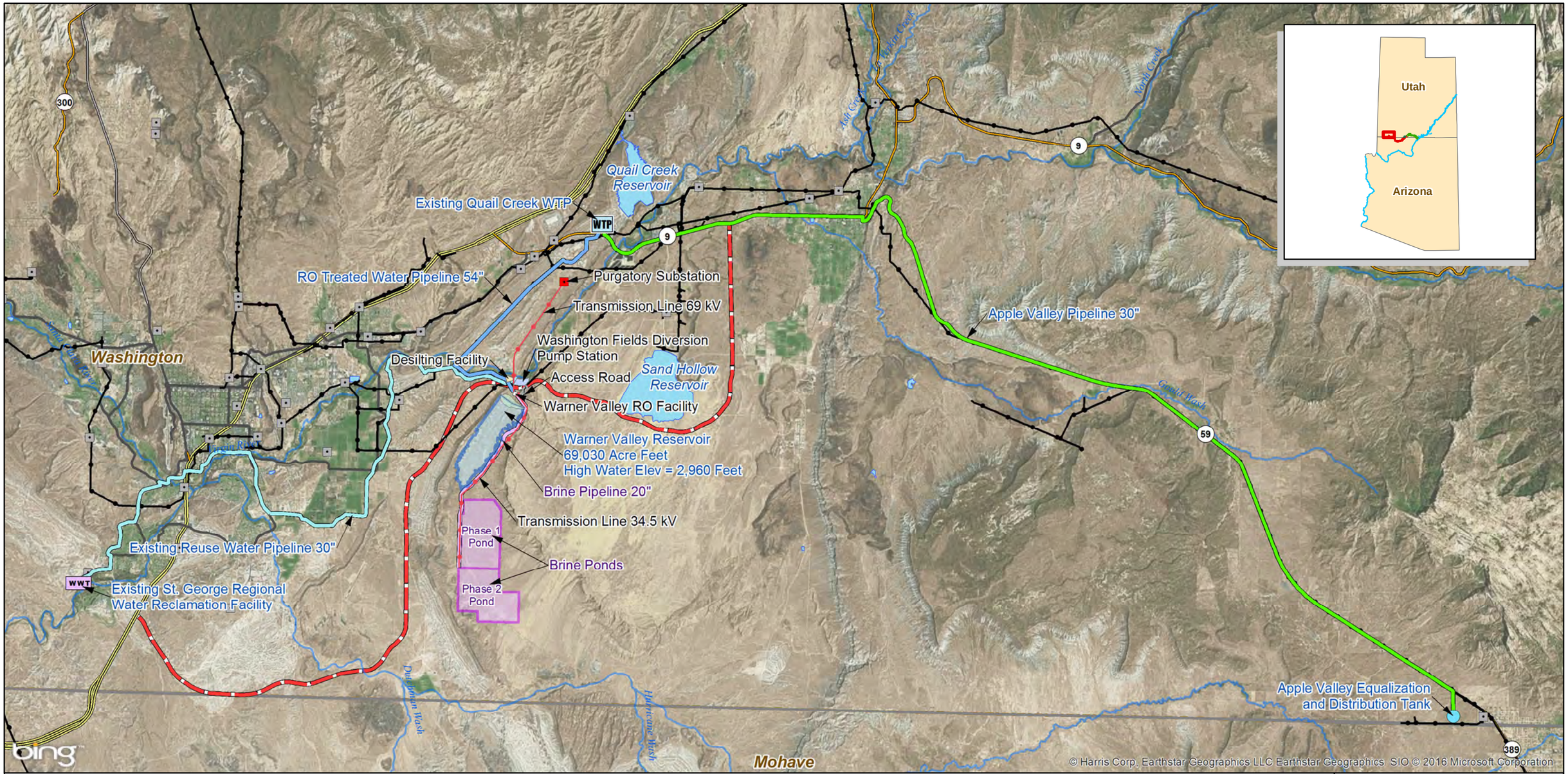
The recommended No Lake Powell Water Alternative for WCWCD consists of RO treatment of Virgin River water and wastewater reuse effluent, and eliminating residential outdoor irrigation with potable water. The components of the recommended No Lake Powell Water Alternative for WCWCD are described in the following paragraphs.

The WCWCD LPP allocation would be 82,249 acre-feet per year, and the WCWCD No Lake Powell Water alternative would need to supply 82,249 acre-feet per year to meet the same future water demands. In addition to the direct supply from Utah's Colorado River water, the water supplied by the LPP Project would provide additional wastewater reuse supply provided that sufficient storage is available.

The No Lake Powell Water Alternative would serve the same population as the LPP Project. WCWCD would implement other future water development projects currently planned by the District, develop additional water reuse/reclamation programs, continue to implement new water conservation measures, and convert additional agricultural water use to M&I use as a result of urban development in agricultural areas through 2028. Remaining planned and future water supply projects include the Ash Creek Pipeline (2,840 acre-feet per year), Sand Hollow recharge/recovery (3,000 acre-feet per year), Westside groundwater wells arsenic treatment (5,000 acre-feet per year), and development/yield increase of existing groundwater wells (2,830 acre-feet per year). Along with existing supplies, these future water supplies would yield an estimated 72,842 acre-feet per year of potable water and 8,505 acre-feet per year secondary water by 2028.

Under the No Lake Powell Water Alternative, actions in addition to the currently planned WCWCD projects would be taken to meet the water demand that would have been supplied by the Lake Powell Pipeline, as described below.

Beginning in 2025, Washington County residential outdoor potable water use would be permanently re-purposed to indoor potable water use to help meet increasing indoor potable water demands. The WCWCD would develop a reverse osmosis (RO) advanced water treatment facility near the Washington Fields Diversion in Washington County, Utah, to treat up to 50,000 acre-feet per year of diverted Virgin River water, which has a high total dissolved solids (TDS) concentration, mixed with an additional 19,030 acre-feet per year of reuse water. WCWCD would develop the Warner Valley Reservoir to store the reuse water and diverted Virgin River water prior to RO treatment. A water distribution pump station and pipeline would be constructed to convey 13,249 acre-feet of potable water from Quail Creek Water Treatment Plant to the Apple Valley area of Washington County. Figure 6-1 shows the primary conceptual components of the No Lake Powell Water Alternative. Table 6-1 summarizes available supplies and projected demands under the No Lake Powell Water Alternative and the LPP Project alternatives.




WTP Quail Creek WTP (Existing)
WWT St. George Regional Water Reclamation Facility (Existing)
Substation
Substation (Future)
Warner Valley Transmission Line
Existing Transmission Lines
Desilting Facility
RO WTP
Washington Fields Diversion Pump Station
Lakes & Reservoirs
Brine Evaporation Ponds
Access Road
Apple Valley Pipeline 30"
Brine Pipeline 20"
Existing Reuse Water Pipeline 30"
RO Treated Water Pipeline 54"
Major Rivers & Streams
Interstate
US Highway
ST Highway
Hwy
Major Road
Southern Corridor Highway
State Boundaries
County Boundaries

**FERC Project Number:**
**12966-001**
**BLM Serial Numbers:**
**AZA-34941**
**UTU-85472**

N

0 0.75 1.5 3 4.5 6 Miles

**Lake Powell Pipeline Project**

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 6-1** MWH

**No Lake Powell Water Alternative Primary Infrastructure**

**Table 6-1**
**Available Supplies and Projected Demands Under the No Lake Powell Water and Lake Powell Pipeline Project Alternatives**

| | No Lake Powell Water Alternative | Lake Powell Pipeline Project Alternative |
|---|---|---|
| Existing Supplies | 67,677 | 67,677 |
| Planned Projects | 13,670 | 13,670 |
| Lake Powell Pipeline Project | 0 | 82,249 |
| RO Treatment of Virgin River and Reuse Water | 57,883 | 0 |
| Agricultural Conversion | 0[1] | 10,080 |
| Reuse | 17,100[2] | 36,130 |
| 2060 Total Supply | 156,330 | 209,806 |
| 2060 Total Demand | 133,119[3] | 185,285 |
| **Surplus in 2060** | **23,211** | **24,521** |

**Notes:**
[1]Agricultural conversion water included in RO treatment.
[2]19,030 acre-feet per year additional reuse included in RO treatment.
[3]Demand reduced 52,166 acre-feet per year from elimination of residential outdoor watering.

### 6.1.1 Re-Purposing Potable Water Use

The No Lake Powell Water Alternative would permanently eliminate residential outdoor water use in Washington County, re-purposing the portion of potable water used for residential outdoor watering to indoor potable use. Projections of future water use through 2060 account for population growth, climate change (projected 6 percent reduction of Virgin River flows by 2050 [Reclamation 2014]), and water conservation (35 percent reduction in per capita water use from 2000 to 2060). Potable water in Washington County is consumed for residential indoor and outdoor uses, commercial uses, institutional uses, and industrial uses. These potable water uses would total 130,245 acre-feet per year by 2052, the year the LPP Project water is anticipated to be fully utilized (UDWRe 2015). Gradually eliminating residential outdoor water use starting in 2025 would provide the growing population with potable water for indoor use through 2045; however, re-purposing residential outdoor potable water use to indoor use would not increase the water supply and would have to be accompanied by adding another water supply to meet the growing demand. Re-purposing residential outdoor water use to indoor use would require converting traditional residential outdoor landscapes and uses to either landscaping requiring no irrigation or desert landscapes compatible with the local climate. Residential water users would be responsible for converting their traditional outdoor landscapes to non-irrigated or desert landscapes. If no additional water supply was added in Washington County after 2025 and potable water use continued to meet residential indoor and outdoor purposes, then the projected population would completely utilize the potable water supply of 72,842 acre-feet per year by 2028.

### 6.1.2 Reverse Osmosis Water Treatment

Washington County's additional future water supply under the No Lake Powell Water Alternative would be dependent on two water sources: 1) Virgin River water diverted at the Washington Fields Diversion; and 2) reuse water from an expanded St. George Regional Water Reclamation Facility. WCWCD would develop a RO advanced water treatment facility near Washington Fields Diversion in Washington County, Utah. The RO facility would be designed to treat 50,000 acre-feet of de-silted water per year diverted from the Virgin River at Washington Fields Diversion. St. George Regional Wastewater Reclamation Facility would provide an additional 19,030 acre-feet of water per year to be treated at the RO facility. The RO facility would be necessary to remove the high concentrations of TDS present in both the Virgin River and the effluent from the St. George Regional Wastewater Reclamation Facility. The reuse facility has a current capacity of approximately 7,800 acre-feet per year, with a future design capacity of 11,760 acre-feet per year. An additional 7,830 acre-feet per year of future wastewater reclamation capacity would need to be added to meet the total reuse water requirement of 19,030 acre-feet per year for RO processing inflow. The RO process would separate the TDS from the water, resulting in two products: 1) a treated water product; and 2) a brine product consisting of highly concentrated salts. A two-stage RO process would be applied to the brine solution to recover additional water and reduce the brine volume for enhanced evaporation. The RO-treated water product would be pH-adjusted to neutral pH, dosed with sodium silicate, mixed with conventionally-treated water from the Quail Creek Water Treatment Plant, and disinfected for distribution throughout the WCWCD service area. The RO advanced water treatment facility would process up to 64,313 acre-feet per year and produce up to 57,883 acre-feet per year of water suitable for M&I potable indoor use. The two-stage RO process would remove 90 percent of the TDS. The remaining 10 percent rejection (6,430 acre-feet per year) of brine by-product from the RO treatment process would require evaporation and disposal meeting State of Utah water quality regulations. The RO water treatment plant would process approximately 64,313 acre-feet per year of inflow water from Warner Valley Reservoir storage to meet the 2052 water demand under the No Lake Powell Water Alternative.

The RO water treatment plant processes would consist of pressurized, parallel ultra-filtration units, an influent storage tank with acid added to adjust the pH, pressurized cartridge filtration to remove additional particles from the water, high pressure pumping to pass the water through the parallel RO membrane units, a product water storage tank with saturated lime solution added to adjust the pH of the treated product water prior to disinfection and distribution as potable water, and brine storage tanks in series with the two-stage RO process units for further brine reduction. These water treatment processes would be housed in a water treatment building with electrical, mechanical, chemical storage and metering, heating/air conditioning/ventilation, and SCADA systems. A seven-mile long buried 54-inch diameter pipeline would convey the product water from a pump station at the RO water treatment plant to the Quail Creek Water Treatment Plant. The RO water treatment plant would add RO membrane units in phases as necessary to meet the growing water demand. The RO water treatment plant would be powered by electricity, requiring a 2.8-mile long 69-kV power transmission line from the proposed Purgatory Substation.

The concentrated brine product (6,430 acre-feet per year) would be pumped from the brine tanks through a pipeline to an evaporation apron, spray system and double-lined pond, and then pumped into spray headers over a series of double-lined ponds with leak detection and recovery systems. The enhanced evaporation ponds would be located south of Warner Valley Reservoir and would cover approximately 2,000 acres, developed in two phases. A buried brine conveyance pipeline approximately 4.4 miles long would convey the concentrated brine to the enhanced evaporation ponds. A 4.4-mile long 34.5-kV power transmission line would be extended from the RO water treatment plant to the enhanced evaporation ponds to provide electricity for the pumps spraying the brine solution. The brine solids would be evaporated for approximately 25 years in the Phase 1 ponds, and then dried, collected and disposed in an

approved solid waste landfill. The Phase 2 enhanced evaporation ponds would be used during the following 25 years to continue evaporating the brine by-product. Additional infrastructure would be required as part of this alternative, including a de-silting facility, pump stations, pipelines, switch stations and substations, blending and storage tanks, and other associated earthwork.

### 6.1.3 Secondary Water Storage in Warner Valley Reservoir

WCWCD would develop the Warner Valley Reservoir to store diverted Virgin River water and reuse water from the St. George Regional Water Reclamation Facility, which would be delivered as inflow to the RO advanced water treatment facility. Warner Valley Reservoir would be located south-southwest of the Washington Fields Diversion. An earth-fill embankment with a clay core and rock-riprap facing would be constructed across the north entrance to the natural valley. The reservoir would have a maximum active storage volume of 69,030 acre-feet and would cover approximately 1,130 acres, including the earth-fill embankment. A large pump station would be constructed at the Washington Fields Diversion to pump the diverted Virgin River water into the Warner Valley Reservoir. The pump station would be powered by electricity via the 69-kV transmission line from the Purgatory Substation to the RO water treatment plant. The reservoir would store Virgin River water diverted at the Washington Fields Diversion (50,000 acre-feet per year) mixed with St. George Regional Water Reclamation Facility effluent (19,030 acre-feet per year), accounting for annual average evaporation (4,717 acre-feet per year), to produce up to 57,883 acre-feet of RO product water (assuming 90 percent recovery). The brine product from RO treatment would total approximately 6,430 acre-feet per year.

### 6.1.4 Water Distribution to Apple Valley

The largest remaining contiguous land area available for development in Washington County would be in Apple Valley. WCWCD would develop a pump station and 28-mile long pipeline to deliver 13,249 acre-feet per year of potable water from the Quail Creek Water Treatment Plant near Hurricane City to the Apple Valley area to meet future residential and commercial water demands.

## 6.2 Recommended No Lake Powell Water Alternative for KCWCD

The recommended No Lake Powell Water Alternative for KCWCD consists of converting agricultural water to M&I raw water supply and treating it to meet projected water demand through 2060.

The KCWCD No Lake Powell Water Alternative would rely on existing water supplies, water conservation measures resulting in reduced water use, and future water development projects consisting of new groundwater production. Reliable water supplies (projected to be 2,170 acre-feet per year in 2035) for the area served by KCWCD (Kanab City and Johnson Canyon), adjusted for projected stream flow reductions (4.2 percent in 2035) resulting from climate change and a planning reserve (10 percent), would be exceeded by projected M&I water demands by 27 acre-feet per year within the KCWCD service area in 2035. KCWCD projected potable water demand in 2060 would be 3,435 acre-feet per year, with a potable water deficit of 1,334 acre-feet per year. Additional groundwater in the Kanab Creek drainage basin could be developed to provide up to 6,615 acre-feet per year of potable water within the aquifer's estimated safe yield. The quality of this water would likely require advanced water treatment. The developed groundwater from the Kanab Creek drainage basin would be pumped and conveyed through an eight-mile long pipeline to the Johnson Canyon drainage basin. The Johnson Canyon drainage basin comprises the potable water supply service area served by KCWCD in the area that could be served by the LPP Project.

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# Abbreviations and Acronyms

| Abbreviation/Acronym | Meaning/Description |
|---|---|
| ac-ft/yr | acre-feet per year |
| BLM | U.S. Bureau of Land Management |
| BPS | Booster Pump Station |
| CFR | Code of Federal Regulations |
| CII | Commercial/Industrial/Institutional |
| Commission | Federal Energy Regulatory Commission |
| GOPB | Governor's Office of Planning and Budget |
| Gpcd | gallons per capita per day |
| GPO | Government Printing Office |
| GSENM | Grand Staircase-Escalante National Monument |
| EIS | Environmental Impact Statement |
| HS | Hydro System |
| KCP | Kane County Pipeline |
| KCWCD | Kane County Water Conservancy District |
| LPP | Lake Powell Pipeline |
| M&I | Municipal and Industrial |
| Mgd | million gallons per day |
| NEPA | National Environmental Policy Act |
| O&M | Operations and Maintenance |
| RO | Reverse Osmosis |
| TDS | Total Dissolved Solids |
| UDWRe | Utah Division of Water Resources |
| WCWCD | Washington County Water Conservancy District |

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