Secondary Irrigation Master Plan

December 2019

Prepared for:

St.George

Prepared by:

BOWEN COLLINS & ASSOCIATES

SECONDARY IRRIGATION MASTER PLAN

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EXECUTIVE SUMMARY

INTRODUCTION

The City of St. George (City) contracted the services of Bowen, Collins & Associates, Inc. (BC&A) to complete a Secondary Irrigation Master Plan. The purpose of this study is to provide the City with a plan to expand the secondary irrigation system while maintaining a viable and efficient overall system. Extending secondary irrigation service to a larger number of customers will help reduce demands on culinary water sources and provide the City with greater flexibility in managing and utilizing its water supply.

SERVICE AREA

The City of St. George secondary irrigation system service area is shown in Figure ES-1.

PROJECTED GROWTH AND WATER USE

Secondary irrigation system growth projections were developed using the City's current land use and zoning plans in conjunction with population projections developed by the Governor's Office of Management and Budget. To project future system water use, historical water use records were evaluated to determine the amount of water used by different customer classes. These customer classes were then converted into Equivalent Residential Units (ERUs), providing a method of evaluating all user types as if they represented an equivalent residential population. The results of this evaluation are shown in Table ES-1. The values shown in Table ES-1 are based on the anticipated extent to which the secondary irrigation system will be expanded.

10-YEAR CAPITAL FACILITIES PLAN

Using the water use estimates for existing and future conditions, the different components of the City's secondary irrigation system (sources, storage tanks, transmission and distribution lines, and pump stations) were evaluated. With the aid of a hydraulic computer model, projects were identified to address existing and future deficiencies in the system. Using the results of this analysis, a 10-Year Capital Facilities Plan was developed, which outlines the capital facilities projects that will be needed over the next 10 years in order to provide the needed service to existing and future customers. Table ES-2 provides a summary of the projects included in the 10-Year Capital Facilities Plan.

LEGEND

St. George Irrigation Service Area

Municipalities

City of St. George provide water service to the Shivwits Community west of Ivins City.

Diamond Valley

Winchester Hills

Ivins City

Santa Clara City

Washington City

Interstate 15

St. George Secondary Irrigation Service Area

Utah

Arizona

BOWEN COLLINS & ASSOCIATES	CITY OF ST. GEORGE SECONDARY IRRIGATION MASTER PLAN	ST. GEORGE SECONDARY IRRIGATION SERVICE AREA	NORTH: NORTH	SCALE: 0 3,750 7,500 Feet	FIGURE NO. ES-1

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure ES-1 - St. George Secondary Irrigation Service Area.mxd aanderson 12/19/2019

Table ES-1
City of St. George Secondary Irrigation Water Use Projections

Year	Overall Residential Growth %	Overall Non-Residential Growth %	Total St. George Residential ERUs	Total St. George Non-Residential ERUs	Total Culinary/Irrigation System ERUs	Total Culinary Water System ERUs	Total Residential Secondary Irrigation ERUs	Total Non-Residential Secondary Irrigation ERUs	Total Secondary Irrigation System ERUs	Annual Secondary Irrigation System Demand (acre-feet/year)	Peak Day Secondary Irrigation System Demand (gal/day)
2017			29,010	17,532	46,542	38,312	266	7,964	8,230	5,872	14,229,935
2018	2.81%	2.81%	29,825	18,025	47,850	39,613	273	7,964	8,237	5,878	14,243,479
2019	2.85%	2.85%	30,675	18,538	49,214	40,969	281	7,964	8,245	5,883	14,256,951
2020	3.00%	3.00%	31,596	19,094	50,690	41,997	709	7,984	8,693	6,203	15,031,036
2021	3.61%	3.61%	32,736	19,784	52,520	43,223	1,250	8,047	9,297	6,634	16,076,280
2022	3.61%	3.61%	33,918	20,498	54,416	43,579	1,812	9,025	10,837	7,733	18,739,137
2023	3.61%	3.61%	35,142	21,238	56,380	44,961	2,394	9,025	11,419	8,148	19,744,913
2024	3.61%	3.61%	36,411	22,005	58,416	45,676	3,001	9,739	12,740	9,090	22,029,091
2025	3.61%	3.61%	37,726	22,799	60,525	47,133	3,630	9,762	13,392	9,555	23,156,051
2026	3.61%	3.61%	39,087	23,622	62,709	48,642	4,283	9,785	14,068	10,038	24,324,509
2027	3.61%	3.61%	40,499	24,475	64,973	50,201	4,965	9,807	14,772	10,540	25,543,112
2028	3.61%	3.61%	41,961	25,358	67,319	51,822	5,667	9,830	15,497	11,058	26,796,709
2029	3.61%	3.50%	43,475	26,246	69,721	53,479	6,328	9,915	16,242	11,589	28,084,985
2030	3.61%	3.50%	45,045	27,164	72,209	55,222	6,988	9,999	16,987	12,121	29,373,261
2031	3.50%	3.00%	46,621	27,979	74,601	56,900	7,629	10,071	17,700	12,630	30,605,904
2032	3.40%	3.00%	48,206	28,819	77,025	58,630	8,251	10,143	18,395	13,125	31,806,897
2033	3.40%	2.50%	49,845	29,539	79,385	60,307	8,874	10,204	19,077	13,612	32,987,070
2034	3.30%	2.50%	51,490	30,278	81,768	62,027	9,478	10,264	19,742	14,086	34,135,595
2035	3.30%	2.50%	53,190	31,035	84,224	63,818	10,082	10,324	20,406	14,560	35,284,119
2036	3.10%	2.50%	54,838	31,810	86,649	65,616	10,649	10,384	21,033	15,008	36,369,345
2037	3.00%	2.00%	56,484	32,447	88,930	67,300	11,198	10,432	21,631	15,434	37,402,102
2038	3.00%	2.00%	58,178	33,096	91,274	69,046	11,747	10,481	22,228	15,860	38,434,859
2039	3.00%	2.00%	59,923	33,758	93,681	70,856	12,296	10,529	22,825	16,286	39,467,616
2040	3.00%	2.00%	61,721	34,433	96,154	72,731	12,846	10,577	23,422	16,713	40,500,373
2041	3.00%	2.00%	63,573	35,121	98,694	74,674	13,395	10,625	24,020	17,139	41,533,130
2042	3.00%	1.75%	65,480	35,736	101,216	76,605	13,944	10,667	24,611	17,561	42,555,477
2043	3.00%	1.75%	67,444	36,361	103,806	78,603	14,493	10,709	25,202	17,983	43,577,824
2044	1.70%	1.75%	68,591	36,998	105,589	80,033	14,804	10,751	25,555	18,235	44,188,730
2045	1.60%	1.75%	69,688	37,645	107,333	81,443	15,097	10,794	25,890	18,474	44,767,987
2046	1.00%	1.75%	70,385	38,304	108,689	82,573	15,280	10,836	26,116	18,634	45,157,348
2047	0.80%	1.75%	70,948	38,974	109,923	83,618	15,426	10,878	26,304	18,769	45,483,411
2048	0.70%	1.50%	71,445	39,559	111,004	84,535	15,555	10,914	26,468	18,886	45,767,414
2049	0.60%	1.50%	71,874	40,152	112,026	85,411	15,664	10,950	26,614	18,990	46,019,768
2050	0.50%	1.50%	72,233	40,755	112,988	86,245	15,756	10,986	26,742	19,081	46,240,473
2051	0.40%	1.35%	72,522	41,305	113,827	86,979	15,829	11,019	26,848	19,157	46,423,282
2052	0.40%	1.25%	72,812	41,821	114,633	87,682	15,902	11,049	26,951	19,230	46,601,928
2053	0.30%	1.25%	73,030	42,344	115,374	88,338	15,957	11,079	27,036	19,291	46,748,925
2054	0.30%	1.00%	73,250	42,767	116,017	88,902	16,012	11,103	27,115	19,347	46,885,511
2055	0.29%	0.49%	73,462	42,977	116,439	89,259	16,065	11,115	27,180	19,394	46,997,697

Table ES-2
City of St. George 10 Year Secondary Irrigation System Capital Facilities Plan

Project Identifier	Project Description	Estimated Total Cost (2018 Dollars)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total Inflated Project Cost
	Source Development												
I1	Upgrade Existing Reuse Facility with 3rd Filter Bay and Additional Booster Pumps	$1,380,000						$1,554,000					$1,554,000
	Storage Facilities												
SS1	1.0 MG Hidden Valley Tank Replacement	$1,035,000			$1,098,000								$1,098,000
SS2	3 MG Commerce Drive Settling Pond	$1,898,000			$2,014,000								$2,014,000
SS3	1.3 MG New Entrada Storage Pond	$523,000			$555,000								$555,000
SS4	1.5 MG Stonecliff Storage Tank	$1,553,000				$1,681,000							$1,681,000
SS5	2.0 MG Desert Canyons Tank No. 1	$2,070,000				$2,241,000							$2,241,000
SS6	Reuse Storage Pond	$3,450,000					$3,809,000						$3,809,000
SS7	1.5 MG Ledges Storage Tank	$1,553,000							$1,784,000				$1,784,000
SS8	1.9 MG Gap Irrigation Tank	$1,639,000								$1,920,000			$1,920,000
	Transmission/Distribution Facilities												
SC1	Ledges 12-inch Transmission Line (Upsize)	$695,800					$768,000						$768,000
SC2	Ledges 10-inch Tank Feed Line	$626,200							$719,000				$719,000
SC3	Ledges 12-inch Distribution Line (Upsize)	$491,100								$575,000			$575,000
SC4	Lava Field 12-inch Transmission Line	$1,037,900		$1,080,000									$1,080,000
SC5	Entrada 12-inch Transmission Line	$529,000		$550,000									$550,000
SC6	Divario 12-inch Transmission Line	$1,092,500							$1,255,000				$1,255,000
SC7	16-inch Gap Irrigation Tank Transmission Line	$813,100							$934,000				$934,000
SC8	14-inch Lago Vista Drive from Divario to West Tonaquint (northern half of project)(Upsize)	$169,050								$198,000			$198,000
SC9	8-inch West Tonaquint Transmission Line (Upsize, southeast half of project)(Upsize)	$133,700								$157,000			$157,000
SC10	6-inch Fossil Ridge Elementary School connection	$48,300				$52,000							$52,000
SC11	8-inch 900 S Distribution Line - Little Valley (Upsize)	$37,400						$42,000					$42,000
SC12	8-inch 3000 E Distribution Line - Little Valley (Upsize)	$42,000							$48,000				$48,000
SC13	10-inch 2780 E Distribution Line	$92,000		$96,000									$96,000
SC14	12-inch 2450 S Transmission Line	$207,000		$215,000									$215,000
SC15	Stone Cliff Tank 12-inch Feed Line	$364,300		$364,300									$364,300
SC16	10-inch 2200 S Distribution Line - Little Valley (Upsize)	$279,500					$309,000						$309,000
SC17	10-inch 3430 E Distribution Line (2200 S to 2450 S) - Little Valley (Upsize)	$139,700						$157,000					$157,000
SC18	10-inch 3430 E Distribution Line (2450 S to Horsemans Park) - Little Valley (Upsize)	$414,000							$476,000				$476,000
SC19	10-inch 3000 E Distribution Line from 2450 s to Horsemans Park Drive - Little Valley	$414,000			$439,000								$439,000

Project Identifier	Project Description	Estimated Total Cost (2018 Dollars)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total Inflated Project Cost
SC20	10-inch Horsemans Park Distribution Line from 3000 E to 3430 E	$279,500				$303,000							$303,000
SC21	6-inch 3000 E Distribution Line from Horsemans Park Drive to Crimson Ridge Drive	$124,200		$129,000									$129,000
SC22	6-inch 2880 E Distribution Line from Horsemans Park Drive to Silkwood Park	$92,000		$96,000									$96,000
SC23	18-inch Fort Pierce Drive Transmission Line	$1,063,800						$1,198,000					$1,198,000
SC24	18-inch Commerce Drive Crossing	$148,900		$155,000									$155,000
SC25	24-inch Reuse Facility Storage Pond Feed Line	$230,000						$259,000					$259,000
SC26	24-inch Pipe from Future Reuse Pond to Reuse Transmission Pipeline	$291,000						$328,000					$328,000
SC30	18-inch Desert Canyons Transmission Line (Settling Pond to tie in at existing 14-inch pipe)	$4,595,400			$4,877,000								$4,877,000
SC31	12-inch Desert Canyons Southern Parkway Crossing (Upsize)	$63,300								$74,000			$74,000
SC39	18-inch Desert Canyons Transmission Line (Desert Canyons Parkway, West Section)	$734,000			$779,000								$779,000
SC40	18-inch Desert Canyons Transmission Line (Desert Canyons Parkway, East Section) (Upsize)	$402,500									$481,000		$481,000
SC41	24-inch Desert Canyons Tank Feed Line	$1,265,000				$1,369,000							$1,369,000
SC42	12-inch Little Valley Pump Station to Distribution System Connection	$46,300		$48,000									$48,000
SC43	18-inch Commerce Drive to Desert Color Transmission Line	$3,829,500										$4,668,000	$4,668,000
	Pumping Facilities												
SP1	Upper Ledges Pump Station with 100,000 Gallon Storage Wet Well	$331,000								$388,000			$388,000
SP2	Intermediate Ledges Pump Station with 200,000 Gallon Storage Wet Well*(35% paid by Ledges GC)	$971,000						$1,094,000					$1,094,000
SP3	Lower Ledges Pump Station (35% paid by Ledges GC)	$876,000					$967,000						$967,000
SP4	Dixie Drive Pump Station	$453,000									$541,000		$541,000
SP6	Little Valley Pump Station	$451,000			$479,000								$479,000
SP7	Commerce Drive Settling Pond - Desert Canyons Pump Station	$714,000			$743,000								$743,000
SP8	Commerce Drive Settling Pond - Desert Color Pump Station	$581,000										$708,000	$708,000
SP10	SGWRF Reuse Pond Pump Station	$1,035,000						$1,166,000					$1,166,000
	Total Improvements	**$41,304,950**	**$0**	**$2,733,300**	**$10,984,000**	**$5,646,000**	**$5,853,000**	**$5,798,000**	**$5,216,000**	**$3,312,000**	**$1,022,000**	**$5,376,000**	**$45,940,300**

[1]A 2% annual inflation rate has been applied to estimated future project costs.

CHAPTER 1
INTRODUCTION

INTRODUCTION

The City of St. George (City) has retained Bowen Collins & Associates (BC&A) to prepare a master plan for the city-operated secondary water system (water not treated to drinking water standards but appropriate for irrigation use). The purpose of this secondary irrigation master plan report is to evaluate the different components of the City's secondary irrigation system and identify the projects needed to expand the secondary irrigation system into new areas of the City.

This report works hand in hand with the Culinary Water Master Plan performed by BC&A. The assumptions made in this report regarding the extent of expansion of the secondary irrigation system that will offset demands on the culinary water system have been accounted for in the Culinary Water Master Plan, eliminating "double-counting" of projected system water usage. This master plan has been developed using current land use plans and population projections. If land use plans and growth projections change in the future, which they tend to, the assumptions made in future master planning efforts should be updated accordingly. In this sense, this master plan should function as a working document and should be updated frequently enough to maintain sufficient accuracy in its overarching assumptions.

SCOPE OF SERVICES

The general scope of this project involved an analysis of the City's secondary irrigation water system and its ability to meet the present and future water needs of its residents. As part of the Secondary Irrigation Master Plan, BC&A completed the following tasks.

Task 1: Collected information as needed to develop the secondary irrigation master plan, including GIS data, source production and water use data, and schematics of system operation.

Task 2: Evaluated outdoor irrigation usage for residential and non-residential development to estimate irrigation water use for future system users.

Task 3: Evaluated existing and future secondary irrigation source capacities and compared them with existing and future secondary irrigation demands.

Task 4: Evaluated existing secondary irrigation storage facilities and calculated the volume of storage needed to meet existing and future system demands.

Task 5: Developed a hydraulic model of the secondary irrigation system under existing and projected future demand conditions.

Task 6: Identified projects needed to service the secondary irrigation system, including new sources, storage facilities, transmission pipelines, and distribution piping.

Task 7: Developed a 10-year capital facilities plan identifying recommended improvements to be completed within a 10-year planning window (through 2028).

Task 8: Documented results in this master plan report.

ACKNOWLEDGMENTS

The BC&A team wishes to thank the following individuals from the City of St. George for their cooperation and assistance in completing this report:

Scott Taylor	Water Services Director
Jeff Lance	Irrigation Manager
Kade Bringhurst	Special Projects Manager
Wes Jenkins	Planning and Zoning
David Evans	GIS Administrator
John Willis	Community Development Director

PROJECT STAFF

The project work was performed by the BC&A team members listed below. Team members' roles on the project are also list. The project was completed in BC&A's St. George, Utah office. Questions may be addressed to Todd Olsen, Project Manager at (435) 656-3299.

Keith Larson	Principal-In-Charge
Todd Olsen	Project Manager
Aaron Anderson	Project Engineer
Mike Hilbert	Technical Writing

CHAPTER 2
EXISTING SYSTEM FEATURES

INTRODUCTION

Alongside the City's extensive culinary water system resides a network of irrigation piping which conveys secondary water to users across the City. This pipe network is utilized by a number of canal and irrigation companies as well as the City to deliver secondary irrigation water to customers. This chapter provides an overview of the existing facilities that make up the secondary irrigation system and can be used as a quick reference for City personnel regarding key system information.

SERVICE AREA

The St. George City secondary irrigation service area encompasses all of St. George City as well as the Shivwits Community located to the west of Ivins City along Old Highway 91 (see Figure 2-1). Although the service area covers the entire city, irrigation service is currently provided primarily to large irrigation users, such as parks, golf courses, schools, and cemeteries. A select number of residential units are provided with secondary irrigation, some from the City of St. George and others from private canal companies. Figure 2-2 displays the location of existing secondary irrigation infrastructure.

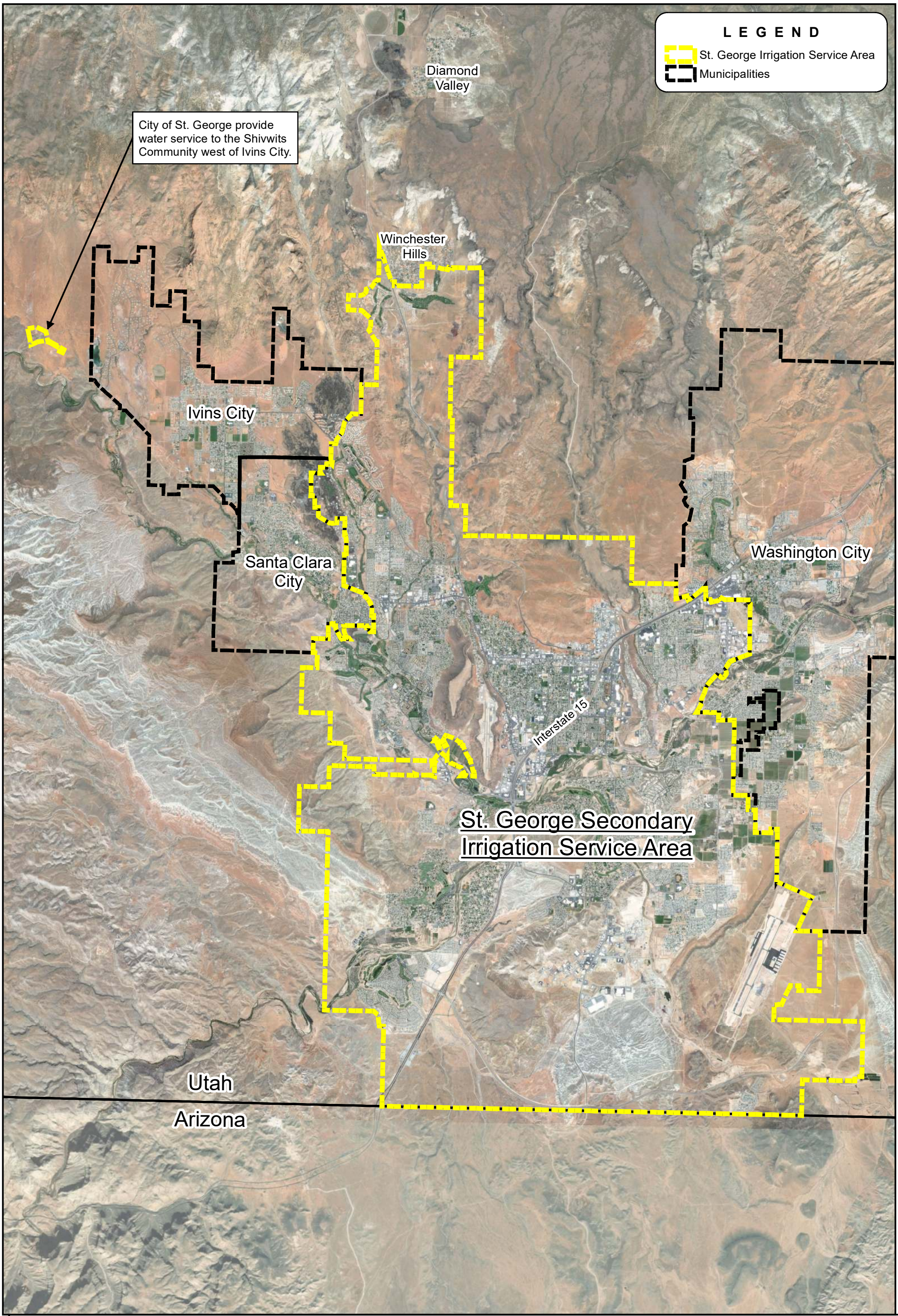
SECONDARY IRRIGATION SYSTEM USERS

The following is a summary description of the different users that currently utilize the St. George secondary irrigation system. Figure 2-3 displays the location of the areas that are currently serviced by secondary irrigation.

Municipal Facilities (Golf Courses, Parks, and Cemeteries)

The secondary irrigation system provides water to a number of City-owned facilities, including:

- Sunbrook Golf Course
- Southgate Golf Course
- St. George Golf Club
- Dixie Red Hills Golf Course
- Sun River Golf Course
- Vernon Worthen Park
- Town Square Park
- Canyons Baseball Fields
- Mathis Park
- Thunder Junction Park



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

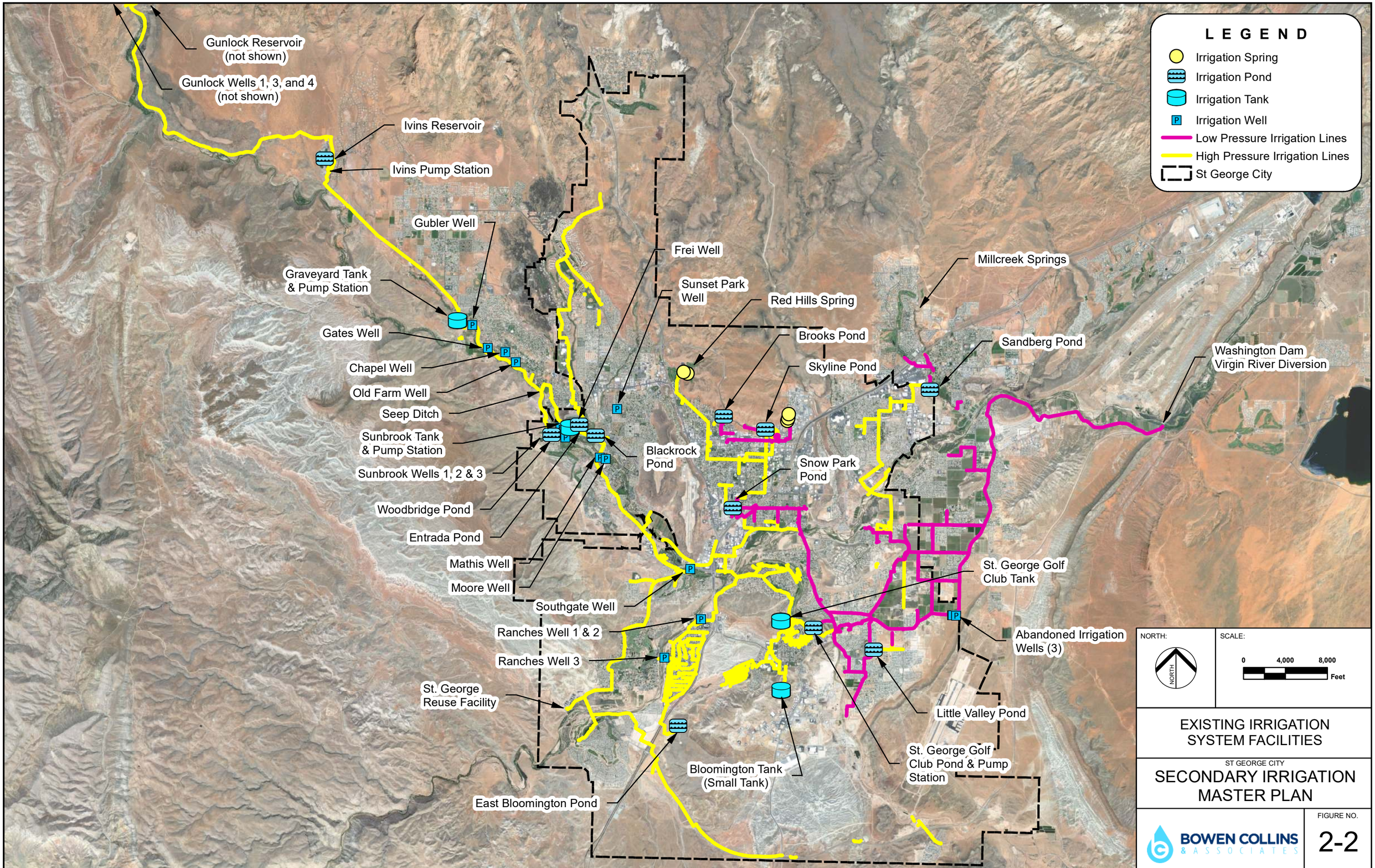
ST. GEORGE SECONDARY IRRIGATION SERVICE AREA

NORTH:

SCALE: 0 3,750 7,500 Feet

FIGURE NO. 2-1

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 2-1 - St. George City Irrigation Service Area.mxd aanderson 12/19/2019



S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 2-2 - St. George Secondary Irrigation System.mxd aanderson 10/26/2019

LEGEND

- Areas Currently Serviced by Secondary Irrigation
- St. George Secondary Irrigation Service Area
- Municipalities

Ivins City

Santa Clara City

Interstate 15

Washington City

BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

AREAS CURRENTLY SERVICED BY SECONDARY IRRIGATION

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 2-3

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 2-3 - Areas Currently Serviced by Secondary Irrigation.mxd aanderson 10/26/2019

- Tonaquint Park & Cemetery
- St. James Park
- St. George City Cemetery
- 2450 East Park
- Christensen Park
- Little Valley Soccer and Baseball Fields
- Bloomington Park
- Sandtown Park
- Brooks Nature Park
- Cottonwood Cove Park
- Boots Cox Park
- J.C. Snow Park
- Slick Rock Park
- Larkspur Park
- Hidden Valley Park
- Bloomington Hills and Bloomington Hills North Park
- St. George Regional Water Reclamation Facility
- Red Hills Conservancy Gardens

Institutional/Educational Facilities

A number of local elementary, intermediate, and high schools as well as Dixie State University receive irrigation water from the St. George system. Several other institutional facilities are serviced by the system. Institutional and educational connections include:

- Dixie State University
- Snow Canyon Middle School and High School
- Sunset Elementary School
- Tonaquint Intermediate School
- Legacy Elementary School
- Dixie Middle School and High School
- Heritage Elementary
- Bloomington Elementary
- Sandstone Elementary

- Pineview High School & Middle School
- Panorama Elementary School
- Little Valley Elementary School
- Sunrise Ridge Intermediate School
- Desert Hills High School and Middle School
- Bloomington Hills Elementary School and Preschool
- St. George Temple
- Several local church meetinghouses

Private Commercial Facilities

The secondary irrigation system services a select number of commercial facilities, including:

- Entrada Golf Course
- Millcreek Health Center
- Dinosaur Crossing Business Park
- Dixie Power Office

Residential Users

A limited number of residential users have access to secondary irrigation; some users are serviced by the City of St. George and others through individual ownership in local irrigation companies. These users are classified as either flood irrigators or pressurized irrigation users.

Flood Irrigation

There is a total of 83 parcels that receive flood irrigation water in the downtown area. Water is conveyed to these users through storm drain gutters and culverts. Unused water from this area flows to 700 South where it is collected in a pipe network that drains into the Snow Park Pond.

Pressurized Irrigation

There are three residential areas of the city that are provided with pressurized secondary irrigation water (i.e. adequate pressure to run a traditional sprinkler system). Approximately 61 homes in the Bloomington Hills area and 290 homes in the Bloomington Ranches area hold shares in the Bloomington Irrigation Company. Approximately 250 residential units in the Hidden Valley area are serviced by the City's secondary irrigation system. The Hidden Valley system is the only system that is currently equipped with individual meters.

SUPPLY SOURCES

The City's existing irrigation sources are a combination of City-owned wells and springs together with shares in a number of irrigation companies, many of which were created by the settlers of St. George and other surrounding communities. Table 2-1 provides a summary of the City's available supply sources with their annual yield and peak production capacity.

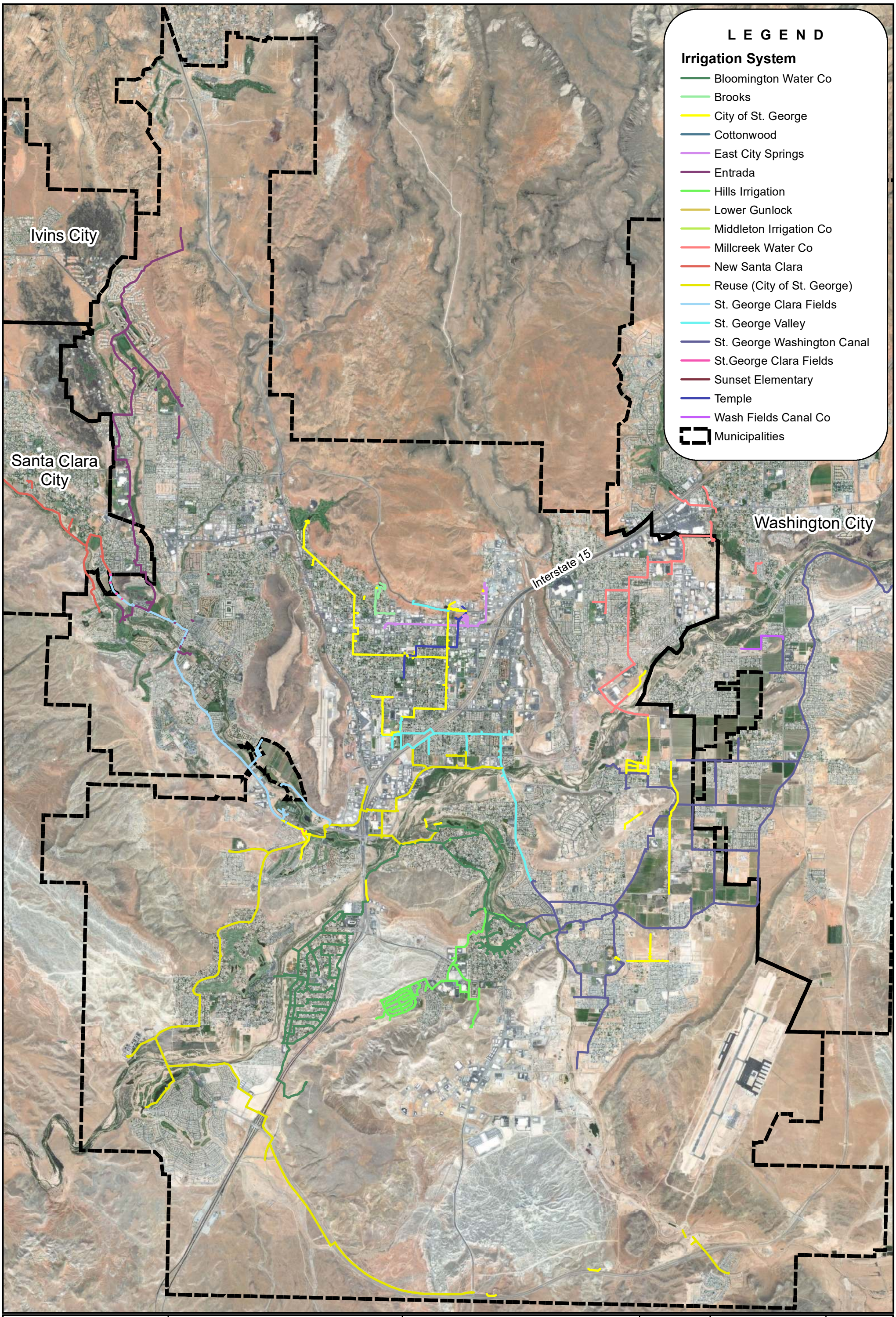
Table 2-1
Existing Irrigation Sources and Capacities

Source	Annual Yield (acre-feet/year)	Peak Source Capacity (gpm)
Sunbrook Well #1	900	600
Sunbrook Well #2	1,276	900
Sunbrook Well #3	640	700
Mathis Well	300	250
Moores Well	175	400
St. George Clara Fields Canal Company[1]	696[4]	1,000
New Santa Clara[1]	5[4]	20
St. George Valley Irrigation Company[2]	1,759	2,700
West City Springs	550	341
East City Springs	480	300
Wastewater Reuse	4,400	4,800
Bloomington Water Company[2]	1,247	900
St. George Washington Fields Canal Company[3]	1,873	2,700
Millcreek Water Company[3]	670	1,000
Sunset Well	200	150
Gunlock Well #1	800	1,000
Gunlock Well #3	636	800
Gunlock Well #4	1,101	1,385
Total	**17,708**	**19,946**

[1]Water is provided from Gunlock Reservoir or Santa Clara Well System.
[2]Water is provided from the Washington Dam Diversion on the Virgin River.
[3]Water is provided from Millcreek Springs.
[4]Value shown is equal to 50% of total allotment, which is the amount typically available during a dry year.

IRRIGATION TRANSMISSION & DISTRIBUTION PIPING

The existing secondary irrigation transmission and distribution piping that forms the backbone of the system is comprised of both "low-pressure" and "high-pressure" piping. The system is comprised of piping owned by the City of St. George as well as the following local irrigation companies (see Figure 2-4 for location of each system's piping):



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

EXISTING IRRIGATION PIPE NETWORK

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 2-4

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 2-4 - Existing Irrigation Pipe Network.mxd aanderson 12/18/2019

- Bloomington Water Company System
- Brooks System
- Cottonwood System
- East City Springs System
- Entrada System
- Hills Irrigation System
- Lower Gunlock System
- Middleton Irrigation Company System
- Millcreek Water Company System
- New Santa Clara System
- St. George Clara Fields System
- St. George Valley System
- St. George Washington Canal System
- St. George Clara Fields System
- Sunset Elementary System
- Temple System
- Washington Fields Canal Company

"Low-pressure" portions of the system refer to piping that does not possess adequate pressure or the ability to hold sufficient pressure to service a typical spray sprinkler irrigation system, which generally requires at least 30 pounds per square inch (psi) of pressure. The "low-pressure" portions of the system are associated with the flood irrigation regions of the area. "High-pressure" piping is the piping that provides or could provide a high enough pressure to support a spray sprinkler system, which could be used by residential or commercial units, parks, golf courses, etc. Table 2-2 provides a summary of the length and diameter of piping owned by the City and each irrigation system.

Table 2-2
Summary of Existing Irrigation Piping

Irrigation System	Size Unknown	1"	2"	3"	4"	6"	8"	10"	12"	14"	15"	16"	18"	20"	21"	24"	27"	28"	30"	34"	36"	48"	54"	60"	72"	Total
Bloomington Water Co.	3,864	277	12,157	3,287	8,838	23,048	27,848	15,195	16,305	37	1,590	0	0	0	0	0	0	0	0	2	0	0	0	0	0	**112,448**
Brooks	674	0	1,055	0	4,043	126	312	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**6,209**
City of St. George	**3,423**	**416**	**271**	**201**	**3,262**	**2,303**	**14,269**	**7,878**	**24,878**	**1,640**	**0**	**9,309**	**3,941**	**604**	**0**	**313**	**11**	**0**	**0**	**603**	**0**	**0**	**0**	**0**	**0**	**73,323**
Cottonwood	0	0	0	0	0	153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**153**
East City Springs	1,561	0	0	0	547	516	3,386	6,618	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**12,627**
Entrada	8,948	0	278	0	3,180	558	3,199	32	0	0	594	25,813	1,349	4,937	0	0	0	0	4	20	476	0	0	0	0	**49,388**
Hills Irrigation	99	75	243	0	86	1,329	24,701	2,268	6,512	2,220	27	0	0	0	0	0	0	0	0	4,190	0	0	0	0	0	**41,749**
Lower Gunlock	1,032	0	0	94	1,226	0	198	10	474	1,124	0	0	0	0	0	6,640	0	3,854	44,593	0	0	0	0	0	0	**59,245**
Middleton Irrigation Co.	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**25**
Millcreek Water Co.	2,138	146	175	0	1,946	1,541	9,442	9,654	6,094	1,008	28	0	0	0	0	0	0	0	1,064	0	0	0	0	0	0	**33,236**
New Santa Clara	0	11	79	0	1,949	2,452	1,985	1,966	598	69	0	0	0	0	0	29,606	0	0	0	0	0	0	0	0	0	**38,715**
Reuse (City of St. George)	0	85	120	34	2,362	1,616	4,263	163	29,850	12,130	5,711	4,758	0	0	0	27,342	0	0	0	34	0	0	0	0	0	**88,467**
St. George Clara Fields	0	0	421	49	495	862	2,666	474	65	0	2,865	0	0	0	0	22,382	0	0	0	190	0	0	0	0	0	**30,469**
St. George Valley	83	0	113	49	798	1,115	401	0	1,277	2,420	0	1,111	2,111	8,580	2,026	2,919	0	0	7,130	0	0	0	0	0	0	**30,134**
St. George Washington Canal	3	390	130	186	1,544	692	588	1,342	4,360	0	0	2,601	56,881	0	0	6,647	0	0	7,601	0	2,531	330	13,494	36,186	309	**135,815**
St.George Clara Fields	0	0	0	0	84	47	112	64	0	0	0	0	0	0	0	390	0	0	0	0	0	0	0	0	0	**697**
Sunset Elementary	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13**
Temple	0	0	0	0	1,145	6,906	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8,051**
Wash Fields Canal Co.	0	0	0	0	0	0	0	0	29	0	0	0	3,417	0	0	0	0	0	0	0	0	0	0	0	0	**3,446**
Total	**21,825**	**1,400**	**15,056**	**3,900**	**31,530**	**43,264**	**93,369**	**45,664**	**90,441**	**20,648**	**10,815**	**43,593**	**67,699**	**14,121**	**2,026**	**96,238**	**11**	**3,854**	**60,391**	**5,039**	**3,007**	**330**	**13,494**	**36,186**	**309**	**724,210**
Percentage of Total System	**3.01%**	**0.19%**	**2.08%**	**0.54%**	**4.35%**	**5.97%**	**12.89%**	**6.31%**	**12.49%**	**2.85%**	**1.49%**	**6.02%**	**9.35%**	**1.95%**	**0.28%**	**13.29%**	**0.00%**	**0.53%**	**8.34%**	**0.70%**	**0.42%**	**0.05%**	**1.86%**	**5.00%**	**0.04%**	

IRRIGATION STORAGE FACILITIES

The existing secondary irrigation system utilizes a combination of ponds and enclosed storage tanks to meet operational needs. Table 2-3 provides a summary of existing storage facilities and their effective, or useable, volume.

Table 2-3
Existing Irrigation Storage Facilities

Non-Concrete Lined Ponds[1]	Approximate Surface Area (sq-ft)	Useable Volume[4] (gallons)
Bloomington Hills	88,964	1,330,990
Entrada	42,005	628,430
North Entrada	64,910	971,120
Sandberg	98,645	1,475,820
Skyline	52,251	781,730
Tonaquint/Southgate	24,173	361,650
Blackrock[2]	67,421	0
Canyon Complex[2]	22,891	0
Middle[2]	10,860	0
Red Hills Golf[2]	53,661	0
Southgate Back 9[2]	38,351	0
Southgate Club[2]	80,057	0
Sun River[2]	465,357	0
Tawa[2]	37,480	0
Woodbridge[2]	79,142	0
Total Natural Pond Storage		**5,550,000**
Concrete Lined Pond	**Total Volume (gallons)**	**Useable Volume[4] (gallons)**
East Bloomington	1,100,000	550,000
Little Valley	1,100,000	550,000
Snow Park	1,200,000	600,000
Total Concrete Lined Storage	**3,400,000**	**1,700,000**
Enclosed Storage Tanks	**Total Volume (gallons)**	**Useable Volume[4] (gallons)**
St. George Golf	1,300,000	1,300,000
Bloomington Hills (Small Tank)	108,000	108,000
Sunbrook[3]	100,000	0
Graveyard[3]	100,000	0
Total Enclosed Storage Volume	**1,308,000**	**1,408,000**
Total Useable Storage		**8,658,000**

[1]Non-concrete lined ponds are typically lined with clay or a rubber membrane.
[2]Storage pond services a specific, localized user and is not a shared facility, and is therefore not included in the total useable storage in the system.
[3]Storage tank functions as a wet well for a pump station and does not provide functional storage for the system.
[4]See Chapter 5 for discussion on how useable storage volume was calculated

PUMP STATIONS

The secondary irrigation system utilizes a number of booster pump stations to deliver water to different parts of the system. These pump stations provide versatility to the system and allow operators to meet demands for a given area from multiple sources, which improves the overall reliability of the system. The capacity of each pump station is summarized in Table 2-4.

Table 2-4
Existing Booster Pump Stations

Pump Station Name	Pump Station Capacity (gpm)
Ivins	2,000
Entrada	1,800
Snow Park	3,600
Sandberg	1,600
Sunbrook	5,250
Graveyard	5,250
Bloomington Hills	700
St. George Golf	1,800
Little Valley Ball Fields	1,000
Canyons Complex	1,900
Southgate	1,000
Skyline Pond	1,400
Red Hills	1,100
SGWRF Reuse Facility	5,250

SYSTEM PRESSURE ZONES

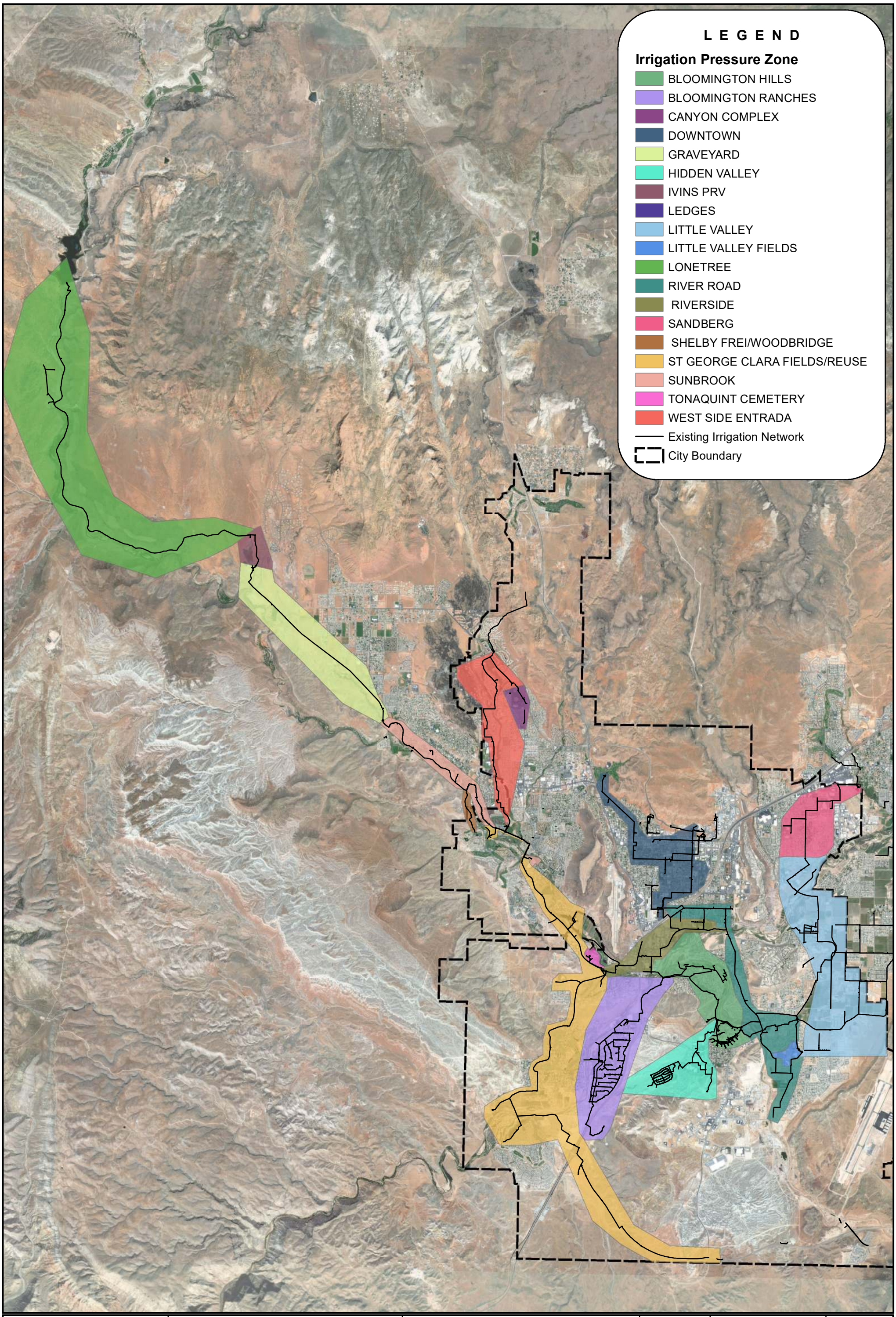
The existing secondary irrigation pressure zones are shown in Figure 2-5. Pressure zones throughout the City are established by:

- The water surface elevation in a reservoir or storage tank or;
- Pressure reducing valves (PRVs) in a pressure regulated zone

As the secondary irrigation system expands into new, undeveloped areas of the City, new pressure zones will be established by constructing new storage tanks or by connecting the new areas into existing pressure zones (with PRVs if necessary).

ST GEORGE REUSE FACILITY

The St. George Reuse Facility is located at the St. George Water Reclamation Facility (SGWRF). The SGWRF treats wastewater from the City of St. George, Ivins City, Santa Clara City, and Washington City. The reuse facility provides tertiary treatment to the effluent from the SGWRF,



BOWEN COLLINS & ASSOCIATES

ST. GEORGE CITY
SECONDARY IRRIGATION MASTER PLAN

IRRIGATION SYSTEM PRESSURE ZONES

NORTH:

SCALE: 0 4,000 8,000 Feet

FIGURE NO. 2-5

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 2-5 - Irrigation System Pressure Zones.mxd aanderson 10/26/2019

treating the water to Type 1 reuse water standards (per Utah Administrative Code R-317). The facility utilizes sand filter beds and a chlorination system to meet these water quality standards. The reuse pump station delivers water through a 24-inch reuse pipeline line to:

a) The Sunbrook Tank and Pump Station, which can then deliver water to the Graveyard Tank and Pump Station. The Graveyard Pump Station can pump water even further to Ivins Reservoir.

b) A 14-inch pipe that crosses the Virgin River and feeds into the Sun River area and is capable of delivering water as far east as the intersection of the Southern Parkway and South River Road.

The existing reuse facility has 3 filter bays, 2 of which are currently equipped. With 2 filter bays in operation, the reuse facility can produce 7.0 million gallons a day (MGD). With the additional bay equipped with the same sand filter technology, the facility could produce up to 10.5 MGD, but with more sophisticated cloth media filter, the reuse facility could produce up to 14 MGD (with the existing 2 sand filter bays remaining as they are).

CHAPTER 3
WATER USE EVALUATION AND GROWTH PROJECTIONS

INTRODUCTION

A key aspect of the master planning process is developing projections of population growth within the City's service area. Population projections have a direct impact on important components of the master plan, including the projected timing of capital improvements. Over-estimating population growth projections may lead to poorly timed capital improvement projects for the City, which could result in aggressive future rate increases that may not actually be necessary. The opposite is true for under-estimating growth, which could leave the City without the necessary financial backing to carry out required capital improvements as well as not providing sufficient lead time for projects.

The purpose of this chapter is to develop growth projections for the City by analyzing historical growth trends as well as reviewing population projections developed by local planning authorities and other national and state planning agencies. These projections, together with an analysis of existing water use trends and needs, have been used to estimate future system water usage. These water use projections will be used to evaluate the system under future conditions and identify the system improvement projects that will be needed to satisfy increased demands as a result of growth.

HISTORICAL GROWTH TRENDS

The City of St. George has seen significant growth in the last few decades. Table 3-1 summarizes population growth for St. George from the year 1990 to 2010 based on data available from the United States Census Bureau.

Table 3-1
U.S. Census Bureau Historical Population Growth for St. George

Year	City of St. George Population	% Growth
1990	28,572	
2000	49,663	73.8%
2010	72,897	46.8%

As shown in Table 3-1, the City of St. George saw a significant boom in growth from 1990 to 2000, continuing on into the following decade. Using the information provided in Table 3-1, Table 3-2 shows the average yearly growth rate for St. George over each respective decade.

Table 3-2
Average Annual Growth Rate[1] in St. George from 1990 to 2010

Time Period	Average Annual Growth Rate[1]
1990-2000	5.7%
2000-2010	3.3%

[1]Represents the average annual growth rate based on U.S. Census records

While the data from the census provides a reliable, high-level overview of growth information for the City in historic 10-year increments, historic annual growth in the area can be monitored in more detail by looking at the increase in new service connections each year (determined by the City approving building permits). Multiplying the number of new service connections by the average household size in the City provides an estimate for population growth from year to year. The most recent U.S. Census Bureau estimate for average household size in St. George is 2.88 persons/household. To see how this compares to other communities near St. George, Table 3-3 provides a summary of average household size estimates for other cities in the Southern Utah/Southern Nevada area. As shown in the table, St. George is just below the average for household size in the region.

Table 3-3
Average Household Size Comparison

City	U.S. Census Estimate for Average Household Size
St. George, UT	**2.88**
Washington City, UT	2.99
Ivins City, UT	2.78
Hurricane, City, UT	2.9
Santa Clara City, UT	3.75
Cedar City, UT	3.0
Mesquite, NV	2.34
Average	**2.95**

Table 3-4 shown below shows the records of new building permits issued within the City from 2014 to 2018.

Table 3-4
Building Permits Issued in the City of St. George (2014 – 2018)

	2014	2015	2016	2017	2018
Single Family	576	741	790	944	942
Townhomes	110	46	46	102	274
Apartment/Duplex	2	2	1	15	11
Mobile Homes	1	3	1	1	6
Condos	12	0	1	35	20
Commerical/Industrial	119	109	25	117	201
Miscellaneous/Additions*	655	685	900	742	805
Hospital/Interior Finish	0	1	2	3	18
Institutes/Schools/Day Care	1	1	0	0	0
Public/Airport/Parks	12	6	16	1	3
Religious	0	3	1	1	2
Subtotal – All Permits	**1,488**	**1,597**	**1,783**	**1,961**	**2,282**
Residential	701	792	839	1,097	1,253
Non-Residential	132	120	44	122	224
Total, Excluding Home Add.	**833**	**912**	**883**	**1,219**	**1,477**

*Miscellaneous/Home Additions were not included in total number considering that they typically do not represent an increase in the population or water use.

Detailed water meter records from the City and data from the Washington County Recorder indicate that at the end of 2017 there were a total of 33,107 residential connections and 2,293 permanent non-residential connections (commercial, industrial, institutional, etc.). Using the U.S. Census Bureau estimate for household size in St. George, the estimated total residential population in St. George as of 2017 was:

$$33{,}107\ residential\ connection\ x\ 2.88\frac{persons}{household} = \mathbf{95{,}349\ residents}$$

It should be noted that, based on County Recorder records, St. George is home to over 6,500 secondary residences that may be occupied for only a portion of the year. However, when comparing water use between primary residences and secondary residences, meter data records indicate that secondary homes use only 10% less water over the course of the year than primary residences. Thus, even though this estimate does include the transient population in the area (i.e. second homes, short term rental units, etc.), **for the purposes of water system master planning, all of these units will be treated as if they were a primary residence.**

Table 3-5 outlines the estimated growth rate for St. George from the 2014-2018.

Table 3-5
Summary of Recent Historical Growth in the City of St. George (2014 – 2018)

Year	2014	2015	2016	2017	2018
New Residential Connections	701	792	839	1097	1253
Total Residential Connections	30,379	31,171	32,010	33,107	34,360
Growth Rate	**-**	**2.6%**	**2.7%**	**3.4%**	**3.8%**
New Non-Residential Connections	132	120	44	122	224
Non-Residential Connections	2,037	2,157	2,201	2,323	2,547
Growth Rate	**-**	**5.89%**	**2.04%**	**5.54%**	**9.6%**

As shown in Table 3-5, the residential growth rate steadily increased over the past 4 years, with an estimated rate of 3.43% from 2016 - 2017 and 3.8% from 2017 - 2018, while non-residential growth fluctuated from year to year. Growth in St. George recently caught national attention as it was identified as the fastest growing metropolitan area in the country, in which the US Census estimated a 4% growth rate from 2016 – 2017 (which included not only St. George but also the majority of Washington County).

Considering that there are a number of large developments currently planned or under construction in the area, it is reasonable to assume that the City will continue to grow at a relatively aggressive rate into the foreseeable future. Through correspondence with City management, the City has elected to use the population projections developed for the Governor's Office of Management and Budget (GOMB), which match historical growth trends relatively well. Table 3-6 summarizes the growth projections from the GOMB for St. George. These projections form the basis of growth projections used in this report, with a minor modification that is discussed in the following section.

Table 3-6
GOMB Growth Projections for St. George City

Year	2010	2020	2030	2040	2050	2060
St. George Population	72,897	103,851	148,078	196,206	249,421	307,037
Average Annual Growth Rate		3.60%	3.61%	2.85%	2.43%	2.10%

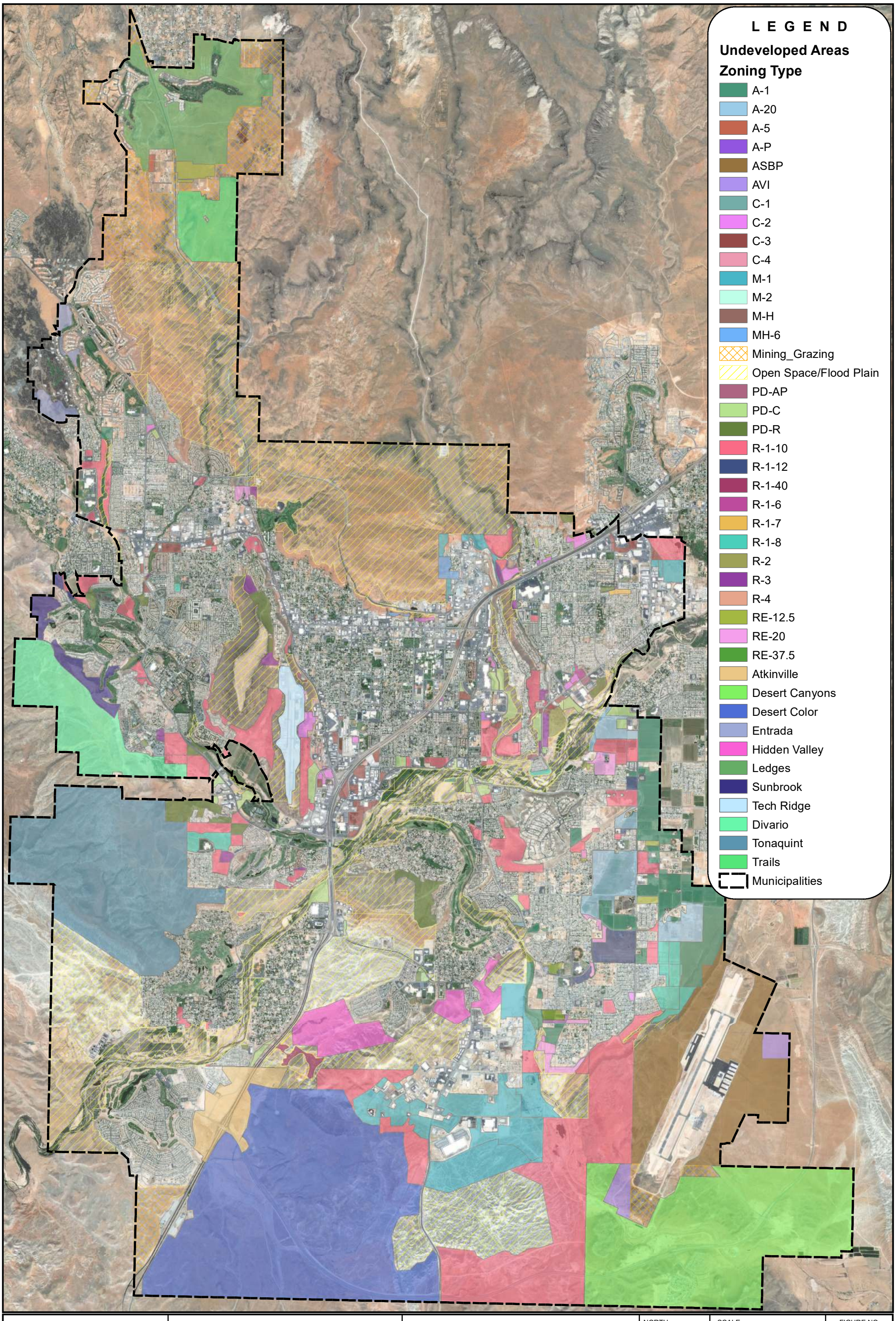
ESTIMATED BUILDOUT POPULATION

The build-out population (the population when all developable land in the City has been developed) of St. George has been estimated using the City's current land use and zoning plans. The land use and zoning plans identify the location and type of development that has been approved for specific areas throughout the City. The City's General Plan describes the difference between the zoning map and land use map:

> *The Zoning Map…and the Land Use Plan…work hand-in-hand with each other. The Land Use Plan indicates general density ranges and indicates how development is to be located on the land, with special regard to preserving special natural features. The Zones in the Zoning Map are legal designations that assign a specific overall density to a specific tract of land.*

Through coordination with City management, the buildout population estimate for St. George was developed using portions of each plan. In some areas, the Land Use Plan provides a more accurate representation of future development density, while the Zoning Plan provides more detailed information in other areas. In this sense, buildout population estimates were developed using a "composite" land use/zoning plan. In addition to the general Land Use and Zoning plans, another component considered in this analysis are Planned Development Areas, or "PD"s, which are specific areas of the City that have an established and approved number of development units. PDs have been accounted for in the estimation of buildout population.

In order to estimate the service area population at full buildout for the City, the currently undeveloped areas of the City needed to be identified and separated from the currently developed areas. This was done using Geographic Information System (GIS) mapping tools to "clip out" areas of the City that are currently developed from the overall land use and zoning plan, leaving only the undeveloped areas with their associated land use/zoning type and respective area. This is illustrated in Figure 3-1 (colored areas are those have are yet to be developed or that represent permanent open space or other preservation areas. Using the result of this exercise, Table 3-7 provides a summary of the estimated service area population that will added when all undeveloped land in the City is developed.



BOWEN COLLINS & ASSOCIATES

ST. GEORGE CITY

SECONDARY IRRIGATION MASTER PLAN

CURRENTLY UNDEVELOPED AREAS OF THE CITY

NORTH: NORTH

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 3-1

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 3-1 - Undeveloped Areas of the City.mxd aanderson 10/26/2019

Table 3-7
Evaluation of Undeveloped Land by Land Use/Zoning Category

Zoning Code	Development Description	Area (Acres)	Density (Units Per Acre)	Number of Units	Estimated Added Residential Population[1]
A-1	Agricultural Use, Min. 40,000 SF	776.3	1.00	776.3	2,236
A-20	Agricultural Use, Min 20 Acres	408.4	0.05	20.4	59
A-5	Agricultural Use, Min 5 Acres	10.3	0.20	2.1	6
A-P	Administrative and Professional, No Min Area	4.0	5.00	19.8	0
ASBP	Airport Supporting Business Park	1,118.4	2.00	2,236.7	0
AVI	Airport Vicinity Industrial	134.1	1.00	134.1	0
C-1	Commercial, No Min Area	5.7	2.00	11.5	0
C-2	Commercial, No Min Area	99.4	2.50	248.5	0
C-3	Commercial, No Min Area	161.3	3.00	483.9	0
C-4	Commercial, No Min Area	0.0	3.50	0.2	0
M-1	Manufacturing, No Min Area	1,025.9	0.50	513.0	0
M-2	Manufacturing, Min 40,000 SF	0.1	7.50	0.7	0
M-H	Mobile Home	2.3	6.00	13.8	40
MH-6	Mobile Home Min 6,000 SF	33.3	6.00	199.9	576
Mining_Grazing	Mining/Grazing, No Area Min	1,252.9	0.00	0.0	0
OS	Open Space, No Min Area	9,824.6	0.00	0.0	0
PD-AP	Planned Development - Admin & Professional Office	12.9	2.00	25.9	0
PD-C	Planned Development - Comm	239.2	2.00	478.3	0
PD-R	Planned Development - Res	341.9	4.00	1,367.5	3,938
R-1-10	Single Family Res. Min 10,000 SF	3,044.7	3.20	9,743.1	28,060
R-1-12	Single Family Res. Min 12,000 SF	130.7	2.80	366.1	1,054
R-1-40	Single Family Res. Min 40,000 SF	39.0	1.00	39.0	112
R-1-6	Single Family Res. Min 6,000 SF	7.0	7.00	49.0	141
R-1-7	Single Family Res. Min 7,000 SF	9.6	6.00	57.5	166
R-1-8	Single Family Res. Min 8,000 SF	216.0	3.70	799.0	2,301
R-2	Multi-Unit Res. Min 6,000 SF	32.9	7.00	230.0	663
R-3	Multi-Unit Res. Min 6,000 SF	97.5	13.00	1,267.3	3,650
R-4	Multi-Unit Res. Min 6,000 SF	0.0	20.00	0.0	0
RE-12.5	Residential Estate Min 12,500 SF	113.7	3.00	341.1	982
RE-20	Residential Estate Min 20,000 SF	132.3	2.00	264.5	762
	Vacant Lots Not in a Planned Development	NA	NA	758	2,183
	TOTAL	**19,275**		**20,447**	**46,929**
Atkinville	Planned Development	Not Applicable	varies	1,057	3,044
Desert Canyons	Planned Development	Not Applicable	varies	7,267	18,193
Desert Color	Planned Development	Not Applicable	varies	10,108	26,173
Entrada	Planned Development	Not Applicable	varies	324	933
Hidden Valley	Planned Development	Not Applicable	varies	400	1,152
Ledges	Planned Development	Not Applicable	varies	2,125	6,120
Stone Cliff	Planned Development	Not Applicable	varies	211	608
Sunbrook	Planned Development	Not Applicable	varies	593	1,708
Sun River	Planned Development	Not Applicable	varies	100	288
Tech Ridge (Old Airport)	Planned Development	Not Applicable	varies	3,500	6,912
The Lakes	Planned Development	Not Applicable	varies	3,196	9,204
Tonaquint	Planned Development	Not Applicable	varies	1,445	4,162
Trails	Planned Development	Not Applicable	varies	923	2,658
	TOTAL			**31,249**	**81,156**
	GRAND TOTAL			**51,696**	**128,085**

[1]Non-residential land uses do not represent an increase is residential population. However, non-residential development does increase water use, which is accounted for using the ERU methodology.

As shown in Table 3-7, the remaining areas of the City to be developed are estimated to increase the City population by **128,085**, resulting in a total build-out population of:

$$95{,}349\ residents\ (existing) + 128{,}085\ (future) = \mathbf{223{,}434\ residents}$$

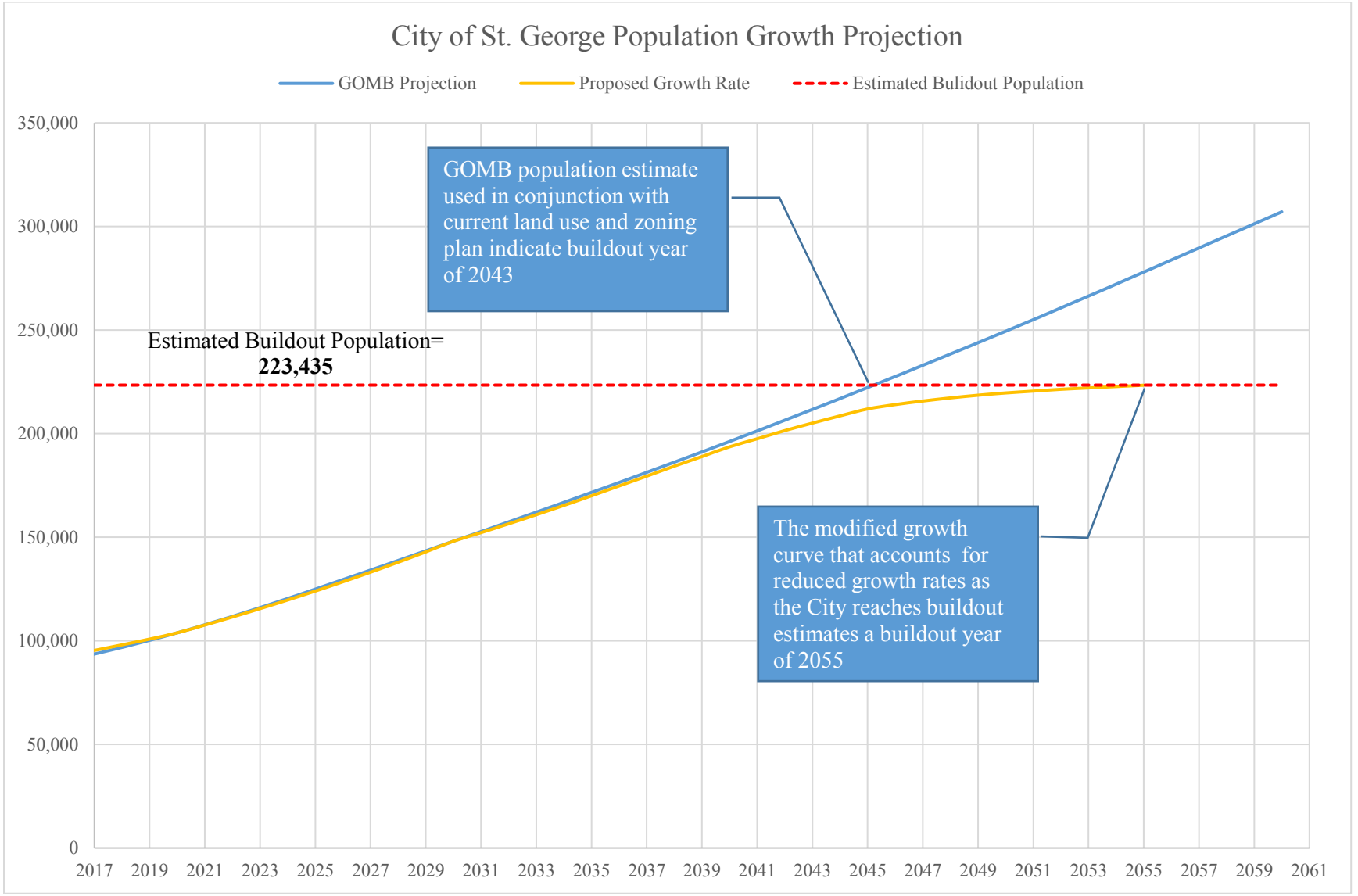
Using this build-out population estimate, Table 3-8 and Figure 3-2 provide the estimated population growth projection for the City. As previously mentioned, the City has elected to utilize the population projections development for the GOMB. Based on the GOMB growth estimates and the City's current land use plan, St. George would reach its full buildout capacity by approximately 2043. However, in reality, population growth tends to slow as it reaches its full carrying capacity (i.e. growth does not abruptly stop at full buildout; the growth rate will gradually slow as buildout is approached). This considered, Figure 3-2 displays 2 growth curves for reference:

- **Governor's Office of Management and Budget**: This growth curve displays the actual growth projection developed for the GOMB. As shown, the full buildout population is reached by the year 2043. Based on the current land use evaluation for the City, it appears that the GOMB growth projections may over-estimate the total buildout population of the City, so some adjustment of the projection as it reaches the estimated buildout population is necessary.
- **Modified GOMB Project Adjusted after 2030 (Recommended for Planning):** This modified growth curve uses the growth projections developed for the GOMB through the year 2030 followed by a gradual decrease in the annual growth rate to produce a more realistic outlook through buildout. Using this approach, it is estimated that the City will reach buildout by the year 2055. This will become the growth projection used for City planning purposes and is reflected in Table 3-8. It should be emphasized that buildout estimates are just that – an estimate. Changes in land use and zoning plans, City annexations, land redevelopment, etc. will all influence how large the City will actually become. For this reason, master plans should be updated frequently enough to keep up with revised development plans in the City.

Table 3-8
St. George Population Growth Estimate

Year	Population
2017	95,349
2018	98,028
2019	100,822
2020	103,851
2021	107,600
2022	111,484
2023	115,509
2024	119,679
2025	123,999
2026	128,475
2027	133,113
2028	137,919
2029	142,898
2030	148,056
2031	152,202
2032	156,463
2033	160,844
2034	165,348
2035	169,978
2036	174,737
2037	179,455
2038	184,300
2039	188,908
2040	193,631
2041	197,503
2042	201,453
2043	205,079
2044	208,566
2045	211,903
2046	214,022
2047	215,734
2048	217,244
2049	218,548
2050	219,640
2051	220,519
2052	221,401
2053	222,065
2054	222,731
2055	223,434

Figure 3-2
Population Growth Projections for the City of St. George



EVALUATION OF HISTORICAL WATER USE IN THE CITY

Chapter 3 of the St. George Culinary Water Master Plan provides a detailed evaluation of historical water use trends from 2016 - 2019. These historical trends have been used to project future water use in the City. As presented in Chapter 3 of the Culinary Water Master Plan, water use projections have been evaluated on the basis of Equivalent Residential Units, or ERUs. The ERU represents the amount of water used by a typical single family home. The water use evaluation for the City yielded the results shown in Table 3-9.

Table 3-9
Summary of Single Family Residential Water Use from 2016 – 2019[1]

Year	Total Average Daily Use Per ERU (gallons per day)[1]	Total Average Day, Peak Month Demand (gallons per day)[1]	Total Peak Day Demand (Average Day, Peak Month x 1.21[2]) (gallons per day)[1]
2016	570	951	1,151
2017	**637**	**1,056**	**1,278**
2018	596	997	1,206
2019	567	1,024	1,239

[1]Value includes estimated percentage of water loss.
[2]The peak day source production data from 2018 was used to estimate peak day demand per ERU for each year.

As shown in Table 3-9, water use varies from year to year. For planning purposes, the highest usage year (2017) has been used to determine the *expected* demand associated with a typical ERU. As discussed in the Culinary Water Master Plan as well as Chapter 4 of this report, for planning purposes, it is recommended that an additional buffer be included in the source sizing standard per ERU to help ensure that the City has adequate source capacity in place to account for potential future variations in demand.

The demands shown in Table 3-9 represent the total annual and peak day usage for an ERU, which is the combination of water used indoors and outdoors. Since the secondary irrigation system only provides water for outdoor use, it is important to have an understanding of indoor vs outdoor usage. By evaluating culinary water meters for the City as a whole, it is estimated that approximately 49% of water is used indoors and 51% of water is used outdoors. For residential connections, water use is estimated to be closer to 35% indoor/65% outdoor with commercial/institutional/industrial users using more water indoors than outdoors. Based on this general split between water use, Table 3-10 provides the summary of estimated indoor/outdoor water use for planning.

Table 3-10
Summary of estimated Indoor/Outdoor Water Use per ERU

Indoor Water Use (gallons/year)	Outdoor Water Use (gallons/year)	Peak Indoor Usage[1] (gallons per day)	Peak Outdoor Usage (gallons per day)
113,927	118,578	390	888

[1]Estimated to be 25% higher than average daily indoor water use from 2017 based on system wide distribution between indoor and outdoor demand.

For the purpose of accounting for water use on the culinary water system and secondary irrigation system, ERUs will be evaluated on the basis of annual demand. This means that 1 ERU that is connected to the culinary system and secondary system represents 0.49 ERUs to the culinary system and 0.51 ERUs to the secondary system. The unique peaking characteristics of each system have been accounted for in water use projections.

Estimating Secondary Irrigation Peak Day Demand

The most important demand scenario for the secondary irrigation system is peak day demand, which is the total daily system demand on the highest usage day in the year. St. George collects monthly meter reads for the majority of secondary irrigation users, but some users are measured only on an annual basis. As part of the Culinary Water Master Plan, data records were evaluated in order to estimate peak day demands on the system. This analysis is presented in Chapter 3 of the Culinary Water Master Plan, which concluded that peak day system demand is approximately equal to 1.21 times average day, peak month demand. In other words, peak day water usage is approximately 21% higher than the average daily usage over the course of the peak usage month (typically July or August).

This ratio helps provide an estimate for peak day demand, but does not involve the separation of indoor and outdoor water use, meaning that the ratios apply only to the combined water use pattern. This considered, the different peaking factors associated with indoor and outdoor water use were estimated based on engineering judgment. For indoor water use, it was assumed that peak day usage is 25% higher than average daily indoor usage (with average daily indoor usage being estimated from January meter reads). Using this estimate for peak day indoor use, the remaining portion of the total peak day system demand is attributed to outdoor use.

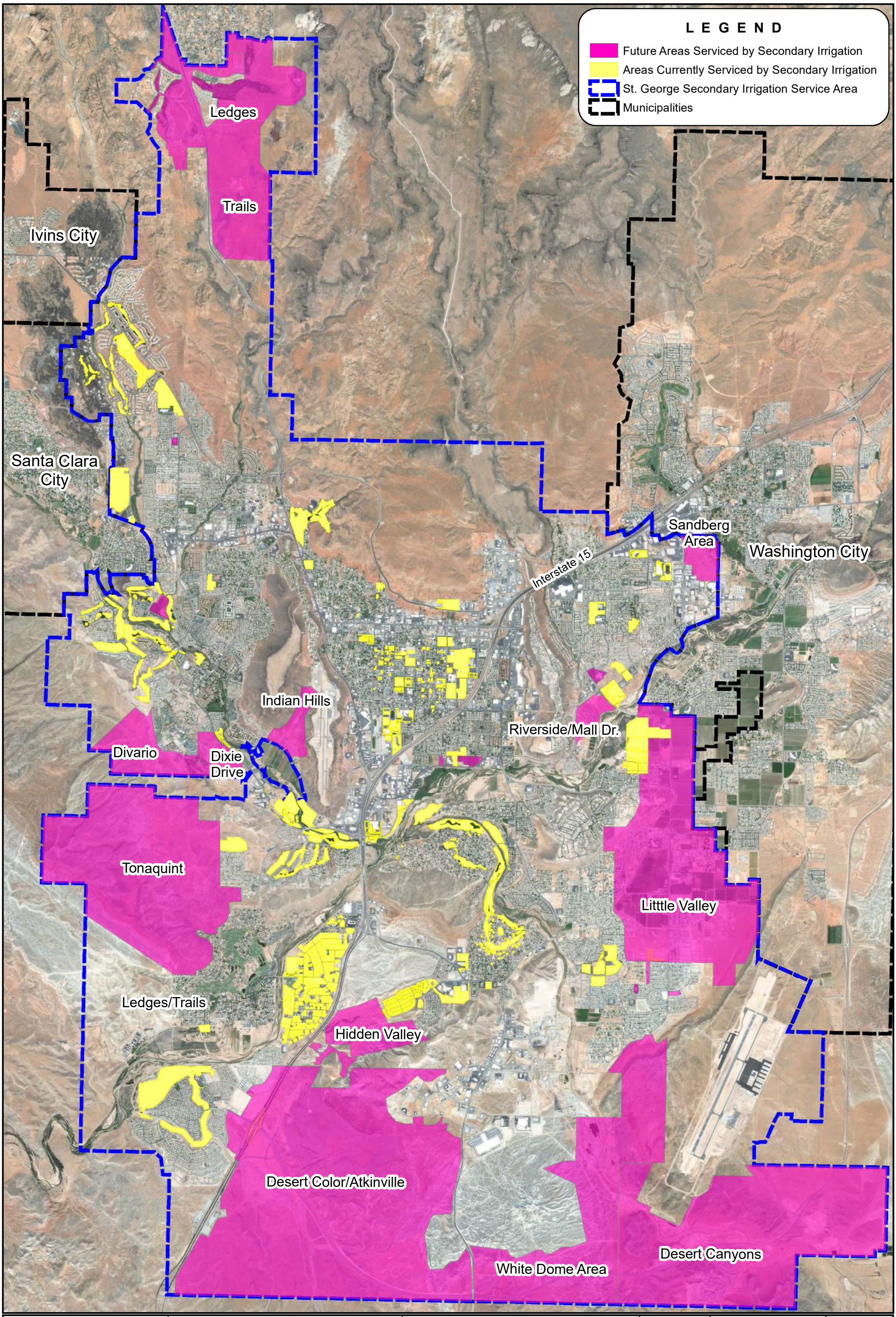
Secondary Irrigation Peak Hour Demand

Peak hour demand, otherwise known as peak instantaneous demand, is the highest demand the system sees over the course of year. Peak hour demand typically occurs during the early morning irrigation period in the summer when several users are watering at the same time. Sizing of distribution piping in the secondary irrigation system is governed by peak hour demand. For this master plan, peak hour demand has been estimated to be equal to peak day demand multiplied by 2.5.

EXISTING AND FUTURE AREAS SERVICED BY SECONDARY IRRIGATION

Figure 2-3 in Chapter 2 displays the locations of the City that are currently serviced by the secondary irrigation system. Currently, the system primarily services golf courses, parks, and schools, but also provides service to a limited number of residential users. As growth continues in St. George, the City is planning to expand the secondary irrigation system into newly developed areas to help offset future impacts on the culinary water system.

The St. George City Water Department management has identified areas of the City in which secondary irrigation service is planned to be extended. These approximate areas are shown in Figure 3-3. Table 3-11 provides a summary description of the amount of new development that has been assumed to be serviced by secondary irrigation.



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

FUTURE AREAS SERVICED BY SECONDARY IRRIGATION

NORTH: NORTH

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 3-3

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 3-3 - Future Areas Serviced by Secondary Irrigation.mxd aanderson 10/26/2019

Table 3-11
Extent of Assumed Secondary Irrigation Expansion

Location	Assumed Extent of Secondary Irrigation Expansion[1]
Ledges PD	2,000 ERUs (80% of PD), convert Ledges Golf Course to Secondary
Trails PD	923 ERUs (100% of PD)
Divario PD	1,598 ERUs (50% of PD)
Tonaquint PD	1,445 ERUS (100% of PD)
Hidden Valley PD	400 ERUs (100% of PD)
Atkinville PD	1,057 ERUs (95% of total PD)
Desert Color PD	10,108 ERUs (100% of PD)
White Dome Area	100% of all new development
Desert Canyons PD	6,000 ERUs (77% of PD)
Little Valley	100% of all new development
Sandberg Pond Area	100% of all new development
Riverside Drive/Mall Drive Area	100% of all new development
Dixie Drive/Indian Hills Area	100% of all new development

[1]ERU counts shown represent the number of ERUs that have access to secondary irrigation, not the total number of secondary irrigation ERUs.

Table 3-20 from Chapter 3 of the Culinary Water Master Plan provides an estimate of the total number of ERUs that will added in St. George through buildout (baseline 2017). In order to determine the total number of ERUs that will have access to secondary irrigation through buildout, a similar analysis was completed by evaluating the land use/zoning for the undeveloped areas of the City that will be serviced by the secondary irrigation system. Table 3-12 provides a summary of the estimated number of ERUs that will be built in the undeveloped areas that fall within the proposed extent of the future secondary irrigation system or that will be converted from culinary irrigation service to secondary irrigation service.

Table 3-12
Estimated Number of ERUs Added to Secondary Irrigation System

Zoning Code	Development Description	Area (Acres)	Density (Units Per Acre)	Number of Units	Estimated ERUs per Unit*	Estimated ERUs with Secondary Irrigation Service[1]	Estimated Secondary Irrigation ERUs[2]
A-1	Agricultural Use, Min. 40,000 SF	681	1	681	0.97	661	**337**
A-20	Agricultural Use, Min 20 Acres	404	0.05	20	0.97	20	**10**
A-5	Agricultural Use, Min 5 Acres	10	0.2	2	0.97	2	**1**
PD-R	Planned Development - Res	5	4	21	1	21	**11**
R-1-10	Single Family Res. Min 10,000 SF	2314	3.2	7405	1	7,405	**3,777**
R-1-12	Single Family Res. Min 12,000 SF	118	2.8	330	1	330	**169**
R-1-40	Single Family Res. Min 40,000 SF	39	1	39	1	39	**20**
R-1-8	Single Family Res. Min 8,000 SF	44	3.7	161	1	161	**82**
R-2	Multi-Unit Res	33	7	230	1	230	**117**
R-3	Multi-Unit Res	16	13	213	1	213	**109**
RE-12.5	Residential Estate Min 12,500 SF	75	3	226	1	226	**115**
RE-20	Residential Estate Min 20,000 SF	55	2	110	1	110	**56**
Atkinville	Planned Development	NA	varies	1,057	1	1,057	**539**
Desert Canyons	Planned Development	NA	varies	5,050	1	5,050	**2,576**
Desert Color	Planned Development	NA	varies	9,088	1	9,088	**4,635**
Hidden Valley	Planned Development	NA	varies	400	1	400	**204**
Ledges	Planned Development	NA	varies	2,000	1	2,000	**1,020**
The Lakes	Planned Development	NA	varies	1,598	1	1,598	**815**
Tonaquint	Planned Development	NA	varies	1,445	1	1,445	**737**
Trails	Planned Development	NA	varies	923	1	923	**471**
					Total Residential ERUs	**30,980**	**15,799**
C-3	Commercial, No Min Area	16	3	48	3.26	157	80
M-1	Manufacturing, No Min Area	51	0.5	25	15.8	402	205
Mining & Grazing	Mining/Grazing, No Area Min	132	0	0	0	0	0
OS	Open Space, No Min Area	2	0	0	0	0	0
PD-C	Planned Development - Comm	26	2	52	3.26	168	86
Desert Canyons	Planned Development	NA	varies	950	1	950	485
Desert Color	Planned Development	NA	varies	1,020	1	1,020	520
Entrada[3]	Planned Development	NA	varies	1	714	714	714
Ledges	Planned Development	NA	varies	1	978	978	978
Other Parks/Schools to be retrofitted with secondary service	Varies	NA	varies	2	83	83	83
					Total Non-Residential ERUs	**4,471**	**3,151**
					Total Combined ERUs[4]	**35,451**	**18,950**

[1]Represents the total number of ERUs with secondary irrigation service, not the total number of secondary irrigation ERUs
[2]Represents the total number of ERUs to be added to the secondary irrigation system. For users with both a culinary and secondary connection, this value is calculated by multiplying the total number of ERUs by 51%, which is the estimated percentage of total water use that occurs outdoors (based on the system as a whole). For ERUs that are solely for irrigation (no culinary service included in ERU estimate), all ERUs count towards a whole ERU on the secondary irrigation system (1:1 ratio).
[3]Additional irrigation demand in Entrada is associated with a future golf course located within the PD. An estimated 450 AF/yr of irrigation water will be used at the new golf course.
[4]The Shivwits Indian Reservation holds 2,000 AF of water shares from the St. George reuse facility. These shares are currently not in use, but are held in reserve. It is uncertain how or when these shares will be used, and have correspondingly been excluded from the total ERU count at buildout.

PROJECTED SECONDARY IRRIGATION DEMAND

Based on the evaluation and assumptions presented in this chapter, Table 3-13 provides the projected secondary irrigation system demand through buildout for St. George.

Table 3-13
St. George City Secondary Irrigation Water Use Projections[1,2]

Year	Overall Residential Growth %	Overall Non-Residential Growth %	Total St. George Residential ERUs	Total St. George Non-Residential ERUs	Total Culinary/Irrigation System ERUs	Total Culinary Water System ERUs	Total Residential Secondary Irrigation ERUs	Total Non-Residential Secondary Irrigation ERUs	Total Secondary Irrigation System ERUs	Annual Secondary Irrigation System Demand (acre-feet/year)	Peak Day Secondary Irrigation System Demand (gal/day)
2017			29,010	17,532	46,542	38,312	266	7,964	8,230	5,872	14,326,465
2018	2.81%	2.81%	29,825	18,025	47,850	39,613	273	7,964	8,237	5,878	14,340,101
2019	2.85%	2.85%	30,675	18,538	49,214	40,969	281	7,964	8,245	5,883	14,353,664
2020	3.00%	3.00%	31,596	19,094	50,690	41,997	709	7,984	8,693	6,203	15,133,000
2021	3.61%	3.61%	32,736	19,784	52,520	43,223	1,250	8,047	9,297	6,634	16,185,334
2022	3.61%	3.61%	33,918	20,498	54,416	43,579	1,812	9,025	10,837	7,733	18,866,255
2023	3.61%	3.61%	35,142	21,238	56,380	44,961	2,394	9,025	11,419	8,148	19,878,854
2024	3.61%	3.61%	36,411	22,005	58,416	45,676	3,001	9,739	12,740	9,090	22,178,527
2025	3.61%	3.61%	37,726	22,799	60,525	47,133	3,630	9,762	13,392	9,555	23,313,131
2026	3.61%	3.61%	39,087	23,622	62,709	48,642	4,283	9,785	14,068	10,038	24,489,516
2027	3.61%	3.61%	40,499	24,475	64,973	50,201	4,965	9,807	14,772	10,540	25,716,385
2028	3.61%	3.61%	41,961	25,358	67,319	51,822	5,667	9,830	15,497	11,058	26,978,486
2029	3.61%	3.50%	43,475	26,246	69,721	53,479	6,328	9,915	16,242	11,589	28,275,501
2030	3.61%	3.50%	45,045	27,164	72,209	55,222	6,988	9,999	16,987	12,121	29,572,517
2031	3.50%	3.00%	46,621	27,979	74,601	56,900	7,629	10,071	17,700	12,630	30,813,521
2032	3.40%	3.00%	48,206	28,819	77,025	58,630	8,251	10,143	18,395	13,125	32,022,661
2033	3.40%	2.50%	49,845	29,539	79,385	60,307	8,874	10,204	19,077	13,612	33,210,840
2034	3.30%	2.50%	51,490	30,278	81,768	62,027	9,478	10,264	19,742	14,086	34,367,155
2035	3.30%	2.50%	53,190	31,035	84,224	63,818	10,082	10,324	20,406	14,560	35,523,471
2036	3.10%	2.50%	54,838	31,810	86,649	65,616	10,649	10,384	21,033	15,008	36,616,058
2037	3.00%	2.00%	56,484	32,447	88,930	67,300	11,198	10,432	21,631	15,434	37,655,821
2038	3.00%	2.00%	58,178	33,096	91,274	69,046	11,747	10,481	22,228	15,860	38,695,584
2039	3.00%	2.00%	59,923	33,758	93,681	70,856	12,296	10,529	22,825	16,286	39,735,347
2040	3.00%	2.00%	61,721	34,433	96,154	72,731	12,846	10,577	23,422	16,713	40,775,109
2041	3.00%	2.00%	63,573	35,121	98,694	74,674	13,395	10,625	24,020	17,139	41,814,872
2042	3.00%	1.75%	65,480	35,736	101,216	76,605	13,944	10,667	24,611	17,561	42,844,154
2043	3.00%	1.75%	67,444	36,361	103,806	78,603	14,493	10,709	25,202	17,983	43,873,437
2044	1.70%	1.75%	68,591	36,998	105,589	80,033	14,804	10,751	25,555	18,235	44,488,487
2045	1.60%	1.75%	69,688	37,645	107,333	81,443	15,097	10,794	25,890	18,474	45,071,674
2046	1.00%	1.75%	70,385	38,304	108,689	82,573	15,280	10,836	26,116	18,634	45,463,676
2047	0.80%	1.75%	70,948	38,974	109,923	83,618	15,426	10,878	26,304	18,769	45,791,950
2048	0.70%	1.50%	71,445	39,559	111,004	84,535	15,555	10,914	26,468	18,886	46,077,880
2049	0.60%	1.50%	71,874	40,152	112,026	85,411	15,664	10,950	26,614	18,990	46,331,946
2050	0.50%	1.50%	72,233	40,755	112,988	86,245	15,756	10,986	26,742	19,081	46,554,148
2051	0.40%	1.35%	72,522	41,305	113,827	86,979	15,829	11,019	26,848	19,157	46,738,198
2052	0.40%	1.25%	72,812	41,821	114,633	87,682	15,902	11,049	26,951	19,230	46,918,055
2053	0.30%	1.25%	73,030	42,344	115,374	88,338	15,957	11,079	27,036	19,291	47,066,049
2054	0.30%	1.00%	73,250	42,767	116,017	88,902	16,012	11,103	27,115	19,347	47,203,562
2055	0.29%	0.49%	73,462	42,977	116,439	89,259	16,065	11,115	27,180	19,394	47,316,509

[1]See Chapter 3 of Culinary Water Master Plan for more information on overall water use projections for the City.
[2]Water use projections shown in the table are based on historical water use trends and do not include adjustments for water conservation. Water conservation goals are discussed and accounted for in Chapter 4 of this report.

LOCATION OF GROWTH OVER 10 YEAR PLANNING WINDOW

To the extent possible, it is helpful in planning to understand the timing and location of growth within the service area, particularly within the 10-year growth window. While it is impossible to predict the exact location and timing of all growth which will occur in the City, reasonable estimates can be made by evaluating recent growth trends and identifying "hotspots" in the system (areas experiencing the most rapid development). Through discussions with City staff, hotspots within the City service area have been identified and growth has been divided between different regions. The estimated distribution of growth is shown in Table 3-14. As indicated in Table 3-14, the number of ERUs estimated to be added to the system over the next 10 years is:

$$67{,}319\ (2028\ total\ ERUs) - 47{,}850\ (2018\ total\ ERUs) = \mathbf{19{,}469\ ERUS}$$

The regions shown in Table 3-14 are displayed in Figure 3-4. Note that the ERUs shown in Table 3-14 will be served by a combination of culinary and secondary irrigation water.

Table 3-14
Estimated Distribution of Growth over 10-Year Planning Window

Region	10 Year Growth in ERUs	Added Culinary ERUs[1]	Added Secondary Irrigation ERUs	% of 10 Year Growth
Airport	4,000	2,694	1,306	21%
Bloomington	100	100	0	1%
Bloomington Hills	350	172	178	2%
Bloomington Hills Upper	1,200	1,200	0	6%
Dixie Drive	2,200	1,547	653	11%
Downtown	2,200	1,434	66	11%
Ledges	650	(573)[2]	1,223	3%
Little Valley	3,069	1,907	1,162	16%
South Block/Sun River	4,500	2,664	1,836	23%
Sunset	1,200	1,064	836	6%
Total	**19,469**	**12,209**	**7,260**	

[1]See St. George Culinary Water Master Plan for more information.
[2]Culinary demands to be converted to secondary irrigation.

Note: Refer to Table 3-14 for information regarding the assumed distribution of growth over the next 10 years

Ledges/Trails
Ivins City
Snow Canyon Parkway
Washington City
Santa Clara City
Sunset
Red Hills Parkway
Downtown
Dixie Drive/ Tonaquint
I-15
Bloomington Hills
Little Valley
Bloomington
Brigham Rd
Bloomington Hills Upper
Sun River/South Block
Airport/Desert Canyons
Southern Parkway

BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE
SECONDARY IRRIGATION MASTER PLAN

REGIONS FOR 10-YEAR GROWTH DISTRIBUTION

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 3-4

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 3-4 - Regions For 10-Year Growth Distribution.mxd aanderson 10/26/2019

CHAPTER 4
SUPPLY SOURCE EVALUATION

INTRODUCTION

Water supply sources are the foundation of St. George's secondary irrigation system. Maintaining reliable sources and developing new source capacity as necessary are critical to the success of the system. The purpose of this chapter is to provide a description of the City's existing secondary irrigation sources, evaluate their ability to meet existing and future demands, and provide recommendations regarding the development of new sources.

SUMMARY OF EXISTING SECONDARY IRRIGATION SOURCES

The St. George secondary irrigation system receives water from a combination of surface water and groundwater sources. Water quality varies with each source, with some sources yielding water with higher levels of total suspended solids (TSS) and total dissolved solids (TDS). In general, sources that are located closer to the Virgin River or that come directly from the Virgin River have higher concentrations of TSS and TDS. TSS can be managed through the use of settling ponds, but TDS removal requires more sophisticated technology that is not cost effective for an irrigation system. High TDS levels in water may have adverse effects on certain types of vegetation. In order to manage the effects of high TDS levels, water can be blended from higher quality water sources to reduce the overall TDS concentrations. It is also important that irrigators understand what type of landscaping is best suited for water that is high in TDS.

The following sections provide a detailed description of each of the City's secondary irrigation sources.

Surface Water Sources

Washington Dam Diversion

The Washington Dam Diversion is located on the Virgin River near the intersection of E. Washington Dam Road and the Southern Parkway. Water is diverted from the river into a large transmission line ranging from 54" to 72" in diameter. The pipeline runs through Washington City and enters St. George near the intersection of 3870 E and 2760 S. The City of St. George holds shares in several irrigation companies that divert flow at Washington Dam. Table 4-1 provides a summary of these water shares:

Table 4-1
Washington Dam Diversion Irrigation Shares

Irrigation Company	Annual Yield (acre-feet/year)	Peak Source Capacity (gpm)	Average TDS (mg/L)
St. George Valley Irrigation Company	1,759	2,700	2,200
Bloomington Water Company	1,247	900	2,500
St. George Washington Fields Canal Company	1,873	2,700	2,300
Total	**4,879**	**6,300**	

Gunlock Reservoir

Gunlock Reservoir is located approximately 15 miles northwest of St. George. A 30" pipeline runs from the reservoir into Ivins, Santa Clara, and St. George. Table 4-2 provide a summary of the City's water shares from the Gunlock system.

Table 4-2
Gunlock Reservoir Irrigation Shares

Irrigation Company	Annual Yield (acre-feet/year)	Peak Source Capacity (gpm)	Average TDS (mg/L)
St. George Clara Fields Canal Company	696	1,000	600
New Santa Clara	5	20	600
Total	**701**	**1,020**	

[1]Shares in the St. George Clara Fields Canal Company and New Santa Clara are subject to cuts in dry years. The annual yield shown is equal to 50% of the total allotment, which is the amount available on a dry year.
[2]Several wells located throughout Santa Clara can provide supplemental water into the Gunlock system. These wells are tied to the canal companies and any water used from these wells counts toward the shares in the irrigation companies. Therefore, the wells do not represent any additional capacity above what is shown in the table.

Seep Ditch Diversion

The Seep Ditch water right is located on the Santa Clara River near Vineyard Road & River Front Drive in Santa Clara City. The water right allows for an annual diversion of 1,097.7 acre-feet and a peak diversion of 1,580 gpm. This water right is currently undeveloped, and the City has considered submitting an application to change the Seep Spring water right from a surface water right to a groundwater right in order to develop a new well source in a more beneficial location.

Spring Water Sources

West City Springs

The West City Springs are located on the Dixie Red Hills Golf Course. The springs are used primarily to irrigate the golf course, but water can also be pumped from the springs in the winter to the Skyline Pond. The annual yield and peak capacity of West City Springs are shown in Table 4-3.

East City Springs

The East City Springs are located off of Industrial Road in the industrial area near I-15 and Red Hills Parkway. Flow from East Springs is collected in a pipe that runs south on Industrial Road and then west on St. George Boulevard. The pipe in St. George Boulevard then discharges water into the gutter to supply water to flood irrigators in the downtown area. Any unused water in the downtown area arrives at 700 South where it is collected and sent to the Snow Park Pond. The annual yield and peak capacity of West City Springs are shown in Table 4-3.

Millcreek Springs

The Millcreek Springs are located near Green Springs Golf Course in Washington City. Flow from the springs feeds into Millcreek where it is then diverted into a turnout pipeline at 200 south in Washington. This pipeline conveys water to Sandberg Pond/pump station. The capacity of Millcreek Springs are shown in Table 4-3.

Table 4-3
St. George Irrigation Spring Sources

Source	Annual Yield (acre-feet/year)	Peak Source Capacity (gpm)	Average TDS (mg/L)
West City Springs	550	341	1,100
East City Springs	480	300	1,250
Millcreek Springs	670	1,000	1,800
Total	**1,700**	**1,641**	

Groundwater Well Sources

Sunbrook Well No. 1, No.2, and No. 3

The Sunbrook Wells are located on Sunbrook Golf Course off of Dixie Drive. The 3 wells tie into the irrigation system on the upstream side of the Sunbrook Pump Station, feeding water into the "St. George Clara Fields/Reuse" pressure zone. The Sunbrook Well capacities are shown in Table 4-4.

Mathis & Moores Well

The Mathis Well and the Moores Well are located near Mathis Park along the Santa Clara River. These wells are not frequently used, but have the ability to deliver water to the Entrada Pond and to the Sunbrook Pump Station. The capacity of the Mathis and Moores Wells is shown in Table 4-4.

Sunset Well

The Sunset Well is located at Sunset Park/Sunset Elementary School. The well produces water to irrigate the park and school. The City water department has discussed reallocating a portion of the water rights tied to Sunset Well in order to develop an additional well in another location. The current capacity of the Sunset Well is shown in Table 4-4.

Gunlock Well No. 1, No. 3, and No. 4

The Gunlock Well Field is located below Gunlock Reservoir. A number of the Gunlock Wells contain high levels of arsenic, making them unsuitable for the culinary water system. The City is currently constructing an arsenic treatment facility for the Gunlock Wells, but wells 1, 3, and 4 will remain as irrigation wells. The wells feed into the 30" Gunlock transmission line. The capacity of each well is shown in Table 4-4.

Table 4-4
St. George Irrigation Well Sources

Well Source	Annual Yield (acre-feet/year)	Peak Source Capacity (gpm)	Average TDS (mg/L)
Sunbrook Well No. 1	900	600	1,800
Sunbrook Well No. 2	1,276	900	1,800
Sunbrook Well No. 3	640	700	1,800
Mathis Well	300	250	4,400
Moores Well	175	400	4,300
Sunset Well	200	150	3,400
Gunlock Well No. 1	800	1,000	300
Gunlock Well No. 3	636	800	300
Gunlock Well No. 4	1,101	1,385	300
Total	**6,028**	**6,185**	

Other Irrigation Sources

SGWRF Reuse Facility

Chapter 2 provides a detailed description of the SGWRF Reuse Facility. The facility currently has a treatment capacity of 7.0 MGD, which is expandable to up to 14 MGD. The pump station has the ability to deliver 4,800 gpm (6.9 MGD) of treated water into the 24-inch reuse pipeline, which can deliver water to as far as Ivins Reservoir. The City's water rights allow for 6,400 acre-feet of water to be used through the Reuse Facility per year. Of this 6,400 acre-foot block of water, the City has an agreement in place with the Shivwits Indian Reservation to deliver up to 2,000 acre-feet per year through the reuse pipeline to the Reservation or a lessee of the Reservation. For this reason, only 4,400 acre-feet has been counted towards the City's water portfolio from the reuse facility; the remaining 2,000 acre-feet is held as a reserve and is not currently available to be used toward the City's future demands.

Total Existing Secondary Water Sources

The yields of all secondary sources discussed above are summarized in Table 4-5.

Table 4-5
Combined Existing Irrigation Source Capacity

Irrigation Company	Annual Yield (acre-feet/year)	Peak Source Capacity (gpm)	Average TDS (mg/L)
St. George Valley Irrigation Company	1,759	2,700	2,200
Bloomington Water Company	1,247	900	2,500
St. George Washington Fields Canal Company	1,873	2,700	2,300
Total Washington Dam Diversion Source Capacity	***4,879***	***6,300***	
St. George Clara Fields Canal Company	696	1,000	600
New Santa Clara	5	20	600
Total Gunlock Reservoir Source Capacity	***701***	***1,020***	
West City Springs	550	341	1,100
East City Springs	480	300	1,250
Millcreek Springs	670	1,000	1,800
Total Spring Capacity	***1,700***	***1,641***	
Sunbrook Well No. 1	900	600	1,800
Sunbrook Well No. 2	1,276	900	1,800
Sunbrook Well No. 3	640	700	1,800
Mathis Well	300	250	4,400
Moores Well	175	400	4,300
Sunset Well	200	150	3,400
Gunlock Well No. 1	800	1,000	300
Gunlock Well No. 3	636	800	300
Gunlock Well No. 4	1,101	1,385	300
Total Well Capacity	***6,028***	***6,185***	
Seep Ditch[1]	1,098	1,580	N/A
SGWRF Reuse Facility	4,400	4,800	1,100
Total Other Source Capacity	***4,400***	***4,800***	
Total Combined Source Capacity	**17,708**	**19,946**	

[1]Seep Ditch is currently undeveloped and is not included in the total existing combined irrigation source capacity.

REQUIRED IRRIGATION SOURCE CAPACITY

Utah Administrative Code (UAC) R309-510 requires that sources for a public water system be capable of physically and legally meeting water demands under two conditions:

1. **Peak Day Demand –** The water system's source capacity shall be able to meet the anticipated water demand on the day of the highest water consumption, which is the peak day demand.

2. **Average Yearly Demand –** The water system's source capacity shall also be able to provide one year's supply of water, which is the average yearly demand.

While UAC R309-510 pertains specifically to drinking water systems, the City's irrigation system sources have been evaluated using the same criteria.

EVALUATION OF SOURCE CAPACITY

Table 3-9 in Chapter 3 presents the actual estimated annual and peak day demand per ERU for St. George from 2016 -2019. This value represents the quantity of water that passes through the customer meter plus any losses that occur between the source and the end user. This unit demand is used to project actual expected demands, but source planning should include a buffer to protect against variations in source production and system demand patterns. Chapter 3 of the Culinary Water Master Plan identifies the recommended source sizing standard per ERU which includes a 20% safety buffer to account for future fluctuations in water demand. The recommended source sizing standard per ERU is summarized in Table 4-6.

Table 4-6
Proposed Source Sizing Standard per ERU

Year	Average Annual Demand per ERU (gal/yr)	Peak Day Demand per ERU (gallons per day)
2016	208,017	1,151
2017	232,583	1,278
2018	217,499	1,206
2019	206,827	1,248
Maximum Value	232,583	1,278
Recommended Variation Factor	**20%**	**20%**
Minimum Source Sizing Value per ERU	***279,100***	**1,534**

EFFECTS OF WATER CONSERVATION

Water conservation has been a priority for the City of St. George and will continue to be a priority moving forward. As part of the water use projections presented in this report, it has been assumed that the City will achieve a 10% reduction in water use per ERU by the year 2030, and that this reduced water use per ERU will be sustained into subsequent years. Based on the recommended source sizing standard per ERU shown in Table 4-6 and the assumed conservation rate in the future, Table 4-7 provides a required source sizing projection through buildout of St. George City.

Table 4-7
Recommended Secondary Irrigation Source Sizing through Estimated Buildout

Year	Total Secondary Irrigation System ERUs	Expected Annual Secondary Irrigation System Demand, No Conservation (acre-feet/year)	Expected Annual Secondary Irrigation System Demand, with Conservation (acre-feet/year)	Expected Peak Day Secondary Irrigation System Demand[1] (gal/day)	Recommended Average Annual Source Sizing Standard with Safety Buffers (acre-feet/year)	Recommended Peak Day Secondary Irrigation System Demand Sizing with Safety Buffers[2] (gal/day)
2017	8,230	5,872	5,872	14,326,465	7,046	17,191,758
2018	8,237	5,878	5,829	14,340,101	6,994	17,208,121
2019	8,245	5,883	5,786	14,353,664	6,943	17,224,397
2020	8,693	6,203	6,049	15,133,000	7,259	18,159,600
2021	9,297	6,634	6,416	16,185,334	7,699	19,422,401
2022	10,837	7,733	7,416	18,866,255	8,899	22,639,506
2023	11,419	8,148	7,749	19,878,854	9,299	23,854,625
2024	12,740	9,090	8,573	22,178,527	10,288	26,614,233
2025	13,392	9,555	8,937	23,313,131	10,724	27,975,757
2026	14,068	10,038	9,309	24,489,516	11,171	29,387,419
2027	14,772	10,540	9,694	25,716,385	11,633	30,859,662
2028	15,497	11,058	10,085	26,978,486	12,102	32,374,184
2029	16,242	11,589	10,482	28,275,501	12,579	33,930,602
2030	16,987	12,121	10,909	29,572,517	13,091	35,487,020
2031	17,700	12,630	11,367	30,813,521	13,640	36,976,225
2032	18,395	13,125	11,813	32,022,661	14,175	38,427,193
2033	19,077	13,612	12,251	33,210,840	14,701	39,853,008
2034	19,742	14,086	12,678	34,367,155	15,213	41,240,587
2035	20,406	14,560	13,104	35,523,471	15,725	42,628,165
2036	21,033	15,008	13,507	36,616,058	16,209	43,939,270
2037	21,631	15,434	13,891	37,655,821	16,669	45,186,985
2038	22,228	15,860	14,274	38,695,584	17,129	46,434,701
2039	22,825	16,286	14,658	39,735,347	17,589	47,682,416
2040	23,422	16,713	15,041	40,775,109	18,050	48,930,131
2041	24,020	17,139	15,425	41,814,872	18,510	50,177,846
2042	24,611	17,561	15,805	42,844,154	18,966	51,412,985
2043	25,202	17,983	16,184	43,873,437	19,421	52,648,124
2044	25,555	18,235	16,411	44,488,487	19,693	53,386,185
2045	25,890	18,474	16,626	45,071,674	19,952	54,086,008
2046	26,116	18,634	16,771	45,463,676	20,125	54,556,411
2047	26,304	18,769	16,892	45,791,950	20,270	54,950,340
2048	26,468	18,886	16,997	46,077,880	20,397	55,293,456
2049	26,614	18,990	17,091	46,331,946	20,509	55,598,335
2050	26,742	19,081	17,173	46,554,148	20,608	55,864,977
2051	26,848	19,157	17,241	46,738,198	20,689	56,085,837
2052	26,951	19,230	17,307	46,918,055	20,769	56,301,666
2053	27,036	19,291	17,362	47,066,049	20,834	56,479,259
2054	27,115	19,347	17,413	47,203,562	20,895	56,644,275
2055	27,180	19,394	17,454	47,316,509	20,945	56,779,811

[1]Conservation assumed to reduce annual average water use, but peak usage has been conservatively assumed to remain unchanged.
[2]Values calculated by multiplying the expected peak day demand values by the appropriate safety buffers rather than multiplying the number of ERUs by the peak day demand per ERU. The peak day demand per ERU value shown in Table 4-6 is based on culinary water use patterns, so the approach taken to calculate the recommended peak day secondary irrigation demand takes into account the appropriate peaking factor for the secondary irrigation system (this is discussed in detail in Chapter 3).

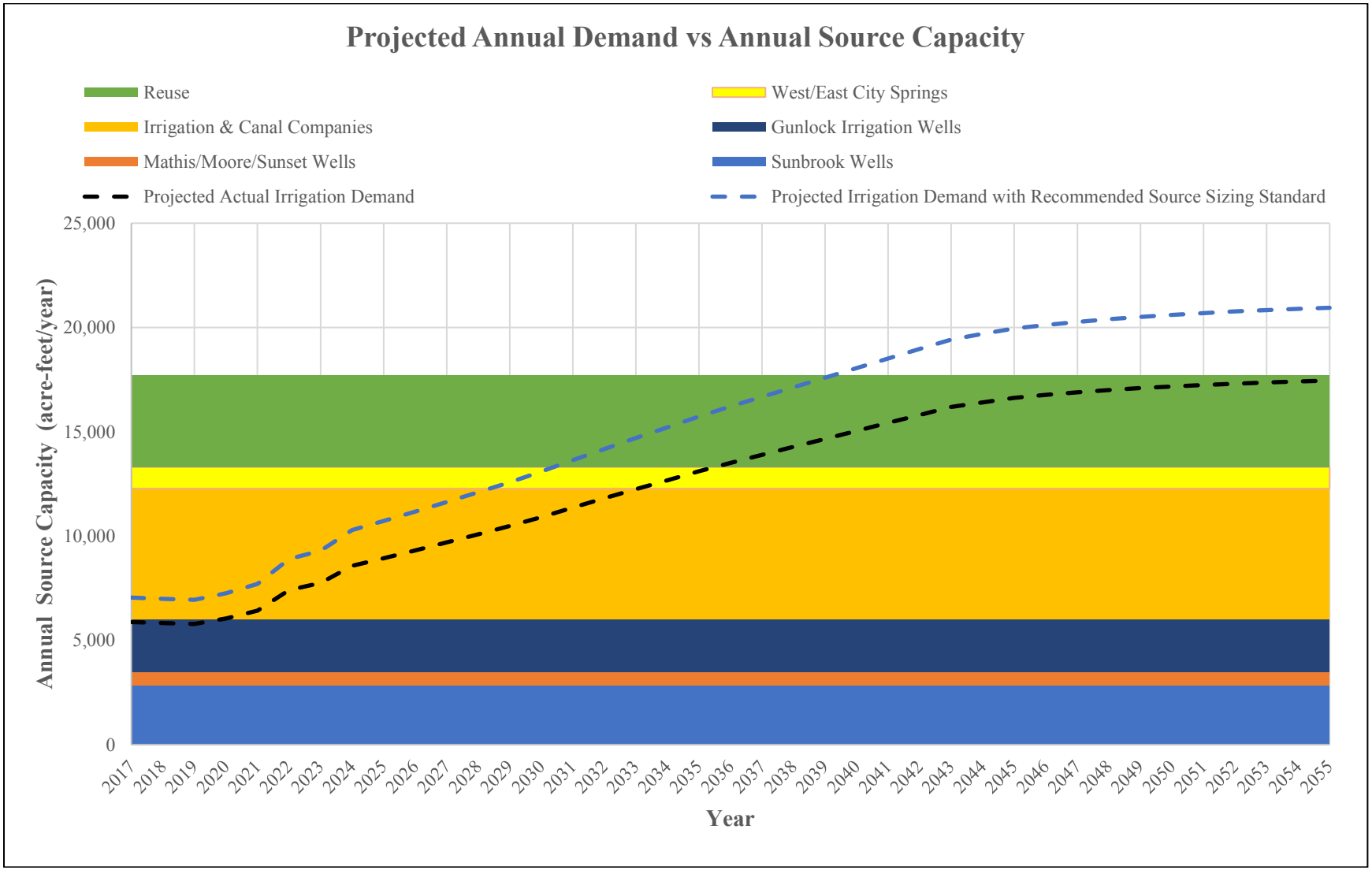
Using the values shown in Table 4-7, Figure 4-1 compares projected annual system demand against the City's annual source capacity, and Figure 4-2 provides the same comparison with peak day demand and peak source production capacity.

SOURCE DEVELOPMENT RECOMMENDATIONS

As shown in Figure 4-1, the City's irrigation sources have enough capacity to meet projected average annual demands through the year 2040. However, when evaluated on the basis of peak day demand capacity, existing sources have enough capacity to meet demands through approximately 2026 (see Figure 4-2). This considered, future source development projects will be driven primarily by a need to meet peak system demands. The following are recommendations for future source development projects. The location of the recommended source improvements is shown on Figure 4-6 at the end of the chapter.

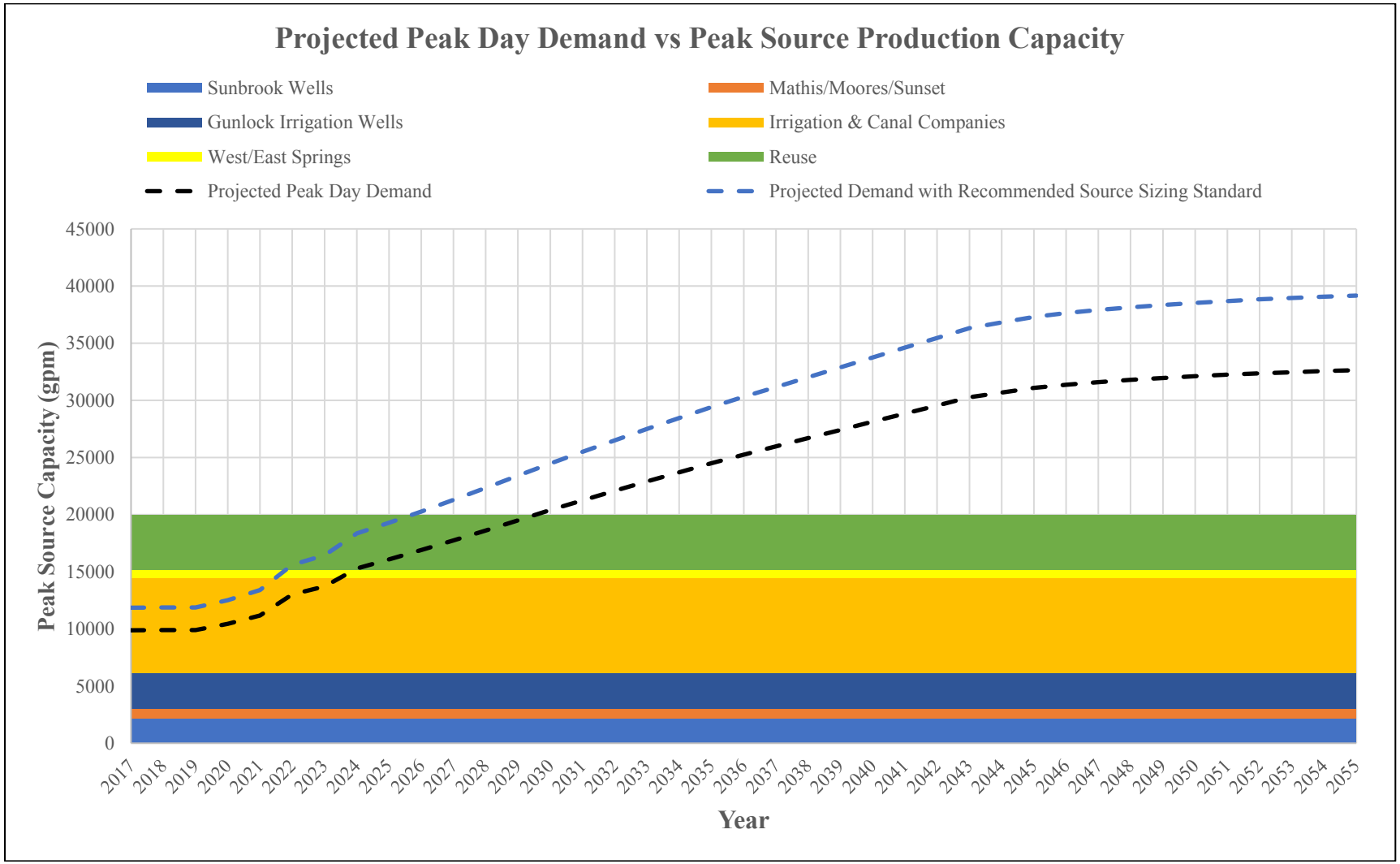
- **Upgrade Existing SGWRF Reuse Facility (Completed by 2024):** The existing SGWRF reuse facility has one empty filter bay and space for two additional pumps. By upgrading the final filter bay with an advanced filter material, the capacity of the facility can be upgraded to 14 MGD. With this upgrade, it has been assumed that the City will be able to acquire an additional 3,000 acre-feet per year in reuse water. Adding two additional pumps to the reuse facility will double the existing capacity from 4,800 gpm to 9,600 gpm.
- **Develop the Seep Springs Source (Completed by 2030, 2031):** If possible, the Seep Ditch water right should be changed to a groundwater right in order to develop a new well or wells in a more beneficial part of the system. The ideal location for a new well or wells would be in the Entrada area. A well or multiple wells in this area could help supplement demands in the Entrada area as well as the Ledges/Trails area.

Figure 4-1
Projected Annual Demand vs. Existing Annual Source Capacity[1]



[1]Projections include estimated conservation in the future.

Figure 4-2
Projected Peak Day Demand vs. Existing Peak Source Production Capacity[1]



[1]Conservation has been assumed to influence average annual usage and has not been assumed to reduce peak system demands.

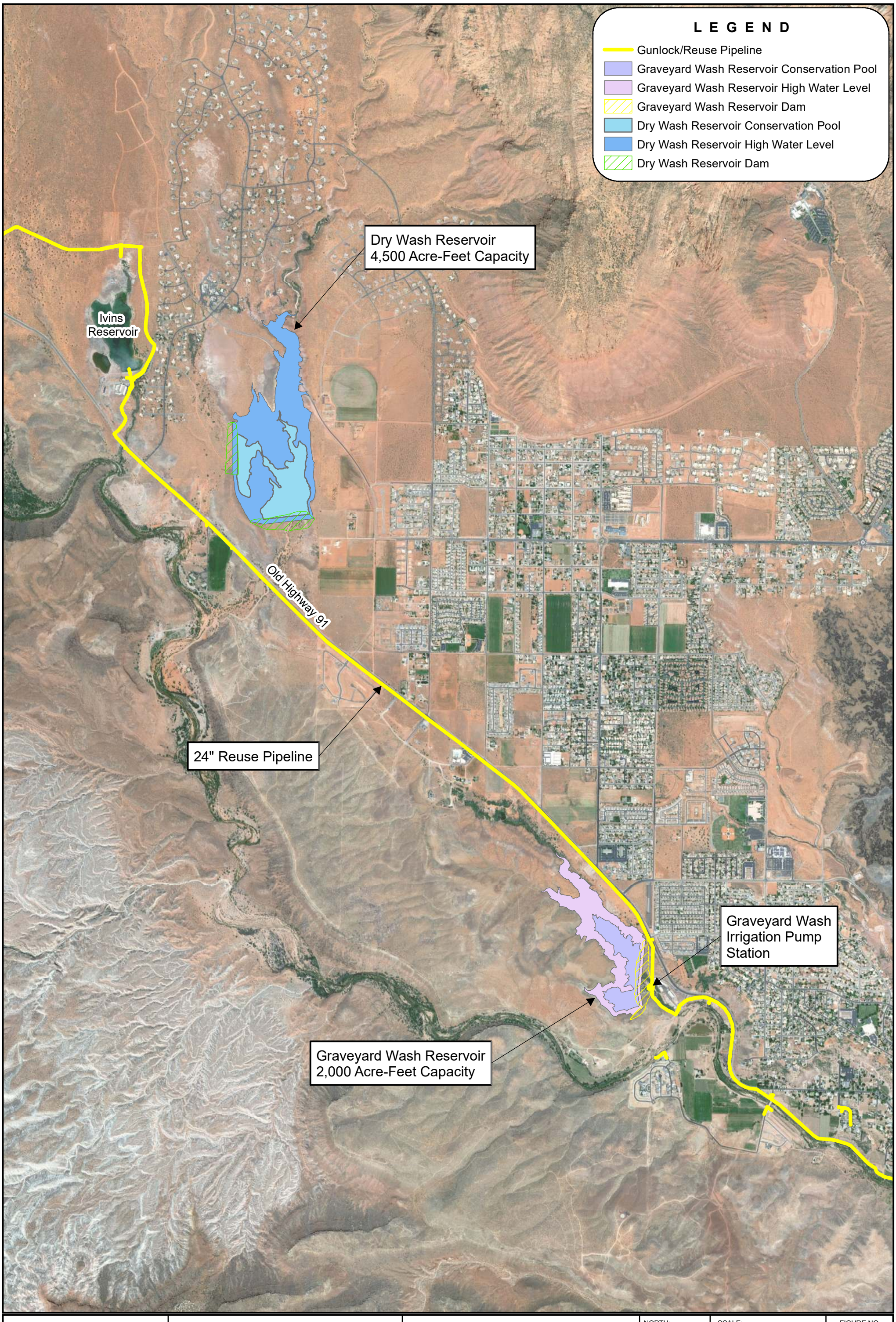
- **Construct Graveyard Wash Reservoir (Completed by 2032)**: The City of St. George has recently evaluated two irrigation reservoir locations in Santa Clara and Ivins: Graveyard Wash Reservoir and Dry Wash Reservoir. These conceptual reservoirs are shown on Figure 4-3. The approximate volume of each reservoir option is summarized in Table 4-8.

Table 4-8
Potential Irrigation Reservoirs

Reservoir Name	Total Storage Volume (acre-feet)	Conservation Pool Volume (acre-feet)	Effective Storage Volume
Graveyard Wash Reservoir	2,000	500	1,500
Dry Creek Wash Reservoir	4,500	1,000	3,500
Total	**6,500**	**1500**	**5,000**

Through discussions with the St. George Water Department, Graveyard Wash Reservoir has been identified as the preferred facility to service the secondary irrigation system. The reservoir will provide valuable storage capacity for the system and will allow the City to run a number of its irrigation sources for a longer period of time throughout the year (water can be produced and stored in the reservoir during the winter in order to be used during the irrigation season). Based on the proposed volume of the reservoir, Graveyard Wash Reservoir could provide up to 10,000 gpm in peaking capacity without draining the reservoir below its conservation pool. However, based on projected system demands in the future, the reservoir will need to provide 3,000 gpm of peak day capacity for the system. This number is based on the assumption that the City's others sources on the west side of the service area are also producing water, such as the Sunbrook Wells and the Gunlock Wells. In reality, the reservoir will provide valuable redundancy for the system that can provide capacity during peak demands without the need to actually run all of the system wells, meaning that the demand out of the reservoir will likely exceed 3,000 gpm under many scenarios. From a "water accounting" standpoint, the reservoir has been assumed add 3,000 gpm of peak source capacity to the system.

- **Additional Reuse Expansion (Completed by 2034, 2040)**: A large portion of future growth in St. George will occur in the south end of the City. Two major developments, Desert Color and Desert Canyons, will add over 15,000 new residential and commercials units over the next several years. All of Desert Color and a large portion of Desert Canyons are included in the expansion areas for the secondary irrigation system. Reuse water will play a pivotal role in meeting future demands in these regions. Based on future demand projections, it is recommended that the City expand its reuse facilities in the future, with a 5,000 gpm upgrade in 2034 and another 5,000 gpm upgrade in 2040.
- **Desert Color Supplemental Wells (2040 – 2045)**: The City owns water rights along the Virgin River that could be used to supplement source capacity for the system. However,



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE
SECONDARY IRRIGATION MASTER PLAN

POTENTIAL IRRIGATION RESERVOIR LOCATIONS

NORTH:

SCALE: 0 1,000 2,000 Feet

FIGURE NO. 4-3

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 4-3 - Potential Irrigation Reservoir Locations.mxd aanderson 10/28/2019

groundwater around the Virgin River is very high is TDS, making it difficult to use in the system. However, if groundwater were blended with reuse water, the TDS concentration could be brought down to useable levels. This considered, it is recommended that the City plan to develop up to 3 wells in the Desert Color area that feed into different ponds in the development (avoiding overloading a single pond with multiple wells, blending at a ratio of 1:1 with reuse water).

- **Ledges/Trails Irrigation Wells (2044, 2050)**: The City has an existing dry irrigation line that starts near the North Entrada Pond, runs to the northeast through the State Park/BLM land, and ends just beyond the BLM property line. This line can provide approximately 2,000 gpm into the Ledge/Trails area of the system (once the necessary booster pump stations have been constructed). Projected secondary irrigation demand in the Ledges/Trails region is approximately 3,000 gpm, meaning that an additional 1,000 gpm of peak source production capacity will be needed at buildout. This additional source capacity will be met through constructing new irrigation wells in the Ledges/Trails area. It has been assumed that the City will construct 2 wells, each with a capacity of 500 gpm.

Table 4-9 provides an overall summary of the recommended source development projects along with an estimated construction cost in 2018 dollars. Figures 4-4 and 4-5 replicate Figure 4-1 and 4-2, respectively, but include the proposed improvement projects outlined in Table 4-9.

Table 4-9
Recommended Source Improvement Projects

Project Year	Project Name	Project ID	Project Description	Estimated Construction Cost (2018 Dollars)	Engineering, Legal, Admin (15% of Construction Cost)	Total Estimated Cost (2018 Dollars)
2024	Upgrade Existing Reuse Facility	I1	Equip 3rd Filter Bay, Install Additional Booster Pumps at Reuse Facility	$1,200,000	$180,000	$1,380,000
2030	Seep Ditch Water Right Well No. 1	I2	Drill and Equip 800 gpm Irrigation Well under Reallocated Seep Ditch Water Right	$1,600,000	$240,000	$1,840,000
2031	Seep Ditch Water Right Well No. 2	I3	Drill and Equip 800 gpm Irrigation Well under Reallocated Seep Ditch Water Right	$1,600,000	$240,000	$1,840,000
2032	Graveyard Wash Reservoir	I4	Construct 2,000 AF Graveyard Wash Reservoir	$11,000,000	$1,650,000	$12,650,000
2034	Additional Reuse Facility	I5	Construct New Reuse Facility at SGWRF with 7 MGD Treatment Capacity and 5,000 gpm pumping capacity (expandable to 14 MGD, 10,000 gpm pumping capacity)	$7,000,000	$1,050,000	$8,050,000
2040	Complete Reuse Facility Expansion	I6	Complete Expansion of 2034 Reuse Project	$1,500,000	$225,000	$1,725,000
2041	Desert Color Irrigation Well No. 1	I7	Drill and Equip 400 gpm irrigation well in Desert Color	$800,000	$120,000	$920,000
2042	Desert Color Irrigation Well No. 2	I8	Drill and Equip 400 gpm irrigation well in Desert Color	$800,000	$120,000	$920,000
2044	Desert Color Irrigation Well No. 3	I9	Drill and Equip 500 gpm irrigation well in Desert Color	$1,000,000	$150,000	$1,150,000
2044	Ledges/Trails Irrigation Well No. 1	I10	Drill and Equip 500 gpm Irrigation Well in Ledges/Trails Area	$1,000,000	$150,000	$1,150,000
2050	Ledges/Trails Irrigation Well No. 2	I11	Drill and Equip 500 gpm Irrigation Well in Ledges/Trails Area	$1,000,000	$150,000	$1,150,000
			Total	**$28,500,000**	**$4,275,000**	**$32,775,000**

Figure 4-4
Projected Annual Demand vs. Annual Source Capacity with Proposed Source Improvements

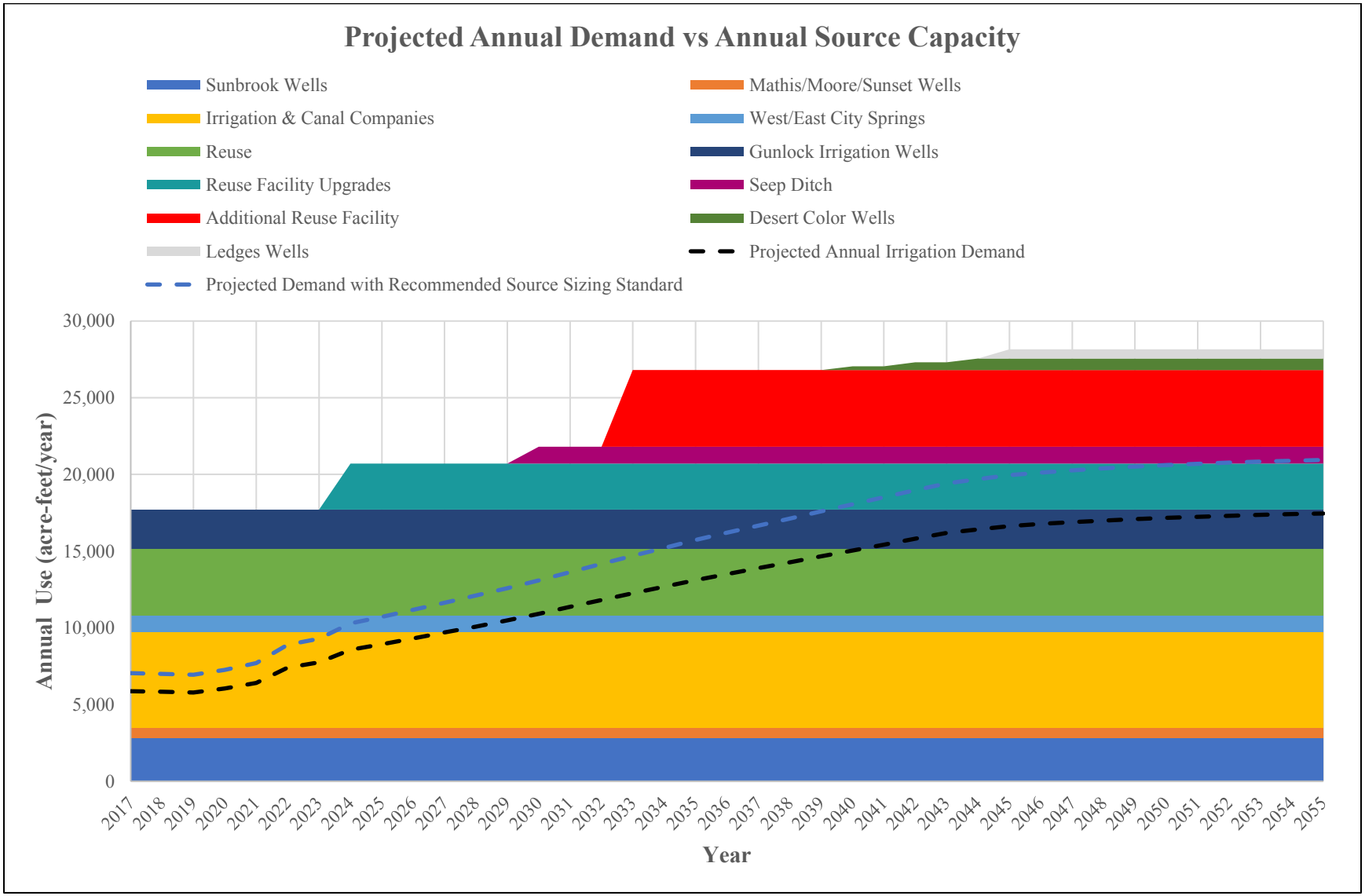
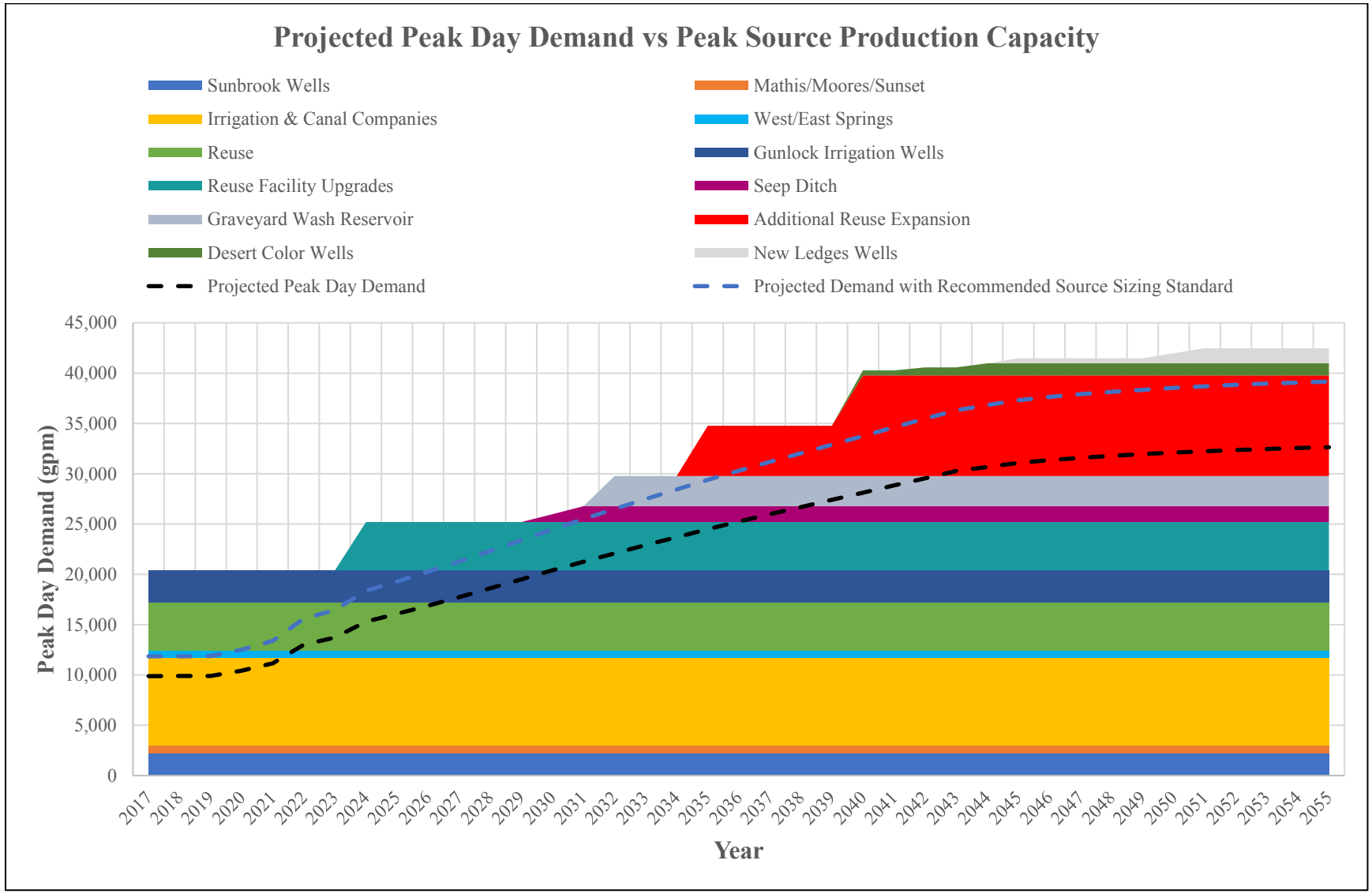


Figure 4-5
Projected Peak Day Demand vs. Peak Source Production Capacity with Proposed Source Improvements



Project I10
Ledges Irrigation Well No. 1
Date: 2044
(Location TBD)

Project I11
Ledges Irrigation Well No. 2
Date: 2050
(Location TBD)

Project I4*
Graveyard Wash Reservoir
Date: 2032

Project I2,I3
Seep Ditch Source Development
(Water Right to be Relocated)
Date: 2030, 2031

Project I1
Upgrade Existing Reuse Facility
Date: 2024

Project I5,16
Additional Reuse Facility
Date: 2034, 2040

Project I7
Deser Color Irrigation Well No.1
Date: 2041
(Location TBD)

Project I9
Deser Color Irrigation Well No.3
Date: 2044
(Location TBD)

Project I8
Deser Color Irrigation Well No.2
Date: 2042
(Location TBD)

LEGEND

- New Irrigation Source
- Graveyard Wash Reservoir
- City Boundary

*Graveyard Wash Reservoir will function as a source development project and a storage project. The project is also discussed in Chapter 5 of this report.

BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

RECOMMENDED SOURCE IMPROVEMENT PROJECTS

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 4-6

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 4-6 - Recommended Source Improvement Projects1.mxd aanderson 10/31/2019

CHAPTER 5
STORAGE EVALUATION

INTRODUCTION

Storage facilities play an important role in a water delivery system. Storage facilities provide a buffer between water sources and the distribution system. The primary function of storage is to provide equalization for the system and provide flow to users when demand exceeds the capacity of sources. This chapter provides a description of the City's existing storage facilities and an evaluation of these facilities under existing and future demand conditions. The results of this evaluation have been used to identify future storage improvements for the system.

REQUIRED STORAGE VOLUME

Storage volume requirements are specific to the type of system being operated. For a culinary water system, storage facilities must include operational storage (also referred to as equalization storage), emergency storage, and fire flow storage. However, secondary irrigation systems are not required to maintain emergency storage or fire flow storage. For the secondary irrigation system, it is recommended that the City maintain an equalization storage volume equal to 50% of peak day demand.

EXISTING STORAGE FACILITIES

Storage for the existing secondary irrigation system is provided through a combination of rubber (EPDM) lined or clay lined ponds, concrete lined settling ponds, and enclosed storage tanks. Table 5-1 provides a summary of the City's existing storage facilities. The available capacity in each facility has been determined as follows:

- **Rubber/Clay Lined Pond**: This type of pond is generally located near a golf course or other large irrigation demand site. Since these ponds are not frequently cleaned, they are susceptible to algal and other microbial growth. If pond levels drop too low, the exposed banks of the pond can generate odors. At the direction of Water Department management, it has been assumed that 2 feet of a rubber lined pond's depth can be used as equalization storage. This volume is roughly calculated by multiplying the pond's area in square feet by 2 feet and converting the volume to gallons.
- **Concrete Lined Ponds**: Concrete lined ponds provide storage for the system, but their primary function is to provide settlement of suspended solids prior to the water entering the distribution system. Settlement is necessary for any water that comes from the Virgin River (Washington Dam Diversion). The concrete lining in the pond helps facilitate routine cleaning and the removal of accumulated solids. Based on discussions with Water Department management, it has been assumed that 50% of the volume of the City's settling ponds can be used as equalization storage. To provide sufficient settlement of suspended solids, settling ponds should be large enough to provide a detention time of 24 hours.
- **Enclosed Storage Tanks**: The City has a total of 4 enclosed storage tanks, 2 of which function as wet wells for pump stations. The full volume of enclosed storage tanks has been assumed to be usable as system storage.

Table 5-1
St. George City Secondary Irrigation Existing Storage Facilities

Rubber/Clay Lined Pond	Approximate Surface Area (sq-ft)	Approximate Useable Storage Volume (gallons)
Bloomington Hills	88,964	1,331,000
Entrada	42,005	628,000
North Entrada	64,910	971,000
Sandberg	98,645	1,476,000
Skyline	52,251	782,000
Tonaquint/Southgate	24,173	362,000
Blackrock[1]	67,421	0
Canyon Complex[1]	22,891	0
Middle[1]	10,860	0
Red Hills Golf[1]	53,661	0
Southgate Back 9[1]	38,351	0
Southgate Club[1]	80,057	0
Sun River[1]	465,357	0
Tawa[1]	37,480	0
Woodbridge[1]	79,142	0
Total Natural Pond Storage		**5,550,000**
Concrete Lined Pond	**Total Volume (gallons)**	**Useable Volume (gallons)**
East Bloomington	1,100,000	550,000
Little Valley	1,100,000	550,000
Snow Park	1,200,000	600,000
Total Concrete Lined Storage	**3,400,000**	**1,700,000**
Enclosed Storage Tanks	**Total Volume (gallons)**	**Total Useable Volume (gallons)**
St. George Golf	1,300,000	1,300,000
Bloomington Hills (Small Tank)	108,000	108,000
Sunbrook[2]	100,000	0
Graveyard[2]	100,000	0
Total Enclosed Storage Volume	**1,308,000**	**1,408,000**
Total Useable Storage		**8,658,000**

[1]Storage pond services a specific, localized user and is not a shared facility. It is therefore not included in the total useable storage in the system.
[2]Storage tank functions as a wet well for a pump station and does not provide functional storage for the system.

EVALUATION OF EXISTING AND FUTURE STORAGE FACILITIES

The City's storage facilities have been evaluated under existing and future demand conditions based on the estimated distribution of demand across the system. Based on the estimated

distribution of demand in the different irrigation system pressure zones, Tables 5-2 through 5-4 provide a summary of the storage evaluation for the existing system, the system 10 years in the future, and the system at full buildout, respectively. Under these three demand scenarios, the tables identify whether a pressure zone has a storage surplus or deficit. A storage deficit indicates that the pressure zone needs additional storage capacity or that it must draw on surplus storage from a different connected pressure zone.

Table 5-2
St. George City Secondary Irrigation Storage Evaluation - Existing Conditions

Pressure Zone Name	Existing Peak Day Demand[1] (gpm)	Storage Facility	Storage Required[2] (gallons)	Available Storage (gallons)	Surplus (Deficit) (gallons)
Lonetree	0	Gunlock Reservoir	0	NA	0
Ivins PRV	2,000[3]	Gunlock Reservoir	1,440,000	1,440,000	0
Graveyard	0	Gunlock Reservoir	0	NA	0
Entrada	190	Entrada Pond	136,500	628,000	491,500
Canyon Complex	0	Canyon Complex Pond	0	NA	0
Sunbrook	150	Entrada Pond	107,800	491,500	383,700
Shelby Frei/Woodbridge	0	Gunlock	0	NA	0
Little Valley Fields	499	Little Valley Pond	359,100	550,000	190,900
St. George Clara Fields/Reuse	270	No Direct Storage	194,700	0	(194,700)
Sandberg	551	Sandberg Pond	396,500	1,476,000	1,079,500
Little Valley	126	Sandberg Pond	90,500	1,079,500	989,000
Downtown	1,317	Skyline Pond	948,000	782,000	(166,000)
Riverside	666	No Direct Storage	479,800	0	(479,800)
River Road	0	Washington Dam Reservoir	0		0
Bloomington Ranches	596	East Bloomington Pond[4]	429,500	550,000	120,500
Bloomington Hills	1,312	St. George Golf Tank[4]	944,400	1,300,000	355,600
Hidden Valley	510	Small Tank	367,000	108,000	(259,000)
Tonaquint Cemetery	399	Southgate Pond	287,300	362,000	74,700

[1]Represents the demand for each respective pressure zone that is not satisfied by a "localized" storage facility, such as a golf course pond.
[2]Equal to 50% of peak day demand of the area serviced.
[3]This demand is tied to the irrigation shares owned by the Shivwits Indian Reservation. While these shares are currently not used, they could be called upon at any time. Hence, the system should be adequately equipped to meet these demands if needed.
[4]Storage facility is owned by the Bloomington Water Company. The City of St. George utilizes storage in each facility as part its shares in the water company.

Table 5-3
St. George City Secondary Irrigation Storage Evaluation – 10-Year Growth Conditions

Pressure Zone Name	Existing Peak Day Demand[1] (gpm)	Estimated Added 10-Year Demand (gpm)	Total Estimated 10-Year Demand[1] (gpm)	Storage Facility	Storage Required[2] (gallons)	Available Storage (gallons)	Surplus (Deficit) (gallons)
Lonetree	0	0	0	Gunlock Reservoir	0	NA	0
Ivins PRV	2,000[3]	0	2,000[3]	Gunlock Reservoir	1,440,000	1,440,000	0
Graveyard	0	863	863	Gunlock Reservoir	621,200	617,000	0
Entrada	190	0	190	Entrada Pond	136,500	628,000	491,500
Canyon Complex	0	0	0	Canyon Complex Pond	0	0	0
Sunbrook	150	0	150	Entrada Pond	107,800	491,500	383,700
Shelby Frei/Woodbridge	0	0	0	Gunlock	0	NA	0
Little Valley Fields	499	0	499	Little Valley Pond	359,100	550,000	190,900
St. George Clara Fields/Reuse	270	95	365	No Direct Storage	262,900	0	(262,900)
Sandberg	551	205	756	Sandberg Pond	544,400	1,476,000	931,600
Little Valley	126	1,418	1,544	Sandberg Pond	1,111,700	936,400	(180,100)
Downtown	1,317	0	1,317	Skyline Pond	948,000	782,000	(166,000)
Riverside	666	36	702	No Direct Storage	505,600	0	(505,600)
River Road	0	0	0	Washington Dam Reservoir	0	NA	0
Bloomington Ranches	596	47	643	East Bloomington Pond[4]	463,200	550,000	86,800
Bloomington Hills	1,312	0	1,312	St. George Golf Tank[4]	944,400	1,300,000	355,600
Hidden Valley	510	167	676	Small Tank	486,900	108,000	(378,900)
Tonaquint Cemetery	399	0	399	Southgate Pond	287,300	362,000	74,700
Added Service Areas							
Desert Canyons/White Dome	0	1,905	1,905	No Direct Storage	1,371,700	0	(1,371,700)
Divario	0	338	338	No Direct Storage	243,500	0	(243,500)
Ledges/Trails	0	238	238	No Direct Storage	171,700	0	(171,700)
West Tonaquint	0	138	138	No Direct Storage	99,200	0	(99,200)
Desert Color/Atkinville	0	2,143	2,143	No Direct Storage	1,543,300	0	(1,543,300)

[1]Represents peak day demand not satisfied by a "localized" storage facility, such as a golf course pond.
[2]Equal to 50% of peak day demand for the area serviced.
[3]See note 3 from Table 5-2.
[4]See note 4 from Table 5-2

Table 5-4
St. George City Secondary Irrigation Storage Evaluation – Buildout Growth Conditions

Pressure Zone Name	Existing Peak Day Demand[1] (gpm)	Estimated Added Demand at Buildout (gpm)	Estimated Total Peak Day Demand at Buildout[1] (gpm)	Storage Facility	Storage Required[2] (gallons)	Available Storage (gallons)	Surplus (Deficit) (gallons)
Lonetree	0	0	0	Gunlock Reservoir	0	NA	0
Ivins PRV	2,000[3]	0	2,000[3]	Gunlock Reservoir	1,440,000	1,440,000	0
Graveyard	0	863	863	Gunlock Reservoir	621,200	621,200	0
Entrada	190	0	190	Entrada Pond	136,500	628,000	491,500
Canyon Complex	0	0	0	Canyon Complex Pond	0	0	0
Sunbrook	150	0	150	Entrada Pond	107,800	491,200	383,700
Shelby Frei/Woodbridge	0	0	0	Gunlock	0	NA	0
Little Valley Fields	499	0	499	Little Valley Pond	359,100	550,000	190,900
St. George Clara Fields/Reuse	270	209	480	No Direct Storage	345,500	0	(345,500)
Sandberg	551	598	1,149	Sandberg Pond	827,300	1,476,000	648,700
Little Valley	126	1,668	1,793	Sandberg Pond	1,291,200	648,700	(642,500)
Downtown	1,317	0	1,317	Skyline Pond	948,000	782,000	(166,000)
Riverside	666	36	702	No Direct Storage	505,600	0	(505,600)
River Road	0	0	0	Washington Dam Reservoir	0	NA	0
Bloomington Ranches	596	47	643	East Bloomington Pond[4]	463,200	550,000	86,800
Bloomington Hills	1,312	0	1,312	St. George Golf Tank[4]	944,400	1,300,000	355,600
Hidden Valley	510	494	1,003	Small Tank	722,500	108,000	(614,500)
Tonaquint Cemetery	399	0	399	Southgate Pond	287,300	362,000	74,700
Added Service Areas							
Desert Canyons/White Dome	0	6,395	6,395	No Direct Storage	4,604,600	0	(4,604,600)
Divario	0	1,183	1,183	No Direct Storage	851,700	0	(851,700)
Ledges/Trails	0	1,905	1,905	No Direct Storage	1,371,700	0	(1,371,700)
West Tonaquint	0	891	891	No Direct Storage	641,300	0	(641,300)
Desert Color/Atkinville	0	7,306	7,306	No Direct Storage	5,260,300	0	(5,260,300)

[1]Represents peak day demand not satisfied by a "localized" storage facility, such as a golf course pond.
[2]Equal to 50% of peak day demand for the area serviced.
[3]See note 3 from Table 5-2
[4]See note 4 from Table 5-2

IRRIGATION STORAGE FACILITY DISCUSSION AND RECOMMENDATIONS

Tables 5-2 through 5-4 provide an evaluation of storage facilities under existing, 10-year growth, and buildout conditions. The following sections provide additional discussion and recommendations based on the information found in the tables. In some cases, storage facilities that are slightly larger than the minimum required volume have been recommended in order to provide versatility to the system.

Existing Conditions

St. George Clara Fields/Reuse Pressure Zone

The St. George Clara Fields/Reuse pressure zone does not have a direct source of storage. The zone receives water from the Gunlock system as well as from the SGWRF Reuse Facility. Because the zone is tied to Gunlock Reservoir, it does technically have access to the storage facility, but the distance between the reservoir and the zone places stress on the transmission line during high usage periods. Ideally, the zone would have a local storage facility that could satisfy peak demands. Because this storage deficiency can technically be covered by Gunlock Reservoir, it is not recommended that the City take immediate action in adding storage closer to this zone. As discussed in Chapter 4 of this report, it is recommended that the City construct Graveyard Wash Reservoir by the year 2032, which will greatly improve the storage capacity for this zone. While Graveyard Wash will not be directly connected to the St. George Clara Fields/Reuse Zone, it will be connected to the pressure zone directly above it, greatly reducing the distance between the storage facility and the end user.

Downtown Pressure Zone

Storage for the Downtown pressure zone is supplied from the Skyline Pond. As shown in Table 5-2, storage for this zone is slightly deficient based on the established evaluation criteria. Due to the limited growth potential in the Downtown zone as well as the ability to provide backup storage into the zone from the Snow Park Pond, there are no recommended storage improvements for the Downtown pressure zone.

Riverside Pressure Zone

The storage condition for the Riverside pressure zone is similar to the St. George Clara Fields/Reuse zone. While it is not directly connected to the storage facility, the zone can draw on storage in Gunlock Reservoir. Like the St. George Clara Fields/Reuse pressure zone, it is not recommended that the City immediately carry out an improvement project to address this deficiency. The construction of the future Graveyard Wash Reservoir will greatly improve storage for the Riverside pressure zone.

Hidden Valley Pressure Zone

The Hidden Valley pressure zone is one of the few zones in the system that is pressurized by an enclosed storage tank. As shown in Table 5-2, the volume of storage for this zone is deficient. In order to provide adequate storage capacity for existing and future growth in the zone, it is

recommended that the existing 108,000-gallon tank be replaced with a 1 MG storage tank. While the water use projections for the Hidden Valley zone call for approximately 750,00 gallons of total storage at buildout, the City would like to build a slightly larger tank to service the zone.

Future Conditions

St. George Clara Fields/Reuse & Riverside Pressure Zone

As discussed in the "Existing Conditions" storage discussion, the St. George Clara Fields/Reuse and Riverside pressure zone have an existing storage deficiency. It is recommended that the City construct Graveyard Wash Reservoir as discussed in Chapter 4 of this report. This new reservoir will improve the storage capacity in these two zones.

Little Valley Pressure Zone

Under existing conditions, secondary irrigation water into the Little Valley pressure zone is provided from Sandberg Pond (Millcreek Springs) through a PRV near 2450 East Park. As the system expands in Little Valley, additional storage capacity will be needed. Under future conditions, users within the Sandberg pressure zone will utilize the majority of the source capacity from Millcreek Springs, meaning that the Little Valley zone will need a different primary source of water. The primary source for Little Valley will become the Washington Dam Diversion via a new pump station at the Little Valley settling pond. Storage from the Little Valley pond is utilized primarily for watering the schools and ball fields near the pond, which leads to a need for a new storage facility in Little Valley.

As shown in Table 5-4, the buildout storage requirement for Little Valley is about 1.3 million gallons. While some of this storage deficiency could technically be covered by the Sandberg pond and pump station, this is not an ideal option from an operational standpoint. This considered, it is recommended that a 1.5 MG reservoir be constructed for the Little Valley pressure zone. The ideal location of a new storage facility for the Little Valley pressure zone would be in the Stone Cliff area, where elevations are high enough to provide sufficient pressure for the system.

Desert Canyons/White Dome Pressure Zone

As shown in the Tables 5-3 and 5-4, the Desert Canyons/White Dome area will need approximately 1.4 MG of storage to meet demands over the next 10 years and a total of about 4.6 MG of storage at full buildout. In order to meet these storage needs, it is recommended that 2 storage facilities be constructed for this pressure zone. It is recommended that the City first construct a 2 MG tank to meet demands over the next 12-15 years, followed by a second 2.7 MG tank to service demands through buildout.

Divario/West Tonaquint Pressure Zones

As the secondary irrigation system expands into the Divario and the West Tonaquint area, new storage facilities will be needed. As shown in Table 5-4, the combined storage volume requirement for the two zones is about 1.5 MG. Based on the proximity of these developments, the zones could

be serviced from the same storage tank. While certain undeveloped areas near Dixie Drive could be serviced prior to constructing a storage tank, it is recommended that a new storage tank be constructed before a significant number of units are connected to the system. The site of the City's existing Gap Tank has a space prepared for an additional storage tank and would serve as an ideal location for the proposed secondary irrigation tank. Although water use projections for this region of the City would suggest that a 1.5 MG storage facility is needed, it is recommended that that the new storage tank be constructed to optimize the size of the existing site, which is sized for a 1.9 MG tank (the same size as the existing "Gap" culinary water tank). This additional storage provides some versatility for the system and would allow the City to expand the secondary irrigation system into a larger portion of the Divario development if necessary.

Ledges/Trails Pressure Zone

The future storage requirement for the Ledges/Trails area is approximately 1.4 MG. This volume does not include the future demand on the Ledges Golf Course; storage for the course will be satisfied by a local pond located on the course. It is recommended that a 1.5 MG storage tank be constructed next to the existing Ledges culinary water tank. This elevation would provide sufficient pressure to service the Ledges/Trails area. As growth extends into the lower elevation area at the south end of The Trails, a regulated pressure zone will need to be established to reduce system pressure throughout the development.

In conjunction with these improvements to the Ledges, a new storage facility will be needed near the Lower Ledges booster pump in Entrada. This new pond should have a volume of 4 acre-feet (1.3 MG) in order to provide reliable equalization for the Lower Ledges pump station.

Desert Color/Atkinville

Secondary irrigation is a key component of the Desert Color community. While plans for the secondary irrigation system in Desert Color have not been finalized, the development currently has plans to construct 5 irrigation ponds. These ponds will service the various pressure zones located throughout the development. Based on preliminary plans, the total storage volume planned to be constructed in Desert Color is over 6 million gallons, which satisfies the minimum requirement set forth in this master plan.

The Atkinville PD is a small area located near I-15 between Sun River and Desert Color. Future irrigation demand in this region will be served from the East Bloomington Pond, and if demand begins to exceed the capacity of the East Bloomington Pond, supplemental water can be supplied to the Atkinville area from the Reuse Facility pipeline.

Other Storage Facilities

Commerce Drive Settling Pond

In order to supply Virgin River water into the southern region of the City, a new settling pond will need to be constructed. The ideal location for this facility is near Commerce Drive and the Fort Pierce Wash. Flow from the Washington Dam Diversion will run through the "meter pit", bypass

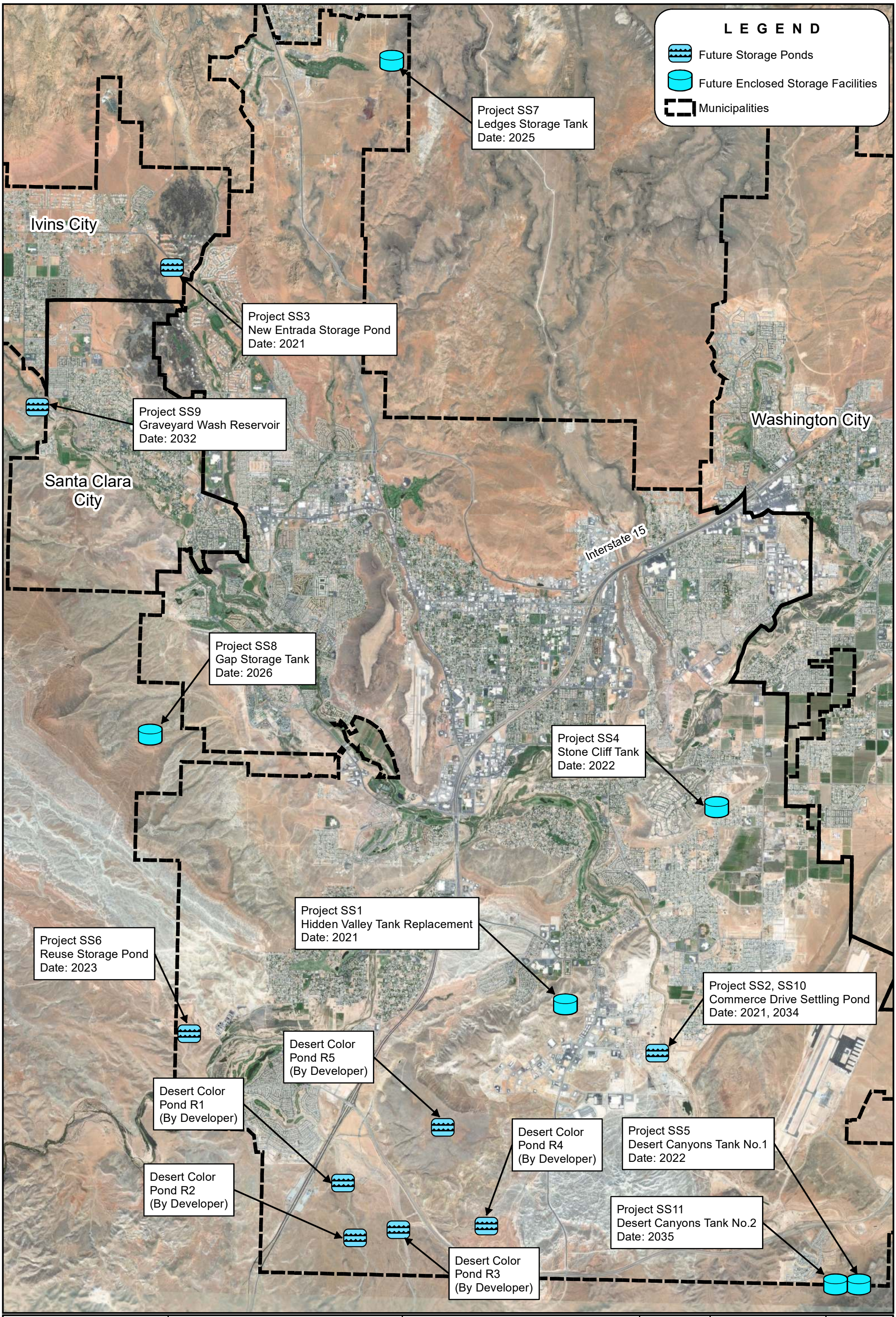
the Little Valley Pond, and flow to this new settling pond. Water will then be pumped into the southern region of the City. In order to provide adequate detention time in the settling pond, the first phase of the project will involve the construction of two 1.5 MG settling bays. As demands increase in the system, a third 1.5 MG basin will be added for a total volume of 4.5 MG.

SGWRF Reuse Pond

One of the challenging aspects of supplying reuse water to secondary irrigation users is the fact the flows at the plant are typically at their lowest diurnal level when irrigation demands are at their highest. Without storage, the reuse facility can only treat and deliver what is available at that particular time at backend of the wastewater treatment plant, so while average daily flows to the plant may be 13-14 MGD, flow available in the morning when it is needed may be less than half of that. In order to provide greater supply capacity and reliability in the future as demands continue to increase in the City, it is recommended that a storage pond be constructed at the SGWRF to provide supplemental water to the system when demand exceeds what is immediately available at the outfall of the treatment plant. Based on the space available at the plant, it has been assumed that a 100 AF reservoir could be constructed just to the west of the tree farm located near the treatment plant.

Recommended Secondary Irrigation Storage Improvements through Buildout

The recommended storage improvements for the City through buildout are shown in Table 5-5. The table provides the estimated project cost in 2018 dollars. Figure 5-1 displays the location of each recommended storage improvement.



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

RECOMMENDED STORAGE IMPROVEMENT PROJECTS

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 5-1

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 5-1 - Recommended Storage Facilities.mxd aanderson 12/17/2019

Table 5-5
Recommended Secondary Irrigation Storage Improvement Projects[1]

Recommended Storage Improvement Project	Project ID	Storage Volume	Estimated Construction Cost	Engineering, Legal, Admin. (15% of Construction Cost)	Construction Date	Estimated Total Project Cost
Hidden Valley Tank Replacement	SS1	1 MG	$900,000	$135,000	2021	$1,035,000
Commerce Drive Settling Pond	SS2	3.0 MG	$1,650,000	$248,000	2021	$1,898,000
New Entrada Storage Pond	SS3	1.3 MG	$455,000	$68,000	2021	$523,000
Stone Cliff Storage Tank	SS4	1.5 MG	$1,350,000	$203,000	2022	$1,553,000
Desert Canyons Tank No. 1	SS5	2.0 MG	$1,800,000	$270,000	2022	$2,070,000
Reuse Storage Pond	SS6	100 AF	$3,000,000	$450,000	2023	$3,450,000
Ledges Storage Tank	SS7	1.5 MG	$1,350,000	$203,000	2025	$1,553,000
Gap Irrigation Tank	SS8	1.9 MG	$1,425,000	$214,000	2026	$1,639,000
Graveyard Wash Reservoir	SS9	2000 AF	$11,000,000	$1,650,000	2032	$12,650,000
Commerce Drive Settling Pond Expansion	SS10	1.5 MG	$825,000	$124,000	2034	$949,000
Desert Canyons Tank No. 2	SS11	2.7 MG	$2,430,000	$365,000	2035	$2,795,000
			$26,185,000	**$3,930,000**		**$30,115,000**

[1]Desert Color is planning to construct 5 storage ponds that will provide storage capacity for the development. These projects will be constructed by the developer and have correspondingly not been included here.

CHAPTER 6
TRANSMISSION AND DISTRIBUTION SYSTEM EVALUATION

INTRODUCTION

Transmission and distribution infrastructure are critical components of the City's water system. Assuring that the water transmission and distribution system is properly sized and appropriately maintained will help provide reliable service to customers. The City's secondary irrigation transmission and distribution network has been evaluated under existing and projected future conditions using a hydraulic computer model. This chapter documents the results of the hydraulic modeling evaluation and provides recommendations for future transmission and distribution improvements for the secondary irrigation system.

SECONDARY IRRIGATION HYDRAULIC COMPUTER MODEL

A hydraulic computer model is a digital representation of physical features and characteristics of the water system, including pipes, valves, storage tanks and pumps. Key physical components of a water system are represented by a set of user-defined parameters that represent the characteristics of the system (such as PRV settings or pipe roughness coefficients). Computer model output includes pressures at each model node, flow rate for each pipe in the water system, etc.

BC&A developed a hydraulic computer model of the existing secondary irrigation system using GIS data and a system schematic provided by the City. Using the water use estimates presented in Chapter 3, total system demands were distributed throughout the model using infrared imagery that was processed to identify irrigated landscape throughout the City. Demand for a given part of the system was directly proportional to its estimated irrigated area. The model demand distribution was then reviewed with the City's irrigation manager and adjustments were made based on the known demands for different parts of the system. The model is set up to run a "steady state" simulation, which provides an instantaneous snapshot of the system for a given demand scenario under steady state flow conditions. The steady state model does not track dynamic, time-dependent variables, such as the depth of water in a storage tank or diurnal variations in demand throughout the course of a day. In future planning efforts, the City may decide to develop an "extended period simulation" which is capable of tracking time-dependent variables in the system.

Once the existing conditions model was developed, two future conditions models were developed to represent estimated system growth within a 10-year planning window (2028) and through build-out (all land developed within the City boundary under the current land use/zoning plan). These future conditions models are based on the demand projections developed in Chapter 3 of this report, with demand being distributed in the models as a function of the land use and zoning designation of the undeveloped area.

CALIBRATION

Calibration is the task of adjusting hydraulic model parameters so that the model output results correlate with actual observed conditions in the water system. Model calibration was achieved by

checking model pressure outputs against known measured pressure readings at critical locations throughout the system. A few assumptions regarding the calibration of the model are:

- **Pipe Roughness –** Pipe roughness in the system was assigned a Hazen-Williams coefficient of 130.
- **Pipe Size Data –** Pipe diameters and locations in the model were assigned based on the City's GIS data and through communication with City Water Department management.
- **Node Elevation –** Junction elevations in the model were assigned using a Digital Elevation Models (DEM) of the City that was created through Lidar survey data collected by Washington County. Nodes that fall outside of the boundary of the County survey were assigned elevations from a United States Geological Survey (USGS) 10-meter resolution DEM.
- **Storage Tank Elevations** – Storage tanks have been set to ½ full for all model simulations.

PEAKING CHARACTERISTICS

Chapter 3 presents estimates for average annual and peak day system demand on the secondary irrigation system under existing and projected future conditions. When evaluating the existing and future distribution system, it is also important to estimate the peak demand that occurs over the course of the peak day, known as peak hour demand. Based on discussions with City staff, peak hour demand on the secondary irrigation system has been estimated to be 2.5 times higher than peak day demand. It should be noted that a number of irrigation users, namely golf courses, have local storage facilities that are used to satisfy peak hour flows. The model nodes that service such connections do not have a peak hour demand multiplier assigned to them because they do not actually peak off of the main distribution system.

MODEL SCENARIOS

The following model simulations were evaluated for existing and future conditions:

1. **Static Pressure** – This scenario provides the static pressure on the system when there is little irrigation demand, which represents the highest pressure that the system typically experiences.
2. **Peak Day Demand** – This scenario represents the average demand on the system during the peak water usage day of the year.
3. **Peak Hour Demand** – This scenario represents the estimated peak hour demand on the system during the peak usage day. Peak hour demand is estimated to be 2.5 times greater than peak day demand for all connections that peak off of the distribution system (this does not include users with local storage facilities and piping used to deliver peak hour irrigation flows, such as a golf course).

DISTRIBUTION SYSTEM EVALUATION CRITERIA

Utah Administrative Code R309-510 establishes requirements for public *drinking water* systems but does not provide such requirements for a secondary irrigation system. Public drinking water systems are required to meet the following minimum pressure requirements:

- **At least 30 psi during peak hour (instantaneous) demand**
- **At least 40 psi during peak day demand**

In order to maintain reliable service to secondary irrigation system users, the secondary irrigation system has been evaluated using these same standards considering that most pressurized irrigation appurtenances require at least 30 psi to operate properly.

In addition to avoiding low system pressures, it is also important to prevent the system from reaching undesirably high pressures (occurring during low demand scenarios). The City does have a significant length of "high-pressure" transmission lines which are intended to experience consistently high pressures, so the bigger concern is high pressure on distribution piping. When system pressures frequently exceed 150 psi, service laterals and mains are more prone to leakage and failure. To the extent possible, the City should limit high pressures in the system to reduce the probability of line breaks. High pressure areas do not necessarily represent a system deficiency, but it is important that water operators are aware of areas that are prone to consistently high pressures.

In addition to these pressure standards, high head losses in the system and potential for problems with hydraulic transients should be minimized by maintaining flow velocities to less than 10 feet per second.

SYSTEM EVALUATION RESULTS

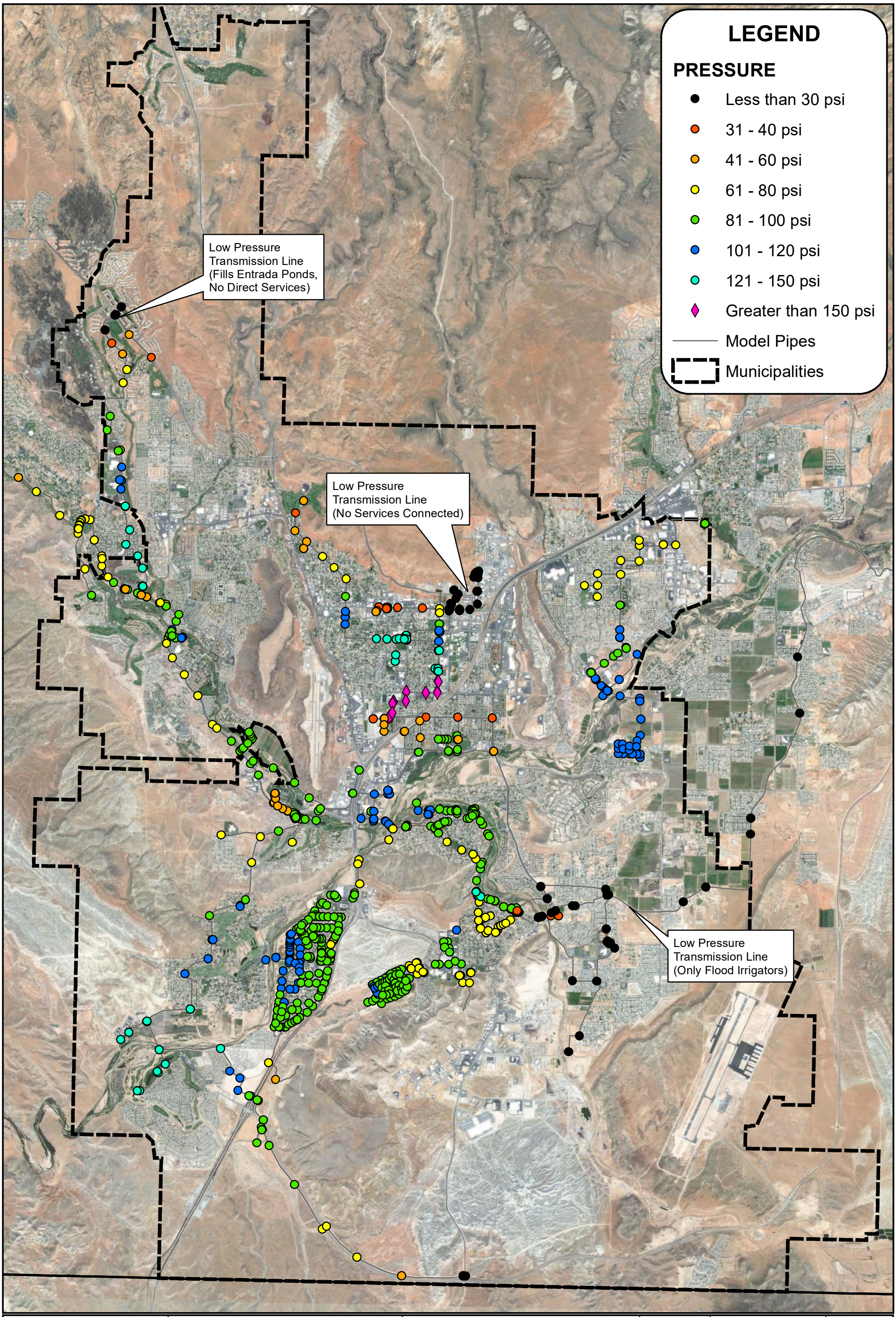
Existing System Evaluation

The hydraulic computer model was used to simulate the existing system under static pressure conditions, peak day demand, and peak hour demand. Model results for these scenarios are discussed below with the following model output figures as a reference:

1. **Figure 6-1 shows existing static pressure on the system**
2. **Figure 6-2 shows pressures under peak day demand**
3. **Figure 6-3 shows pressures under peak hour demand**

Static Demand Scenario (Winter Nighttime Conditions)

As shown in Figure 6-1, there are not a significant number of high static pressure locations on the system. The low static pressure regions of the system are associated with low pressure transmission lines on the system; pressurized irrigation connections are not connected to these parts of the system. It should be noted that a number of pumps stations and wells are turned off in the static simulation, and that some areas will experience higher pressure during high usage periods as a result of pump stations being in operation.



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE
SECONDARY IRRIGATION MASTER PLAN

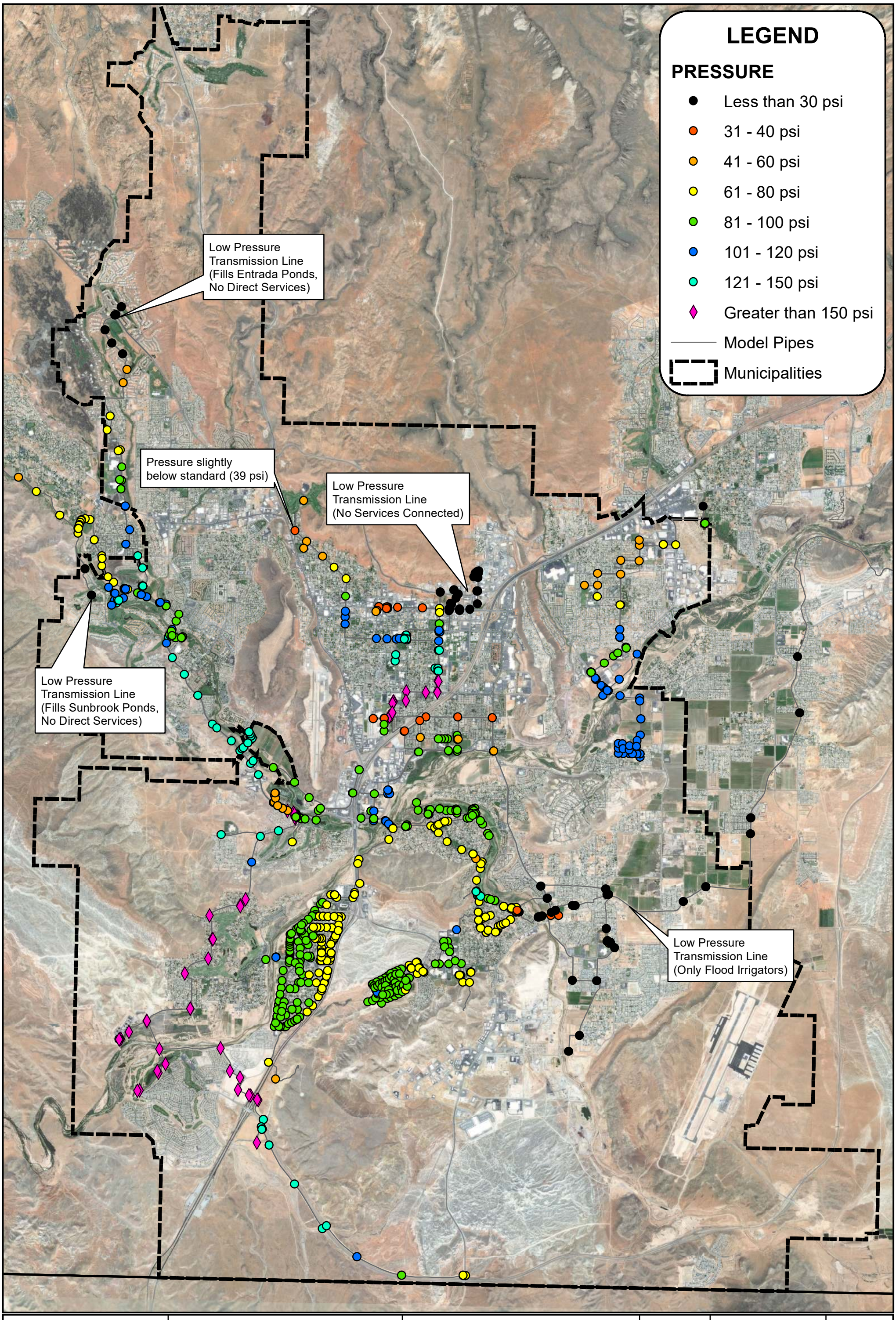
EXISTING SYSTEM STATIC PRESSURE

NORTH: NORTH

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 6-1

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 6-1 - Existing Static Demand.mxd aanderson 10/31/2019



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE
SECONDARY IRRIGATION MASTER PLAN

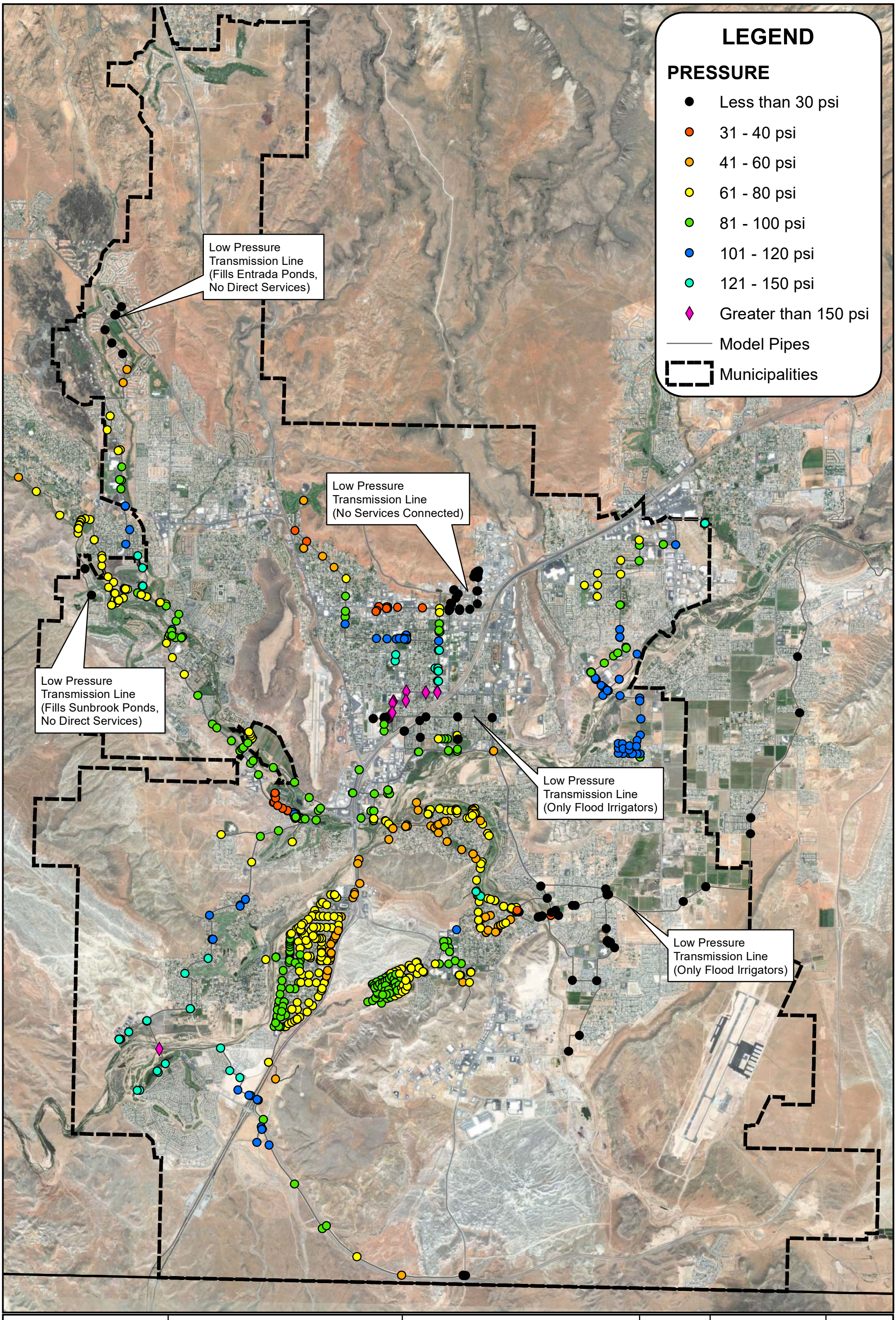
EXISTING PEAK DAY PRESSURE

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 6-2

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 6-2 - Existing Peak Day Pressure.mxd aanderson 12/18/2019



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE
SECONDARY IRRIGATION MASTER PLAN

EXISTING SYSTEM PEAK HOUR PRESSURE

NORTH:

SCALE: 0 2,500 5,000 Feet

FIGURE NO. 6-3

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 6-3 - Existing Peak Hour Pressure.mxd aanderson 12/18/2019

Peak Day Demand Scenario

While the results of the peak day demand scenario indicate that a number of locations throughout the system experience pressures below 40 psi, it is important to understand that the majority of these locations are either:

a) Low pressure transmission lines

b) Near the end of a high-pressure transmission line that terminates at a pond of reservoir

Model results do indicate that one location near 700 W and Diagonal Street has a peak day demand pressure of 39 psi, which is slightly below the standard. Because the pressure is so close to the standard minimum, no improvements are recommended for this area of the system.

Peak Hour Demand Scenario

Similar to the results of the peak day demand scenario, the only areas of the system with pressures below the minimum standard are areas that intentionally operate under low pressure. Model results indicate that the system can provide estimated peak hour demands at the minimum required pressure.

System Evaluation under Future Conditions

A hydraulic model for estimated 10-year growth and buildout growth were developed using the City's current land use and zoning maps. Future demands were added to the models and new facilities were added in order meet the needs of future growth. New facilities were added to the system in order to:

A) Convey water from sources to demand locations under a peak day demand scenario

B) Convey water from sources and storage tanks to demand locations under a peak hour demand scenario

The future conditions hydraulic models were used to determine the size and location of new improvement projects needed to service demands through buildout. The following are important assumptions that were made in the development of the hydraulic models for future conditions:

- **Virgin River (Washington Dam) Source Capacity** – Future irrigation demands in the southern region of the City will be met through a combination of water from the Washington Dam Diversion and the SGWRF Reuse Facility. Model results indicate that the Valley Irrigation Company connection has capacity to deliver approximately 3,200 gpm to the intersection of Commerce Drive and the Fort Pierce Wash, which is the proposed location of a new settling pond. It has been assumed that this capacity will primarily be used in the Desert Canyons/Airport region of the City, but a connection will also be constructed into the Desert Color development to provide redundant supply for the development. Additional capacity into the Desert Canyons/Airport region above what is available from the Washington Dam Diversion will be provided by a new line from the SGWRF Reuse Facility. If a new, higher pressure transmission line is constructed as part of the Warner Valley Reservoir Project that increases capacity from the Virgin River into

St. George, additional capacity above 3,200 gpm from the Valley Irrigation Company system may become available.

- **Irrigation Well Development in the Desert Color Area** – The City holds groundwater rights along the Virgin River that could be used for the development of new groundwater well sources. However, because the water in this area is high in TDS, well water should be blended with water having a lower TDS concentration. Assuming that well water could be blended with reuse water, 3 wells have been planned for the Desert Color area (two 400 gpm wells on the south side of Southern Parkway and one 500 gpm well on the north side of the Parkway). Each of these wells will discharge directly into one of the Desert Color irrigation ponds to be blended with reuse water.
- **Continuing Expansion of Reuse Capacity** – Reuse water will play a pivotal role in the secondary irrigation system moving forward. This report assumes that the City will continue to develop reuse treatment and conveyance capacity as flows increase at the SGWRF.

RECOMMENDED CONVEYANCE SYSTEM IMPROVEMENTS

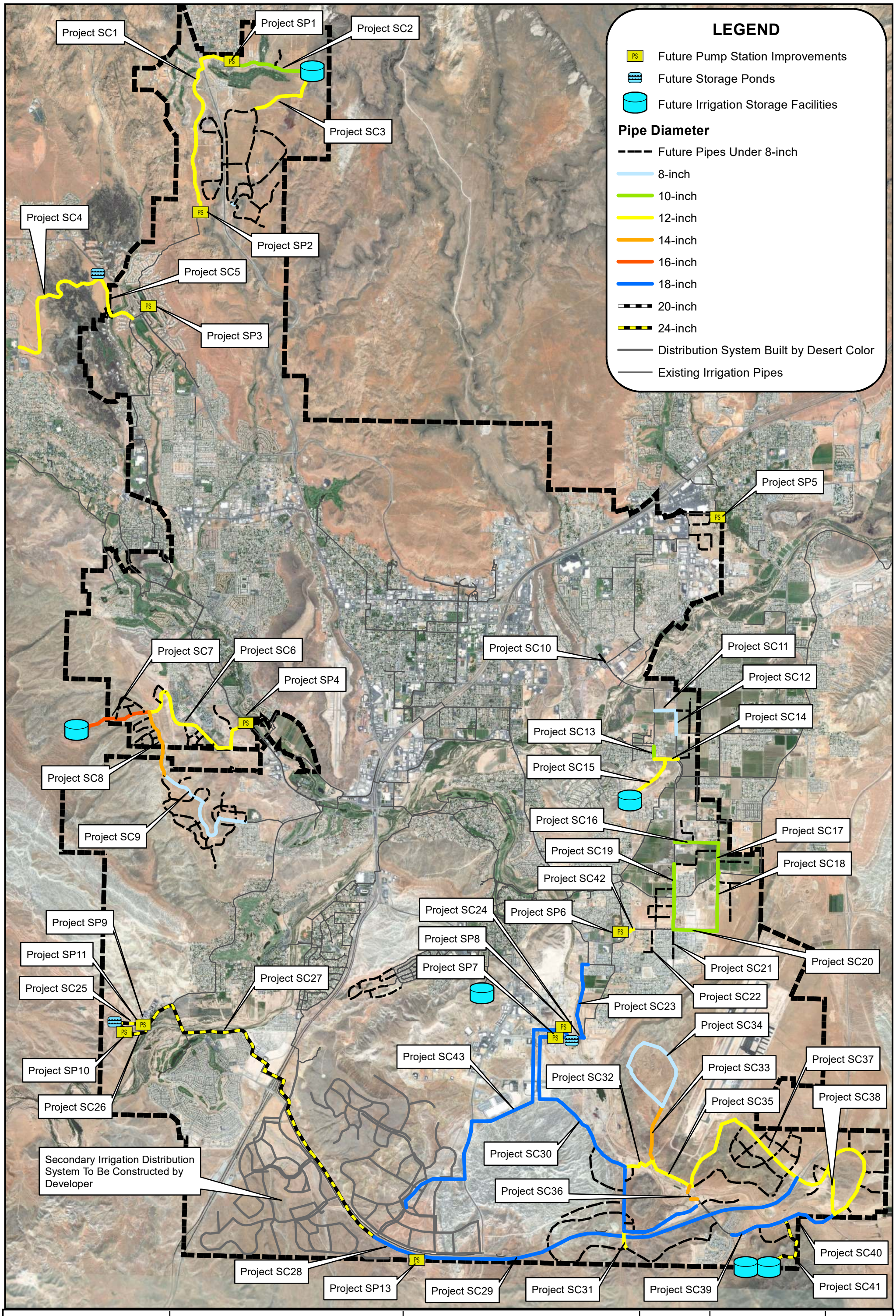
Based on the results of the hydraulic computer model simulations as well as through coordination with City Water Department management, recommended system improvements have been identified through buildout. The recommended improvements, along with a "Project ID", are shown in Figure 6-4. Project descriptions and the estimated project costs are shown in Table 6-1. The recommended system improvements shown are for all pipes of 8" diameter or greater. While smaller diameter pipes were included in the model, any pipe under 8" diameter has been assumed to be a project level improvement (intended primarily for distribution within individual developments and funded completely by the individual developers). Note that a number of projects in the list are designated as "upsize" projects. For these projects, the developer will be responsible for the cost associated with the installation of a 6-inch pipe (standard minimum size for an irrigation main) and the City will pay the cost to "upsize" the line to the diameter identified in this report.

The following is a description of the conveyance projects identified in Figure 6-4 (not listed in any particular order; projects to be completed within the 10-year planning window are identified in Chaper 7).

Pipeline Projects

SC1. Ledges Main Transmission Line

Project SC1 will provide a secondary irrigation connection into the Ledges/Trails region of the City. This 12-inch transmission line will connect to the existing 12-inch line from Entrada that runs through the State Park/BLM land. The line will run north along the SR-18 and end near the Ledges Golf Course. Water will be pumped through the line via the Intermediate Ledges Pump Station (see description of Project SP2).



BOWEN COLLINS & ASSOCIATES

CITY OF ST. GEORGE

SECONDARY IRRIGATION MASTER PLAN

RECOMMENDED CONVEYANCE SYSTEM IMPROVEMENTS

NORTH:

SCALE: 0 2,550 5,100 Feet

FIGURE NO. 6-4

S:\St. George City\001-18-02 Culinary Water, Sewer, and Secondary Irrigation Master Plan\Secondary Irrigation\4.0 GIS\4.4 Figures\Figure 6-4A - Recommended Conveyance System Improvements.mxd aanderson 11/8/2019

SC2. Ledges Upper Transmission Line

Project SC1 will bring irrigation water into the Ledges/Trails area, and Project SC2 will connect to the end of Project SC1 and convey water to a future Ledges storage tank via a new pump station and 10-inch pipe (see description of Project SP1).

SC3. Ledges Main Distribution Line

Project SC3 will provide the distribution backbone for residential connections in the Ledges/Trails area with a 12-inch line. The conceptual alignment for the pipeline begins at the future Ledges storage tank and runs to the southwest into the future distribution system.

SC4. Rachel Drive to New Entrada Storage Pond Transmission Line

Project SC4 will provide additional transmission capacity from the Gunlock System into the Entrada/Ledges region of the system. The 12-inch line will connect into the Santa Clara distribution system at Rachel Drive and runs through the lava fields, ending at the future Entrada storage pond near Snow Canyon Parkway.

SC5. New Entrada Pond to Lower Ledges Booster Pump Station Transmission Line

Project SC5 will connect the future Entrada storage pond into the existing irrigation system at the intersection of Sinagua Trail and Entrada Trail Road. The 12-inch line will provide additional capacity for the West Side Entrada pressure zone and will serve as the primary feed to the future Lower Ledges booster pump station (see description of Project SP3).

SC6. Dixie Drive to Plantations Drive Transmission Line

Project SC6 will provide an irrigation connection for development along the west side of Dixie Drive, including the Divario development and West Tonaquint development. The 12-inch line will connect into the existing 24-inch reuse line just south of Cottonwood Cove Park and will run along Plantations Drive to Lago Vista Drive (future road in Divario). Water will be pumped through the line via the Dixie Drive Pump Station (see description of Project SP4).

SC7. Gap Irrigation Tank Distribution Line

Project SC7 includes the installation of a 16-inch line to connect the future Gap Irrigation Tank to end of Project SC6. The project will serve as the fill and discharge line for the future tank.

SC8. Divario to West Tonaquint Transmission Line

Project SC8 will provide an irrigation connection between the Divario and West Tonaquint developments, allowing both developments to be serviced from the future Gap Irrigation Tank. This 10-inch line will run along Lago Vista Drive and connect into the West Tonaquint development.

SC9. West Tonaquint Main Distribution Line

Project SC9 will provide the backbone for irrigation service through the West Tonaquint development. The conceptual alignment of the 8-inch line begins at Curly Hollow Road and runs through the development, connecting to Project SC8 at the north end of the development.

SC10. Riverside Drive to Fossil Ridge Intermediate School Connection

Provide SC10 will connect Fossil Ridge Intermediate School to the secondary irrigation system. The project includes the installation of a 6-inch line along Mall Drive to the school, connecting to the existing 8-inch pipeline in Riverside Drive.

SC11. Little Valley Distribution Line (900 S from 2780 E to 3000 E)

Project SC11 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC12. Little Valley Distribution Line (3000 E from 900 S to 1140 S)

Project SC12 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC13. Little Valley Distribution Line (2780 E from 1250 S to 1450 S)

Project SC13 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC14. Little Valley Transmission Line (1450 S from 2780 S to 3000 E)

Project SC14 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC15. Stone Cliff Tank Feed & Distribution Line

Project SC15 will serve as the fill and distribution line from the proposed Stone Cliff Tank. The line will run from the tank and tie into the system at 1450 E.

SC16. Little Valley Distribution Line (2200 S from 3000 E to 3430 E)

Project SC16 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC17. Little Valley Distribution Line (3430 E from 2200 S to 2450 S)

Project SC17 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC18. Little Valley Distribution Line (3430 E from 2450 S to Horseman Park Drive)

Project SC18 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC19. Little Valley Distribution Line (3000 E from 2450 S to Horseman Park Drive)

Project SC19 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC20. Little Valley Distribution Line (Horseman Park Drive from 3000 E to 3430 E)

Project SC20 will extend secondary irrigation service into future development in the Little Valley/Washington Fields area.

SC21. Little Valley Distribution Line (Horseman Park Drive to Crimson Ridge Drive)

Project SC21 will extend secondary irrigation service to a future park located at the intersection of Crimson Ridge Drive and 3000 E. The project includes the installation of a 6-inch pipe that connects into the existing distribution network in Horseman Park Drive.

SC22. Little Valley Distribution Line (2880 E from Horsemans Park Drive to Silkwood Park)

Project SC22 will provide a 6-inch secondary irrigation connection to the existing Silkwood Park. The project will also provide a connection to residential users along the alignment.

SC23. Fort Pierce Wash Low Pressure Transmission Line

To increase capacity from the St. George Valley Irrigaiton Company system into the southern region of the City, Project SC23 includes the installation of an 18-inch low pressure transmission line that will parallel the existing 18-inch line to Commerce Drive.

SC24. Commerce Drive Crossing

The City is planning to install a road across the Fort Pierce Wash at Commerce Drive. With this road construction project, a new 18-inch irrigation line will be installed across the Fort Pierce Wash that will feed into the Commerce Drive Settling Pond.

SC25. SGWRF Reuse Facility to Reuse Storage Pond

The proposed SGWRF Reuse Pond will be constructed to the west of the treatment plant and will provide valuable irrigation storage for the system. Project SC25 includes the installation of a new 24-inch line from the reuse facility to the future pond site.

SC26. Reuse Storage Pond Transmission Line

With the completion of the Reuse Storage Pond, and new pipeline will be needed to deliver water from the pond to the reuse transmission line. Project SC26 includes the installation of a new 24-inch line from the pond that ties into the reuse transmission line. The line will be connected to a new pump station at the storage pond (see description of Project SP10).

SC27. SGWRF Parallel Reuse Transmission Line

Project SC27 includes the construction of a new 24-inch transmission line from the reuse facility into the southern region of the City. The line will begin at the treatment plant, cross the Virgin River, and run through the Sun River development into the Desert Color/Desert Canyons developments.

SC28. Desert Canyons Reuse Transmission Line

Project SC28 builds on Project SC27 to extend transmission capacity further to the east. The 18-inch pipe will connect to the end of project SC27 and continue east to the proposed Desert Canyons Pump Station (see description of Project SP12).

SC29. Desert Canyons Pump Station Transmission Line

Project SC29 will finish the connection from the SGWRF Reuse Facility into the Desert Canyons/Airport region of the City. The 18-inch pipe will connect to the Desert Canyons Pump Station and will continue east into the Desert Canyons development, ending at a connection point to Project SC37 (see Figure 6-4). The pipeline will be connected to the proposed Desert Canyons Pump Station and will be used to fill the proposed Desert Canyons storage tanks. The line will also be connected into the distribution system to provide better pressure for the zone under high demand periods.

SC30. Commerce Drive Settling Pond to Desert Canyons Transmission Line

The primary source of water for the Desert Canyons development, primarily during the early stages of development, will come from St. George Valley Irrigation Company water from the Washington Dam Diversion. The Commerce Drive Settling Pond will be constructed near the Commerce Drive Road crossing over the Fort Pierce Wash. Project SC30 include the construction of an 18-inch pipeline from the settling pond to the proposed location of the Desert Canyons storage tanks. The conceptual alignment of the pipeline is shown in Figure 6-4. The end of the project will connect to an existing 14-inch line located near Desert Canyons Parkway on the north side of the Southern Parkway.

SC31. Southern Parkway Crossing to Desert Canyons

Project SC31 involves the installation of a 12-inch line that connects Project S30 into future development along the south side of the Southern Parkway in the Desert Canyons/White Dome

area. This line will help maintain adequate operating pressure in the distribution system during periods of the high demand.

SC32. Desert Canyons Distribution Loop, Reach 1

Project SC32 is a 12-inch pipe that serves as a section of the overall distribution loop through the Desert Canyons development.

SC33. West Airport Transmission Line

Project SC33 will extend service into the currently undeveloped area to the west of the St. George Airport with a new 14-inch pipe.

SC34. West Airport Distribution Loop

Project SC34 is a conceptual 8-inch distribution loop through the currently undeveloped area on the west side of the St. George Airport.

SC35. Desert Canyons Distribution Loop, Reach 2

Project SC35 is a 12-inch pipe that serves as a section of the overall distribution loop through the Desert Canyons development.

SC36. Fort Pierce Wash Crossing in Desert Canyons

Project SC36 involves the installation of two sections of 14-inch pipe to loop the system in Desert Canyons. The project will connect into an existing 14-inch line that crosses the Fort Pierce Wash.

SC37. Desert Canyons Distribution Loop, Reach 3

Project SC37 is a 12-inch pipe that serves as a section of the overall distribution loop through the Desert Canyons development.

SC38. Desert Canyons Distribution Loop, Reach 4

Project SC38 is a 12-inch pipe that serves as a section of the overall distribution loop through the Desert Canyons development.

SC39. Desert Canyons Transmission Line

Project SC39 is a continuation of Project SC30. The project will extend the transmission line to the location of Project 41, which is the main fill/distribution line from the proposed Desert Canyons storage tank.

SC40. Desert Canyons Distribution Line, Reach 5

Project SC40 completes the loop through the Desert Canyons development with an 18-inch pipe.

SC41. Desert Canyons Storage Tank Feed & Distribution Line

Project SC41 includes the construction of a 24-inch line connecting the proposed Desert Canyons tank to the distribution system in Desert Canyons.

SC42. Little Valley Booster Pump Station Connection

Project SC42 provides the connection from the new Little Valley Pump Station into the existing distribution system with a 12-inch pipe.

SC43. Commerce Drive Settling Pond to Desert Color Transmission Line

Project SC43 involves the construction of an 18-inch transmission line from the proposed Commerce Drive Settling Pond into the Desert Color development. This connection provides a redundant source into Desert Color, allowing the City to supply the region with reuse water or water from the St. George Valley Irrigation Company system.

Pump Station Projects

SP1. Upper Ledges Pump Station

Project SP1 includes the construction of a 900 gpm booster pump station and 100,000 gallon storage wet well that will pump water from the Ledges transmission line (Project SC1) to the proposed Ledges storage tank.

SP2. Intermediate Ledges Pump Station

Project SP2 is the "intermediate" pump station needed to deliver water from the existing irrigation system in Entrada to the Ledges. The 2,000 gpm pump station will include a 200,000 gallon storage wet well and will be pump water to a point near the Ledges Golf Course. The pump will provide enough head to fill the Ledge Golf Course irrigation pond and to fill the wet well associated with Project SP1 (to be pump again to the Ledges irrigation tank).

SP3. Lower Ledges Pump Station

Project SP3 includes the installation of the lower Ledges booster pump station located on Entrada Trail Road that will pump water through an existing 12-inch transmission line to Project SP2 (which continues pumping to the Ledge Golf Course). This 2,000 gpm pump station will primarily be fed from the new Entrada storage pond via Project SC5.

SP4. Dixie Drive Pump Station

Project SP4 includes the installation of a 2,080 gpm pump station on Dixie Drive just south of Cottonwood Cove Park. The pump station will send irrigation water from the 24-inch reuse line to the proposed Gap irrigation tank. The tank will then supply water to the Divario and West Tonaquint development as well as other new development along Dixie Drive.

SP5. Sandberg Pump Station Upgrade

As demands increase in the Sandberg pressure zone, the Sandberg pump station will require an upgrade. Project SP5 includes adding an additional 1,400 gpm of pump capacity to the facility.

SP6. Little Valley Pump Station

Project SP6 includes the construction of a new 1,800 gpm pump station at the Little Valley settling pond that will deliver water into the Little Valley pressure zone. The pump station will pump water from the settling pond to the proposed Stone Cliff storage tank.

SP7. Commerce Drive Settling Pond - Desert Canyons Pump Station

Project SP7 will provide pumping capacity from the proposed Commerce Drive Settling Pond into the Desert Canyons/White Dome area. The pump station will have a 3,200 gpm capacity and will pump water from the settling pond to the proposed Desert Canyon storage tank.

SP8. Commerce Drive Settling Pond – Desert Color Pump Station

Project SP8 will provide redundant source capacity for the Desert Color community. This pump station will have a pumping capacity of 3,200 gpm and will deliver water to an irrigation pond in Desert Color. Although reuse water will provide the primary source of water into Desert Color, this connection will provide the City with operational flexibility.

SP9. SGWRF Reuse Facility, Upgrade Existing Pump Station

As irrigation demands continue to increase in the system, the existing Reuse Facility should be upgraded with a larger pumping capacity. The existing pump station manifold has space for to add 2 additional 2,500 gpm pumps.

SP10. SGWRF Reuse Pond Pump Station

With the addition of the SGWRF Reuse Pond, a pump station will be needed to pump water from the pond back into the Reuse transmission pipeline. This pump station will have a capacity of 5,000 gpm and will provide supplemental capacity to the system when irrigation demands from the reuse facility exceed the amount of water available through the wastewater treatment plant.

SP11. SGWRF Future Reuse Facility Booster Pump Station

As flows to the SGWRF increase, the City will continue to expand its reuse treatment capacity. When the existing Reuse Facility reaches its full capacity, a new facility will need to be constructed. This new facility will include the development of a new pump station facility (see Chapter 4 for details).

SP12. Desert Canyons Booster Pump Station

When demand in the Desert Canyons/White Dome area exceeds the capacity of the Commerce Drive Settling Pond connection, additional capacity will come from the Reuse Facility. In order to deliver water into this region of the City, a pump station will be needed on the Southern Parkway just west of South River Road. The pump station will include a 200,000 gallon wet well storage tank to provide consistent pressures at the pump station.

Table 6-1
Recommended Conveyance System Improvements

Pipeline Projections					
Project ID	**Project Description**	**Length**	**$/foot**	**Engineering, Admin, etc. (15% of Construction Cost)**	**Total Estimated Project Cost (2018 Dollars)**
SC1	Install 12-inch pipe from Ledges Intermediate Storage Pond to the Ledges Golf Course/Upper Ledges Booster Pump Station (Upsize)	12,100	$50	$90,750	$695,800
SC2	Install 10-inch pipe from Ledges Booster Pump Station to New Ledges Storage Tank	6,050	$90	$81,675	$626,200
SC3	Install 12-inch pipe from New Ledges Tank into The Ledges/Trails (Upsize)	6,100	$70	$64,050	$491,100
SC4	Install 12-inch pipe from Rachel Drive in Santa Clara to New Entrada Storage Pond through lava field	9,500	$95	$135,375	$1,037,900
SC5	Install 12-inch pipe from New Entrada Storage Pond to Lower Ledges Booster Pump Station	4,000	$115	$69,000	$529,000
SC6	Install 12-inch pipe from Dixie Drive along Plantations Drive to Future Lago Vista Drive	10,000	$95	$142,500	$1,092,500
SC7	Install 16-inch pipe from future Lago Vista Drive to future Gap Irrigation Storage Tank	5,050	$140	$106,050	$813,100
SC8	Install 14-inch pipe along future Lago Vista Drive connecting Divario to West Tonaquint PD (Upsize)	4,200	$70	$44,100	$338,100
SC9	Install 8-inch pipe through West Tonaquint PD (Upsize)	9,300	$25	$34,875	$267,400
SC10	Install 6-inch pipe from Riverside Drive to Fossil Ridge Intermediate School	700	$60	$6,300	$48,300
SC11	Install 8-inch pipe along 900 S from 2780 E to 3000 E (Upsize)	1,300	$25	$4,875	$37,400
SC12	Install 8-inch pipe along 3000 E from 900 S to 1140 S (Upsize)	1,460	$25	$5,475	$42,000
SC13	Install 10-inch pipe along 2780 E from 1250 S to 1450 S	800	$100	$12,000	$92,000
SC14	Install 12-inch pipe along 1450 S from 2780 E to 3000 E	1,500	$120	$27,000	$207,000
SC15	Install 12-inch pipe from future Stonecliff Tank to 1450 S	3,520	$90	$47,520	$364,300
SC16	Install 10-inch pipe along 2200 S from 3000 E to 3430 E (Upsize)	2,700	$40	$16,200	$124,200
SC17	Install 10-inch pipe along 3430 E from 2200 S to 2450 S (Upsize)	1,350	$40	$8,100	$62,100
SC18	Install 10-inch pipe along 3430 E from 2450 S to Horsemans Park Drive (Upsize)	4,000	$40	$24,000	$184,000
SC19	Install 10-inch pipe along 3000 E from 2450 S to Horsemans Park Drive	4,000	$90	$54,000	$414,000
SC20	Install 10-inch pipe along Horsemans Park Drive from 3000 E to 3430 E	2,700	$90	$36,450	$279,500
SC21	Install 6-inch pipe along 3000 E from Horsemans Park Drive to Crimson Ridge Drive	1,800	$60	$16,200	$124,200
SC22	Install 6-inch pipe along 2880 E from Horsemans Park Drive to Silkwood Park	2,000	$40	$12,000	$92,000
SC23	Install 18-inch pipe along the Fort Pierce Wash from Crimson Ridge Drive to Commerce Drive	5,000	$185	$138,750	$1,063,800
SC24	Install 18-inch pipe along Commerce Drive across the Fort Pierce Wash crossing	700	$185	$19,425	$148,900
SC25	Install 24-inch pipe from SGWRF Reuse Facility to future Reuse Storage Pond	2,000	$100	$30,000	$230,000
SC26	Install 24-inch pipe from future Reuse Pond pump station to reuse transmission pipeline	2,300	$110	$37,950	$291,000
SC27	Install 24-inch pipe from SGWRF Reuse Facility along Southern Parkway to Desert Color/Desert Canyons	23,700	$250	$888,750	$6,813,800
SC28	Install 18-inch pipe from end of Project SC27 to Desert Canyons Booster Pump Station	2,900	$190	$82,650	$633,700
SC29	Install 18-inch pipe along Southern Parkway from Desert Canyons Booster Pump Station to the Desert Canyons area	24,700	$185	$685,425	$5,254,900
SC30	Install 18-inch pipe from Commerce Drive Settling Pond to Desert Canyons, connecting to existing 14-inch pipe north of Southern Parkway	21,600	$185	$599,400	$4,595,400
SC31	Install 12-inch pipe across Southern Parkway in Desert Canyons (Upsize)	1,100	$50	$8,250	$63,300
SC32	Install 12-inch pipe as part of Desert Canyons Loop (Upsize)	2,000	$50	$15,000	$115,000
SC33	Install 14-inch pipe into area west of SG Airport (Upsize)	3,400	$70	$35,700	$273,700
SC34	Install 8-inch transmission loop in area west of SG Airport (Upsize)	10,100	$25	$37,875	$290,400

Pipeline Projections					
Project ID	**Project Description**	**Length**	**$/foot**	**Engineering, Admin, etc. (15% of Construction Cost)**	**Total Estimated Project Cost (2018 Dollars)**
SC35	Install 12-inch pipe as part of Desert Canyons Loop (Upsize)	3,000	$50	$22,500	$172,500
SC36	Install 14-inch line across Fort Pierce Wash in Desert Canyons area (Upsize)	900	$70	$9,450	$72,500
SC37	Install 12-inch loop through Desert Canyons area (Upsize)	20,100	$50	$150,750	$1,155,800
SC38	Install 12-inch loop through Desert Canyon area (Upsize)	2,800	$50	$21,000	$161,000
SC39	Install 18-inch line in Desert Canyons area (Desert Canyons Parkway, West Section)	3,450	$185	$95,738	$734,000
SC40	Install 18-inch line in Desert Canyons area (Desert Canyons Parkway, East Section) (Upsize)	3,500	$100	$52,500	$402,500
SC41	Install 24-inch line from future Desert Canyons Storage Tank into Desert Canyons area	4,400	$250	$165,000	$1,265,000
SC42	Install 12-inch pipe to connect future Little Valley Pump Station to existing transmission line	350	$115	$6,038	$46,300
SC43	Install 18-inch Connection from Commerce Settling Pond to Desert Color	18,000	$185	$499,500	$3,829,500
			TOTAL	**$4,640,145**	**$35,575,100**
Pumping Improvements					
Project ID	**Project Description**	**Capacity (gpm)**	**$/hp**	**Engineering, Admin, etc. (15% of Construction Cost)**	**Total Estimated Project Cost (2018 Dollars)**
SP1	Upper Ledges Pump Station with 100,000 gallon storage wet well (~63 hp)	900	$3,000	$43,000	$331,000
SP2	Intermediate Ledges Pump Station with 200,000 gallon storage wet well (~215 hp)	2,000	$3,000	$127,000	$971,000
SP3	Lower Ledges Pump Station (~420 hp)	2,000	$1,800	$115,000	$876,000
SP4	Dixie Drive Pump Station (~135 hp)	2,080	$3,000	$59,000	$453,000
SP5	Sandberg Pump Station Upgrade (Add 1,400 gpm capacity to existing pump station)	1,400	$1,000	$20,000	$153,000
SP6	Little Valley Pump Station (~130 hp)	1,800	$3,000	$59,000	$451,000
SP7	Commerce Drive Settling Pond - Desert Canyons Pump Station (~415 hp)	3,200	$1,500	$93,000	$714,000
SP8	Commerce Drive Settling Pond - Desert Color Pump Station (~250 hp)	3,200	$2,000	$76,000	$581,000
SP9	SGWRF Reuse Facility - Expansion of Existing Pump Station (Cost included in source Development Project in Chapter 4)	NA	NA	NA	NA
SP10	SGWRF Reuse Pond Pump Station (~600 hp)	5,000	$1,500	$135,000	$1,035,000
SP11	SGWRF Reuse Facility - Future Facility Pump Station (Cost included in source development project in Chapter 4)	NA	NA	NA	NA
SP12	Desert Canyons Booster Pump Station with 200,000 gallon storage wet well (~390 hp)	3,200	$1,500	$116,000	$892,000
			TOTAL	**$843,000**	**$6,457,000**
			GRAND TOTAL	***$5,483,145***	***$42,032,100***

CHAPTER 7
CAPITAL FACILITIES PLAN

A Capital Facilities Plan has been developed to serve as a guideline for the budgeting and implementation of recommended system improvements over the next 10 years. This chapter presents the recommended 10-year capital facilities plan for the secondary irrigation system.

10-YEAR CAPITAL FACILITIES PLAN

Based on the City's identified project needs, BC&A has developed a Capital Facilities Plan (CFP) for the secondary irrigation system. Table 7-1 provides a detailed outlay of the recommended projects to be completed in the next 10 years. Project costs shown in each year are future dollars and have been based on annual construction cost inflation of 3 percent. The projects included in the CFP are those projects that are anticipated to be needed within the next 10 years based on the estimated distribution of future growth in the City. If growth patterns deviate from what was assumed in this report, the CFP can be revised and updated to meet the City's needs.

Table 7-1
City of St. George 10-Year Secondary Irrigation System Capital Facilities Plan

Project Identifier	Project Description	Estimated Total Cost (2018 Dollars)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total Inflated Project Cost
	Source Development												
I1	Upgrade Existing Reuse Facility with 3rd Filter Bay and Additional Booster Pumps	$1,380,000						$1,554,000					$1,554,000
	Storage Facilities												
SS1	1.0 MG Hidden Valley Tank Replacement	$1,035,000			$1,098,000								$1,098,000
SS2	3 MG Commerce Drive Settling Pond	$1,898,000			$2,014,000								$2,014,000
SS3	1.3 MG New Entrada Storage Pond	$523,000			$555,000								$555,000
SS4	1.5 MG Stonecliff Storage Tank	$1,553,000				$1,681,000							$1,681,000
SS5	2.0 MG Desert Canyons Tank No. 1	$2,070,000				$2,241,000							$2,241,000
SS6	Reuse Storage Pond	$3,450,000					$3,809,000						$3,809,000
SS7	1.5 MG Ledges Storage Tank	$1,553,000							$1,784,000				$1,784,000
SS8	1.9 MG Gap Irrigation Tank	$1,639,000								$1,920,000			$1,920,000
	Transmission/Distribution Facilities												
SC1	Ledges 12-inch Transmission Line (Upsize)	$695,800					$768,000						$768,000
SC2	Ledges 10-inch Tank Feed Line	$626,200							$719,000				$719,000
SC3	Ledges 12-inch Distribution Line (Upsize)	$491,100								$575,000			$575,000
SC4	Lava Field 12-inch Transmission Line	$1,037,900		$1,080,000									$1,080,000
SC5	Entrada 12-inch Transmission Line	$529,000		$550,000									$550,000
SC6	Divario 12-inch Transmission Line	$1,092,500							$1,255,000				$1,255,000
SC7	16-inch Gap Irrigation Tank Transmission Line	$813,100							$934,000				$934,000
SC8	14-inch Lago Vista Drive from Divario to West Tonaquint (northern half of project)(Upsize)	$169,050								$198,000			$198,000
SC9	8-inch West Tonaquint Transmission Line (Upsize, southeast half of project)(Upsize)	$133,700								$157,000			$157,000
SC10	6-inch Fossil Ridge Elementary School connection	$48,300				$52,000							$52,000
SC11	8-inch 900 S Distribution Line - Little Valley (Upsize)	$37,400						$42,000					$42,000
SC12	8-inch 3000 E Distribution Line - Little Valley (Upsize)	$42,000							$48,000				$48,000
SC13	10-inch 2780 E Distribution Line	$92,000		$96,000									$96,000
SC14	12-inch 2450 S Transmission Line	$207,000		$215,000									$215,000
SC15	Stone Cliff Tank 12-inch Feed Line	$364,300		$364,300									$364,300
SC16	10-inch 2200 S Distribution Line - Little Valley (Upsize)	$279,500					$309,000						$309,000
SC17	10-inch 3430 E Distribution Line (2200 S to 2450 S) - Little Valley (Upsize)	$139,700						$157,000					$157,000
SC18	10-inch 3430 E Distribution Line (2450 S to Horsemans Park) - Little Valley (Upsize)	$414,000							$476,000				$476,000
SC19	10-inch 3000 E Distribution Line from 2450 s to Horsemans Park Drive - Little Valley	$414,000			$439,000								$439,000

Project Identifier	Project Description	Estimated Total Cost (2018 Dollars)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total Inflated Project Cost
SC20	10-inch Horsemans Park Distribution Line from 3000 E to 3430 E	$279,500				$303,000							$303,000
SC21	6-inch 3000 E Distribution Line from Horsemans Park Drive to Crimson Ridge Drive	$124,200		$129,000									$129,000
SC22	6-inch 2880 E Distribution Line from Horsemans Park Drive to Silkwood Park	$92,000		$96,000									$96,000
SC23	18-inch Fort Pierce Drive Transmission Line	$1,063,800						$1,198,000					$1,198,000
SC24	18-inch Commerce Drive Crossing	$148,900		$155,000									$155,000
SC25	24-inch Reuse Facility Storage Pond Feed Line	$230,000						$259,000					$259,000
SC26	24-inch Pipe from Future Reuse Pond to Reuse Transmission Pipeline	$291,000						$328,000					$328,000
SC30	18-inch Desert Canyons Transmission Line (Settling Pond to tie in at existing 14-inch pipe)	$4,595,400			$4,877,000								$4,877,000
SC31	12-inch Desert Canyons Southern Parkway Crossing (Upsize)	$63,300								$74,000			$74,000
SC39	18-inch Desert Canyons Transmission Line (Desert Canyons Parkway, West Section)	$734,000			$779,000								$779,000
SC40	18-inch Desert Canyons Transmission Line (Desert Canyons Parkway, East Section) (Upsize)	$402,500									$481,000		$481,000
SC41	24-inch Desert Canyons Tank Feed Line	$1,265,000				$1,369,000							$1,369,000
SC42	12-inch Little Valley Pump Station to Distribution System Connection	$46,300		$48,000									$48,000
SC43	18-inch Commerce Drive to Desert Color Transmission Line	$3,829,500										$4,668,000	$4,668,000
	Pumping Facilities												
SP1	Upper Ledges Pump Station with 100,000 Gallon Storage Wet Well	$331,000								$388,000			$388,000
SP2	Intermediate Ledges Pump Station with 200,000 Gallon Storage Wet Well*(35% paid by Ledges GC)	$971,000						$1,094,000					$1,094,000
SP3	Lower Ledges Pump Station (35% paid by Ledges GC)	$876,000					$967,000						$967,000
SP4	Dixie Drive Pump Station	$453,000									$541,000		$541,000
SP6	Little Valley Pump Station	$451,000			$479,000								$479,000
SP7	Commerce Drive Settling Pond - Desert Canyons Pump Station	$714,000			$743,000								$743,000
SP8	Commerce Drive Settling Pond - Desert Color Pump Station	$581,000										$708,000	$708,000
SP10	SGWRF Reuse Pond Pump Station	$1,035,000						$1,166,000					$1,166,000
	Total Improvements	**$41,304,950**	**$0**	**$2,733,300**	**$10,984,000**	**$5,646,000**	**$5,853,000**	**$5,798,000**	**$5,216,000**	**$3,312,000**	**$1,022,000**	**$5,376,000**	**$45,940,300**

[1]A 2% annual inflation rate has been applied to estimated future projects costs.

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