Jacobs

Juab County and Southern Utah County Water Supply and Infrastructure Plan Formulation Project

Plan Formulation Phase II Final Report

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Central Utah Water Conservancy District

CENTRAL UTAH WATER
CONSERVANCY DISTRICT

Juab County and Southern Utah County Water Supply and Infrastructure Plan Formulation Project

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Acronyms and Abbreviations

AF	acre-feet
AFY	acre-feet per year
Ag	agricultural
ASR	aquifer storage and recovery
B	billion
cfs	cubic feet per second
CUWCD	Central Utah Water Conservancy District
Dia.	Diameter
DF	Diamond Fork
ft	feet
HGL	hydraulic grade line
HWL	high water level
in	inches
LWL	low water level
M	million
M&I	municipal and industrial
MG	million gallons
MGD	million gallons per day
mi	miles
NEPA	National Environmental Policy Act
No.	number
OM&R	operations, maintenance, and replacement
PFP	Plan Formulation Project
Project Team	Jacobs and Hansen, Allen & Luce
SDC	services during construction
SF	Spanish Fork
SFC	Spanish Fork Canyon
SFR	Spanish Fork River
SUC	southern Utah County
SVP	Strawberry Valley Project
TDH	total dynamic head
TM	technical memorandum
ULS	Utah Lake System
WTP	water treatment plant

1. Executive Summary

1.1 Overview and Need for Study

Over the next 50 years, the portions of southern Utah County and Juab County within the Central Utah Water Conservancy District's (CUWCD) service area (Figure 1-1) are anticipated to experience significant population growth. In 2017, the Kem C. Gardner Policy Institute reported that Utah will nearly double in population by 2065. Over this timeframe, southern Utah County will add almost 400,000 people and Juab County approximately 19,000. At the same time, southern Utah County and Juab County currently do not have all of the water supply, infrastructure, or water management plans in place to meet the expected demand from this increase in population. As a result, this Plan Formulation Project (PFP) Report investigates how the southern Utah County and Juab County regions can collaboratively develop additional water supplies, infrastructure, and water management tools to provide a reliable and resilient municipal and industrial (M&I) water supply for the projected population growth.

The key objectives of this PFP Phase I and II Report include the following:

- Characterize existing and future M&I water demands and supplies through 2065 for communities in the study area over a broad range of plausible future conditions.
- Develop portfolios of regional infrastructure, operational, and water management solutions to assist CUWCD and water providers in the study area in their efforts to meet their 2065 water demands reliably and sustainably.
- Engage key stakeholders in the planning process to collaboratively develop a sustainable regional plan for southern Utah County and Juab County to optimize the water resources that support economic growth and quality of life.

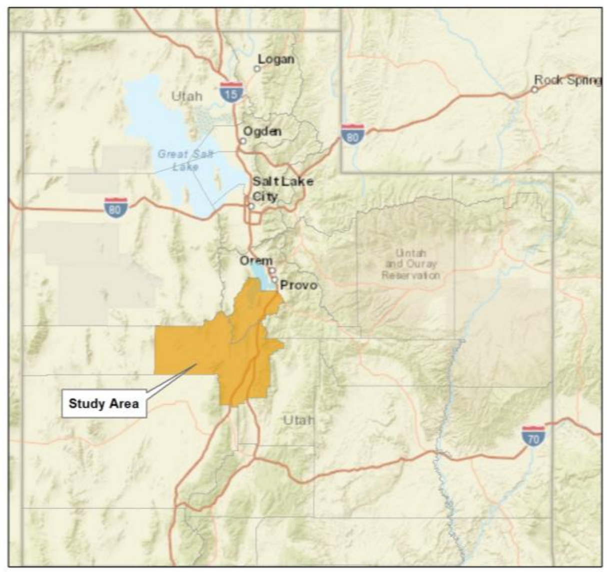

Figure 1-1. Project Study Area

1.2 Supply and Demand Analysis and Findings

To better consider uncertain future supply and demand conditions in this technical analysis and provide for a wide range of possible future supplies and demands, the PFP makes use of a scenario planning approach. This approach incorporates the inherent variability and uncertainty in key drivers that influence water demands and supply availability, including climate effects on supplies, demand growth distribution and magnitude, levels of water conservation, and other social and regulatory factors that could impact future conditions.

Detailed projections of future water demands and supplies by community in the study area were developed on a monthly time step through 2065 and included estimates of unique future supply sources and multiple demand conditions for indoor potable and outdoor non-potable water demands. To bracket ranges of plausible future conditions, two supply and demand scenarios were developed:

- **Baseline Scenario:** Assumes future growing water conservation, increasing evapotranspiration rates, and agricultural land conversion to M&I uses in southern Utah County

- **Alternative Scenario:** Assumes additional demands, reduced surface water availability, and reduced agricultural conversion to M&I uses when compared to the Baseline Scenario

In both southern Utah and Juab Counties, the analysis shows that demands will exceed supplies between now and 2065. These supply/demand shortages are summarized in Tables 1-1 and 1-2 for the Baseline and Alternative Scenarios:

Table 1-1. Baseline Southern Utah County and Juab County No-Action Shortages

Year	Potable Shortages (AFY)		Non-Potable Shortages (AFY)		Total Shortages (AFY)	
	South Utah County	Juab County	South Utah County	Juab County	South Utah County	Juab County
2030	2,599	1,119	1,845	380	4,444	1,499
2040	3,447	1,789	1,887	1,570	5,333	3,360
2050	7,176	2,399	3,504	2,836	10,680	5,235
2060	12,749	2,992	5,964	4,145	18,713	7,137
2065	17,462	3,286	7,944	4,813	25,406	8,099

Table 1-2. Alternative Southern Utah County plus Juab County No-Action Shortages

Year	Potable Shortages (AFY)		Non-Potable Shortages (AFY)		Total Shortages (AFY)	
	Southern Utah County	Juab County	Southern Utah County	Juab County	Southern Utah County	Juab County
2030	4,462	1,494	1,851	491	6,313	1,985
2040	6,804	2,772	2,411	2,793	9,215	5,565
2050	15,479	3,980	10,774	5,169	26,254	9,149
2060	24,278	5,169	19,385	7,590	43,663	12,759
2065	30,596	5,766	24,739	8,813	55,335	14,579

1.3 Infrastructure Needs and Costs

To address future supply/demand shortages, numerous infrastructure and operational solutions were identified and evaluated by the Project Team. These solutions were grouped into portfolios to enable comparison and define a range of plausible future infrastructure configurations, sizes, and costs. As a result of the portfolio evaluation process, several recommended future infrastructure and operational solutions were identified as needed to develop a reliable, flexible, and adaptable regional supply system. Recommended portfolios were titled *Portfolio 7* and *Portfolio 7A*. Key elements of these portfolios are described below and in Figure 1-2.

- A new regional water treatment plant will be required to meet future potable water needs.
- New potable conveyance pipelines and pumping facilities will be required to deliver potable water to communities in southern Utah and Juab Counties.
- In conjunction with a regional water treatment plant, a regional ASR program was identified as an additional solution with potential to partially meet future potable water needs and increase the overall resiliency of the water supply system.
- Non-potable water needs will continue to be met via the existing Highline Canal and ULS Spanish Fork-Santaquin Pipeline.
- *Balancing* (surplus Utah Lake System [ULS] and Strawberry Valley Project [SVP] supplies from cities in the study area that could be delivered to other cities in the study area that still have shortages) and *retiming* (using storage from Strawberry Reservoir to make deliveries on an M&I schedule instead of on the historical summer agricultural delivery schedule) should be considered as possible operational solutions.

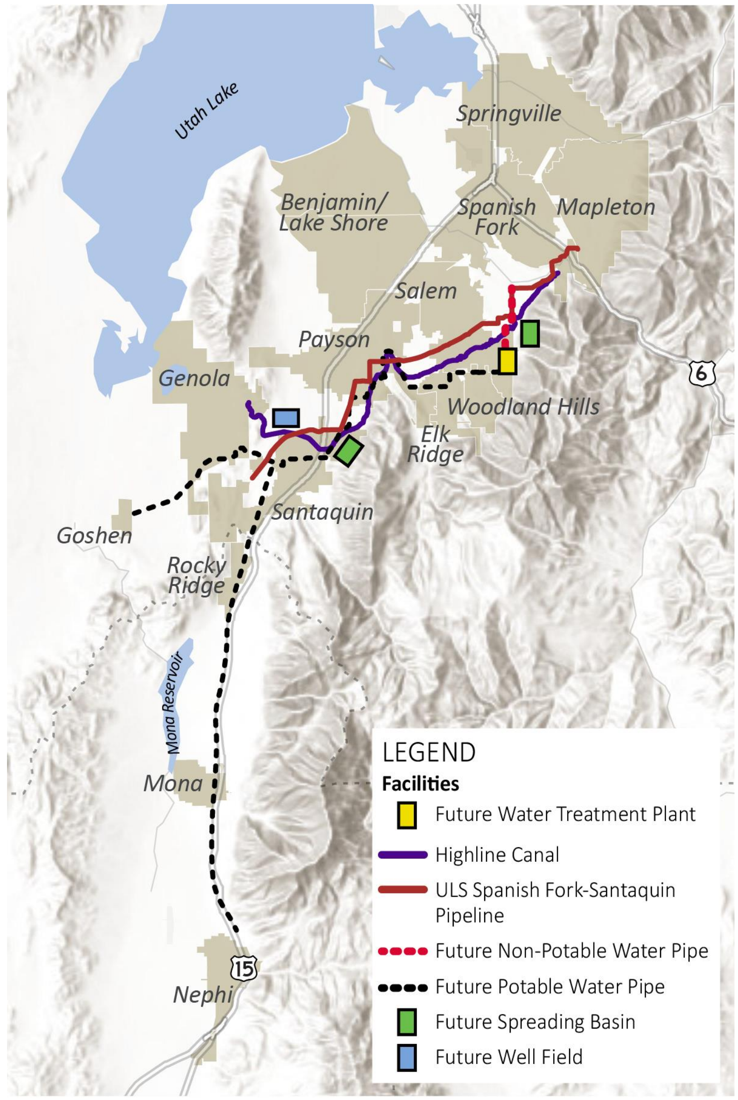

Image Source: ESRI, USGS, Garmin, NASA, HERE, NOAA, CGIAR, NCEAS, NLS, OS, NMA, GSA, Geoland.

Figure 1-2. Key Recommended Infrastructure

Figure 1-3 details the range of potable water delivered as well potential sizes and phasing of key water treatment and conveyance infrastructure over time for recommended portfolios.

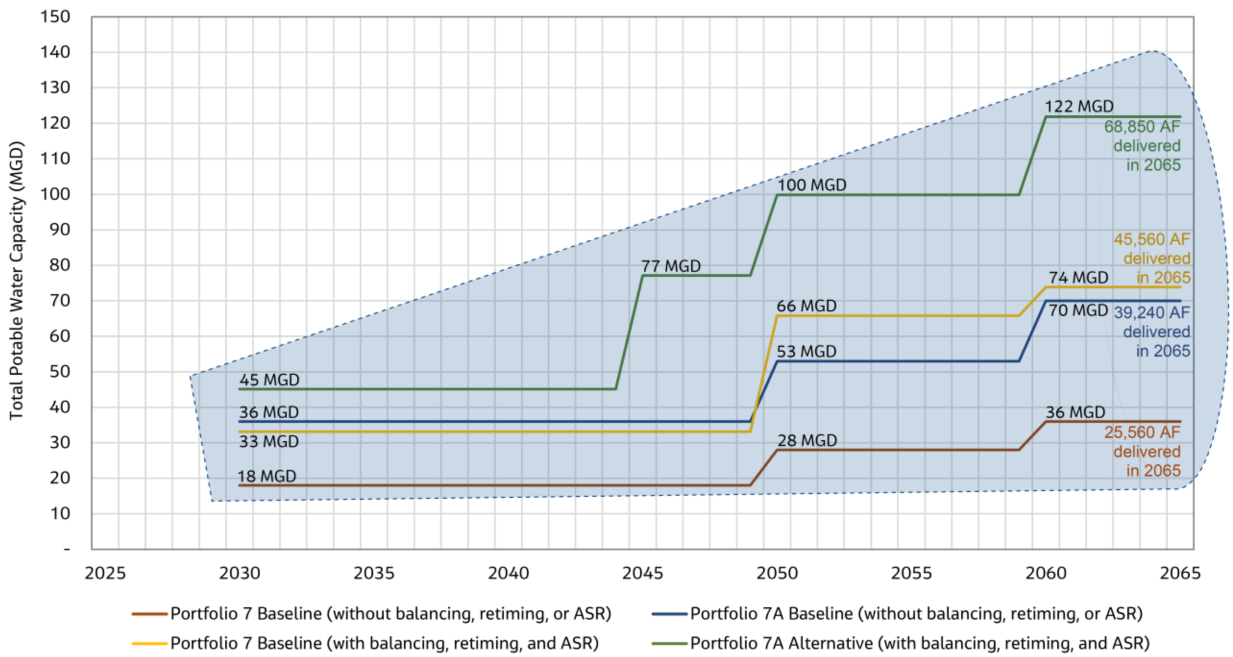

Figure 1-3: Range of Potable Water Infrastructure Sizes and Phasing

While remaining future shortages are reduced under the recommended portfolios, potable shortages exist under many conditions with currently unidentified sources of future supply. Further study on identifying new supply sources beyond those identified in this PFP effort is recommended. Additionally, the feasibility of implementing ASR, balancing, and retiming is uncertain, as there are numerous technical and institutional issues that must be overcome and further studied.

Table 1-3 shows detailed capital, operations and maintenance, financing, and unit cost summaries for new infrastructure in the recommended portfolios. The capital and administrative costs are total costs over a 40-year period, from 2030 to 2070 (including 30 percent contingency), which aligns with the assumed bonding period. The operations, maintenance, and replacement (OM&R) costs are average annual costs and include annual average energy costs for pump stations. All costs are in 2021 dollars.

Table 1-3. Portfolio Costs over the 2030–2070 Planning Period (2021 dollars)

Portfolio		Ultimate delivery in 2070 (AF)	Cost Components				Total unit cost ($2021/ AF delivered annually)	Total unit cost ($2021/ AF developed)
			Total capital cost ($2021)	Total admin cost ($2021)	Cost of Financing[a] ($2021)	Average annual OM&R cost ($2021)		
7 Baseline	Without balancing, retiming, or ASR	25,561	334M	80M	697M	4.4M	1,260	50,395
7A Baseline	Without balancing, retiming, or ASR	39,240	494M	119M	1.03B	6.4M	1,211	48,430
7 Baseline	With balancing, retiming, and ASR	45,561	374M	90M	781M	11.5M	935	37,392
7A Alternative	With balancing, retiming, and ASR	68,855	674M	162M	1.41B	9.7M	956	38,222

[a] 6% interest rate, 0% discount rate over 40 years back to 2021 dollars.
Note: AF = acre-feet, M = millions, B = billions

1.4 Summary of Key Findings and Recommendations

1.4.1 Key Findings from PFP Phases I and II

As a result of the PFP planning process, the Project Team has quantified plausible ranges of future supply and demand conditions and identified flexible and resilient water supply and infrastructure options that can adapt to the wide range of future conditions identified in this study. Key findings from the PFP Phase I and II efforts are summarized below.

Water Supply

- Conservation measures are and will become even more important.
- Non-potable regional conveyance needs are estimated to be serviced by the Regional ULS Pipeline and Rehabilitated Highline Canal and the cost of this infrastructure is not included in the PFP cost estimates.
- Conversion of Ag Water to M&I will contribute to meeting future M&I demands.
- Sustainable development of groundwater will be needed and is important.
- Treated surface water infrastructure will be needed to meet potable water demand.
- Balancing and retiming (as defined within this Report) are important issues for the future.
- Waters flowing to Utah Lake should be investigated for ASR, using exchanges with Utah Lake.
- Under certain conditions, additional water supplies will also be needed in the future.

Water Treatment

- Regional water treatment plant and conveyance infrastructure are needed to meet potable water demands.
- Capacity and phasing needs to be flexible and adaptable to meet actual future demands.

ASR

- Further study of institutional, technical, and regulatory issues is needed.
- During Phase III, the Project Team will develop an ASR pilot, modeling, geotechnical, and monitoring program.

1.4.2 Near-term Recommendations

Recommend near-term actions in Phase III that build upon work performed in Phases I and II include the following:

- Further investigate ASR pilot program.
- Stakeholder outreach and engagement with communities to gauge interest in future regional water supply system.
- Advance infrastructure configuration, design, and costs.
- Further refine financial analysis and investigate possible cost or repayment structures for future regional water supply system.
- Further explore feasibility of preliminary identified potential future water supplies to meet potable needs.
- Further explore regulatory and institutional issues related to use of water supplies and infrastructure.

2. Introduction

2.1 Need for Study

Over the next 50 years, the portions of southern Utah County and Juab County within the Central Utah Water Conservancy District's (CUWCD) service area (Figure 2-1) are anticipated to experience significant population growth (Figure 2-2). In 2017, the Kem C. Gardner Policy Institute reported that Utah will nearly double in population by 2065. Over this timeframe, southern Utah County will add almost 400,000 people and Juab County approximately 19,000.

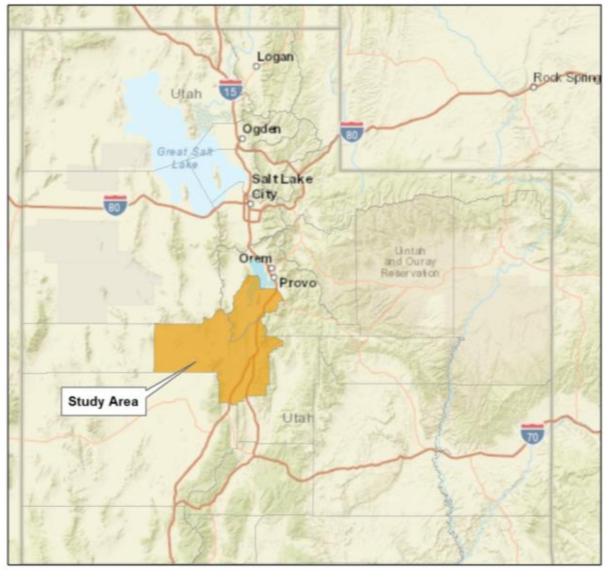

Figure 2-1. Project Study Area

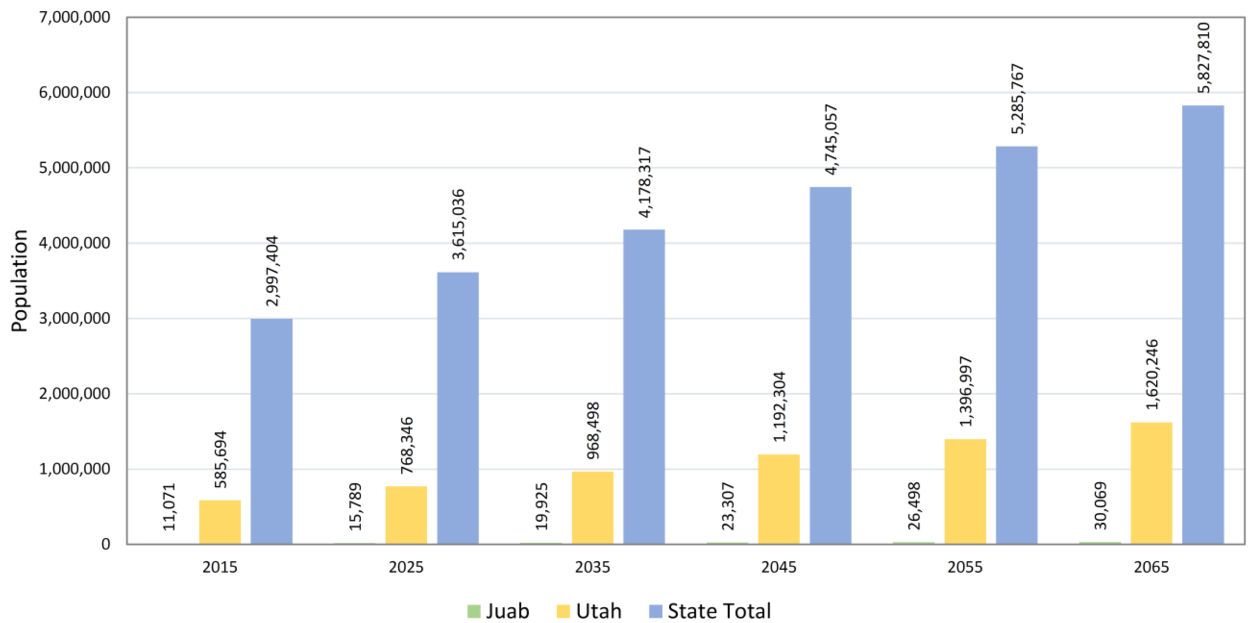

Figure 2-2. Population Growth in Juab and Utah Counties

At the same time, southern Utah County and Juab County currently do not have all of the water supply, infrastructure, or water management plans in place to meet the expected demand from this increase in population. Potential future water supply availability will be influenced by a variety of uncertain factors including variations in type and distribution of population growth and changing climate and supply conditions. As a result, this Plan Formulation Project (PFP) Report investigates how the southern Utah County and Juab County regions can collaboratively develop additional water supplies, infrastructure, and water management tools to provide a reliable and resilient municipal and industrial (M&I) water supply for the projected population growth.

The key objectives of this PFP Report include the following:

- Characterize existing and future M&I water demands and supplies through 2065 for communities in the study area over a broad range of plausible future conditions.
- Develop portfolios of regional infrastructure, operational, and water management solutions to assist CUWCD and water providers in the study area in their efforts to meet their 2065 water demands reliably and sustainably.
- Engage key stakeholders in the planning process to collaboratively develop a sustainable regional plan for southern Utah County and Juab County to optimize the water resources that support economic growth and quality of life.

2.2 Planning Process

2.2.1 PFP Phases

The initial PFP planning process was broadly divided to into Phase I and Phase II efforts, as shown on Figure 2-3.

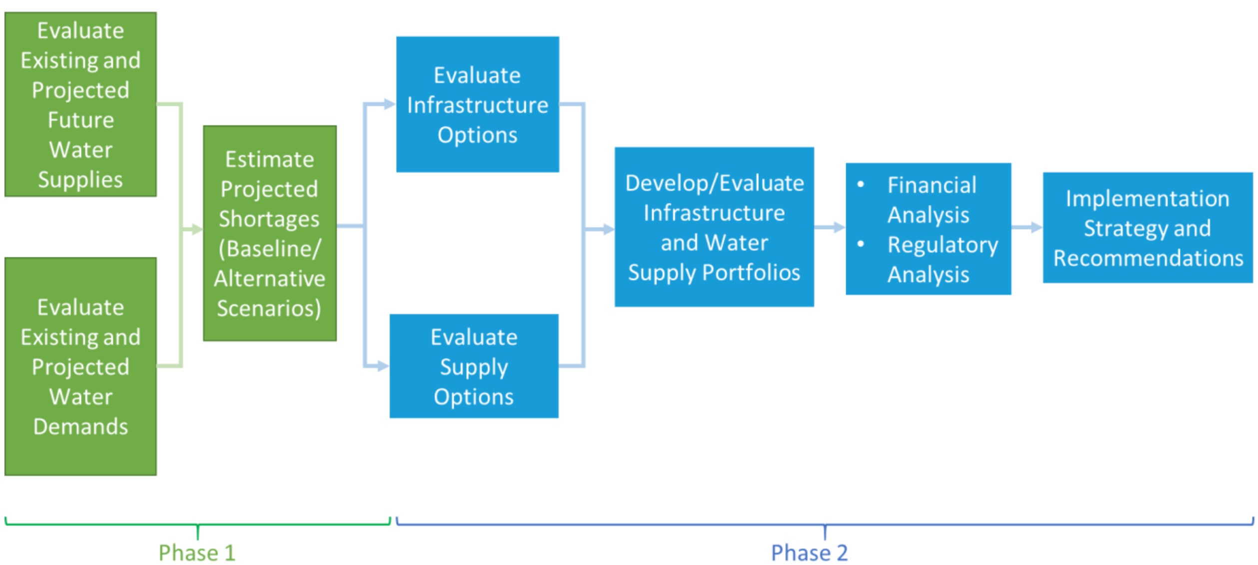

Figure 2-3. PFP Process

A brief description of Phase I and II efforts and references to other PFP documentation developed separately from this summary report are provided as follows.

Phase I:

- Identify future water demands between now and 2065 (HAL 2020a, 2020b), see Appendix A.
- Quantify water supply from existing and projected future sources (HAL 2020a, 2020b), see Appendix A.
- Quantify remaining groundwater safe yield in the study area (HAL 2020c); see Appendix B.
- Estimate the future shortages under different supply and demand scenario conditions (Jacobs 2020); see Appendix C.

- Formulate potential solutions and develop Portfolios of solutions to provide a reliable water supply for the region out to year 2065 and evaluate water supply needs under the Portfolios using a system model (Jacobs 2020); see Appendix C.

Phase II (This Summary Report):

- Summarize planning process and selected portfolios
- Present potential infrastructure needs and costs to implement selected portfolios
- Identify possible other water supplies to fill remaining shortages identified in Phase I
- Summarize high-level financial and regulatory considerations and risks
- Present an adaptive implementation plan

2.2.2 Scenario Planning Process

Traditional planning approaches often rely on a single linear projection comparison of supplies and demands that approximate a single point in the future. This method provides planners with limited perspective on how the future may ultimately develop and does not acknowledge that actual future conditions are uncertain. To better consider uncertain future conditions in this technical analysis and provide for a wide range of possible future supplies and demands, the PFP makes use of a scenario planning approach. This approach incorporates the inherent variability and uncertainty in key drivers that influence water demands and supply availability, including climate effects on supplies, demand growth distribution and magnitude, levels of water conservation, and other social and regulatory factors that could impact future conditions. By testing and varying unique combinations of drivers, planners can develop a range of uncertainty that provides perspective on how conditions may be bounded in the future, with recognition that actual future conditions will likely unfold somewhere between these bounds (Figure 2-4).

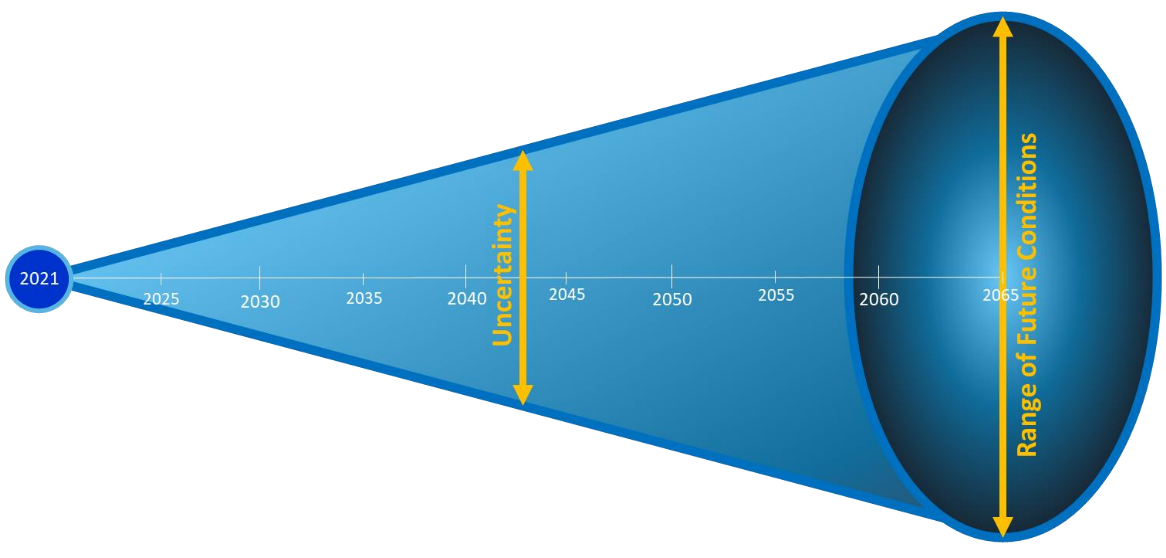

Figure 2-4. Scenario Planning Conceptual Visualization

2.3 Definitions of Key Terms

This PFP uses many terms that are regularly used in the scenario planning process that guided the portfolio evaluation process. However, terminology can be used somewhat differently throughout the industry. The following are the definitions of terms used throughout the PFP.

"Actions" are defined steps that can be completed to implement the ultimately recommended portfolios.

"Alternative Scenario" is the combination of alternative demand conditions and alternative supply conditions.

"Balancing" are surplus Utah Lake System (ULS) and Strawberry Valley Project (SVP) supplies from cities in the study area that could be delivered to other cities in the study area that still have shortages.

"Baseline Scenario" is the combination of baseline demand conditions and baseline supply conditions.

"Demand Conditions" are the estimated amount of water demands considering a defined set of "demand drivers." Note that two future demand conditions (Baseline and Alternative) are evaluated in this Project. These conditions are further described in Section 3.

"Drivers" are external physical, social, or legal conditions that can directly impact water supply availability or water demand needs.

"Non-potable water" (also called "secondary water") is water that does not meet the applicable standards for drinking water and can only be used for outdoor or other demands that do not require drinking water treatment.

"Portfolios" are a collection of solutions that could be used to address shortages.

"Potable Water" is water that is safe to drink or use for food preparation. Potable water can also be used for outdoor or non-potable uses.

"Retiming" is using storage from Strawberry Reservoir to make deliveries on an M&I schedule instead of on the historical summer agricultural delivery schedule.

"Scenario" is a combination of supply and demand conditions.

"Shortages" are the amount of water demands that are in excess of available supplies within the monthly pattern of demands and supplies.

"Solutions" are infrastructure options, operational actions, water acquisition options, conservation options, or other options that could reduce or eliminate the shortages.

"Supply Conditions" are the estimated amount of water supplies available considering a defined set of "supply drivers." Two future supply conditions (Baseline and Alternative) are evaluated in this Project. These conditions are further described in Section 3.

3. Water Supply and Demand Analysis

The foundation of the planning work completed as part of the PFP Report relies on the development of a range of comprehensive future water demands and supply conditions for communities in the study area. The PFP Report provides a brief overview of water supply and demand projections developed in Phase I and discusses how that data was used to develop future water supply and demand scenarios that formed the basis of the portfolio evaluation process and Phase II analysis.

3.1 Projected Supply and Demand Development Process

Work conducted under Tasks 5 & 6 and through the Groundwater Remaining Safe Yield Report (HAL 2020c; see Appendix B) of the PFP Report developed future projected demands and supplies, by community, for the project study area in southern Utah County and Juab County. Projections by city were developed on a monthly time step through 2065 and included estimates of unique future supply sources and multiple demand conditions for indoor potable and outdoor non-potable water demands. Specific assumptions and the analysis methodology used to develop these supply and demand projections are detailed in the Tasks 5 & 6 technical memoranda (HAL 2020a, 2020b; see Appendix A) and the Groundwater Remaining Safe Yield Report (HAL 2020c; see Appendix B). While certain aspects, such as the conservation driver, of the Tasks 5 & 6 TMs have evolved during the development of the PFP Report, the technical data collected and analyzed remains the foundation of the PFP Report. Cities included in the planning process for the PFP Report are listed in Table 3-1.

Table 3-1. Cities Included in PFP Report Planning Process

Southern Utah County
Benjamin/Lake Shore
Elk Ridge
Genola
Goshen
Mapleton
Payson
Salem
Santaquin
Spanish Fork
Springville
Woodland Hills
Juab County
Mona
Nephi
Rocky Ridge

Following development of these initial future supply and demand projections, Jacobs and Hansen, Allen & Luce (Project Team) elected to vary key drivers in order to test the sensitivity of the assumptions and bracket possible future supply and demand conditions as part of the scenario planning process. This resulted in the development of two projected supply and demand scenarios, the Baseline Scenario and the Alternative Scenario, that were used as the basis of analysis for the portfolio development process. The Baseline and Alternative supply/demand scenarios do not include potential infrastructure or operational solutions that could be used to address future supply and demand shortages but rather are intended to provide a starting point from which to evaluate the effectiveness of potential solutions. These potential solutions are further described and evaluated in Section 4.

Demands used in the Baseline and Alternative scenarios were based on the conservation demand conditions defined in the Tasks 5 & 6 memoranda and were disaggregated into indoor potable demands and outdoor non-potable water demands for a given city. If a city does not currently have, or is not anticipated to have, a secondary water system, it was assumed that outdoor demands would be met using potable water from the potable water system.

Water supply sources used in the Baseline and Alternative scenarios are summarized at a high level in Table 3-2, along with the assumed use type of water (indoor potable or outdoor non-potable) that a given supply can serve. Outdoor non-potable supplies cannot be used for indoor potable purposes without water treatment. Also, the portfolios envision a regional water treatment plant (described further in Section 4) as a potential solution to treat non-potable water for delivery as potable supply.

Table 3-2. Baseline and Alternative Scenario Supply Sources

Supply Source	Use Type
Groundwater and springs	Indoor potable and outdoor non-potable
Reuse	Outdoor non-potable
Surface water streams and irrigation shares	Outdoor non-potable/indoor with treatment
ULS water	Outdoor non-potable/indoor with treatment
SVP water	Outdoor non-potable/indoor with treatment

3.2 Baseline Supply and Demand No-Action Scenario and Shortages

3.2.1 Key Drivers

The Baseline Scenario is based on the following high-level key drivers that affect projected supplies and demands, and does not include potential actions or solutions to reduce the projected supply/demand shortages:

- **Population:** Southern Utah County is projected to grow at one of the highest rates (an increase of 177 percent from 2015) in the state and is expected to have a population of over 1.6 million, an increase of approximately 1 million by year 2065. Juab County's population is projected to increase to over 30,000 by year 2065, an increase of 172 percent from 2015 (Kem C. Gardner Policy Institute 2017).
- **Conservation:** The Baseline Scenario assumes, among other things, metering of secondary water systems and adjusting water billing rate structures to further encourage conservation. These and other measures will have the effect of reducing consumptive use within the study area.

- **Weather and Climate Effects:** The Baseline Scenario assumes a 10 percent increase in evapotranspiration rates, due to increased temperatures, which is assumed to increase consumptive use linearly between 2015 and 2065. This has the effect of increasing overall demand.

3.2.2 Agricultural Land Conversion

Assumptions regarding conversion of agricultural land in southern Utah County and Juab County are summarized below:

- Agricultural land in southern Utah County is assumed to be converted to serve M&I demands as the land changes to urban uses. This increase in supply is reflected on Figure 3-1.
- In Juab County, supplies and demands were investigated with and without agricultural land being converted to urban land uses, and the associated water converted to M&I uses.
- After discussions with officials in Juab County, it was decided that the Baseline Scenario would be developed with no agricultural land or water conversions to M&I use.

Agricultural water assumed to be converted to M&I use for southern Utah County cities by decade for the Baseline Scenario is shown in Table 3-3, while Table 3-4 shows the remaining irrigated acres after conversion to M&I use.

Table 3-3. Southern Utah County Baseline Scenario Agricultural Water Converted to M&I Use by Decade (Acre-Feet)

City	2030	2040	2050	2060	2065
Benjamin/Lake Shore	0	0	17,689	6,409	7,667
Elk Ridge	0	0	0	0	0
Genola	0	57	701	258	308
Goshen	127	352	306	257	144
Mapleton	2,086	1,656	978	0	0
Payson	4,032	6,317	11,301	7,593	0
Salem	5,145	3,844	0	0	0
Santaquin	2,509	5,518	1,143	0	0
Spanish Fork	7,064	10,675	377	0	0
Springville	5,510	1,960	0	0	0
Woodland Hills	0	0	0	0	0
Total	**26,473**	**30,379**	**32,495**	**14,517**	**8,119**
Cumulative	**26,473**	**56,852**	**89,347**	**103,864**	**111,983**

Table 3-4. Southern Utah County Baseline Scenario Remaining Irrigated Acres After Conversion to M&I Use (Acres)

City	2030	2040	2050	2060	2065
Benjamin/Lake Shore	10,588	10,588	4,692	2,556	0
Elk Ridge	0	0	0	0	0
Genola	4,273	4,254	4,020	3,934	3,832
Goshen	2,283	2,166	2,064	1,978	1,930
Mapleton	878	326	0	0	0
Payson	8,404	6,298	2,531	0	0
Salem	1,281	0	0	0	0
Santaquin	2,220	381	0	0	0
Spanish Fork	3,684	126	0	0	0
Springville	653	0	0	0	0
Woodland Hills	0	0	0	0	0
Total	34,264	24,139	13,307	8,468	5,762

3.2.3 Juab County Industrial Demands

In addition to growth directly associated with population increases, Juab County's demands were further increased by 6,000 acre-feet per year (AFY) over time to account for potential future industrial demand. It was assumed that these demands were a mix of potable and not-potable needs distributed throughout Juab County communities in the study area and were increased linearly throughout the study period to reach 6,000 AFY by year 2065.

3.2.4 Projected Supplies and Demands

Total Baseline Scenario projected potable and non-potable M&I demands, supplies available to meet demands, and remaining shortages for southern Utah County and Juab County are shown on Figures 3-1 and 3-2, respectively, while Figure 3-3 shows the spatial distribution of Baseline Scenario 2065 potable and non-potable shortages by city. Table 3-5 details Baseline Scenario no-action potable and non-potable shortages by decade for both southern Utah County and Juab County. These shortages indicate the amount of water demands that are in excess of available supplies within the monthly pattern of demands and supplies under the Baseline Scenario.

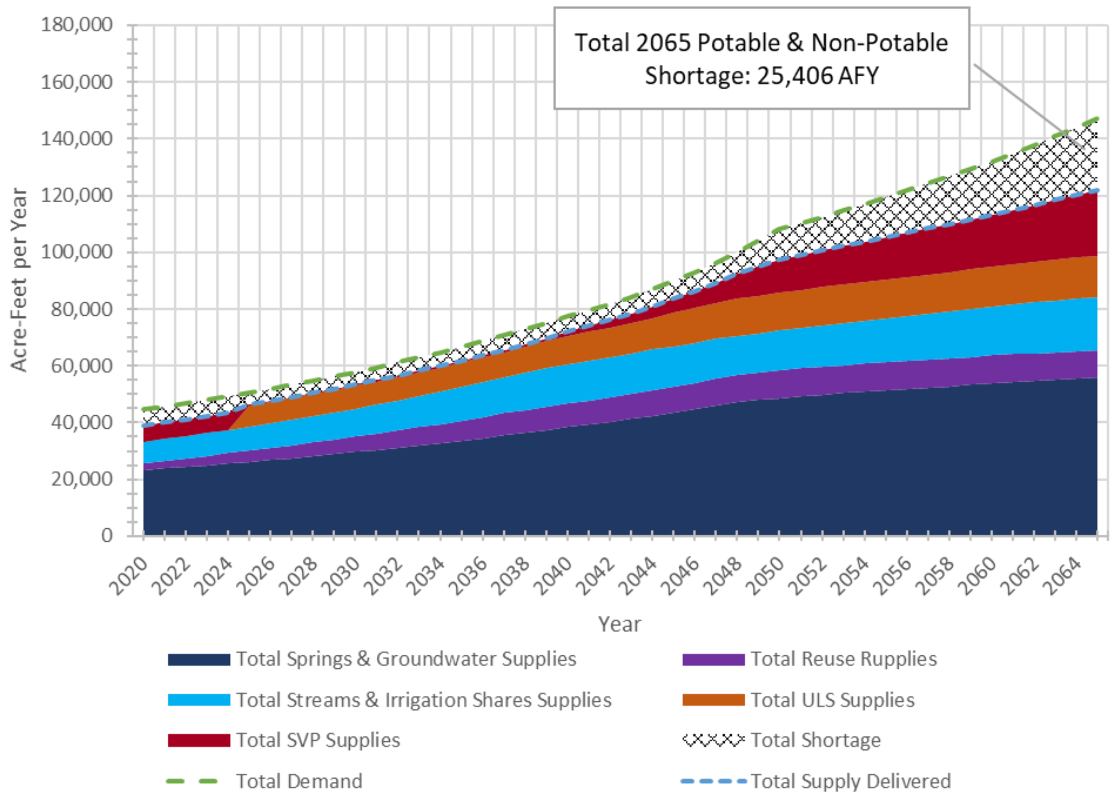

Figure 3-1. Southern Utah County Baseline No-Action Supply and Demand Scenario Plot

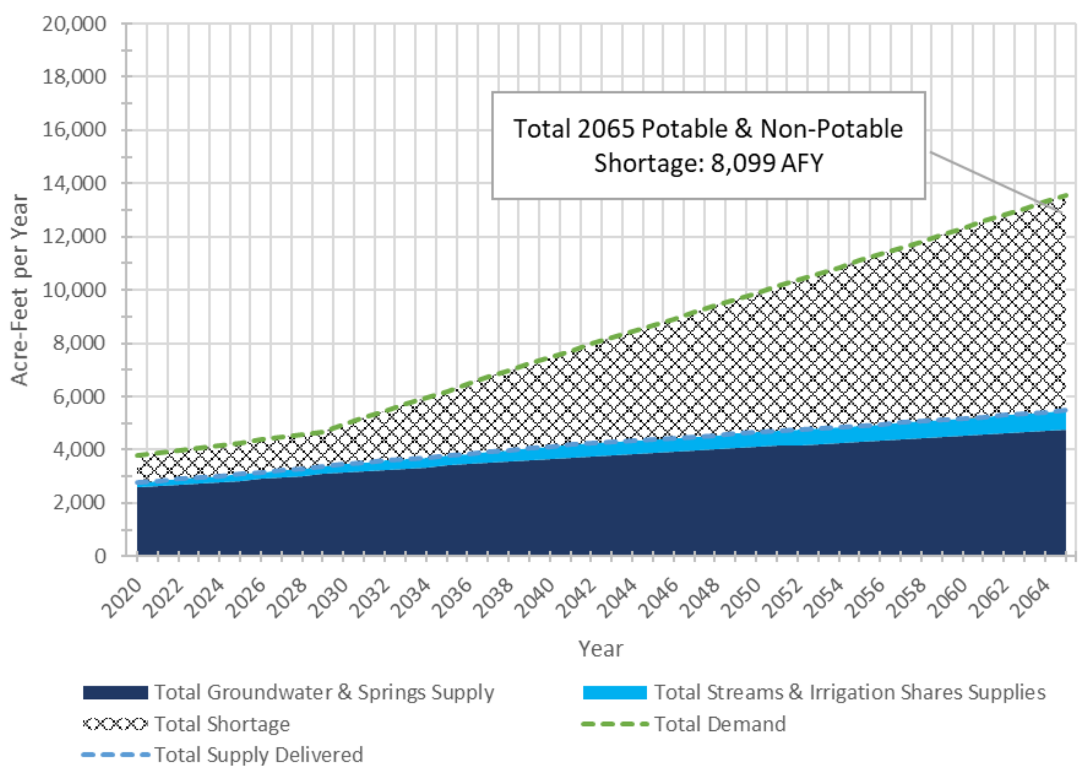

Figure 3-2. Juab County Baseline No-Action Supply and Demand Scenario Plot

As noted in the Tasks 5 & 6 TMs (HAL 2020a, 2020b; see Appendix A), if total annual supplies are compared to demands without considering the spatial distribution and the seasonal aspect of supplies versus demands, the total supplies exceed estimated demands. However, when the spatial distribution between communities and individual systems and the seasonal timing of available supplies versus demands are considered, future 2065 countywide Baseline potable and non-potable shortages are approximately 25,000 AFY in southern Utah County and 8,000 AFY in Juab County.

Table 3-5. Baseline Southern Utah County and Juab County No-Action Shortages

Year	Potable Shortages (AFY)		Non-Potable Shortages (AFY)		Total Shortages (AFY)	
	South Utah County	Juab County	South Utah County	Juab County	South Utah County	Juab County
2030	2,599	1,119	1,845	380	4,444	1,499
2040	3,447	1,789	1,887	1,570	5,333	3,360
2050	7,176	2,399	3,504	2,836	10,680	5,235
2060	12,749	2,992	5,964	4,145	18,713	7,137
2065	17,462	3,286	7,944	4,813	25,406	8,099

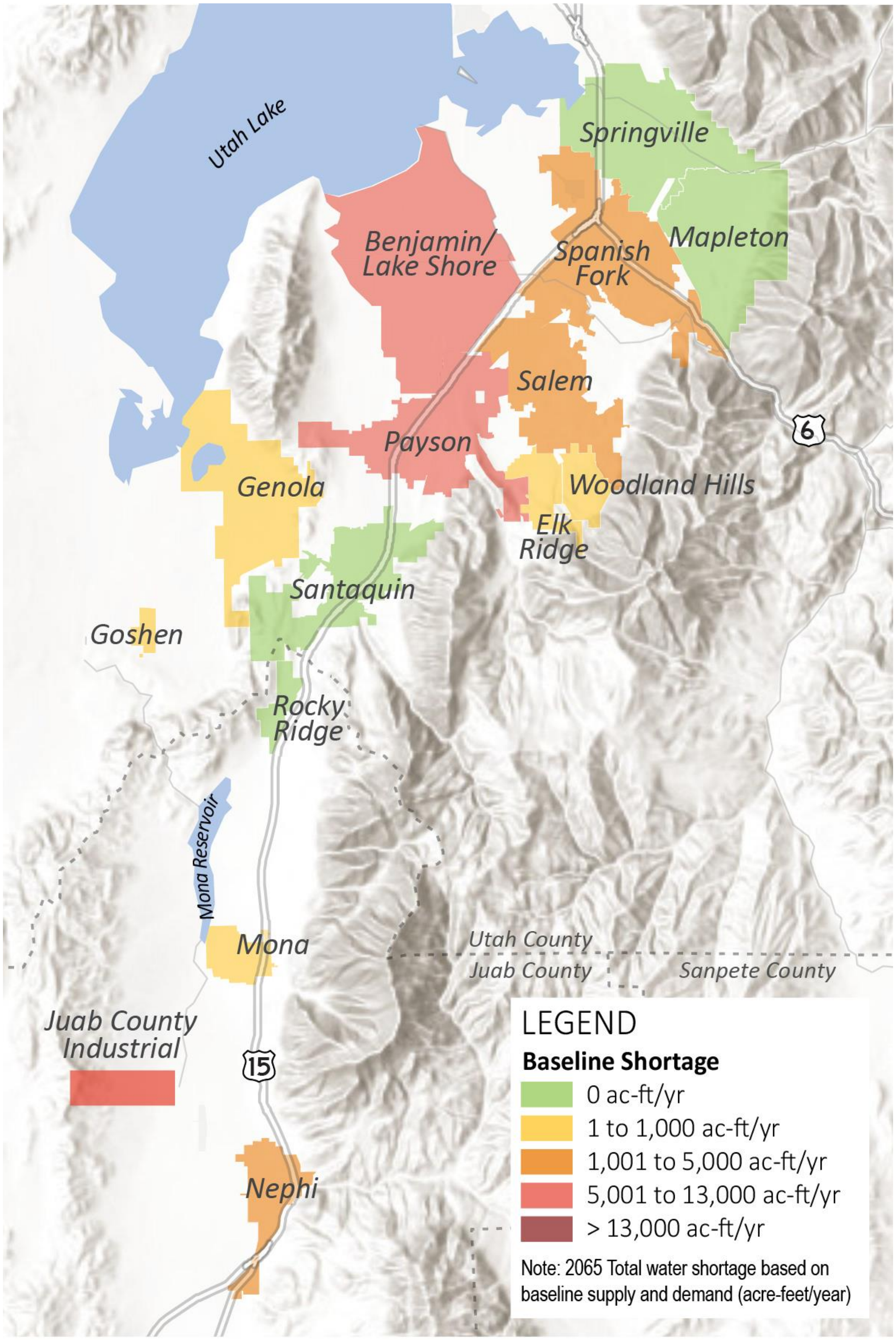

Image Source: ESRI, USGS, Garmin, NASA, HERE, NOAA, CGIAR, NCEAS, NLS, OS, NMA, GSA, Geoland.

Figure 3-3. Baseline Scenario Total Water Shortage in 2065

3.3 Alternative Supply and Demand No-Action Scenario and Shortages

The Alternative supply and demand scenario is intended to represent future conditions having greater hydrologic stress that affect supply availability and include increased demands in key identified growth locations in the study area. Potential actions or solutions to reduce the projected supply and demand shortages are not included. The Alternative Scenario includes the same assumptions as the Baseline Scenario with the following key adjustments:

- Reduced surface (-15 percent) and groundwater (-20 percent) supply because of potential future supply variability
- Open space preservation options that could reduce agricultural conversion by 25 percent in southern Utah County
- Additional demand of 15,000 AFY for the Goshen Valley Local District Mega Site (assumed to increase linearly over the study period)
- Increased industrial demand in Juab County to a total of 12,000 AFY (assumed to increase linearly over the study period)

Total Alternative Scenario's projected potable and non-potable M&I demands, supplies available to meet demands, and shortages for southern Utah County and Juab County are shown on Figures 3-4 and 3-5. Figure 3-6 shows the spatial distribution of Alternative Scenario 2065 potable and non-potable shortages by city. Table 3-6 shows Alternative Scenario no-action potable and non-potable shortages by decade for both southern Utah County and Juab County. As shown, future 2065 countywide Alternative shortages are approximately 55,000 AFY in southern Utah County and 14,500 AFY in Juab County.

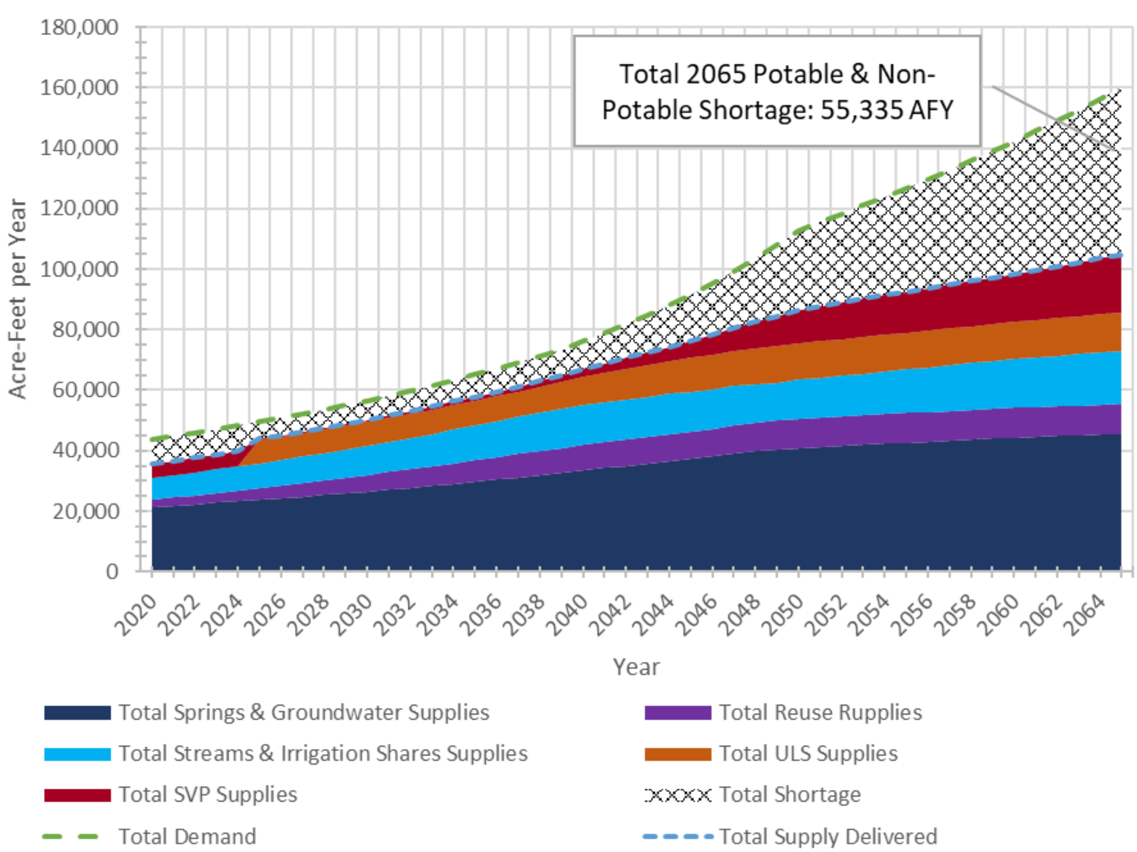

Figure 3-4. Southern Utah County, Alternative No-Action Supply and Demand Scenario Plot

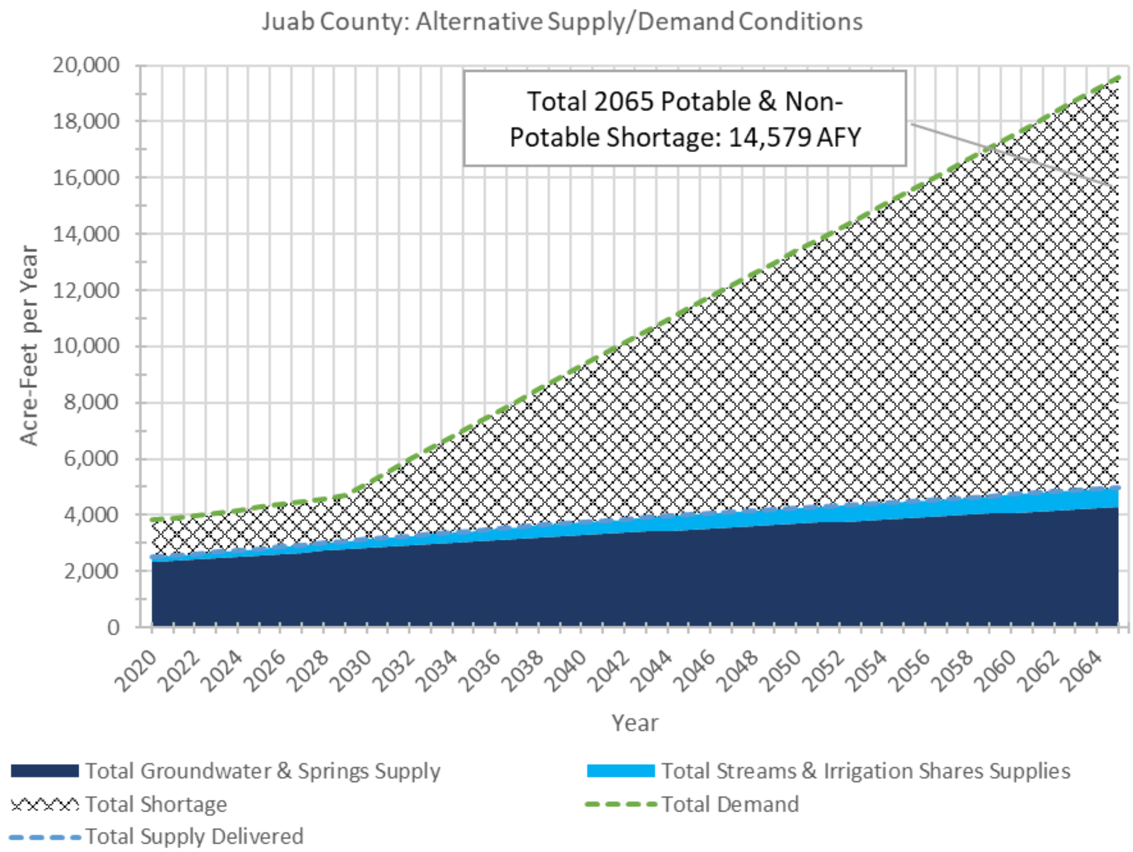

Figure 3-5. Juab County, Alternative Supply and Demand Scenario Plot

Table 3-6. Alternative Southern Utah County plus Juab County No-Action Shortages

Year	Potable Shortages (AFY)		Non-Potable Shortages (AFY)		Total Shortages (AFY)	
	Southern Utah County	Juab County	Southern Utah County	Juab County	Southern Utah County	Juab County
2030	4,462	1,494	1,851	491	6,313	1,985
2040	6,804	2,772	2,411	2,793	9,215	5,565
2050	15,479	3,980	10,774	5,169	26,254	9,149
2060	24,278	5,169	19,385	7,590	43,663	12,759
2065	30,596	5,766	24,739	8,813	55,335	14,579

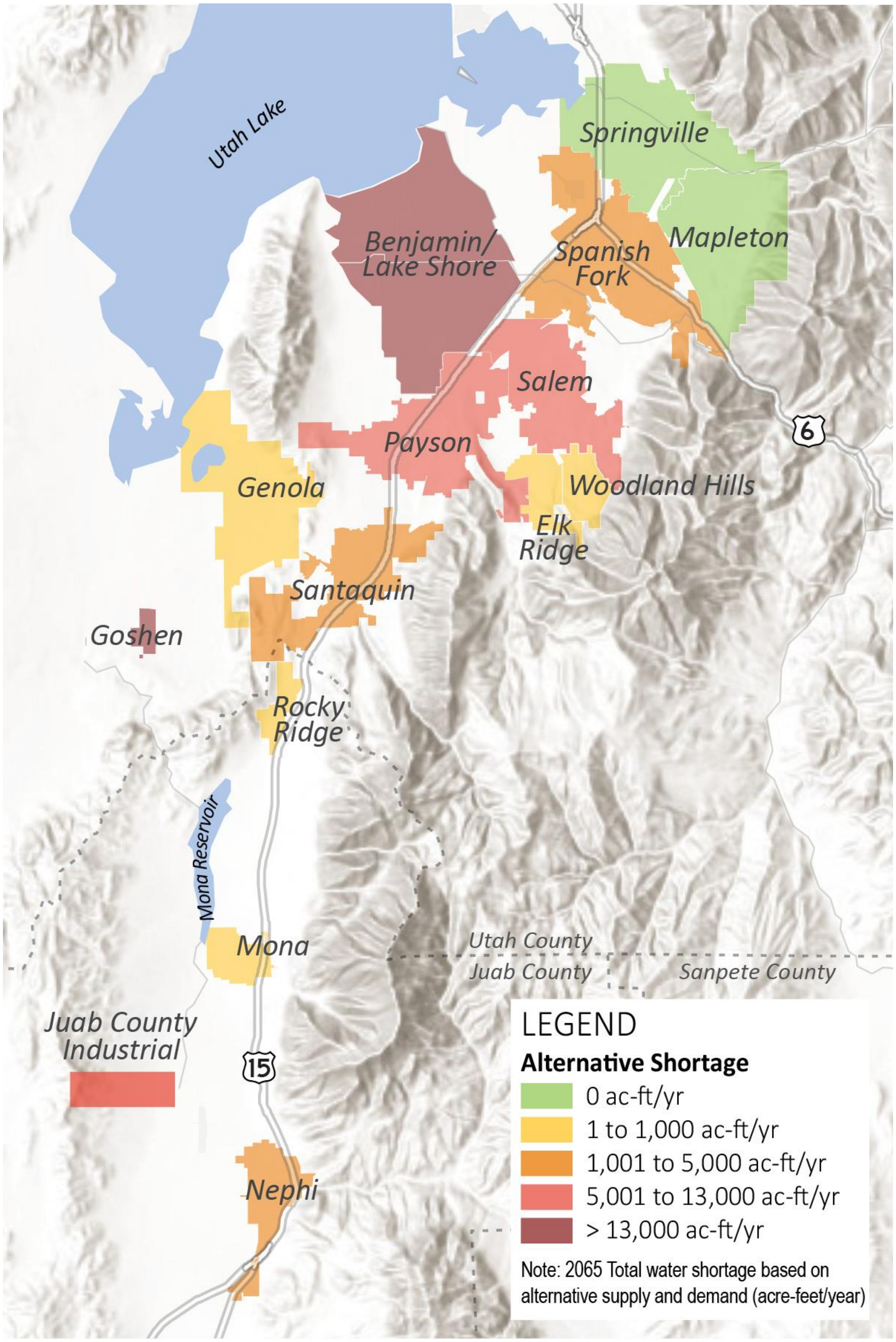

Image Source: ESRI, USGS, Garmin, NASA, HERE, NOAA, CGIAR, NCEAS, NLS, OS, NMA, GSA, Geoland.

Figure 3-6. Alternative Scenario Total Water Shortage in 2065

This Phase II Report has focused on long-term water supply conditions, demands, water supply options, and facilities. However, there are potential circumstances where supply shortages could manifest before long-term solutions can be implemented, especially in Juab County.

3.4 Near-term Options (2021–2030)

Figures 3-7 and Figure 3-9 show potential shortages beginning as early as 2020 for Juab and southern Utah Counties. These shortages are based on the initial conditions of the modeling conducted for Tasks 5 & 6; the exact timing and magnitude of the shortages is difficult to quantify exactly. Although the Project Team cannot precisely predict the near-term shortages, the shortages are likely to occur before long-term solutions can be implemented by 2030. The options outlined in the following subsections are adaptable and could be brought online incrementally, depending on how the shortages actually occur.

3.4.1 Juab County

The blue and light blue areas in Figure 3-7 represent existing Juab County water supplies; the green line represents potential demands under Baseline Condition conditions.

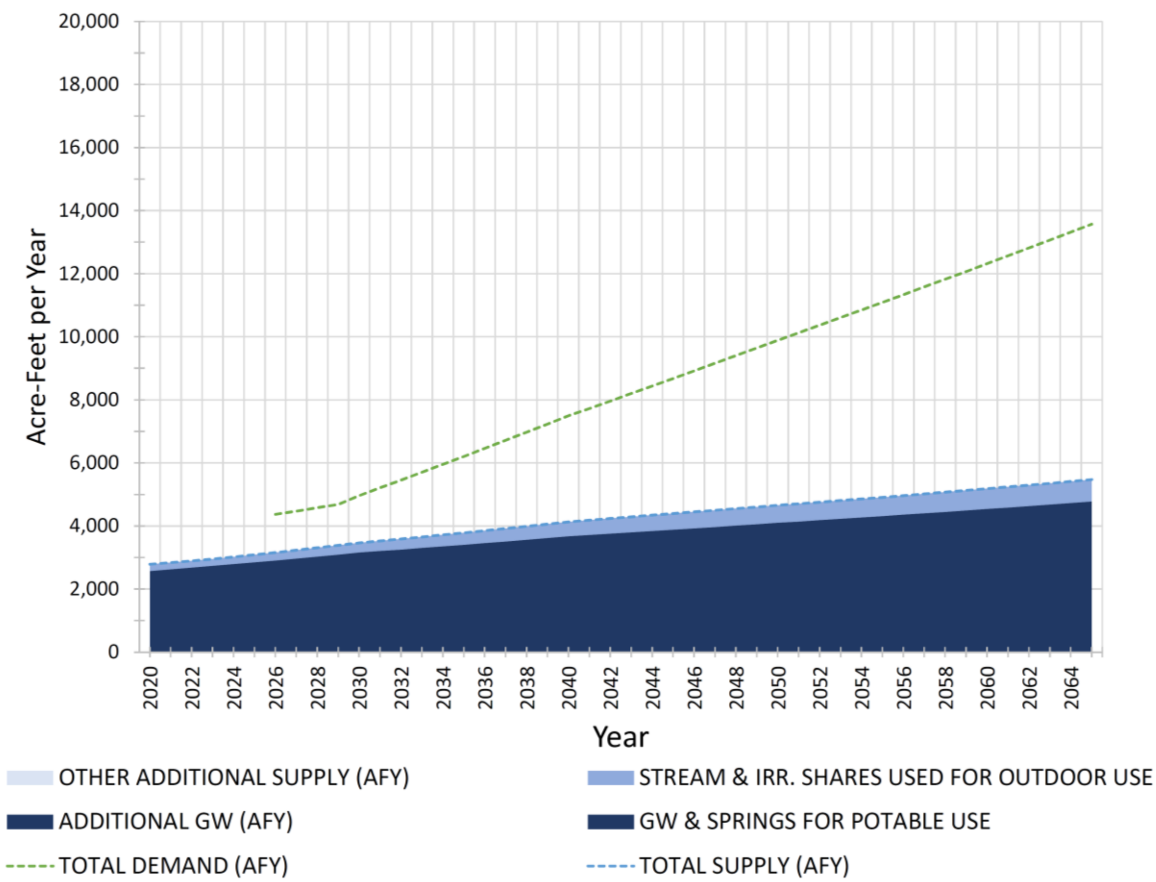

Figure 3-7. Baseline Supply and Demand Conditions, Juab County

It is likely that long-term infrastructure and operations solutions to address shortages will not be brought online before 2030 (see Section 6). This means that Juab County could potentially face shortages until long-term solutions are implemented. Although this report has focused on long-term solutions, in the process of evaluating as many potential solutions as possible, the Project Team has determined that there are several potential near-term solutions that Juab County could implement.

The Project Team has determined that the following actions could be implemented to reduce potential shortages and negative impacts resulting from a near-term water supply shortage:

- **Nephi Well**: Currently Under construction
- **Mona Well:** Relocate existing or new construction
- **PacifiCorp Well:** Develop lease agreement
- **Aquifer Storage and Recovery (ASR):** Develop early implementation or demonstration project

CUWCD has not committed to addressing the short-term issues. However, Figure 3-8 shows how these options could help mitigate shortages in the near term.

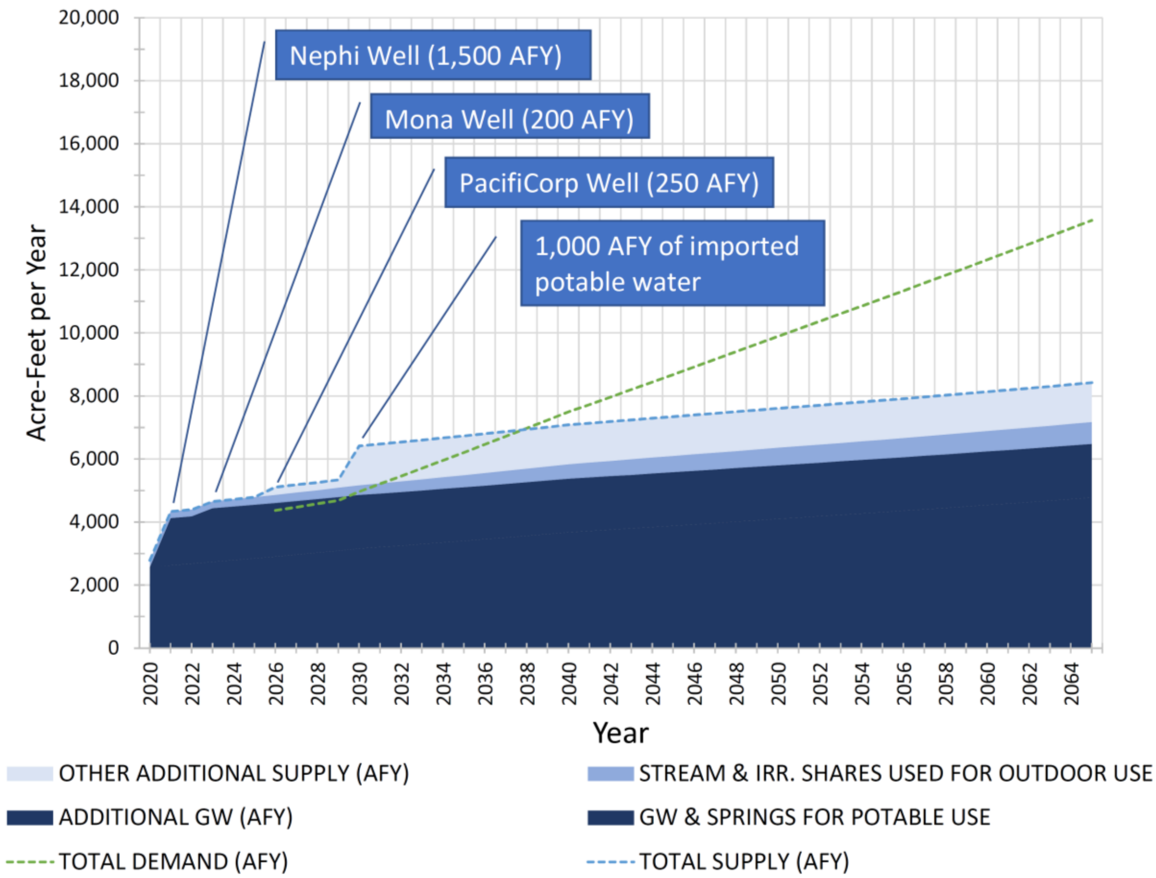

Figure 3-8. Near-term Shortage Mitigation, Juab County (Baseline Scenario)

3.4.2 Southern Utah County

As noted previously, this Report has focused on long-term water supply conditions, demands, water supply options, and facilities. However, in southern Utah County, there are also potential circumstances where supply shortages could manifest before long-term solutions can be implemented.

Figure 3-9 shows the potential southern Utah County shortages under Baseline Condition assumptions.

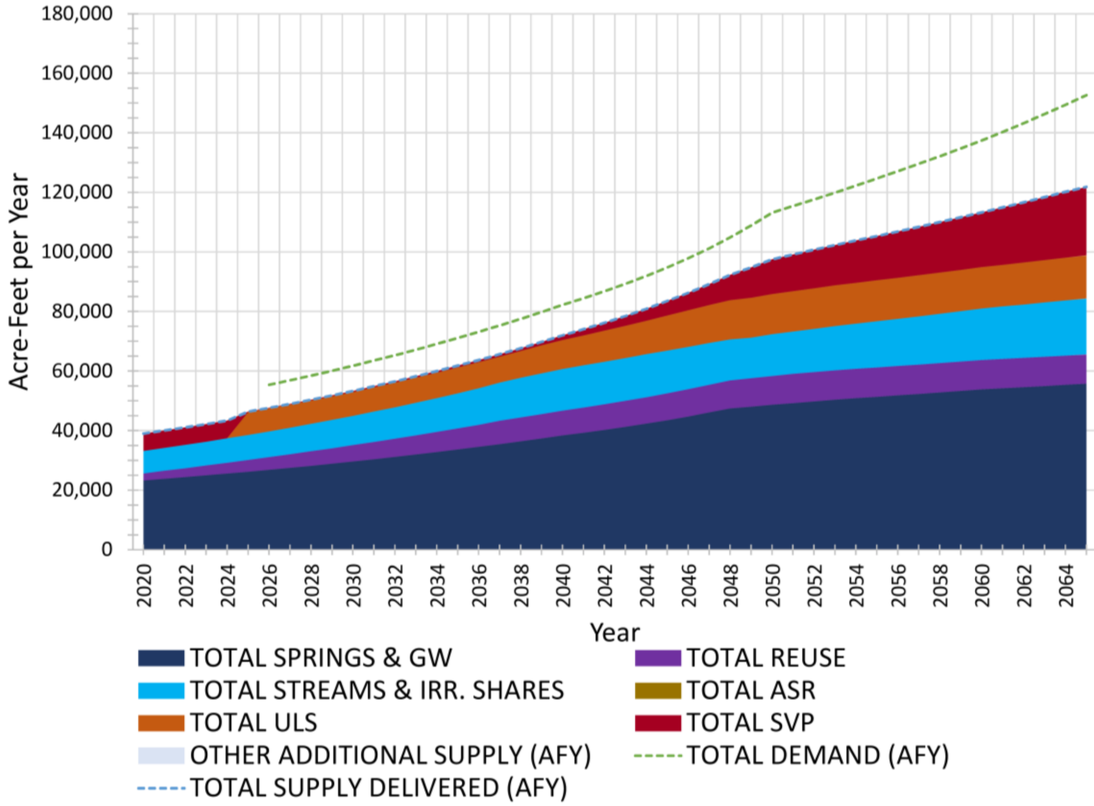

Figure 3-9. Baseline Supply and Demand Conditions, Southern Utah County

As noted in Section 6 of this report, it is likely that long-term infrastructure or operational solutions will not be brought online before 2030. This means that southern Utah County could potentially face shortages until long-term solutions are implemented (Figure 3-9). In the process of evaluating as many potential solutions as possible, the Project Team has determined that ASR has the potential to mitigate short-term shortages. Although this report focuses on long-term solutions, and CUWCD has not committed to addressing the short-term issues, Figure 3-10 shows how ASR could help mitigate shortages in the near term. Figure 3-10 shows ASR development at a pilot level of 1,000 AFY. Depending on the actual shortages and the outcome of further study regarding ASR feasibility, ASR could be brought on at higher or lower levels in the interim period.

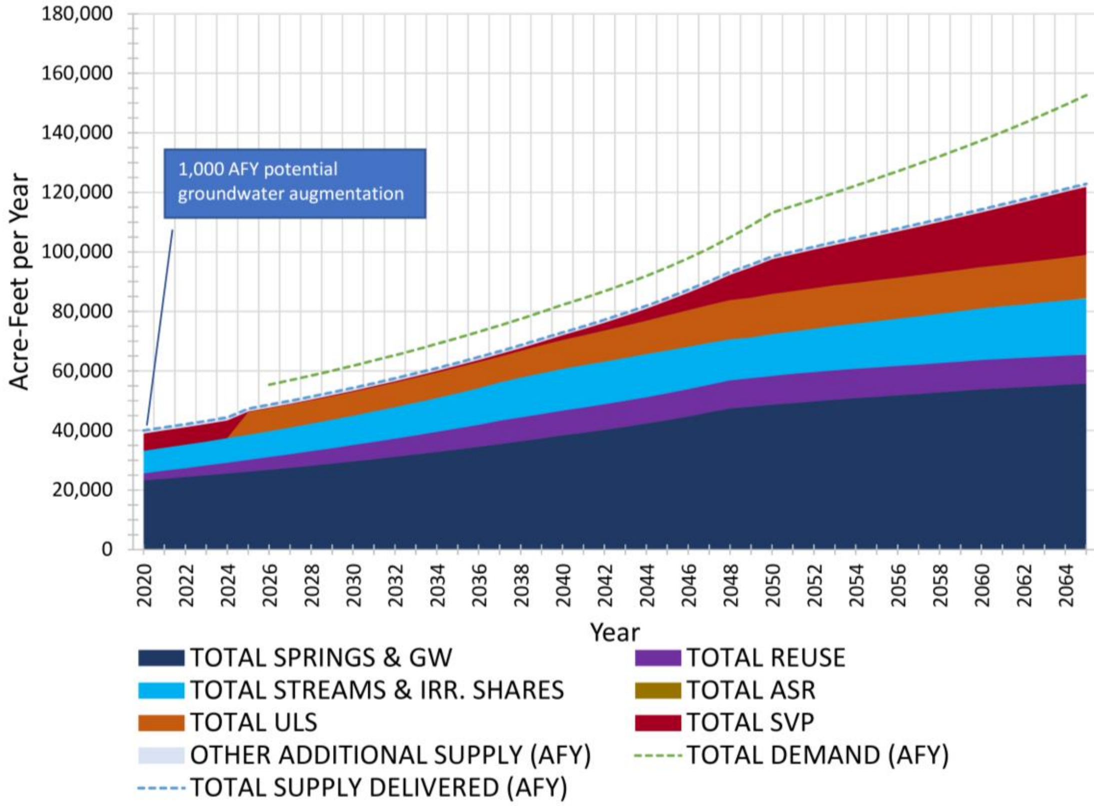

Figure 3-10. Aquifer Storage and Recovery Development, Southern Utah County (Baseline Scenario)

3.5 Comparison of Agricultural to M&I Land Conversion Projections for Southern Utah County

As part of developing this PFP, the Project Team used population projections from the Kem C. Gardner Policy Institute and Mountainland Association of Governments to estimate the amount of land required to provide housing for the increased population which would come from existing irrigated agricultural land converting to urban uses, as shown in Table 3-7 and Figures 3-11 and 3-12 (HAL 2020a, 2020b; see Appendix A). This conversion of agricultural land is critical to understand in a planning effort because historically the water used to irrigate serves as the first source (though potentially requiring further treatment to serve as a potable supply) for the new demands associated with development on historically irrigated lands.

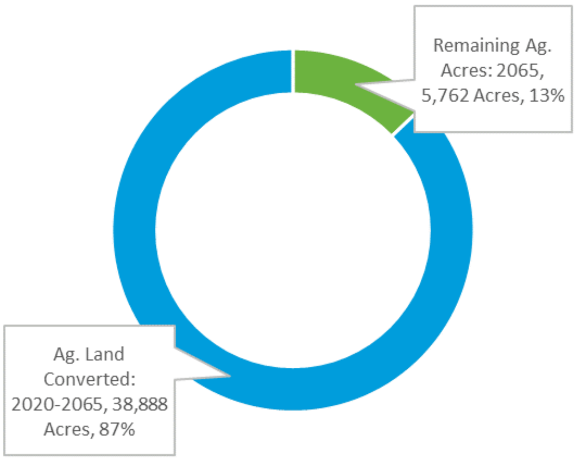

Figure 3-11. PFP Agricultural Land Conversion – Baseline Scenario

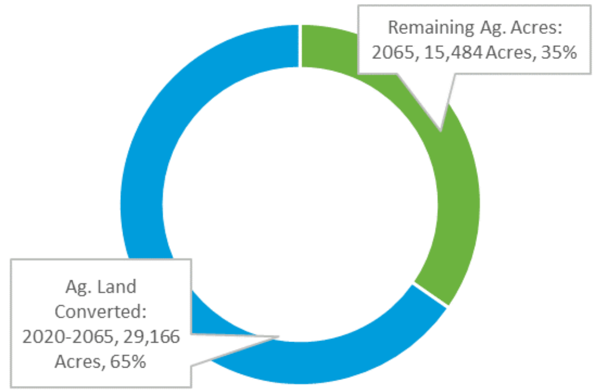

Figure 3-12. PFP Agricultural Land Conversion – Alternative Scenario

Simultaneous to this PFP effort, Envision Utah (a leading non-profit planning group based in Salt Lake City) conducted an independent, long-range planning effort titled *Valley Visioning* to develop a vision for growth throughout Utah County. Valley Visioning also estimated how agricultural conversion could occur under multiple development patterns, including a Status Quo Scenario based on historical development throughout Utah, a Preferred Scenario based on community feedback expressing interest in increased density in urban cores, and a Western Growth Scenario in which a lower percentage of growth occurs in the area also covered by this PFP (See Table 3-7 and Figures 3-13, 3-14, and 3-15).

Table 3-7. Population Projections and Land Requirements for Agricultural Conversion

	Plan Formulation Project 2065		**Valley Visioning 2065[a]**		
	Baseline Scenario	Alternative Scenario	Preferred Scenario	Status Quo Scenario	Western Growth Scenario
Initial Ag. 2020 Land (acres)	44,650		44,650		
Remaining Ag. 2065 Land (acres)	5,762	15,484	7,461	0	10,123
Ag. Land Converted 2020–2065 (acres)	38,888	29,166	37,190	44,650	34,527
Percentage Converted (%)	87	65	83	100	77

[a] Linear extrapolation based on projections through 2050.

Note:
Ag. = agricultural

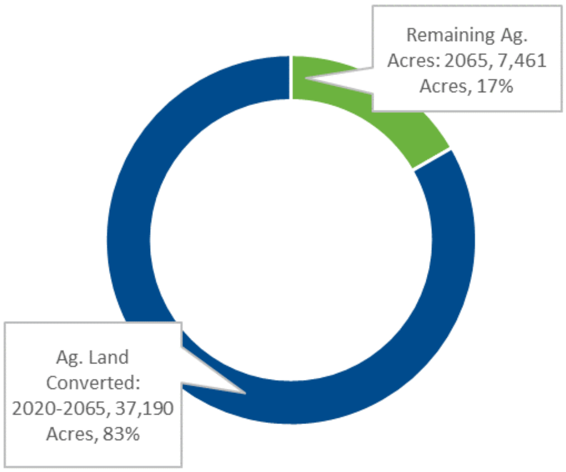

Figure 3-13. Valley Visioning – Preferred Scenario

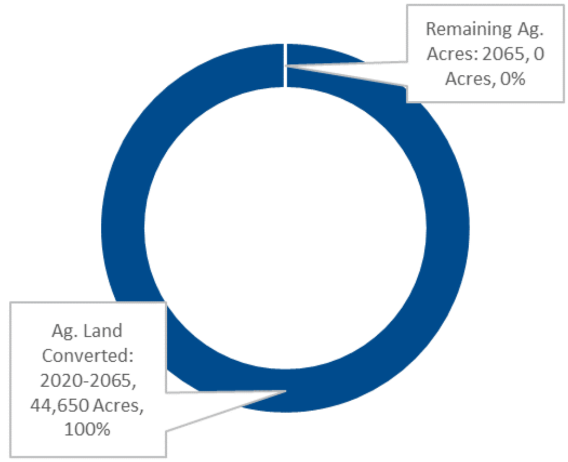

Figure 3-14. Valley Visioning – Status Quo Scenario

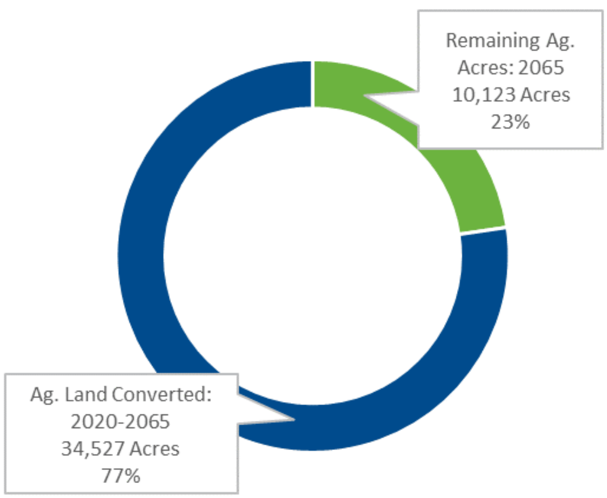

Figure 3-15. Valley Visioning – Western Growth Scenario

By comparing the PFP projections with those from the Valley Visioning effort, it is apparent that the PFP Baseline Scenario estimate is similar to the independent Valley Visioning Preferred Scenario. The other Valley Visioning scenarios show that a status quo growth pattern would result in a near total conversion of all agriculture in the area, while even an emphasis on minimizing growth in this area would still result in an estimated 77% of all agricultural land in southern Utah County converting by 2065. This is then bracketed by the PFP Alternative scenario in which it is assumed only 65% of current agricultural lands convert to urban uses.

4. Portfolio Development Overview

4.1 Portfolio Development Process and Modeling

4.1.1 Portfolio Development Process and Potential Solutions

As described in Section 3, future supply shortages are projected for southern Utah County and Juab County for both the Baseline and Alternative scenarios, with shortages comprising both potable and non-potable water. Numerous potential infrastructure and operational solutions that could help address the future shortages were developed based on collaborative input from the Project Team, CUWCD staff, and staff from various stakeholders. Solutions considered as part of the portfolio development process comprised a mix of existing and new infrastructure as well as operational changes to water supply and delivery. While the collaborative solution development process yielded many potential options, a short list of possible solutions was ultimately refined and developed for further investigation. A brief description of the characteristics of these short-listed solutions that were carried forward for further evaluation in the portfolios of solutions are shown in Table 4-1.

Table 4-1. Potential Solutions Considered in Portfolio Development Process

Solution	Type	Description
Regional Water Treatment Plant	New Infrastructure	A new regional water treatment plant located on a greenfield site owned by CUWCD in southeastern Salem could be used to treat non-potable ULS water, SVP water, surface water, or other water for deliveries to cities that have potable water shortages in both southern Utah County and Juab County. For purposes of this analysis, a conventional water treatment plant process (including flocculation, sedimentation, and filtration) was assumed.
Potable Water Conveyance Pipelines	New Infrastructure	New potable water conveyance pipelines were considered in order to deliver potable water from the regional water treatment plant to cities in southern Utah County and Juab County with potable water shortages. Because of the proposed location and anticipated hydraulic grade of the regional water treatment plant, it was assumed that pump stations would not be needed for deliveries to southern Utah County, but a booster pump station would likely be needed to deliver potable water into Juab County.
ULS Spanish Fork-Santaquin Pipeline and Highline Canal	Existing Infrastructure	It was assumed that combinations of the existing and planned ULS Spanish Fork-Santaquin Pipeline and a rehabilitated or enclosed Highline Canal could be used to deliver non-potable water to cities in southern Utah County with non-potable water shortages as agricultural lands convert to M&I purposes. To deliver water on an M&I pattern, these facilities would need to be operated continuously throughout the year.
Juab County Non-Potable Water Pipeline[a]	New Infrastructure	A new non-potable water pipeline could be constructed to convey non-potable supplies from southern Utah County into Juab County. It was assumed that this pipeline would begin near Santaquin and take water from the ULS Spanish Fork-Santaquin Pipeline or the Highline Canal.

Table 4-1. Potential Solutions Considered in Portfolio Development Process

Solution	Type	Description
ASR in Southern Utah County	New Infrastructure	It was assumed that an ASR program could be implemented in southern Utah County. For purposes of this analysis, it was assumed that incremental average minus dry winter streamflows would be conveyed to regional infiltration sites near the proposed regional water treatment plant and near Santaquin and recovered with a 1-year lag at regional wellfields north of Santaquin and at other to-be-determined locations. It was assumed that recovered water would be pumped and piped into the new potable water pipeline near Payson for subsequent distribution to communities participating in the regional ASR program. It is important to note that water supply availability, water rights ownership, legal, or regulatory aspects of making water available for regional ASR require further study.
ASR in Juab County[a]	New Infrastructure	It was assumed that non-potable or potable water delivered into Juab County from southern Utah County could be conveyed to ASR infiltration sites near cities with shortages and recovered via extraction wellfields to serve non-potable or potable demands.
Balancing ULS and SVP Supplies[b]	New Operational	For this analysis, it was assumed that ULS and SVP supplies (supply from storage) were made available on a historical agricultural delivery pattern during summer months. This can result in periods where some cities have a surplus of these supplies in excess of what is needed to serve their own non-potable or potable demands. In these cases, surplus ULS and SVP supplies could potentially be "balanced" and delivered via new or existing infrastructure to cities that still have shortages. It is important to note that numerous legal, institutional, detailed operational, and regulatory aspects would need to be overcome and require further study prior to implementing supply balancing.
Retiming[b] ULS and SVP Supplies	New Operational	Like the process for balancing ULS and SVP supplies (as described previously), retiming the delivery pattern of these supplies from a summer agricultural delivery schedule to an M&I delivery schedule could be a viable solution to better align availability of these supplies with the timing of future demands and mitigate future water supply shortages. However, there are several regulatory, institutional, and operational issues that would need to be addressed, which would require further study prior to implementing this solution.

[a] These options were not carried forward in Phase II.

[b] See Appendix E for a more detailed description of balancing and retiming.

The Project Team worked to group the potential solutions detailed in Table 4-1 into portfolios of various solutions that could be compared against each other. For all portfolios considered, potential solutions were evaluated under both the Baseline and Alternative supply and demand scenarios. The general portfolio evaluation process is shown conceptually on Figure 4-1.

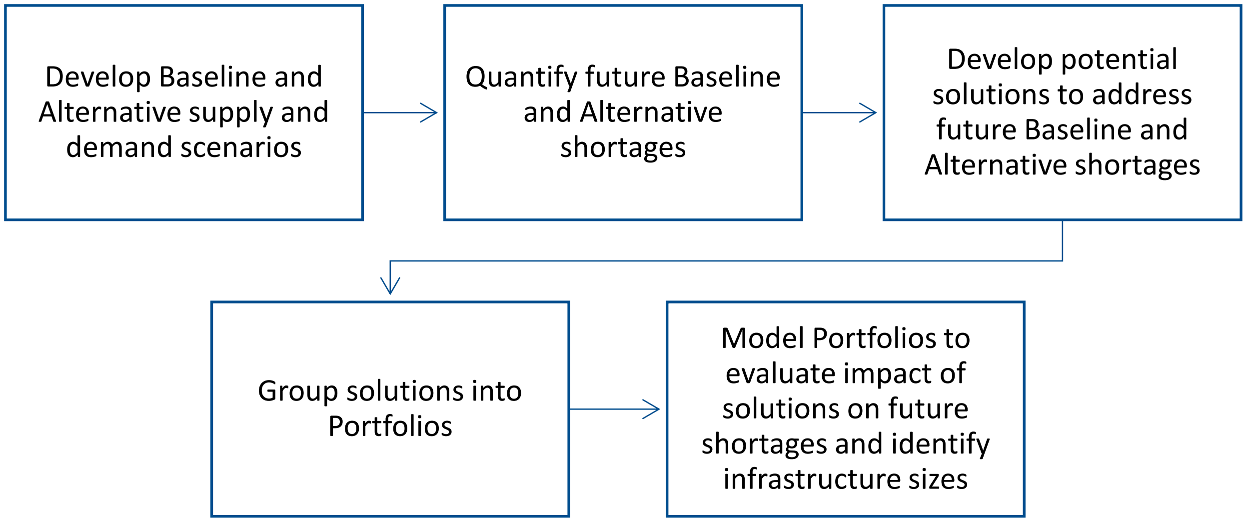

Figure 4-1. Conceptual Portfolio Evaluation Process

4.1.2 Modeling Approach

In order to evaluate the supply, demand, shortage conditions, and infrastructure characteristics of a given portfolio, a custom Microsoft Excel-based water supply mass balance and infrastructure model (Model) was developed by the Project Team. The Model was designed and constructed specifically for this project to enable quick evaluation of assumed water supply, demand, shortage, infrastructure, and operational conditions that reflect the various portfolio configurations.

The Water Supply Mass Balance Module of the Model consists of the following:

- Conceptual layout of existing and potential future infrastructure facilities
- Water supply availability
- Projected demands

Detailed projected supply and demand data by city were developed in Tasks 5 & 6 and incorporated into the Model. Supply and demand data were represented on a monthly time step between 2020 and 2065 for cities in southern Utah County and Juab County. The mass balance module synthesizes the supply and demand data and calculates the required size of conveyance, treatment, pump stations, and ASR infrastructure to deliver available supplies to each city. The Model also calculates any remaining supply-demand shortages for each city after considering solutions incorporated into a given portfolio.

It is important to note that the primary goal of the Water Supply Mass Balance Module is to provide a flexible platform to compare water supply and demand shortages and infrastructure solutions and help inform the PFP Report portfolio decision-making process. Results should be considered order of magnitude at this stage. More detailed systems analysis and engineering conceptual design will be required as solutions described in the portfolio definitions are further considered and studied.

4.2 Initial Portfolios 1–5

The Project Team developed five initial Portfolios, including a no-action portfolio, that were designed to evaluate various combinations of solutions and provide perspective on how a given portfolio performed with regard to reducing future supply and demand shortages. Additional descriptions of initial Portfolios 1–5 are included in the Plan Formulation Phase I Portfolios Alternatives Summary prepared by the Project Team in December 2020 and included in Appendix C.

Portfolio 1 was designed to evaluate a no-action condition, and it is represented conceptually as the Baseline and Alternative no-action scenarios described in Section 3. While Portfolio 1 represented the initial conditions and helped establish the portfolio that others could be compared against, it was not used to develop or investigate potential solutions going forward.

Table 4-2 summarizes Portfolios 1 through 5 and provides for a quick comparison between the initially considered portfolios in one view space. The portfolios offer infrastructure solutions that are sized to deliver water to meet the projected shortages. The water supplies to meet these demands have not been fully defined or developed (additional discussion of potential water supplies that could potentially fill remaining shortages is included in Section 8). For example, Portfolio 2, Treat and Convey, proposes a water treatment plant in southern Utah County. A portion of this treatment plant's capacity would be used to treat water converted to M&I from ULS and agriculture. As a result, there is a corresponding reduction in shortage in southern Utah County.

Table 4-2. Initial Portfolios 1–5 Summary

Portfolio Number	Portfolio Description	Southern Utah County 2065 Remaining Shortage (AFY)[a]				Juab County 2065 Remaining Shortage (AFY)[a]				Key Required Infrastructure
		Baseline		Alternative		Baseline		Alternative		
		Potable	Non-Potable	Potable	Non-Potable	Potable	Non-Potable	Potable	Non-Potable	
1	No action	17,462	7,944	30,596	24,729	3,286	4,813	5,766	8,813	None beyond existing facilities
2	Treat and convey in southern Utah County	6,414	12,604	15,515	33,606	3,286	4,813	5,766	8,813	▪ Regional WTP (23 MGD Baseline, 39 MGD Alternative) ▪ New Potable Pipeline in southern Utah County ▪ Non-potable Conveyance in southern Utah County via Spanish Fork-Santaquin Pipeline and Highline Canal
3	Treat and convey + balancing of ULS and SVP supplies in southern Utah County	5,846	4,132	12,705	29,226	3,286	4,813	5,766	8,813	▪ Regional WTP (23 MGD Baseline, 38 MGD Alternative) ▪ New potable Pipeline in southern Utah County ▪ Non-potable Conveyance in southern Utah County via Spanish Fork-Santaquin Pipeline and Highline Canal
4A	Treat and convey + balancing of ULS and SVP supplies + ASR in southern Utah County and ASR in Juab County via Spanish Fork-Santaquin Pipeline	4,361	2,028	9,303	19,358	3,286	4,813	5,766	8,813	▪ Regional WTP (18 MGD Baseline, 26 MGD Alternative) ▪ New Potable Pipeline in southern Utah County ▪ Non-potable Conveyance in southern Utah County via Spanish Fork-Santaquin Pipeline and Highline Canal ▪ ASR Spreading Basins and Wellfield in southern Utah County ▪ New Non-potable Pipeline into Juab County ▪ ASR Spreading Basins and Wellfield in southern Utah County

Table 4-2. Initial Portfolios 1–5 Summary

Portfolio Number	Portfolio Description	Southern Utah County 2065 Remaining Shortage (AFY)[a]				Juab County 2065 Remaining Shortage (AFY)[a]				Key Required Infrastructure
		Baseline		Alternative		Baseline		Alternative		
		Potable	Non-Potable	Potable	Non-Potable	Potable	Non-Potable	Potable	Non-Potable	
4B	Treat and convey + balancing of ULS and SVP supplies + ASR in southern Utah County and ASR in Juab County via Highline Canal	4,361	2,028	9,303	19,358	3,286	4,813	5,766	8,813	▪ Regional WTP (18 MGD Baseline, 26 MGD Alternative) ▪ New potable pipeline in southern Utah County ▪ Non-potable conveyance in southern Utah County via Spanish Fork-Santaquin Pipeline and Highline Canal ▪ ASR spreading basins and wellfield in southern Utah County ▪ New non-potable pipeline into Juab County ▪ ASR spreading basins and wellfield in southern Utah County and Juab County
5	Treat and convey in southern Utah County, exchange non-potable water surface supplies to Juab via Spanish Fork-Santaquin Pipeline + potable water pipe to Juab County	6,414	12,604	15,515	33,606	3,286	4,813	5,766	8,813	▪ Regional WTP (29 MGD Baseline, 48 MGD Alternative) ▪ New potable pipeline in southern Utah County ▪ Non-potable conveyance in southern Utah County via Spanish Fork-Santaquin Pipeline and Highline Canal ▪ ASR spreading basins and wellfield in southern Utah County ▪ New potable and non-potable pipelines into Juab County ▪ ASR spreading basins and wellfield in southern Utah County and Juab County

[a] Remaining shortages indicate the amount of water supplies that still need to be identified after implementation of solutions and infrastructure identified in each portfolio. The shortages in Juab County do not change because there is no identified water supply. The identified infrastructure are the facilities needed to treat and convey potential water supplies. Data assume no conversion of agricultural water to M&I in Juab County.

Notes:
MGD = million gallons per day
WTP = water treatment plant

4.3 Selected Portfolios 7 and 7A

Following internal workshops, discussion, and stakeholder outreach by the Project Team, concepts developed in initial Portfolios 1 through 5 were refined and updated into a new set of portfolios—Portfolios 7 and 7A—that were carried forward for further evaluation. As a result of the refinement process, several key changes were made from initial Portfolios 1 through 5:

- It was decided that the optimal solution to address long-term shortages for Juab County would be to deliver potable water in amounts that could meet Juab County's future potable and non-potable shortages. A system that included both potable and non-potable supply conveyance for Juab County was deemed too expensive. Thus, in Portfolios 7 and 7A, Juab County's future potable and non-potable shortages are served via ASR in southern Utah County or the proposed regional water treatment plant in southern Utah County and a new potable water pipeline extending from southern Utah County down to Nephi in Juab County.
- Likewise, the Project Team developed solutions for potable water shortages and the required infrastructure to meet those shortages in southern Utah County and Juab County. Non-potable supplies and conveyance, such as the Highline Canal, are controlled by entities other than CUWCD, and the focus of selected Portfolios 7 and 7A narrowed to primarily consider solutions to meet potable water shortages. This analysis does, however, track and quantify non-potable supplies and demands.
- Balancing southern Utah County ULS and SVP supplies was viewed as a favorable potential solution, but there are numerous regulatory, institutional, and operational issues to be addressed before balancing can be accomplished. As a result, Portfolios 7 and 7A were evaluated both with and without the estimated effect of balancing these supplies. Balancing is further discussed in Sections 4.4, 8.1.2, and Appendix E.
- Like balancing, retiming southern Utah County ULS and SVP supplies, as described previously, is considered a favorable potential solution to meet future water supply shortages. However, there are numerous regulatory, institutional, and operational issues that would need to be addressed before retiming can be accomplished. As such, Portfolios 7 and 7A were evaluated both with and without the estimated effect of potentially retiming these supplies. Retiming is further discussed in Sections 4.4, 8.1.2, and Appendix E.
- An ASR program in southern Utah County was viewed as a favorable potential solution, with recognition that the future configuration or assumed water sources are uncertain at this time and require future study. To provide perspective on how a regional ASR program might affect future shortages in southern Utah County, Portfolios 7 and 7A were evaluated both with and without the effect of ASR. It was assumed that the maximum size of a potential ASR program would be 20,000 AFY.
- It was noted that the nature of future development in Benjamin/Lake Shore and the Goshen Valley Mega Site areas is uncertain. To account for this uncertainty, Portfolio 7 splits the demands for these areas between potable and non-potable, whereas Portfolio 7A treats all demands for these areas being served as potable demands. This has the effect of increasing the required size of the regional water treatment plant and other potable water infrastructure components.

Table 4-3 summarizes the remaining shortages and water treatment requirements for the selected Portfolios 7 and 7A without considering the effect of an ASR program or the implementation of balancing and retiming ULS and SVP supplies. These numbers serve as the basis for evaluating the potable water needs that must be met through new infrastructure and operational actions. Infrastructure and operational considerations required to implement Portfolios 7 and 7A are further discussed in Section 5.

Table 4-3. Selected Portfolios 7 and 7A Summary without Balancing, Retiming, or ASR

Portfolio Number	Portfolio Description	Southern Utah County 2065 Remaining Shortage (AFY)[a]				Juab County 2065 Remaining Shortage (AFY)[a]				Key Required Infrastructure
		Baseline		Alternative		Baseline		Alternative		
		Potable	Non-Potable	Potable	Non-Potable	Potable	Non-Potable	Potable	Non-Potable	
1	No action	17,462	7,944	30,596	24,729	3,286	4,813	5,766	8,813	None beyond existing facilities
7	Regional WTP in southern Utah County, Goshen Mega Site, and Benjamin/Lake Shore demands split between potable and non-potable in southern Utah County, potable water pipe to Juab County	6,414	12,604	15,515	33,606	3,286	4,813	5,766	8,813	▪ Regional WTP (35 MGD Baseline, 58 MGD Alternative) ▪ New potable pipeline in southern Utah County ▪ New potable pipeline into Juab County
7A	Regional WTP in southern Utah County, Goshen Mega Site, and Benjamin/Lake Shore demands represented as potable demands in southern Utah County, potable water pipe to Juab County	15,841	5,326	37,755	13,267	3,286	4,813	5,766	8,813	▪ Regional WTP (70 MGD Baseline, 101 MGD Alternative) ▪ New potable pipeline in southern Utah County ▪ New potable pipeline into Juab County

[a] Remaining shortages indicate the amount of water supplies that still need to be identified after implementation of solutions and infrastructure identified in each portfolio. The shortages in Juab County do not change because there is no identified water supply. The identified infrastructure are the facilities needed to treat and convey potential water supplies. Data assume no conversion of agricultural water to M&I in Juab County.

4.4 Potential Impact of Balancing, Retiming, and ASR on Portfolio 7 and 7A Potable Shortages

Future implementation of ASR, balancing of ULS and SVP supplies, and retiming of ULS and SVP supplies all have the potential to serve as new sources of water supply that could be used to reduce the amount of potable water shortages shown in Table 4-4. While balanced or retimed ULS and SVP supplies would require treatment through a regional water treatment plant to be used as a potable supply, it is assumed that ASR supplies would not require treatment. As such, use of ASR supplies has the potential to reduce the required size of a regional water treatment plant.

To provide perspective on how various combinations of ASR, balanced ULS and SVP supplies, and retimed ULS and SVP supplies can potentially help reduce remaining southern Utah County and Juab County potable shortages for Portfolios 7 and 7A, Table 4-4 details the additive effects of these solutions by decade over the study timeframe. It is important to note that for all conditions shown in Table 4-4, use of a regional water treatment plant in southern Utah County is considered, and up to 20,000 AFY of ASR is considered available for use under conditions where ASR is assumed.

As can be seen, ASR, balancing, and retiming all have the potential to significantly reduce remaining southern Utah County and Juab County potable shortages. For example, considering Portfolios 7 and 7A Baseline with ASR, balancing, and retiming, ASR could be optional if balancing and retiming of ULS and SVP supplies are implemented to the maximum extent. However, it is important to note that remaining potable shortages exist under many conditions with currently unidentified sources of future supply. Additionally, the feasibility of implementing assumed amounts of ASR, balancing, and retiming shown here is uncertain, as there are numerous technical and institutional issues that must be overcome and further studied.

Table 4-4. Impact of Balancing, Retiming, and ASR on Portfolio 7 and 7A Remaining Unidentified Potable Water Supplies

Year	Portfolio	South Utah County & Juab County Remaining Potable Shortages [Acre-Feet per Year]							
		Unbalanced & No Re-Timed ULS/SVP Supplies				Balanced + Re-Timed ULS/SVP Supplies			
		Baseline + WTP	Baseline + WTP + ASR	Alternative + WTP	Alternative + WTP + ASR	Baseline + WTP	Baseline + WTP + ASR	Alternative + WTP	Alternative + WTP + ASR
2030	7	2,955	0	4,060	0	0	*ASR optional*	0	*ASR optional*
	7A	4,820	0	5,926	0	0	*ASR optional*	0	*ASR optional*
2040	7	5,050	0	8,340	0	0	*ASR optional*	0	*ASR optional*
	7A	6,944	0	10,597	0	0	*ASR optional*	0	*ASR optional*
2050	7	7,655	0	16,145	0	0	*ASR optional*	4,824	0
	7A	13,099	0	27,664	7,664	0	*ASR optional*	8,392	0
2060	7	11,674	0	24,765	4,765	0	*ASR optional*	20,351	351
	7A	18,857	0	42,319	22,319	0	*ASR optional*	27,561	7,561
2065	7	14,513	0	30,095	10,095	0	*ASR optional*	26,493	6,493
	7A	23,940	3,940	52,334	32,334	0	*ASR optional*	37,397	17,397

5. Infrastructure Needs for Selected Portfolios

During Phase II of the PFP planning process, it became apparent that a regional water treatment plant would be required for all considered portfolios in order to provide water for future potable water needs. Finished water conveyance facilities serving southern Utah County and Juab County would also be needed to deliver potable water from the water treatment plant to cities with future needs. In conjunction with a regional water treatment plant, a regional ASR program was identified as an additional solution with potential to partially meet future potable water needs and increase the overall resiliency of the water supply system.

Knowing these major components will be needed to develop a reliable, flexible, and adaptable regional supply system, a planning-level evaluation was conducted to determine sizes, capacities, potential locations, and costs of major infrastructure components for the selected portfolios described in Section 4. This infrastructure evaluation is expected to be refined in future phases of study, but an initial layout of the infrastructure was necessary to quantify the range of costs that might be expected to design, construct, and maintain the water supply system. This section will describe major components of the infrastructure required to implement the selected portfolios. Appendix F contains further documentation of the infrastructure components.

Figure 5-1 presents a concept-level overview of infrastructure components and their general locations in the study area. The existing ULS Spanish Fork-Santaquin Pipeline and the existing Highline Canal are shown as solid red and purple lines, respectively, because these two components will be critical to the success of the water delivery system in southern Utah County and Juab County.

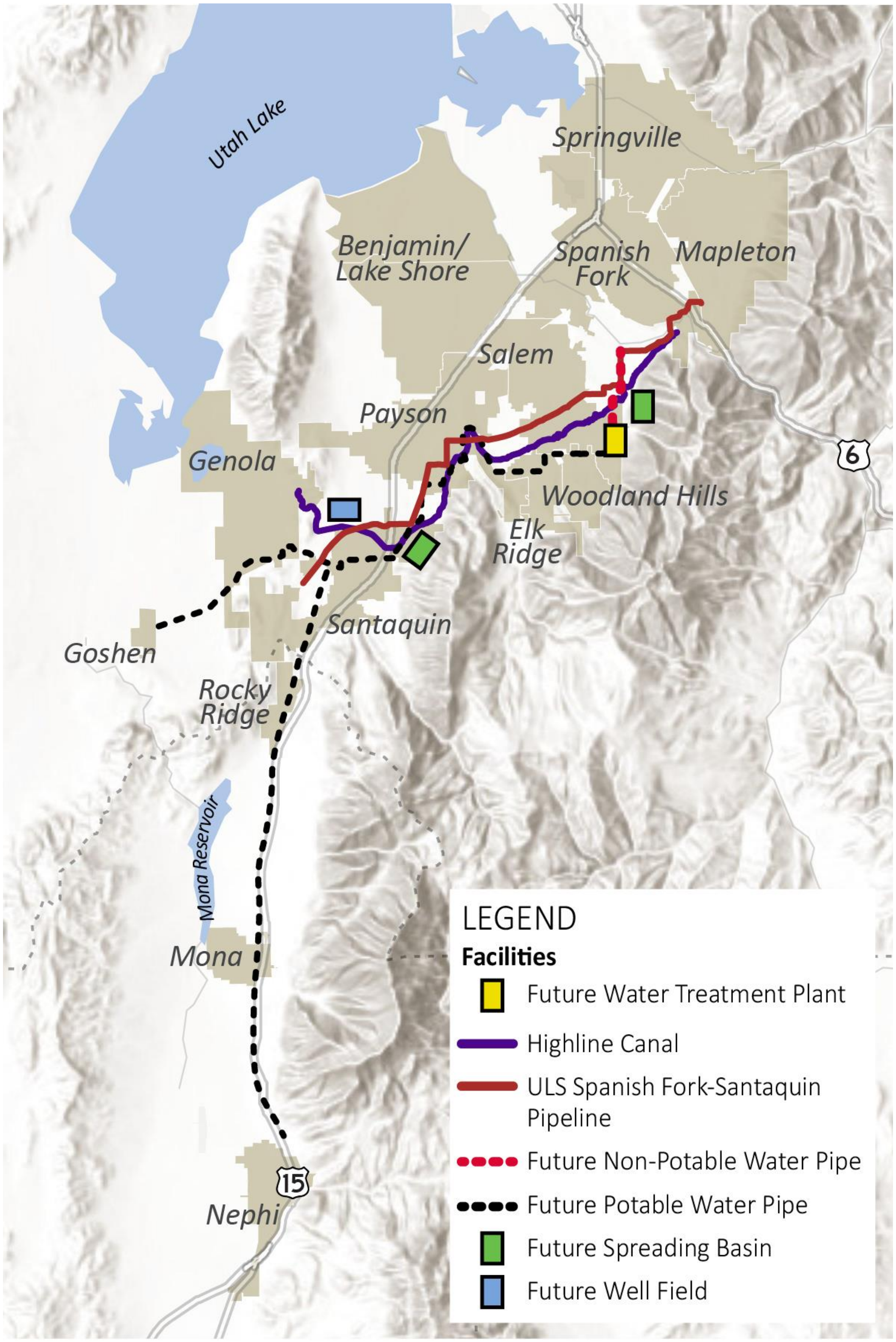

Image Source: ESRI, USGS, Garmin, NASA, HERE, NOAA, CGIAR, NCEAS, NLS, OS, NMA, GSA, Geoland.

Figure 5-1. Potential Plan Formulation Project Facilities

5.1 Infrastructure Components and Operations Overview

Figure 5-2 shows a detailed conceptual layout of existing and proposed conveyance and treatment infrastructure components required to meet regional potable water needs. It is important to note that although the selected portfolios have many infrastructure components in common (for example, a regional water treatment plant, potable water conveyance, and ASR facilities), the sizes of these components vary among portfolios because of the unique supply, demand, and operational conditions defined for each portfolio. The schematic shows how the proposed infrastructure connects to the existing infrastructure so as to create an adaptable and flexible system. The components are positioned on the schematic to show their general elevations or hydraulic grade lines (HGL), which can help determine locations of certain components to allow for cost-efficient operation.

The new proposed infrastructure components required for each selected portfolio, as shown on Figure 5-2, were then numbered to assist in the hydraulic analysis and cost-development process, as seen on Figure 5-3. The components are color-coded according to type of infrastructure (for example, turnouts, pump stations, ASR facilities, storage reservoirs, raw water pipelines, finished water pipelines, or the WTP).

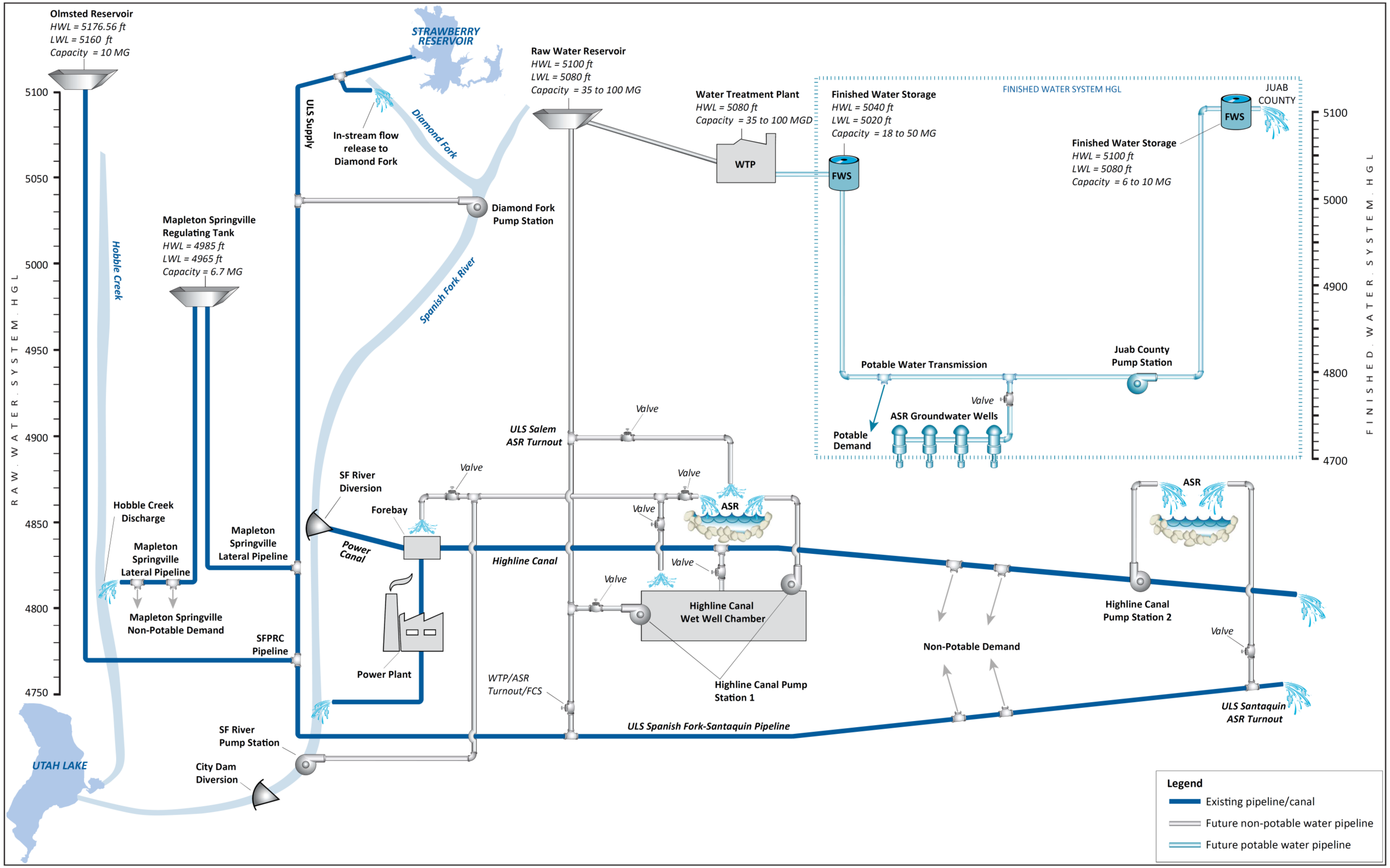

Figure 5-2. Existing and Proposed Infrastructure Schematic

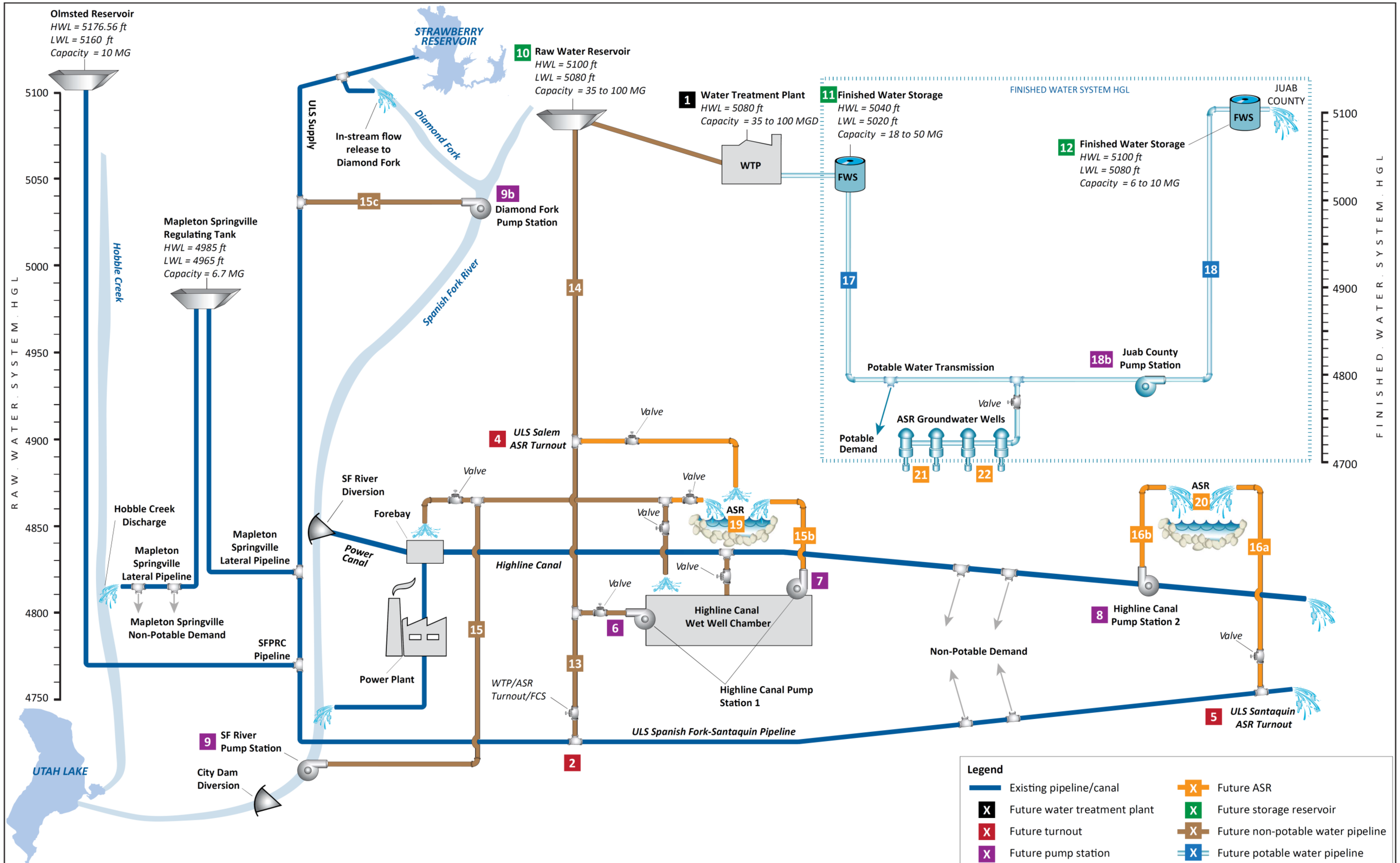

Figure 5-3. Infrastructure Schematic with Numbered Labels

5.2 Key Infrastructure Components Descriptions

Table 5-1 presents a high-level view of each proposed infrastructure component required as part of the selected portfolios. The label numbers and colors correlate with those shown on Figure 5-3. More information on the components follows in Sections 5.3.1 through 5.3.6 and in Appendix F.

Diameters, heads, flows, alignments, locations, and lengths are all planning-level estimates that provide a starting point to estimate potential infrastructure costs for the selected portfolios. For example, component number 12 in Table 5-1 (one of two proposed finished water reservoirs) was assumed to be located near the border of Utah County and Juab County for purposes of this analysis, but it is assumed that other potential locations will be identified and analyzed in future phases of study, depending on system hydraulics and further development of the infrastructure.

As noted previously, the sizes of these components vary among portfolios because of the unique supply, demand, and operational conditions defined for each portfolio. Sizing of infrastructure components for the selected portfolios will be discussed in Section 5.3.

Table 5-1. Major Infrastructure Components

Component Number	Infrastructure component	Category	Description
1	Water treatment plant	WTP	The regional WTP would be located on a greenfield site owned by CUWCD in southeastern Salem to treat ULS, SVP, surface water, or other identified raw water for deliveries to cities that have potable water shortages in both southern Utah County and Juab County. WTP process components assumed for this analysis include rapid mix, flocculation, sedimentation, ozone, and filtration.
2	ULS turnout to WTP	Conveyance	A turnout would be built near Sta 237+00 of the ULS pipeline (part of South Fields Reach 2) to deliver raw water to the WTP. The turnout would include a meter and flow control valve to break the pressure from the ULS system to the HGL of the WTP.
3	Highline Canal turnout to WTP	Conveyance	Accounted for in Component 6.
4	ULS turnout to Salem ASR	ASR	A turnout off of the Spanish Fork-Santaquin Pipeline to the WTP could deliver flow to the Salem ASR spreading basin (Component 19). It could be designed to accommodate flows up to 40 cfs.
5	ULS turnout to Santaquin ASR	ASR	This turnout could be located just east of where the Spanish Fork-Santaquin Pipeline crosses Interstate 15 and deliver flow to a Santaquin ASR spreading basin (Component 20). It could be designed to accommodate a flow of 20 cfs.

Table 5-1. Major Infrastructure Components

Component Number	Infrastructure component	Category	Description
6	Highline Canal turnout and pump station to WTP	Conveyance	This component includes a turnout and pump station to deliver water from the Highline Canal into a pipeline that delivers raw water to the WTP. It would include a screen structure and turnout off of the Highline Canal into a hydraulic chamber or wet well that would contain pumps designed to deliver flow to the WTP. The hydraulic chamber could be designed to also accommodate pumps to deliver water to a Salem ASR facility (Component 7). Conceptually, this turnout and pump station could be located southwest of the intersection of the Highline Canal and 1700 East in Salem. It has a static HGL gain of approximately 270 feet from the Highline Canal to the raw water reservoir at the WTP.
7	Highline Canal pump station to Salem ASR	ASR	This component is a pump station to deliver raw water from the Highline Canal to the Salem ASR facilities, which is an addition to Component 6. The pumps from the Highline Canal to the Salem ASR spreading basin (Component 19) would have a static HGL gain of 20 feet and require an approximate TDH of 27 feet. A flow of up to 40 cfs could be pumped to the spreading basins.
8	Highline Canal pump station to Santaquin ASR	ASR	This component would pump water from the Highline Canal to the Santaquin ASR spreading basin (Component 20) and would be very similar to Components 6 and 7, except at a smaller size and capacity. It would have a static HGL gain of 112 feet and would require a TDH of approximately 130 feet, based on the assumed location of the ASR facilities and the location of the Highline Canal. A flow of up to 20 cfs could be pumped to the spreading basins.
9	Spanish Fork River pump station	Conveyance	This pump station was considered as a way to take Spanish Fork River flows downstream of the Strawberry Power Plant at City Dam and pump them to the Salem ASR spreading basins. Upon further analysis and evaluation, this component was removed from the cost evaluation and replaced with Component 9b.
9b	Diamond Fork pump station	ASR	This component would pump water near the confluence of Diamond Fork and Spanish Fork River into the Diamond Fork/Spanish Fork Canyon Pipeline near the Spanish Fork River Flow Control Structure. This would capture the in-stream flow releases that were delivered further upstream in Diamond Fork and Sixth Water. It would have a static HGL gain of 580 feet if it required operation at the Monks Hollow static HGL. Alternatively, during the winter, the static HGL gain could be reduced, depending on the final destination of the recaptured water. It was assumed that a flow between 20 and 40 cfs could be pumped.

Table 5-1. Major Infrastructure Components

Component Number	Infrastructure component	Category	Description
10	WTP raw water reservoir	Storage	A raw water reservoir with a high-water elevation of 5,100 feet and a low-water elevation of 5,080 feet could be situated in the northeastern corner of the WTP site. It would have a total capacity equivalent to the WTP capacity. The raw water reservoir could be a single-cell or a multiple-cell reservoir facility, depending on timing and phasing of the construction.
11	WTP finished water reservoir	Storage	A finished water reservoir with a high-water elevation of 5,040 feet and a low-water elevation of 5,020 feet could be situated in the southwestern corner of the WTP site. It would have a capacity equivalent to one-half of the WTP capacity. Similar to the raw water reservoir, the finished water reservoir would likely be a multiple-cell and multiple-reservoir facility, depending on the timing and phasing of construction.
12	Juab County finished water reservoir	Storage	A finished water reservoir with a high-water elevation of approximately 5,100 feet and could be situated somewhere near the Utah County and Juab County border. The purpose of the finished water reservoir is to provide operational storage for deliveries into Juab County and provide enough hydraulic head to make deliveries to Mona.
13	ULS to Highline Canal raw water pipeline	Conveyance	This pipeline would extend from the ULS turnout (Component 2) to near the Highline Canal pump station (Component 6). It would have an approximate length of 4,750 feet. The water would flow by gravity from the ULS system.
14	Highline Canal to WTP raw water pipeline	Conveyance	This pipeline would extend from the Highline Canal pump station (Component 6) and connect to the ULS to Highline Canal raw water pipeline (Component 13) and then extend to the raw water reservoir at the WTP (Component 10). It would have an approximate length of 4,180 feet. The ULS to Highline Canal raw water pipeline and the Highline Canal to WTP raw water pipeline would operate off the same HGL set by the raw water reservoir located at the WTP.
15	Spanish Fork River pump station pipeline	Conveyance	Similar to the Spanish Fork River Pump Station (Component 9), this pipeline was considered early in the analysis but then replaced by the Diamond Fork pump station and pipeline. The pipeline from the Spanish Fork River City Dam to the Salem ASR spreading grounds is approximately 4 miles long and did not present a feasible solution for delivery. In the future, if the Highline Canal were enclosed with a pipeline and water could be pumped a short distance from City Dam to the Highline Canal pipeline, then this might represent a more feasible solution.
15b	Highline Canal pipeline to Salem ASR	ASR	This pipeline would extend from the Highline Canal pump station (Component 7) to the Salem ASR spreading basin (Component 19). It would have an approximate length of 1,850 feet. This pipeline and associated pump station could convey water from the Highline Canal to the Salem ASR spreading basin.

Table 5-1. Major Infrastructure Components

Component Number	Infrastructure component	Category	Description
15c	Diamond Fork pump station pipeline	ASR	This pipeline would extend from the Diamond Fork pump station (Component 9b) to the Diamond Fork/Spanish Fork Canyon Pipeline near the mouth of Diamond Fork Canyon. It would have an approximate length of 700 feet.
16a	ULS pipeline to Santaquin ASR	ASR	This pipeline would extend from the ULS turnout (Component 5) to the Santaquin ASR spreading basin (Component 20). It would have an approximate length of 5,700 feet.
16b	Highline Canal pipeline to Santaquin ASR	ASR	This pipeline would extend from the Highline Canal pump station (Component 8) to the Santaquin ASR spreading basin (Component 20). It would have an approximate length of 970 feet.
17	Potable water pipeline to southern Utah County	Conveyance	This pipeline would begin at the southwestern corner of the WTP and would extend westward to Goshen. The alignment will be analyzed in greater detail in future phases of study, but at this stage, approximately 30 percent of the 16.8-mile pipeline is assumed to follow the Highline Canal. There could be treated water delivery turnouts in Salem (for Salem, Woodland Hills, and Elk Ridge), Payson (for Payson and Benjamin/Lake Shore), Santaquin (for Santaquin and the pipeline to Juab County; Component 18), Genola, and Goshen. For the flow capacity and sizing analysis, it was assumed the pipeline would have four major reaches, with each reach having a smaller diameter than the previous. Reach 1 would have an approximate length of 5,400 feet, Reach 2 would have an approximate length of 20,680 feet, Reach 3 would have an approximate length of 31,470 feet, and Reach 4 would have an approximate length of 31,040 feet.
18	Potable water pipeline to Juab County	Conveyance	This pipeline could begin in Santaquin and extend south to Juab County. It could be built in two phases: the first reaching to Mona (approximately 12 miles) and the second reaching to Nephi (approximately 6 additional miles). Reach 1 would have an approximate length of 64,300 feet, and Reach 2 would have an approximate length of 31,000 feet.
18b	Juab County booster pump station	Conveyance	This pump station would pump water from the southern Utah County potable water pipeline (Component 17) to the Juab County finished water reservoir (Component 12) and into the Juab County potable water pipeline (Component 18). It would have a static HGL gain of approximately 200 feet, depending on system demands and hydraulics. This booster pump station is needed to deliver water from southern Utah County over a high point near Rocky Ridge and into Juab County.
19	Salem ASR spreading basin	ASR	CUWCD has purchased land between the Highline Canal and the future WTP site in southeastern Salem. This land could be used as ASR spreading basins and could receive flows from the Spanish Fork-Santaquin Pipeline (Components 2, 13, and 4) and the Highline Canal (Components 7 and 15b).

Table 5-1. Major Infrastructure Components

Component Number	Infrastructure component	Category	Description
20	Santaquin ASR spreading basin	ASR	CUWCD has potentially identified a site in Santaquin southeast of the location where the Highline Canal crosses under Interstate15 that could be used as an ASR spreading basin. This would receive flows from the Spanish Fork-Santaquin Pipeline (Components 5 and 16a) and the Highline Canal (Components 8 and 16b).
21	Salem ASR recovery wells	ASR	The Salem ASR recovery wells would be downgradient of the Salem ASR spreading basin in a location yet to be determined. The location would need to be coordinated with the individual cities and communities. There is also potential that some of the existing city wells could be used for recovery.
22	Santaquin ASR recovery wells	ASR	The Santaquin ASR recovery wells would be downgradient of the Santaquin ASR spreading basin in a location yet to be determined. The location would need to be coordinated with the individual cities and communities.

Notes:
cfs = cubic feet per second
Sta = station
TDH = total dynamic head

5.3 Infrastructure Sizing and Planning-Level Capital Costs

As described in Section 4.3, Portfolios 7 and 7A were selected for further analysis. Both portfolios were analyzed under the Baseline and Alternative supply and demand scenarios, and each have the option of including or excluding the balancing of ULS and SVP supplies, retiming of ULS and SVP supplies, and regional ASR. As such, the two portfolios were analyzed across eight solutions in order to carefully evaluate the effects of including or excluding balancing, retiming, and ASR on required infrastructure sizes and costs, as shown in Table 5-2. The coloring scheme in Table 5-2 (and succeeding tables) is included to help quickly identify portfolios.

Table 5-2. Portfolios 7 and 7A Solutions Considered for Infrastructure Sizing and Costing

Portfolio	Baseline or Alternative	Balancing, Retiming, and ASR
7	Baseline	Without balancing, retiming, or ASR
7	Alternative	Without balancing, retiming, or ASR
7A	Baseline	Without balancing, retiming, or ASR
7A	Alternative	Without balancing, retiming, or ASR
7	Baseline	With balancing, retiming, and ASR
7	Alternative	With balancing, retiming, and ASR
7A	Baseline	With balancing, retiming, and ASR
7A	Alternative	With balancing, retiming, and ASR

Sections 5.3.1 through 5.3.6 contain tables showing capacities, design flow rates, TDH, horsepower requirements, areas, water elevations, lengths, diameters, and costs of the different infrastructure components. The costs are only representative of capital construction costs in 2021 dollars and do not include administration, legal, environmental, engineering, construction management, services during construction, operations and maintenance, or energy costs. A 30 percent contingency is included in the infrastructure capital costs.

In addition to considering the ultimate buildout capacity and size of the infrastructure, it is also important to consider the phasing of construction of these facilities to help reduce overall life cycle costs. Section 6, Phasing, presents a discussion on how infrastructure components could be built at different times throughout the study period (2030 to 2065) based on portfolio demands. The costs presented in Section 6 include administration, legal, environmental, engineering, construction management, services during construction, operations and maintenance, energy, and water costs.

When considering the size, configuration, and operations of proposed infrastructure described in this analysis, it is important to note that CUWCD is a wholesale water provider, and its M&I water delivery policy has historically been to size facility (such as raw water storage, water treatment plants, and finished water storage) capacity to meet peak month delivery requirements. Wholesale delivery of water from CUWCD to customers is peaked to the daily average flow for the peak month of a given year. Further peaking (such as maximum day or beyond) is the responsibility of cities and customers. As such, peak capacities presented in this analysis represent the average flow for the peak month of a given year.

5.3.1 Water Treatment Plant

Table 5-3 shows capacities and capital construction costs for a conventional water treatment plant (including rapid mix, flocculation, sedimentation, ozone, and filtration), with capacities for each portfolio sized for daily average flow for the peak month of the study period.

Table 5-3. Water Treatment Plant Size and Capital Cost Summary

No.	Purpose	Portfolio			Capacity (MG)	Cost ($)
1	WTP	7	Baseline	Without balancing, retiming, or ASR	36	115.2M
			Alternative		57	162.9M
		7A	Baseline		70	191.3M
			Alternative		101	255.5M
		7	Baseline	With balancing, retiming, and ASR	36	115.2M
			Alternative		39	122.2M
		7A	Baseline		57	162.9M
			Alternative		84	220.9M

Note:
M = millions
MG = million gallons
No. = number

5.3.2 Turnouts

Table 5-4 shows flow rates and capital construction costs for turnouts. The costs were estimated by using flow and cost data from over 30 turnouts along the Wasatch Front from the past 12 years (costs were adjusted for inflation).

Table 5-4. Turnouts Size and Capital Cost Summary

<table>
<tr><th>No.</th><th>Purpose</th><th colspan="3">Portfolio</th><th>Flow Rate (cfs)</th><th>Cost ($)</th></tr>
<tr><td rowspan="8">2</td><td rowspan="8">ULS Turnout to WTP</td><td rowspan="2">7</td><td>Baseline</td><td rowspan="4">Without balancing, retiming, or ASR</td><td>33</td><td>0.7M</td></tr>
<tr><td>Alternative</td><td>50</td><td>1.0M</td></tr>
<tr><td rowspan="2">7A</td><td>Baseline</td><td>51</td><td>1.0M</td></tr>
<tr><td>Alternative</td><td>82</td><td>1.5M</td></tr>
<tr><td rowspan="2">7</td><td>Baseline</td><td rowspan="4">With balancing, retiming, and ASR</td><td>33</td><td>0.7M</td></tr>
<tr><td>Alternative</td><td>40</td><td>0.8M</td></tr>
<tr><td rowspan="2">7A</td><td>Baseline</td><td>60</td><td>1.2M</td></tr>
<tr><td>Alternative</td><td>58</td><td>1.1M</td></tr>
<tr><td rowspan="8">3</td><td rowspan="8">Highline Canal Turnout to WTP</td><td rowspan="2">7</td><td>Baseline</td><td rowspan="4">Without balancing, retiming, or ASR</td><td>21</td><td>0.5M</td></tr>
<tr><td>Alternative</td><td>38</td><td>0.8M</td></tr>
<tr><td rowspan="2">7A</td><td>Baseline</td><td>56</td><td>1.1M</td></tr>
<tr><td>Alternative</td><td>74</td><td>1.4M</td></tr>
<tr><td rowspan="2">7</td><td>Baseline</td><td rowspan="4">With balancing, retiming, and ASR</td><td>21</td><td>0.5M</td></tr>
<tr><td>Alternative</td><td>21</td><td>0.5M</td></tr>
<tr><td rowspan="2">7A</td><td>Baseline</td><td>48</td><td>1.0M</td></tr>
<tr><td>Alternative</td><td>70</td><td>1.3M</td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">ULS Salem Turnout to ASR</td><td rowspan="2">7</td><td>Baseline</td><td rowspan="4">With balancing, retiming, and ASR</td><td>40</td><td>0.8M</td></tr>
<tr><td>Alternative</td><td>40</td><td>0.8M</td></tr>
<tr><td rowspan="2">7A</td><td>Baseline</td><td>40</td><td>0.8M</td></tr>
<tr><td>Alternative</td><td>40</td><td>0.8M</td></tr>
<tr><td rowspan="4">5</td><td rowspan="4">ULS Santaquin Turnout to ASR</td><td rowspan="2">7</td><td>Baseline</td><td rowspan="4">With balancing, retiming, and ASR</td><td>20</td><td>0.5M</td></tr>
<tr><td>Alternative</td><td>20</td><td>0.5M</td></tr>
<tr><td rowspan="2">7A</td><td>Baseline</td><td>20</td><td>0.5M</td></tr>
<tr><td>Alternative</td><td>20</td><td>0.5M</td></tr>
</table>

5.3.3 Pump Stations

Table 5-5 shows flow rates, TDH, approximate horsepower requirements, and capital construction costs of pump stations. A Hazen-Williams coefficient of 110 was used in head loss calculations, which helped determined the required TDH.

Table 5-5. Pump Stations Size and Capital Cost Summary

No.	Purpose	Portfolio			Flow Rate (cfs)	TDH (ft)	Approximate Power (HP)	Cost ($)
6	Pump from Highline Canal to WTP (does not include flow from ULS line)	7	Baseline	Without balancing, retiming, or ASR	21	297	1,026	6.3M
			Alternative		38	287	1,767	9.9M
		7A	Baseline		56	284	2,568	13.8M
			Alternative		74	287	3,420	18.0M
		7	Baseline	With balancing, retiming, and ASR	21	297	1,026	6.3M
			Alternative		21	286	951	5.9M
		7A	Baseline		48	284	2,188	12.0M
			Alternative		70	282	3,171	16.8M
7	Pump from Highline Canal to Salem ASR	7	Baseline	With balancing, retiming, and ASR	40	27	174	2.1M
			Alternative		40	27	174	2.1M
		7A	Baseline		40	27	174	2.1M
			Alternative		40	27	174	2.1M
8	Pump from Highline Canal to Santaquin ASR	7	Baseline	With balancing, retiming, and ASR	20	130	419	3.3M
			Alternative		20	130	419	3.3M
		7A	Baseline		20	130	419	3.3M
			Alternative		20	130	419	3.3M
9	Pump from SF River to Salem ASR	7	Baseline	With balancing, retiming, and ASR	40	286	1,847	10.3M
			Alternative		40	286	1,847	10.3M
		7A	Baseline		40	286	1,847	10.3M
			Alternative		40	286	1,847	10.3M
9B	Pump from DF and SFR to SFC Pipeline	7	Baseline	With balancing, retiming, and ASR	20	600	1,939	10.8M
			Alternative		40	600	3,878	20.2M
		7A	Baseline		20	600	1,939	10.8M
			Alternative		40	600	3,878	20.2M
18B	Pump Station to Juab County	7, 7A	Baseline		19	415	1,291	7.6M
			Alternative		29	440	2,080	11.5M

Notes:
DF = Diamond Fork
ft = feet
HP = horsepower
SF = Spanish Fork
SFC = Spanish Fork Canyon
SFR = Spanish Fork River

5.3.4 Aquifer Storage and Recovery

Table 5-6 shows ASR spreading basin and recovery well flow rates, surface areas, and capital construction costs. The spreading basin areas were calculated according to the flow rate (ground infiltration rate) and a maximum water depth of 5 feet.

Table 5-6. ASR Spreading Basins Size and Capital Cost Summary

No.	Purpose	Portfolio			Flow Rate (cfs)	Area (acres)	Cost ($)
19	Salem Spreading Basin	7	Baseline	With balancing, retiming, and ASR	40	16	2.1M
			Alternative				
		7A	Baseline				
			Alternative				
20	Santaquin Spreading Basin	7	Baseline	With balancing, retiming, and ASR	20	8	1.1M
			Alternative				
		7A	Baseline				
			Alternative				
21	Salem Recovery Wells	7	Baseline	With balancing, retiming, and ASR	40	NA	9.3M
			Alternative				
		7A	Baseline				
			Alternative				
22	Santaquin Recovery Wells	7	Baseline	With balancing, retiming, and ASR	20	NA	4.7M
			Alternative				
		7A	Baseline				
			Alternative				

5.3.5 Storage Reservoirs

Table 5-7 shows the capacities, high and low water levels, required land areas, and capital construction costs for the storage reservoirs.

Table 5-7. Storage Reservoirs Size and Capital Cost Summary

No.	Purpose	Portfolio			Capacity (MG)	HWL (ft)	LWL (ft)	Area (acres)	Cost ($)
10	WTP Raw Water Reservoir	7	Baseline	Without balancing, retiming, or ASR	35	5,100	5,080	6	29.6M
		7	Alternative	Without balancing, retiming, or ASR	60			11	50.7M
		7A	Baseline	Without balancing, retiming, or ASR	70			13	59.2M
		7A	Alternative	Without balancing, retiming, or ASR	100			18	84.5M
		7	Baseline	With balancing, retiming, and ASR	35			6	29.6M
		7	Alternative	With balancing, retiming, and ASR	40			7	33.8M
		7A	Baseline	With balancing, retiming, and ASR	70			13	59.2M
		7A	Alternative	With balancing, retiming, and ASR	85			16	71.8M
11	WTP Finished Water Reservoir	7	Baseline	Without balancing, retiming, or ASR	18	5,040	5,020	3	27.3M
		7	Alternative	Without balancing, retiming, or ASR	30			6	46.8M
		7A	Baseline	Without balancing, retiming, or ASR	35			6	54.6M
		7A	Alternative	Without balancing, retiming, or ASR	50			9	78.0M
		7	Baseline	With balancing, retiming, and ASR	18			3	27.3M
		7	Alternative	With balancing, retiming, and ASR	20			4	31.2M
		7A	Baseline	With balancing, retiming, and ASR	35			6	54.6M
		7A	Alternative	With balancing, retiming, and ASR	43			8	66.3M
12	Juab County Finished Water Reservoir	7	Baseline	Without balancing, retiming, or ASR	6	5,100	5,080	1	9.4M
		7	Alternative	Without balancing, retiming, or ASR	10			2	15.6M
		7A	Baseline	Without balancing, retiming, or ASR	6			1	9.4M
		7A	Alternative	Without balancing, retiming, or ASR	10			2	15.6M
		7	Baseline	With balancing, retiming, and ASR	6			1	9.4M
		7	Alternative	With balancing, retiming, and ASR	10			2	15.6M
		7A	Baseline	With balancing, retiming, and ASR	6			1	9.4M
		7A	Alternative	With balancing, retiming, and ASR	10			2	15.6M

Notes:
HWL = high water level
LWL = low water level

5.3.6 Pipelines

Table 5-8 shows the flow rates, lengths, diameters, and capital construction costs for raw water pipelines. Pipeline costs shown in Table 5-8 and Table 5-9 are based on a 20-year database of over $1 billion of large-diameter pipelines constructed along the Wasatch Front and adjusted for inflation.

Table 5-8. Raw Water Pipelines Size and Capital Cost Summary

No.	Purpose	Portfolio			Flow Rate (cfs)	Length (mi)	Pipe Dia. (in)	Cost ($)
13	Raw water pipeline from ULS turnout to near Highline Canal wet well chamber	7	Baseline	Without balancing, retiming, or ASR	33	0.9	30	3.4M
			Alternative		50		36	4.4M
		7A	Baseline		51		36	4.4M
			Alternative		82		42	5.5M
		7	Baseline	With balancing, retiming, and ASR	33		30	3.4M
			Alternative		40		30	3.4M
		7A	Baseline		60		36	4.4M
			Alternative		58		36	4.4M
14	Continuation of raw water pipeline from Highline Canal wet well chamber to WTP	7	Baseline	Without balancing, retiming, or ASR	54	0.8	36	3.9M
			Alternative		88		48	5.9M
		7A	Baseline		107		54	7.0M
			Alternative		156		60	8.2M
		7	Baseline	With balancing, retiming, and ASR	54		36	3.9M
			Alternative		61		42	4.8M
		7A	Baseline		107		54	7.0M
			Alternative		128		60	8.2M
15B	Raw water pipeline from Highline Canal to Salem ASR	7	Baseline		40	0.4	36	1.7M
			Alternative		40		36	1.7M
		7A	Baseline		40		36	1.7M
			Alternative		40		36	1.7M
15C	Diamond Fork Pump Station Pipeline	7	Baseline		20	0.1	24	0.4M
			Alternative		40		36	0.7M
		7A	Baseline		20		24	0.4M
			Alternative		40		36	0.7M

Table 5-8. Raw Water Pipelines Size and Capital Cost Summary

No.	Purpose	Portfolio		Flow Rate (cfs)	Length (mi)	Pipe Dia. (in)	Cost ($)
16A	Raw water pipeline from ULS to Santaquin ASR	7	Baseline	20	1.1	24	3.1M
			Alternative	20		24	3.1M
		7A	Baseline	20		24	3.1M
			Alternative	20		24	3.1M
16B	Raw water pipeline from Highline Canal to Santaquin ASR	7	Baseline	20	0.2	20	0.4M
			Alternative	20		20	0.4M
		7A	Baseline	20		20	0.4M
			Alternative	20		20	0.4M

Notes:
Dia. = diameter
in = inches
mi = miles

Table 5-9 shows the flow rates, reach lengths, diameters, and capital construction costs for finished water pipelines.

Table 5-9. Finished Water Pipelines Size and Capital Cost Summary

No.	Purpose	Portfolio		Flow Rate (cfs)				Length (mi)				Pipe Dia. (in)				Cost ($)
				R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	
17	Pipeline from WTP to Goshen	7	Baseline	54	48	23	4	1.0	3.9	6.0	5.9	50	48	33	16	73.0M
			Alternative	85	74	43	11					60	54	42	24	98.3M
		7A	Baseline	108	102	23	4					66	60	33	16	88.8M
			Alternative	152	141	56	25					78	72	48	32	138.4M
18	Pipeline to Juab County	7, 7A	Baseline	19	10			12.2	5.9			28	22			57.3M
			Alternative	29	14							32	26			69.3M

5.4 Summary of Infrastructure Capital Costs

Depending on the portfolio selected, the total capital construction costs of the infrastructure vary and are directly related to the potable water capacity required for regional supply to southern Utah County and Juab County. Figure 5-4 shows the range of capital costs expected based on the different portfolios presented and includes a 30 percent contingency but does not include additional costs for administration, legal, environmental, engineering, construction management, and services during construction. Capital construction costs are represented in 2021 dollars.

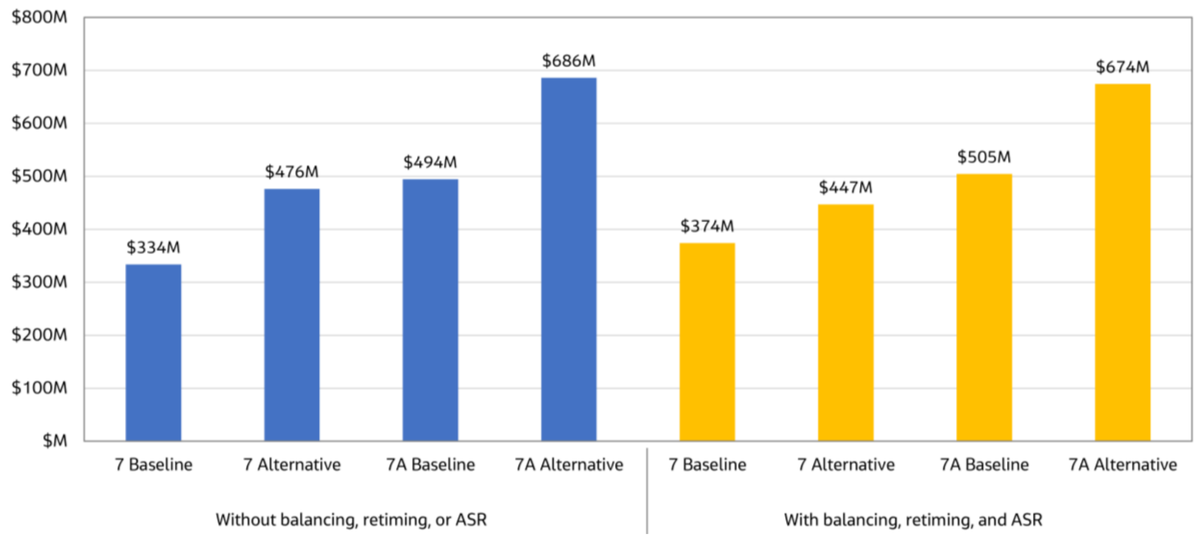

Figure 5-4. Capital Construction Costs (2021 dollars with 30 percent contingency)

6. Phasing of Infrastructure

The infrastructure described in Section 5 includes all major components needed for a fully flexible and adaptable water supply system through the year 2065. However, not all infrastructure components will be needed at the beginning of the project period. It is necessary to estimate when each component will be needed to meet the timing of potable water needs for a given portfolio and how many phases of expansion (if required) will be needed for that component.

Of the eight portfolio configurations considered for infrastructure sizing and costing evaluation shown in Table 5-2, only four were chosen for the phasing analysis. The four configurations were strategically chosen, as they generally encompass the range of supplies, demands, and costs that may be seen in the next 45 years and serve as upper and lower bounds of possible phasing timing and magnitude. The four configurations are as follows:

1) Portfolio 7 Baseline without balancing, retiming, or ASR
2) Portfolio 7A Baseline without balancing, retiming, or ASR
3) Portfolio 7 Baseline with balancing, retiming, and ASR
4) Portfolio 7A Alternative with balancing, retiming, and ASR

Table 6-1 shows ultimate deliveries in 2065 for the four selected portfolios by supply type.

Table 6-1. Ultimate Deliveries for the Four Selected Portfolios

Portfolio		Ultimate Deliveries in 2065 (AF)							
				Balanced and Retimed			Remaining Unidentified Potable Water Supplies		
		ULS	SVP	ULS	SVP	Estimated ASR supplies	Utah County	Juab County	Total Volume of Potable Supplies Treated
7 Baseline	Without balancing, retiming, or ASR	6,299	4,749	0	0	0	6,414	8,099	25,561
7A Baseline	Without balancing, retiming, or ASR	6,299	9,001	0	0	0	15,841	8,099	39,240
7 Baseline	With balancing, retiming, and ASR	6,299	4,749	850	13,663	20,000	0	0	45,561
7A Alternative	With balancing, retiming, and ASR	8,005	8,515	5,933	9,005	20,000	2,817	14,579	68,854

Note:
AF = acre-feet

Figures 6-1 and 6-2 show how modeled supplies and demands govern the selection of infrastructure phasing between 2030 and 2065 for two of the selected portfolios. These examples represent future conditions with the lowest and highest potable water needs and conveyance infrastructure and represent both a "lower bound" and an "upper bound" of the phasing scenario planning process.

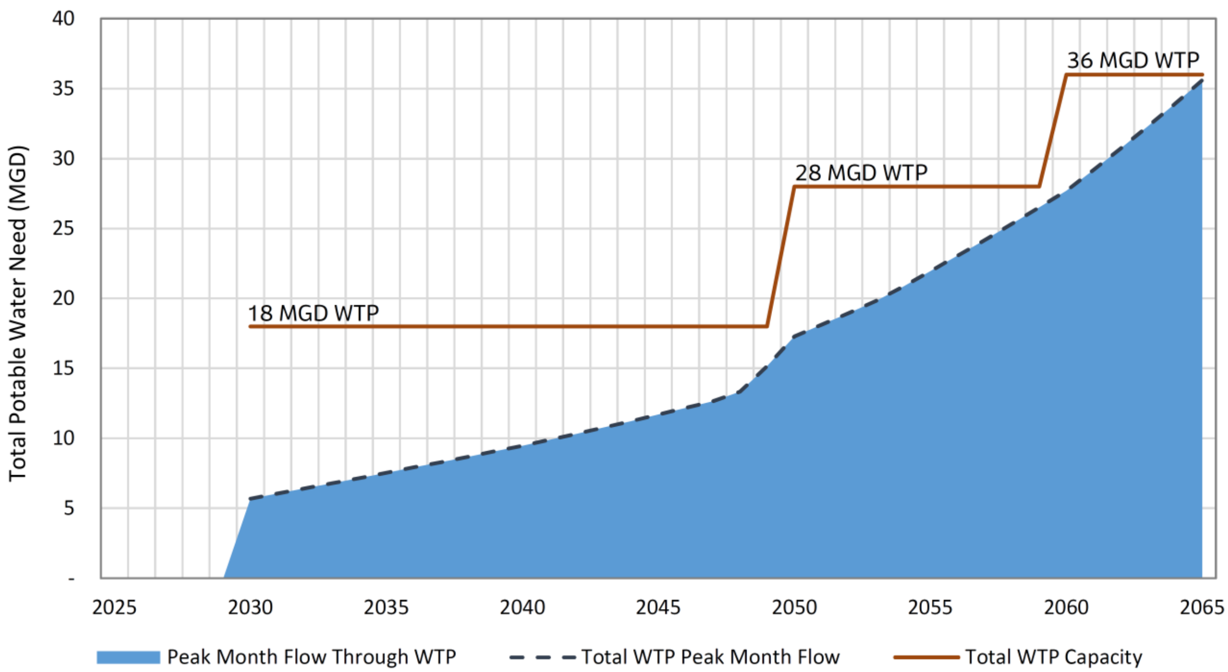

Figure 6-1. Peak Month Southern Utah County plus Juab County Potable Water Demand and WTP Capacity for Portfolio 7 Baseline without Balancing, Retiming, or ASR.

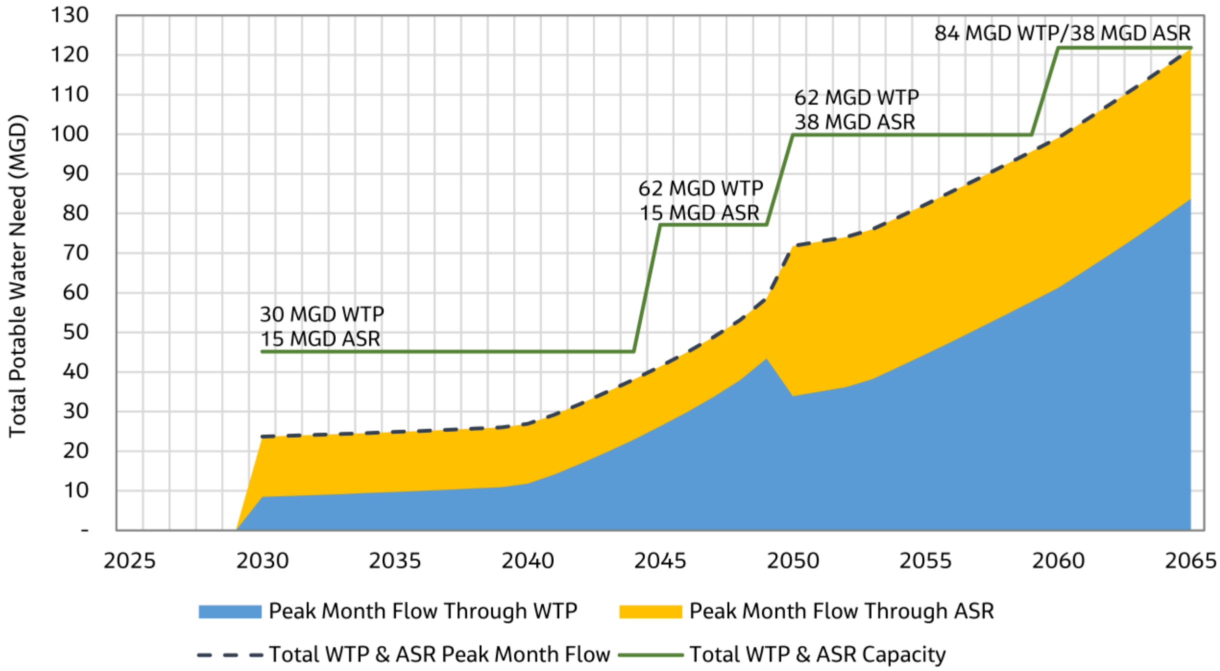

Figure 6-2. Peak Month Southern Utah County plus Juab County Potable Water Demand and WTP and ASR Capacity for Portfolio 7A Alternative with Balancing, Retiming, and ASR.

The dashed black line depicted on Figure 6-2 indicates the future peak month potable water needs for southern Utah County plus Juab County. The blue region (flow through WTP) and yellow region (flow through ASR) show how the need is met. The green line represents the capacity to provide treated water through the years based on phased infrastructure coming online to meet potable water needs as the needs increase over time. For example, a 30-MGD water treatment plant and ASR facilities with a flow capacity of 15 MGD coming online by 2030 would last until the mid-2040s. Adding additional phased WTP capacity by 2045 would result in a new WTP capacity of 60 MGD. Upsizing the ASR facilities by 2050 would result in a new ASR peak flow capacity of 38 MGD, while adding a third phase of WTP capacity for a total WTP size of 84 MGD by 2060 would allow the WTP and ASR facilities to meet the projected potable needs through the year 2065.

Tables 6-2 through 6-5 show the assumed phasing required for WTP and ASR facilities for the four selected portfolios.

Table 6-2. WTP and ASR Infrastructure Phasing for Portfolio 7 Baseline without Balancing, Retiming, or ASR

Year	Phasing Description	Potable Need for Peak Month (MGD)	WTP Capacity (MGD)	ASR Capacity (MGD)	Total Capacity (MGD)
2030	WTP and ASR Phase I Online	5.7	18	0	18
2045	WTP Phase II Online	11.7	18	0	18
2050	ASR Phase II Online	17.3	28	0	28
2060	WTP Phase III Online	27.7	36	0	36
2065	-	35.6	36	0	36

Table 6-3. WTP and ASR Infrastructure Phasing for Portfolio 7A Baseline without Balancing, Retiming, or ASR

Year	Phasing Description	Potable Need for Peak Month (MGD)	WTP Capacity (MGD)	ASR Capacity (MGD)	Total Capacity (MGD)
2030	WTP and ASR Phase I Online	10.2	36	0	36
2045	WTP Phase II Online	20.9	36	0	36
2050	ASR Phase II Online	35.3	53	0	53
2060	WTP Phase III Online	52.3	70	0	70
2065	-	67.3	70	0	70

Table 6-4. WTP and ASR Infrastructure Phasing for Portfolio 7 Baseline with Balancing, Retiming, and ASR

Year	Phasing Description	Potable Need for Peak Month (MGD)	WTP Capacity (MGD)	ASR Capacity (MGD)	Total Capacity (MGD)
2030	WTP and ASR Phase I Online	5.7	18	15	33
2045	WTP Phase II Online	11.7	18	15	33
2050	ASR Phase II Online	17.3	28	38	66
2060	WTP Phase III Online	27.7	36	38	74
2065	-	35.6	36	38	74

Table 6-5. WTP and ASR Infrastructure Phasing for Portfolio 7A Alternative with Balancing, Retiming, and ASR

Year	Phasing Description	Potable Need for Peak Month (MGD)	WTP Capacity (MGD)	ASR Capacity (MGD)	Total Capacity (MGD)
2030	WTP and ASR Phase I Online	23.7	30	15	45
2045	WTP Phase II Online	41.4	62	15	77
2050	ASR Phase II Online	71.8	62	38	100
2060	WTP Phase III Online	99.1	84	38	122
2065	-	121.6	84	38	122

It is helpful to see how the four portfolios compare with each other. When the total capacities for each portfolio are displayed together, a "cone of uncertainty," similar to that described in Section 2.2.2 (see Figure 2-4), can be seen, as shown on Figure 6-3. While ultimate demands and corresponding WTP and ASR capacities are not known at this time, the demands are anticipated to be within the range calculated by the portfolios.

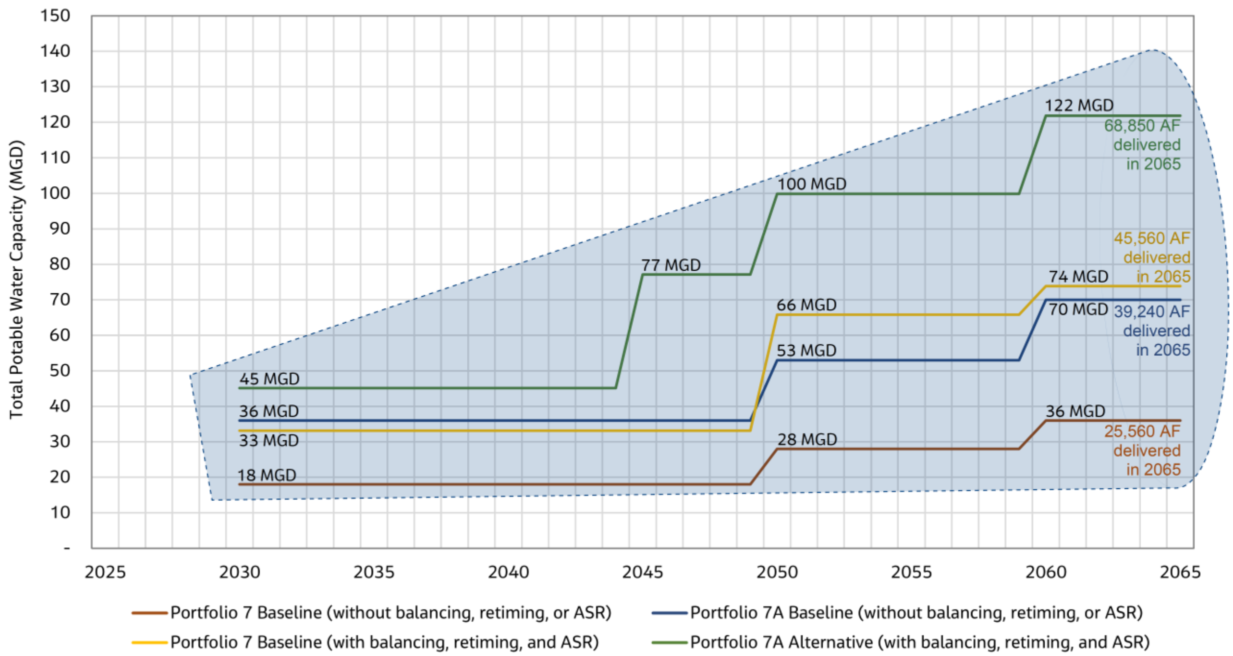

Figure 6-3. Portfolio Cone of Uncertainty

Based on the timing of WTP and ASR phasing, implementation dates for other infrastructure components were chosen for each portfolio. Table 6-6 details the year each infrastructure component listed in Table 5-1 will begin operation. Each component has either one, two, or three phases of development. It should be noted that some of the infrastructure, such as pipelines, will likely need to be built at full capacity in the first phase, whereas other infrastructure components have more flexibility with timing and capacity. The total capital construction cost assumed for each phase is listed in 2021 dollars.

Table 6-6. Phasing for Four Selected Portfolios with Costs in 2021 Dollars (with 30% Contingency)

Component Number	Component name	Portfolio 7 Baseline without Balancing, Retiming, or ASR		Portfolio 7A Baseline without Balancing, Retiming, or ASR		Portfolio 7 Baseline with Balancing, Retiming, and ASR		Portfolio 7A Alternative with Balancing, Retiming, and ASR	
		Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)
1	Water treatment plant	2030	57.6M	2030	95.7M	2030	57.6M	2030	110.5M
		2050	28.8M	2050	47.8M	2045	28.8M	2045	55.2M
		2060	28.8M	2060	47.8M	2060	28.8M	2060	55.2M
2	ULS turnout to WTP	2030	0.7M	2030	1.0M	2030	0.7M	2030	1.1M
3	Highline Canal turnout to WTP								
4	ULS turnout to Salem ASR					2030	0.8M	2030	0.8M
5	ULS turnout to Santaquin ASR					2030	0.5M	2030	0.5M
6	Highline Canal turnout and pump station to WTP	2050	4.4M	2050	9.7M	2045	4.4M	2045	11.8M
		2060	1.9M	2060	4.1M	2060	1.9M	2060	5.0M
7	Highline Canal pump station to Salem ASR					2030	2.1M	2030	2.1M
8	Highline Canal pump station to Santaquin ASR					2030	3.3M	2030	3.3M
9	Spanish Fork River pump station								
9b	Diamond Fork pump station					2030	10.8M	2030	20.2M
10	WTP raw water reservoir	2030	14.8M	2030	29.6M	2030	14.8M	2030	35.9M
		2050	14.8M	2050	29.6M	2045	14.8M	2045	35.9M

Table 6-6. Phasing for Four Selected Portfolios with Costs in 2021 Dollars (with 30% Contingency)

Component Number	Component name	Portfolio 7 Baseline without Balancing, Retiming, or ASR		Portfolio 7A Baseline without Balancing, Retiming, or ASR		Portfolio 7 Baseline with Balancing, Retiming, and ASR		Portfolio 7A Alternative with Balancing, Retiming, and ASR	
		Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)
11	WTP finished water reservoir	2030	13.7M	2030	27.3M	2030	13.7M	2030	33.2M
		2050	6.8M	2050	13.7M	2045	6.8M	2045	16.6M
		2060	6.8M	2060	13.7M	2060	6.8M	2060	16.6M
12	Juab County finished water reservoir	2035	4.7M	2035	4.7M	2035	4.7M	2035	7.8M
		2050	4.7M	2050	4.7M	2050	4.7M	2050	7.8M
13	ULS to Highline Canal raw water pipeline	2030	3.4M	2030	4.4M	2030	3.4M	2030	4.4M
14	Highline Canal to WTP raw water pipeline	2030	3.9M	2030	7.0M	2030	3.9M	2030	8.2M
15	Spanish Fork River pump station pipeline								
15b	Highline Canal pipeline to Salem ASR					2030	1.7M	2030	1.7M
15c	Diamond Fork pump station pipeline					2030	0.4M	2030	0.7M
16a	ULS pipeline to Santaquin ASR					2030	3.1M	2030	3.1M
16b	Highline Canal pipeline to Santaquin ASR					2030	0.4M	2030	0.4M
17	Potable water pipeline to southern Utah County	2030	54.8M	2030	66.6M	2030	54.8M	2030	103.8M
		2050	18.3M	2050	22.2M	2045	18.3M	2045	34.6M

Table 6-6. Phasing for Four Selected Portfolios with Costs in 2021 Dollars (with 30% Contingency)

Component Number	Component name	Portfolio 7 Baseline without Balancing, Retiming, or ASR		Portfolio 7A Baseline without Balancing, Retiming, or ASR		Portfolio 7 Baseline with Balancing, Retiming, and ASR		Portfolio 7A Alternative with Balancing, Retiming, and ASR	
		Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)	Year Online	Capital Cost Spent in Phase ($)
18	Potable water pipeline to Juab County	2030	38.2M	2030	38.2M	2030	38.2M	2030	46.2M
		2050	19.1M	2050	19.1M	2045	19.1M	2045	23.1M
18b	Juab County booster pump station	2030	7.6M	2030	7.6M	2030	7.6M	2030	11.5M
19	Salem ASR spreading basin					2030	0.7M	2030	0.7M
						2050	1.4M	2050	1.4M
20	Santaquin ASR spreading basin					2030	0.5M	2030	0.5M
						2050	0.5M	2050	0.5M
21	Salem ASR recovery wells					2030	3.1M	2030	3.1M
						2050	6.2M	2050	6.2M
22	Santaquin ASR recovery wells					2030	2.3M	2030	2.3M
						2050	2.3M	2050	2.3M
Total capital construction cost (in 2021 dollars, includes 30% contingency)		334M		494M		374M		674M	

Note:
shaded = not applicable

7. Economic and Financial Feasibility

7.1 Project Costs

Table 7-1 shows detailed cost summaries for the four portfolios described in Section 6. The capital and administrative costs are total costs over a 40-year period, from 2030 to 2070 (including 30 percent contingency), which aligns with the assumed bonding period. The operations, maintenance, and replacement (OM&R) costs are average annual costs and include annual average energy costs for pump stations. All costs are in 2021 dollars.

Table 7-1. Portfolio Costs over the 2030–2070 Planning Period (2021 dollars)

Portfolio		Ultimate delivery in 2070 (AF)	Cost Components				Total unit cost ($2021/ AF delivered annually)	Total unit cost ($2021/ AF developed)
			Total capital cost ($2021)	Total admin cost ($2021)	Cost of Financing[a] ($2021)	Average annual OM&R cost ($2021)		
7 Baseline	Without balancing, retiming, or ASR	25,561	334M	80M	697M	4.4M	1,260	50,395
7A Baseline	Without balancing, retiming, or ASR	39,240	494M	119M	1.03B	6.4M	1,211	48,430
7 Baseline	With balancing, retiming, and ASR	45,561	374M	90M	781M	11.5M	935	37,392
7A Alternative	With balancing, retiming, and ASR	68,855	674M	162M	1.41B	9.7M	956	38,222

[a] 6% interest rate, 0% discount rate over 40 years back to 2021 dollars.
Note: B = billions

The values in the second-to-right column of Table 7-1 show the total unit cost in 2021 dollars per acre-foot of potable water delivered annually for each portfolio. These unit costs include estimated capital and administrative, financing, and OM&R costs, and is calculated as shown in the equation below.

$$\frac{\frac{Total\ capital\ cost + Total\ admin\ cost + Total\ cost\ of\ financing}{40\ years} + Avg\ annual\ OM\&R\ cost}{Ultimate\ delivery\ in\ 2070} = Total\ unit\ cost$$

The values in the far-right column of Table 7-1 show the total unit cost in 2021 dollars per acre-foot of potable water developed for each portfolio. These unit costs are calculated by multiplying the total unit cost values (calculated in the equation above) by 40 years (the assumed bonding period).

7.1.1 Capital Costs

The capital costs presented in Table 7-1 include the costs described in Section 5.3 (which include a 30 percent contingency) along with estimates of administrative costs. These administrative costs were calculated as a percentage of the capital construction cost (including contingency) and are shown in Table 7-2.

Table 7-2. Administrative Capital Costs

Service	Percentage of capital construction costs (%)
Administrative and Legal	5
Engineering	10
Environmental	2
Construction management and Services during construction	7

7.1.2 Operations, Maintenance, and Replacement Costs

The OM&R costs were calculated as fixed yearly costs based on capital construction costs (including contingency) only. Table 7-3 shows the infrastructure facility types and the related OM&R costs that were assumed for each type of infrastructure based on cost data provided by CUWCD.

Table 7-3. Yearly Operations, Maintenance, and Replacement Costs as a Percentage of Total Capital Construction Cost

Facility type	Yearly OM&R Cost (% of total capital)
Water treatment plant	2.375
Turnout	0.5
Pump station	1.5
ASR	1.1
Storage reservoir	1.0
Pipeline	0.5

7.1.3 Energy Costs

Energy costs were calculated assuming a cost of electricity of $0.075 per kilowatt hour. The Strawberry Highline Canal to WTP pump station (Component 6 in Table 5-1) and the Juab County pump station (Component 18b) were assumed to run year round, while the ASR pump stations (Components 7, 8, and 9b) were assumed to run 6 months of the year. In Table 7-1, the average annual energy costs were added to the average annual OM&R costs for the pump stations.

7.2 Escalated Costs

All of Section 7.1 showed costs in 2021 dollars. To aid in understanding what the proposed infrastructure might cost in actual dollars over the 2030–2070 period, costs were escalated based on a fixed rate, according to the year the costs occurred. Table 7-5 shows yearly escalation rates for each type of cost.

Table 7-4. Escalation Rates

Cost	Yearly Escalation Rate (%)
Capital construction	3.5
OM&R	4.5
Energy	1.0
Water	2.0

To provide perspective on potential yearly expenditures that include escalation, Figures 7-1 and 7-2 show how phased costs appear over time, using the yearly escalation rates shown in Table 7-4 for Portfolio 7 Baseline without balancing, retiming, or ASR and Portfolio 7A Alternative with balancing, retiming, and ASR. These portfolios were chosen as examples because they represent the lower and higher bounds of possible estimated capital costs. The amount of potable water in acre-feet delivered each year is also shown on a secondary vertical axis. For Portfolio 7 Baseline without balancing, retiming, or ASR, three main capital cost phases can be seen in 2030, 2050, 2060, with a smaller phase beginning in 2035. For Portfolio 7A Alternative with balancing, retiming, and ASR, three main capital cost phases can be seen in 2030, 2045, and 2060, with smaller phases beginning in 2035 and 2050.

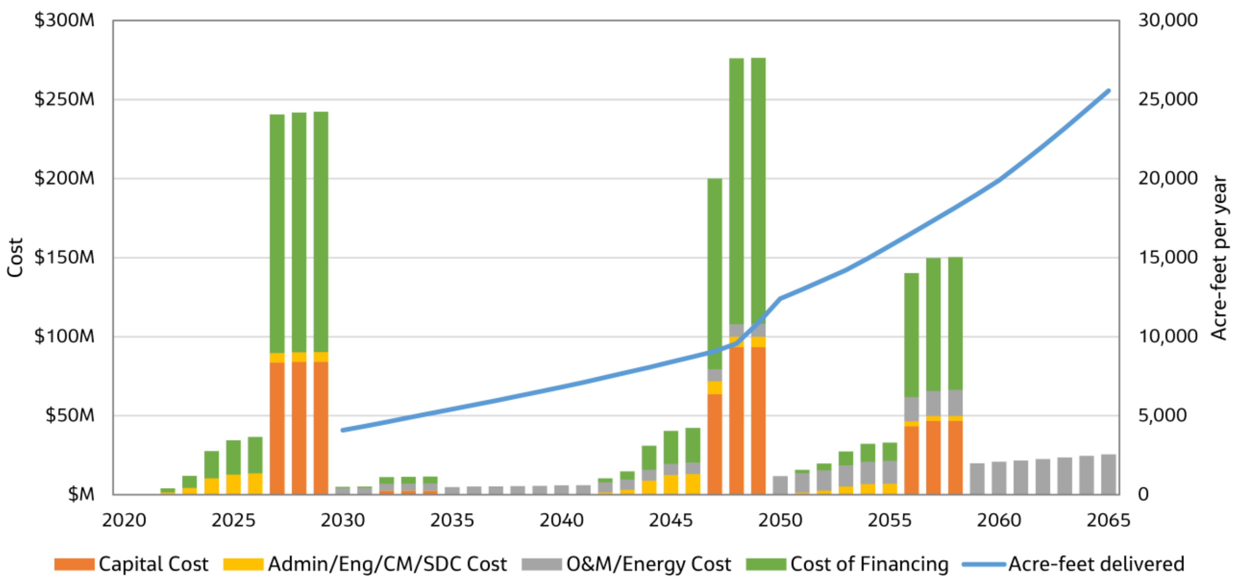

Figure 7-1. Escalated Costs for Portfolio 7 Baseline without Balancing, Retiming, or ASR (with annual deliveries)

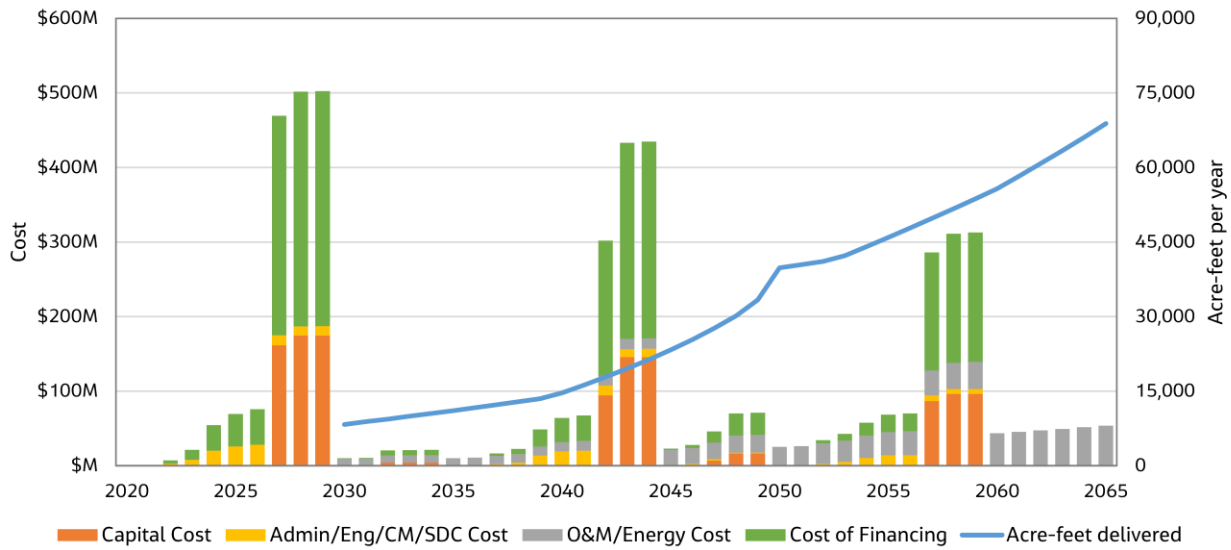

Figure 7-2. Escalated Costs for Portfolio 7A Alternative with Balancing, Retiming, and ASR (with annual deliveries)

8. Planning Assumptions and Considerations

8.1 Potential Water Supplies to Meet Future Demands

8.1.1 Potential Sources of Supply

As discussed in previous sections, projected potable water demands in southern Utah County and Juab County exist in excess of currently identified supplies for some portfolios. While the magnitude and timing of these supply and demand shortages varies across portfolios, it is clear that regardless of portfolio, additional increments of new supplies must be identified to meet projected future potable demands in southern Utah County and Juab County.

As part of the PFP planning process, a long list of potential sources of new supply that could potentially be used to meet shortages was developed. While the magnitude and feasibility of potentially identified future supplies are largely uncertain at this time, the goal of this exercise was to identify supplies that, based on the PFP Team's knowledge and experience, demonstrate possibility as a future supply source and warrant further regulatory and technical evaluation in future phases of study. Supplies considered as part of this effort are summarized in Table 8-1. Additional documentation of potential water supplies is included in Appendix D. Note that potential costs of these supplies were not estimated at this time.

Table 8-1. Potential Sources of Future Supply

Potential Source of Supply	Description	Priority for Future Investigation	Potential Supply Yield
Spanish Fork River Natural Flows	Natural river flows are likely a potential source of supply for ASR or a regional WTP. Initial planning-level estimates indicate that approximately 14,000 AF could potentially be available from the Spanish Fork River during the winter months. This potentially available flow was considered as the difference between average and 25-year low measured flows in winter months (November through March). Regulatory and water rights considerations will need to be further evaluated.	High	14,000 AFY
Spanish Fork River In-stream Flow Releases	Water is currently added to the river for required in-stream flow purposes for the Sixth Water and Diamond Fork reaches of the streams. This water currently continues to the Spanish Fork River and ultimately to Utah Lake, and is not recaptured. There may be between 20 and 40 cfs of in-stream flows in Spanish Fork River that could be captured in winter months for ASR or a regional WTP. Regulatory, environmental and water rights considerations will need to be further evaluated.	High	6,000 – 12,000 AFY
ULS and SVP Water	ULS and SVP shares that can become available to cities and potentially converted from agriculture to M&I use could be used a number of ways, including via a regional WTP, for ASR, or for non-potable uses. These supplies could potentially be balanced and retimed among cities to provide additional flexibility and resiliency. Additional SVP shares could also be purchased to further increase this supply.	High	Varies

Table 8-1. Potential Sources of Future Supply

Potential Source of Supply	Description	Priority for Future Investigation	Potential Supply Yield
Hobble Creek	Winter streamflows and June Sucker in-stream flows on Hobble Creek could potentially be exchanged out of Utah Lake. Further investigation into the magnitude and frequency of supply, regulatory issues, and technical feasibility is recommended.	Medium	Uncertain
ULS/SVP/Provo River/Jordanelle Reservoir Exchange Water	ULS supplies are currently delivered to Salt Lake County. Substituting Provo River water for these ULS supplies could provide more ability to use these ULS supplies in southern Utah County or Juab County, and enable use of more flexible storage in the Jordanelle Reservoir for deliveries to Salt Lake County. Further investigation into the regulatory and technical feasibility of this concept is recommended.	Medium	Uncertain; requires further study
Canal Enclosure Efficiency	Enclosing or piping existing open channels within the study area could create additional supplies that could be used for ASR or other uses. Potential canal enclosures include the following: ▪ Strawberry Highline Canal ▪ Salem Canal ▪ South Field Canal ▪ East Bench Canal	Medium	Uncertain; requires further study
Maple Creek	The potential for available surface water supplies on Maple Creek was determined to be low, and this source was not considered for further evaluation.	Low	0 AFY
Peteetneet Creek	The potential for available surface water supplies on Peteetneet Creek was determined to be low, and this source was not considered for further evaluation.	Low	0 AFY
Wastewater Treatment Plant Reuse Water	Treated wastewater effluent that is currently not recaptured could be captured and used for ASR, potable or non-potable uses. However, numerous regulatory, water rights, and infrastructure considerations would have to be further explored to determine the potential magnitude and feasibility of this option.	Low	Uncertain; requires further study

8.1.2 Potential Benefits of Balancing and Retiming ULS and SVP Supplies

As noted in the previous sections, potential balancing and retiming of ULS and SVP supplies offers an opportunity to address remaining projected shortages in southern Utah County and Juab County. For example, potable shortages for southern Utah County and Juab County exist for Portfolio 7 Baseline without balancing or retiming ULS and SVP supplies, as shown on Figure 8-1. However, as shown on Figure 8-2, balancing and retiming could potentially significantly reduce remaining potable shortages in this case. It is important to note that there are numerous regulatory, operational, legal, and institutional issues that would need to be addressed and further studied prior to potential implementation of balancing or retiming. It is recommended to further evaluate the feasibility of these solutions in conjunction with other potential additional water supplies as part of a future balanced portfolio of future water supply and infrastructure solutions.

See Appendix E for more discussion on balancing and retiming.

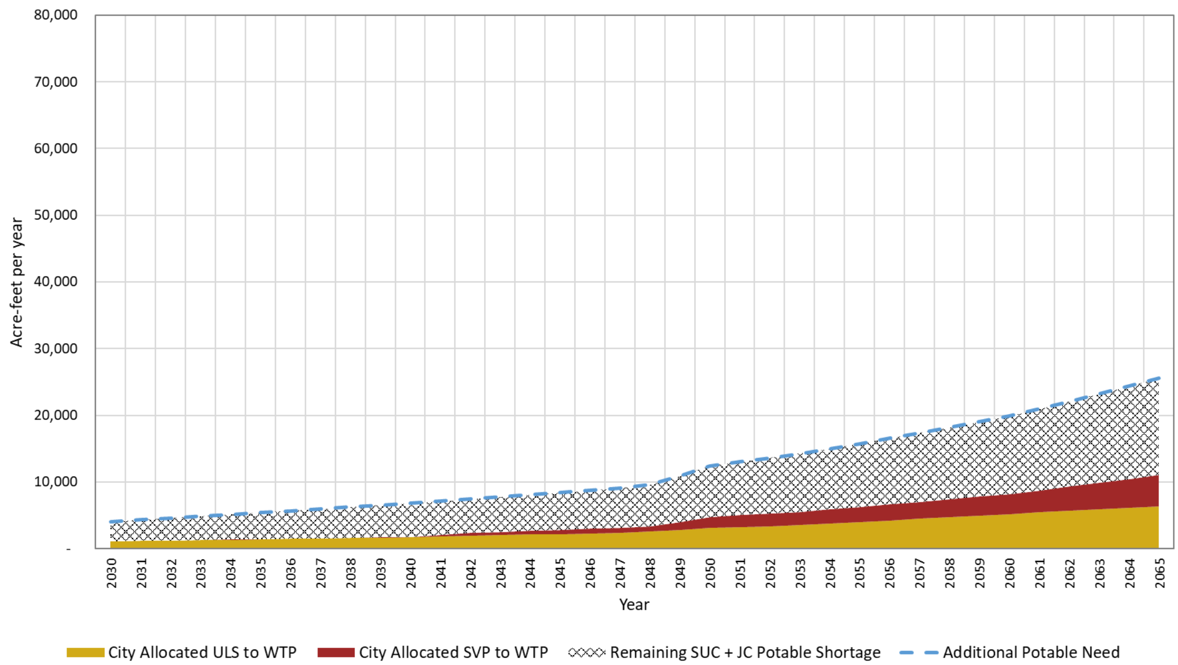

Figure 8-1. Southern Utah County and Juab County Additional Potable Need: Portfolio 7 Baseline without Balancing, Retiming, or ASR

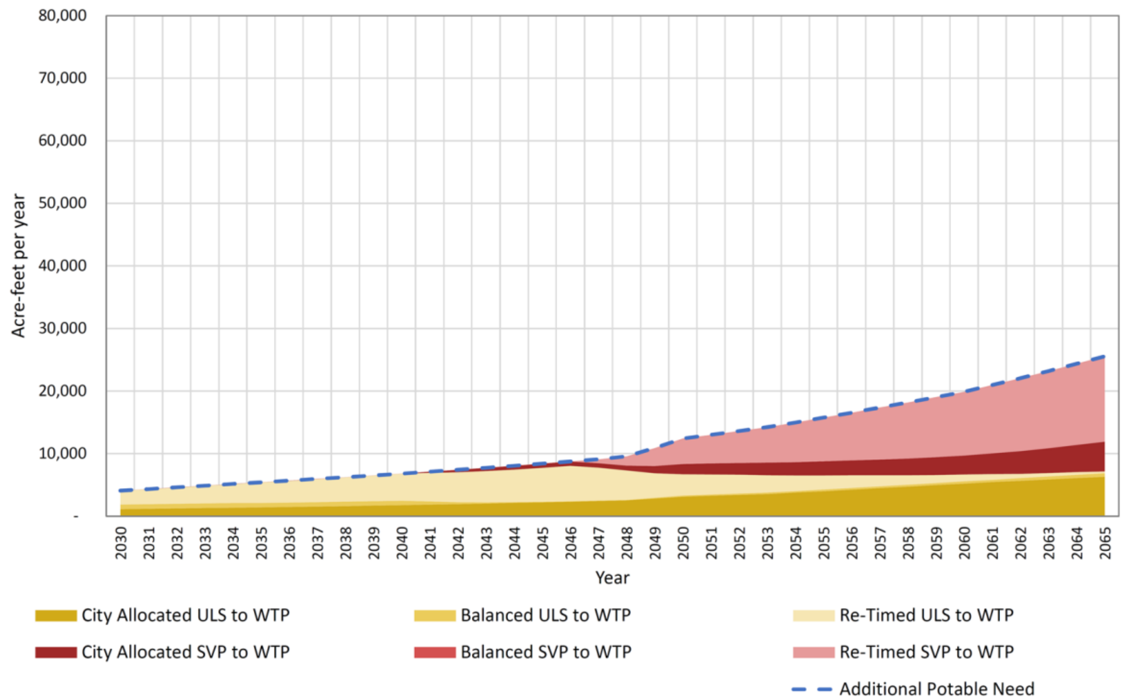

Figure 8-2. Southern Utah County and Juab County Additional Potable Need: Portfolio 7 Baseline with Balancing and Retiming

8.2 National Environmental Policy Act Considerations

A critical future component of advancing concepts presenting in this PFP Report is a thorough examination and evaluation of all recommendations in light of National Environmental Policy Act (NEPA) requirements. This effort will establish which aspects of the proposed infrastructure components, water supplies, and operational adjustments would trigger the NEPA review process and establish the appropriate level of formal NEPA analysis required before a proposal could be implemented.

9. Summary of Findings and Recommendations

9.1 Key Findings from PFP Phases I and II

As a result of the PFP planning process, the Project Team has quantified plausible ranges of future supply and demand conditions and identified flexible and resilient water supply and infrastructure options that can adapt to the wide range of future conditions identified in this study. Key findings from the PFP Phase I and II efforts are summarized below.

Water Supply

- Conservation measures are and will become even more important.
- Non-potable regional conveyance needs are estimated to be serviced by the Regional ULS Pipeline and Rehabilitated Highline Canal and the cost of this infrastructure is not included in the PFP cost estimates.
- Conversion of Ag Water to M&I will contribute to meeting future M&I demands.
- Sustainable development of groundwater will be needed and is important.
- Treated surface water infrastructure will be needed to meet potable water demand.
- Balancing and retiming (as defined within this Report) are important issues for the future.
- Waters flowing to Utah Lake should be investigated for ASR, using exchanges with Utah Lake.
- Under certain conditions, additional water supplies will also be needed in the future.

Water Treatment

- Regional water treatment plant and conveyance infrastructure are needed to meet potable water demands.
- Capacity and phasing needs to be flexible and adaptable to meet actual future demands.

ASR

- Further study of institutional, technical, and regulatory issues is needed.
- During Phase III, the Project Team will develop an ASR pilot, modeling, geotechnical, and monitoring program.

9.2 Near-term Recommendations

Recommend near-term actions in Phase III that build upon work performed in Phases I and II include the following:

- Further investigate ASR pilot program.
- Stakeholder outreach and engagement with communities to gauge interest in future regional water supply system.
- Advance infrastructure configuration, design, and costs.
- Further refine financial analysis and investigate possible cost or repayment structures for future regional water supply system.
- Further explore feasibility of preliminary identified potential future water supplies to meet potable needs.
- Further explore regulatory and institutional issues related to use of water supplies and infrastructure.

10. References

Hansen, Allen & Luce, Inc. (HAL). 2020a. *Juab County and South Utah County Water Supply & Infrastructure Plan Formulation Project, Tasks 5 & 6 Technical Report – Juab County*. Prepared for the Central Utah Water Conservancy District. April.

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