Santaquin

PRESSURIZED IRRIGATION WATER MASTER PLAN AND CAPITAL FACILITY PLAN

(HAL Project No.: 415.03.100)

DRAFT

January 2021

SANTAQUIN CITY

PRESSURIZED IRRIGATION WATER MASTER PLAN

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ABBREVIATIONS AND UNITS

ac	acre [area]
ac-ft	acre-foot (1 ac-ft = 325,851 gal) [volume]
CIP	Capital Improvement Plan
CFP	Capital Facilities Plan
CUWCD	Central Utah Water Conservancy District
CWP	Central Water Project
DBP	disinfection byproduct
EPA	U.S. Environmental Protection Agency
EPANET	EPA hydraulic network modeling software
ERC	Equivalent Residential Connection
ft	foot [length]
ft/s	feet per second [velocity]
gal	gallon [volume]
gpd	gallons per day [flow rate]
gpm	gallons per minute [flow rate]
HAL	Hansen, Allen & Luce, Inc.
hp	horsepower [power]
hr	hour [time]
IFA	Impact Fee Analysis
IFFP	Impact Fee Facilities Plan
in.	inch [length]
irr-ac	irrigable acreage
kgal	thousand gallons [volume]
kW	kilowatt [power]
kWh	kilowatt hour [energy]
MG	million gallons [volume]
mg/L	milligram per liter [concentration]
µg/L	microgram per liter [concentration]
mi	mile [length]
PRV	Pressure Reducing Valve
psi	pounds per square inch [pressure]
s	second [time]
SCADA	Supervisory Control And Data Acquisition
SHLC	Strawberry High Line Canal
ULS	CUWCD Utah Lake System projects
UV	ultraviolet radiation (disinfection method)
wsfu	water supply fixture unit
yr	year[time]

EXECUTIVE SUMMARY

PURPOSE OF STUDY

The purpose of this study is to help Santaquin City provide efficient and reliable pressurized irrigation water service to its customers, both now and into the future, at the lowest cost.

PLANNING HORIZONS

The ultimate planning horizon for this study is the year 2060. However, this report provides guidance applicable at various time scales:

1. Near future: low-cost actions and best practices the City can implement to reduce costs and improve operations.
2. 10-year: system improvements needed within 10 years to provide capacity for anticipated new development. The cost of these improvements will be used to set impact fees and guide the formulation of near-term budgets.
3. 20-year: system improvements needed within 20 years for anticipated new development. These improvements are included in the capital facility plan to guide the formulation of longer-term budgets.
4. Future: all system improvements necessary to serve the City at year 2060, when it is developed at the density defined by the City's current general plan and zoning ordinances (except for remaining agricultural lands). These recommendations will help the City secure key pieces of land and work with developers to properly plan for infrastructure that is compatible with the future system.

COMPONENTS OF A WATER DISTRIBUTION SYSTEM

The following three components of a pressurized water system were analyzed to determine the capacity and ability of the water system to meet existing and future water demands:

1. Source – the water used to supply the system
2. Storage – a location to store water between the time it is delivered to the system, and the time it is used by a customer
3. Distribution – pipelines used to deliver water from sources or storage locations to the customer

Each of these components must have enough capacity and capability to serve existing and future customers. To ensure adequate capacity, this study proposes a level of service as a design standard for new development (as discussed in the following section).

METHODS

Water usage and water system data were used to develop a responsible level of service for each component (source, storage, and distribution) of the water system. The level of service was used to evaluate the existing system, identify existing deficiencies, and develop a computer model of the existing system.

The land use element of the general plan, population projections, development concept plans, and the proposed level of service were used to forecast the magnitude and locations of future water demands in the City. Computer modeling and other tools were used to determine what infrastructure is necessary to best meet these demands.

LEVEL OF SERVICE

Level of Service is the standard of performance that the pressurized irrigation system is designed to meet. It includes components of pressure, storage, and water delivery. The level of service was developed using water billing and production data, input from City personnel, and industry best practices. The level of service is based on irrigable acreage.

Table ES-1 shows the levels of service defined for this study. Pressure requirements are expressed in units of pounds per square inch (psi). Other requirements are expressed in units of demand (gallons per minute [gpm]) or volume (gallons [gal] and acre-feet [ac-ft]) per irrigable acre (irr-ac).

Table ES-1
Level of Service Parameters

Parameter	Level of Service
Minimum system pressure	30 psi
Peak Day Demand	8.0 gpm/irr-ac
Average Yearly Demand	4.0 ac-ft/irr-ac
Storage	9,200 gal/irr-ac

These level of service parameters were used to quantify system demand and compare it to system capacity. This allowed the project team to identify vulnerabilities in the water system and make plans for future growth.

SYSTEM VULNERABILITIES

The system was analyzed to identify vulnerabilities in the existing system and areas which need improvements in order to support future growth. Table ES-2 contains a summary of existing or near-term (0 – 10 years) system vulnerabilities. Further information about these vulnerabilities is described in subsequent sections.

Table ES-2
Existing or Near-Term (0 – 10 Years) System Vulnerabilities

ID	Description	Notes
V1	**Zone 10W Source and Storage**	Growth in Zone 10W has led to high pressure swing and pressures which are near the minimum level of service. This is chiefly due to high head losses through the single 4-inch diameter backflow preventer that serves this zone. Additionally, Zone 10W borrows capacity from the drinking water system, which is becoming increasingly limited as development continues.
V2	**Zone 11W Source and Storage**	Pressure Zone 11W borrows capacity from the drinking water system, which is becoming increasingly limited as development continues.
V3	**Limited Source Capacity**	During dry years, there is minimal excess peak day source capacity available in the PI system. Continued development will place further strain on the irrigation water supply. Backup capacity in the drinking water system is becoming increasingly limited as development continues.
V4	**Increased Wastewater Effluent**	Because the City does not have a sewer effluent discharge permit, there is a need to use as much reclaimed wastewater as is available. As wastewater influent continues to increase, the existing reuse pumps will not have adequate capacity to supply it to the PI system.

Recommended solutions to these vulnerabilities are summarized in Table ES-3 and discussed in detail in Chapter 7.

Table ES-3
Proposed Solutions to System Vulnerabilities

Description	Notes	Vulnerabilities Addressed
Additional 10W Backflow Preventer	Construct an additional backflow preventer to assist the existing 4-inch backflow preventer in supplying adequate flow and pressure to Zone 10W.	V1
Drinking Water Projects	Projects included in the Drinking Water Master Plan will provide increased source and storage capacity to areas of the system currently supplied by the drinking water system. While the chief purpose of drinking water projects is to provide capacity for indoor use, they will assist the City in supplying the PI system until water is available in the future ULS pipeline.	V1, V2, V3
ULS Source Project	Construct pipelines to convey source from the future ULS source pipeline (currently under construction) to the system, including Zone 10W.	V1, V3
Upgraded Reuse Pump Station	Add capacity to the existing wastewater reuse pump station.	V3, V4
Zone 11W Source and Storage	Construct a PI pump station and storage facility to provide capacity and support future growth in Zone 11W.	V2, V3

DISTRIBUTION SYSTEM – GENERAL RECOMMENDATIONS

The following subsections contain general recommendations for Santaquin to follow to ensure continued water service at the lowest cost, into the future.

General Source Recommendations

The following are recommended actions for Santaquin to take to ensure adequate source capacity into the future:

1. Continue to require developers to provide the City with water rights as a condition of development.
2. To the extent possible, use surface water from Summit Creek Irrigation Company as the preferred irrigation source. Reuse water should be used as the next preferred irrigation source. Reserve groundwater for use in the drinking water system or for periods when minimal surface water is available.

General Storage Recommendations

The following are recommended actions for Santaquin to take to ensure adequate storage capacity into the future:

1. Construct additional storage tanks/ponds to support growth. Recommended sizes and locations are shown on the Master Plan map in Appendix A.

General Distribution Recommendations

The following are recommended actions for Santaquin to take to ensure adequate distribution capacity into the future:

1. Upsize pipes to master plan size as development occurs. Master plan pipe sizes are shown on the Master Plan map in Appendix A.
2. Keep a record of the age of system pipes. Replace pipes which are experiencing frequent leaks.

CAPITAL FACILITY PLAN

Projects necessary to support growth over the next 20 years are identified and described in the Capital Facility Plan. Conceptual-level cost estimates were prepared for each project. Costs were classified as either (1) An operations/maintenance project; or (2) A project attributable to growth. Projects attributable to growth are eligible to be paid for by impact fees.

Table ES-4 briefly summarizes the estimated costs of the recommended operations/maintenance project. This project should be pursued as resources allow and according to the priorities of the City.

Table ES-4
Operations/Maintenance Projects

Project	Estimated Cost
Two PI Flush Stations	$16,000
Total	**$16,000**

System growth will necessitate four major capital projects within the next 20 years. These projects have an estimated cost of **$11,018,000** (see Table ES-5 and further details in Chapter 7). These costs will be eligible to be paid by impact fees.

Table ES-5
System Growth-Related Capital Projects (0 – 20 Years)

Type & Year	Map ID	Recommended Project	Cost
Source **10-20 Years**	2	Drill and equip a well to serve the western portion of Zone 10.	$701,000
Source, Distribution **2021**	3	Install approximately 5700 feet of 24-inch diameter pipe to provide source conveyance to the western portion of the City and from the future planned ULS pipeline.	$1,596,000
Source, Storage, Distribution **2021**	4	Construct a pump station, storage pond/tank, and associated distribution mains to provide service to Zone 11W.	$4,949,000
Distribution **2026**	5	Install approximately 3600 feet of 16-inch diameter pipeline to provide a direct connection from the ULS pipeline to Zone 11W.	$687,000
Source **5-10 Years**	7	Increase the capacity of the Type 1 reuse booster station to accommodate increasing sewer inflows and provide additional source to the PI system. Install approximately 5800 feet of 12-inch diameter pipe.	$1,489,000
Distribution **10-20 Years**	10	Install approximately 2,700 feet of 12-inch diameter pipe to provide increased conveyance to Zones 10 and 9N.	$470,000
Source **10-20 Years**	15	Install a pump station and approximately 1300 feet of 12-inch pipe to pump out of the City's planned south Type 1 reuse storage facility.	$1,126,000
TOTAL			**$11,018,000**

Development will necessitate that a number of pipes be installed or upsized throughout the 20-year planning period to provide continuing service and future capacity. A brief summary of these costs is included in Table ES-6, with more details included in Chapter 7.

Table ES-6
Development-Driven Projects (0 – 20 Years)

Project	Estimated Cost
Pipe Upsizing and Installation (0 – 10 Years)	$182,000
Source Facilities (0-10 Years)	$84,000
Pipe Upsizing and Installation (10 – 20 Years)	$2,249,000
Source Facilities (10 – 20 Year)	$1,015,000
Total	**$3,530,000**

CONCLUSIONS

It is recommended that the City take the following actions immediately in order to ensure safe, reliable, cost-effective, and financially responsible water service into the future:

1. Immediately begin planning and budgeting for the projects outlined in the Capital Facility Plan.
2. Use the master plan to review each new development, to ensure properly sized and located infrastructure is constructed as development progresses. Doing so will eliminate the need for guesswork, help the City use its resources most effectively, and ensure excellent performance of the PI system, both now and into the future.

CHAPTER 1 INTRODUCTION

PURPOSE AND SCOPE

The purpose of this master plan is to provide direction to the City of Santaquin regarding decisions that will be made to provide an adequate pressurized irrigation water system for its customers at the most reasonable cost. Recommendations are based on demand data, growth projections, standards outlined by the Utah Administrative Code, and standard engineering practices. The planning horizon for the master plan is 40 years, or approximately 2060.

The master plan is a study of the City's pressurized irrigation water system and customer outdoor water use. The following topics are addressed herein: general planning, growth projections, water rights, water rates, impact fees, source requirements, storage requirements, and distribution system requirements. Operational parameters for the City's pressurized irrigation water system were reviewed and are recommended to be optimized based on stability, ease of use, and cost. Based on this study, needed capital improvements have been identified and conceptual-level cost estimates for the recommended improvements have been provided.

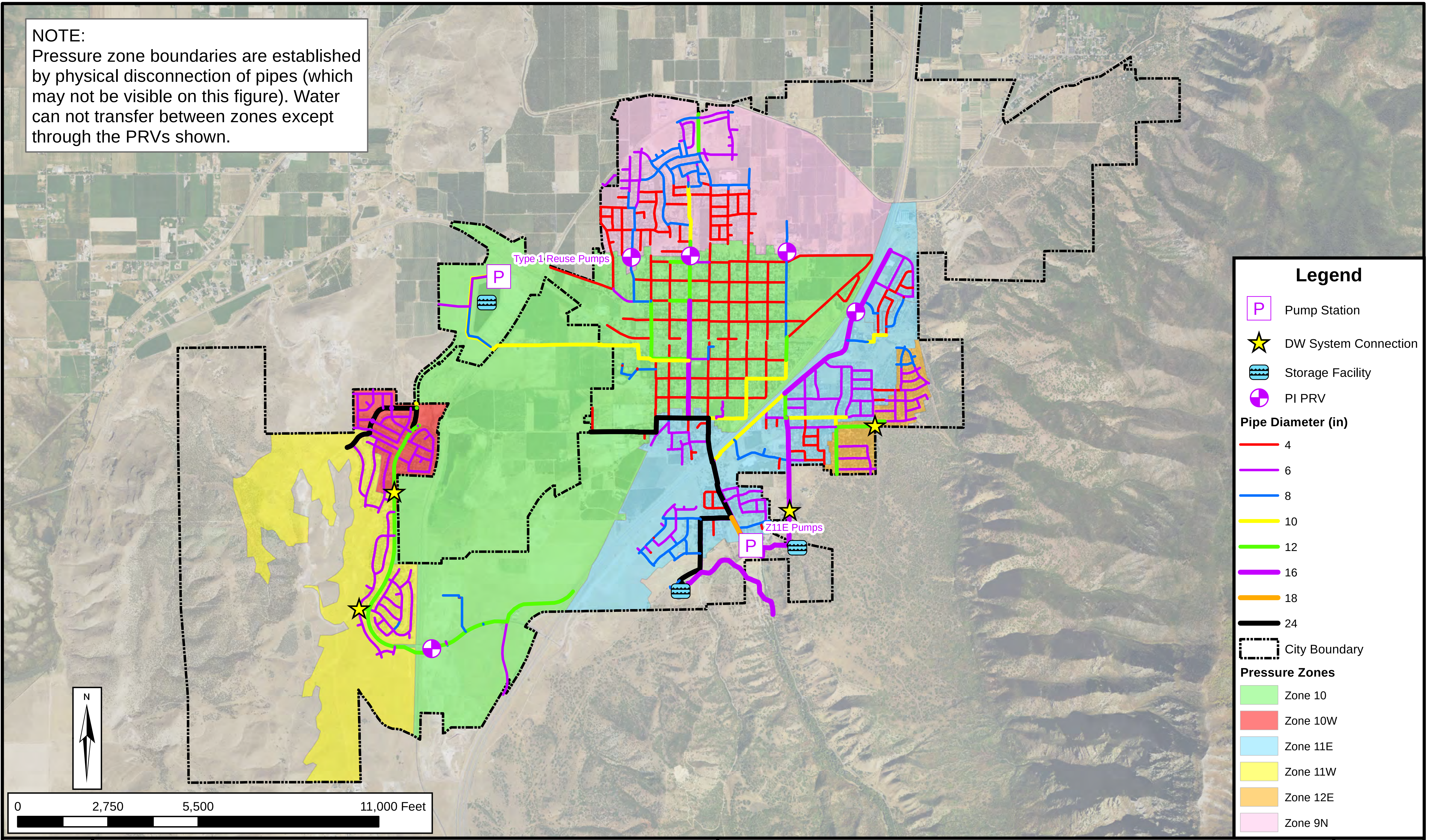
The results of the study are limited by the accuracy of growth projections, data provided by the City, and other assumptions used in preparing the study. It is expected that the City will review and update this master plan every 5–10 years as new information about development, system performance, or water use becomes available.

BACKGROUND

Santaquin City was first settled in late 1851 and is located about 70 miles south of Salt Lake City in Utah County. Although its history lies mostly in agriculture, its population today also has a substantial number of commuters who work in Provo, Spanish Fork, and other nearby cities. Utah County has experienced rapid growth in recent decades, and this growth has extended to Santaquin as population centers have expanded and property values have increased. From 2010–2018, Santaquin grew at a rate of 34.1% from a population of 9,128 to an estimated 12,274 (U.S. Census Bureau). In 2019, the City provided pressurized irrigation water service to 3,299 connections.

The existing pressurized irrigation water system includes three storage facilities, three pump stations, five pressure zones, and about 69 miles of pipe with diameters ranging from 4 inches to 24 inches. See Figure 1-1. About 16 miles of these pipes are currently served by crossovers from the drinking water system. The City recognizes that its continued growth necessitates proactively planning additional pressurized irrigation water facilities to maintain an acceptable level of service for outdoor water use.

The Santaquin pressurized irrigation system is master planned to be an independent system, but is currently supplemented by excess capacity in the drinking water system. Separate drinking water and pressurized irrigation water pipelines exist in nearly all areas of the system. As the excess capacity in the drinking water system is needed for future growth, pressurized irrigation water system facilities will be constructed to increase the capacity of the pressurized irrigation water system, thus freeing up capacity for future drinking water demands. The drinking water system is addressed in a separate master plan document.



NOTE:
Pressure zone boundaries are established by physical disconnection of pipes (which may not be visible on this figure). Water can not transfer between zones except through the PRVs shown.

HANSEN ALLEN & LUCE INC ENGINEERS

SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

EXISTING PRESSURIZED IRRIGATION SYSTEM

FIGURE
1-1

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LEVEL OF SERVICE

The level of service (LOS) is the standard of performance, including water supply and service pressure, that the pressurized irrigation (PI) water system is designed to meet. Because state codes do not regulate the LOS of a PI system, it must be selected based on sound engineering judgment and incorporate appropriate safety factors. The LOS for the Santaquin City PI water system was selected based on a review of aerial imagery and of secondary water production and meter data for the past three years. Safety factors, City preferences, and input from City personnel were also incorporated.

It is important to plan for and design a water system based on a consistent unit of measurement. For this study, irrigable acres were selected as the basis of planning and design. Although different types of vegetation require varying amounts of water, the vast majority of irrigated area in Santaquin is turf grass or garden with a similar water requirement. Thus, the amount of water required on a per-area basis can safely be considered uniform over the entire city. This study was not based on Equivalent Residential Connections (ERCs) or lot numbers, since lot sizes in Santaquin vary considerably.

The LOS parameters in this study are designed to produce an effective water system that performs well in varying states of system operation. However, they are not necessarily designed for every “worst-case” scenario. For instance, Santaquin City does not intend to enable wasteful watering. Rather than design a system capable of meeting excessive water demands, the City prefers to take actions to keep landscape watering at an appropriate level. To that end, the City has implemented mandatory time-of-day watering restrictions and is working to implement a tiered rate structure that will encourage conservation. The planned tiered rate structure, together with the LOS parameters, are intended to result in the design of a responsible system.

The LOS parameters used for this study are summarized in Table 1-1. The development of each LOS parameter is described in later chapters.

Table 1-1
Level of Service Parameters

Parameter	Level of Service
Minimum system pressure	30 psi
Peak Day Demand	8.0 gpm/irr-ac
Average Yearly Demand	4.0 ac-ft/irr-ac
Storage	9,200 gal/irr-ac

MASTER PLANNING METHODOLOGY

Pressurized irrigation water systems consist of water sources, storage facilities, distribution pipes, pump stations, and other components. Design and operation of the individual components must be coordinated so that they operate efficiently under a range of demands and conditions. The system must be capable of responding to daily and seasonal variations in demand.

Identifying present and future water system needs is essential in the management and planning of a water system. For this study, existing water demands are based on the level of service defined by the City as a part of the master planning process. This report addresses sources, storage, distribution, minimum pressures, hydraulic modeling, capital improvements, funding, and other topics pertinent to the Santaquin pressurized irrigation water system.

A computer model of the City's pressurized irrigation water system was prepared to simulate the performance of facilities under existing and future conditions. System improvement recommendations were prepared from the analysis and are presented in this report.

DESIGN AND PERFORMANCE CRITERIA

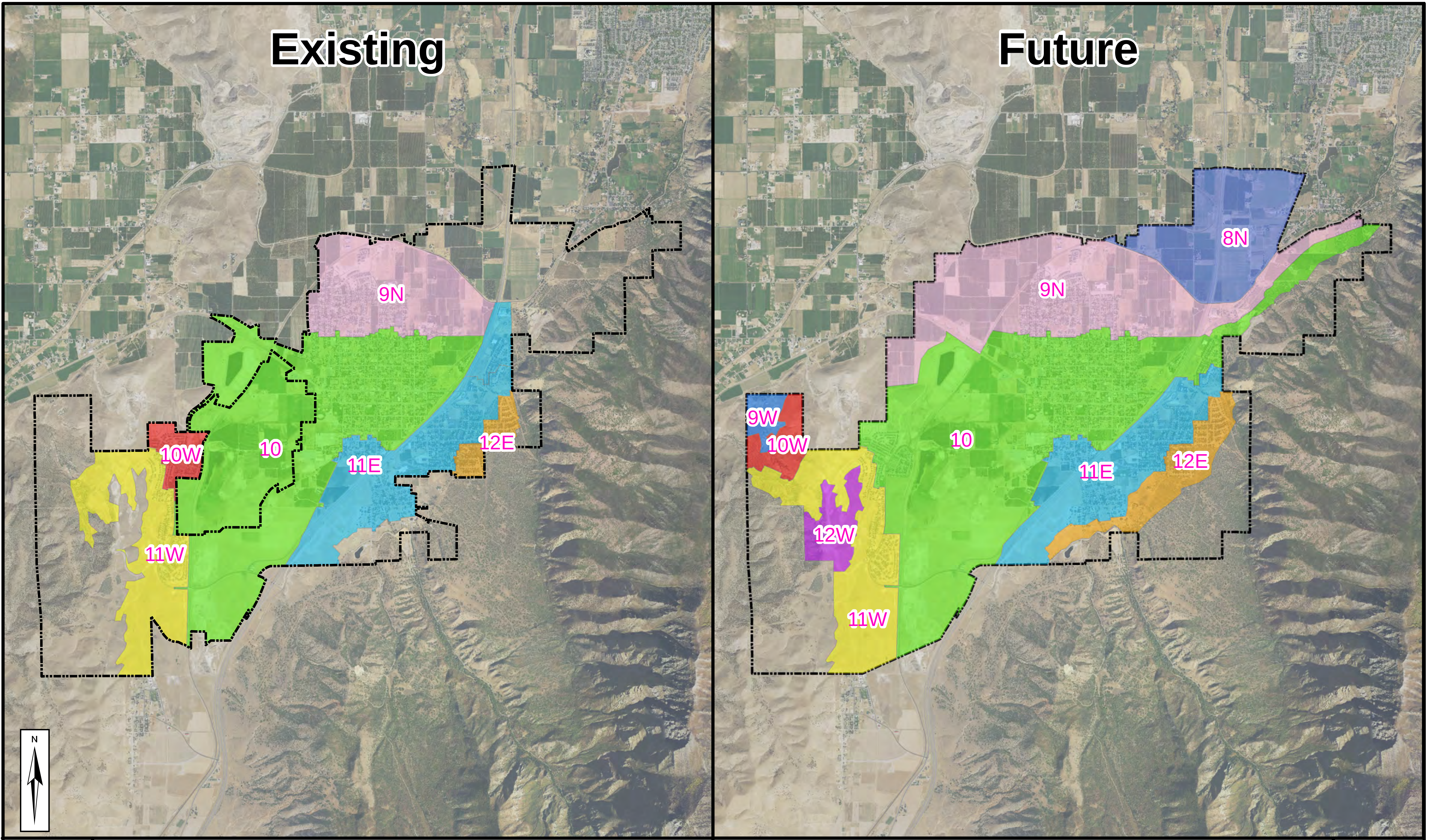
Summaries of the key design criteria and demand requirements for the pressurized irrigation water system are included in Table 1-2. The design criteria were used in evaluating system performance and in recommending future improvements.

Table 1-2
Key System Design Criteria

	Criteria	Existing Requirements	Estimated Future Requirements
Irrigable Acreage	Existing and Planned Irrigable acreage	570	1,720
Source			
Peak Day Demand	Level of Service	4,560 gpm	13,760 gpm
Average Yearly Demand	Level of Service	2,280 acre-ft	6,880 acre-ft
Storage	Level of Service	16.09 ac-ft	48.56 ac-ft
Distribution			
Peak Instantaneous	2.1 × Peak Day Demand	9,576 gpm	28,896 gpm
Max. Operating Pressure	City Preference	130 psi	130 psi
Min. Operating Pressure	Level of Service	30 psi	30 psi

PRESSURE ZONES

Source, storage, and distribution requirements are organized in this report based on system pressure zones. Boundaries for future pressure zones were drawn in order to keep pressures within level of service criteria and keep pressurized irrigation pressures below drinking water pressures. Existing and proposed future pressure zone boundaries are shown in Figure 1-2. These are shown to provide context for the tables in subsequent chapters. The master plan map in Appendix A shows additional proposed infrastructure, including pipelines, PRVs, sources, and storage facilities.



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SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

EXISTING AND FUTURE PRESSURE ZONES

FIGURE 1-2

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CHAPTER 2 IRRIGABLE ACREAGE

GROWTH PROJECTIONS

The development of impact fees requires growth projections over the next ten years. In addition to impact fee projects, this report will also highlight anticipated projects 10-20 years out in the Capital Facilities Plan section of this report (Chapter 7). Growth projections for Santaquin were evaluated as a part of this master planning effort.

City input and growth projections made by the Governor's Office of Management and Budget (GOMB), Mountainland Association of Governments (MAG), and a market-driven growth analysis prepared for Envision Utah were considered in the development of growth projections used for this study. Detailed information is included in Appendix B. Figure 2-1 shows the historic and projected population for Santaquin through 2060.

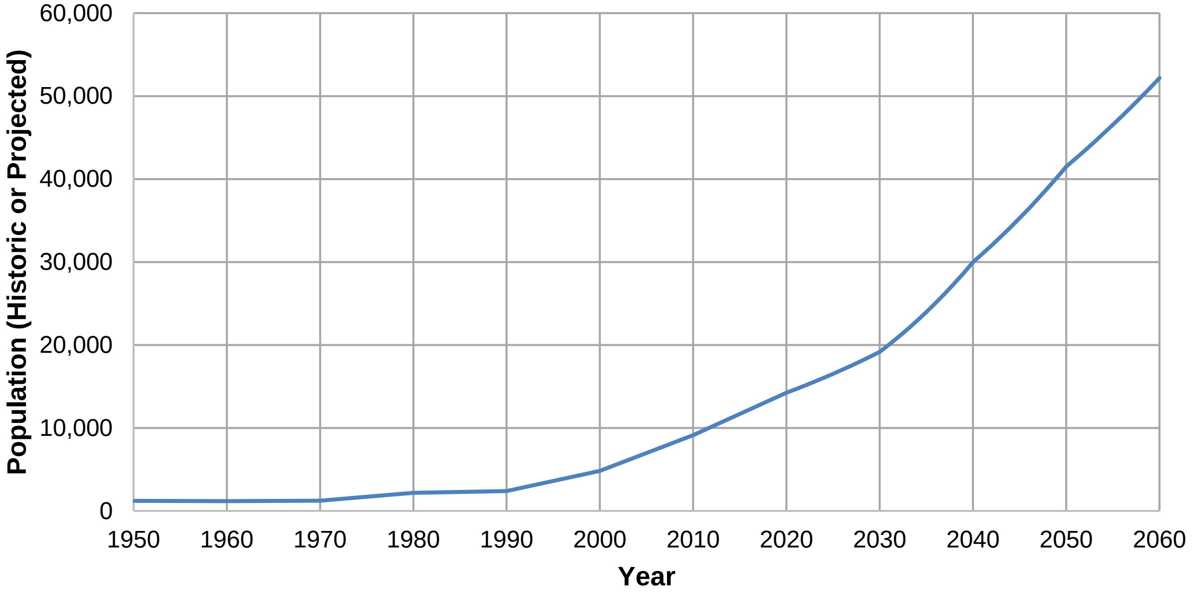


Figure 2-1: Santaquin Historic and Projected Population

Although growth projections are important for planning purposes, it should be noted that land use changes will ultimately serve as the triggers for expansion of the PI system. Population projections will be used to help predict when and where these land use changes will occur.

EXISTING AND FUTURE IRRIGABLE ACREAGE

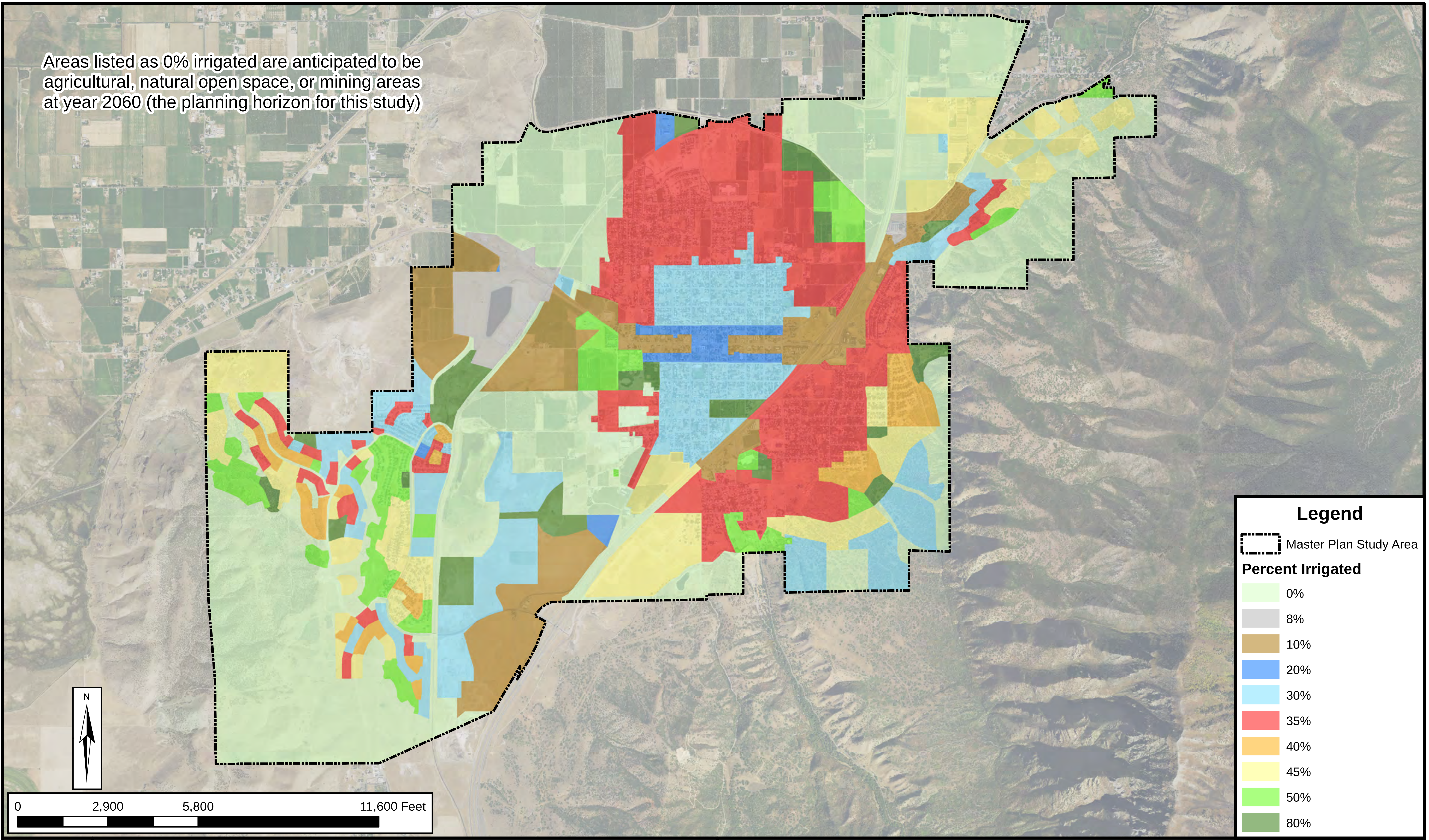
Outdoor water demands are based on irrigable acreage (irr-ac). Existing irrigable acreage in Santaquin was determined based on an analysis of aerial imagery. For purposes of this report, "Existing" will refer to development constructed as of January 1, 2020.

Future irrigable acreage was calculated by starting with the existing irrigable acreage and adding to it the area of land that is expected to be irrigated at year 2060. Future projections were based on the future land use plans. For each planned land use, an irrigation factor was determined based on similar surrounding developments and requirements in City land use code (Title 10). Figure 2-2 shows the assumed irrigation factor for each area within the Master Plan study area, which was defined by Santaquin City personnel based on the existing City boundary, approved development concepts, and other areas identified as likely to develop within the planning horizon of the study. Table 2-1 presents the irrigation factors for each land use type.

Table 2-1
Irrigation Factors by Land Use Type

Land Use	Irrigation Factor
Business Park	0.10
Central Business District	0.20
Commercial	0.10
Industrial	0.08
Main Street Commercial	0.10
Multi-family Residential	0.30
Park	0.80
Public Facilities	0.20
R-8 Residential	0.30
R-10 Residential	0.35
R-12 Residential	0.40
R-15 Residential	0.45
R-20 Residential	0.50
R-43 Residential	0.30
School	0.50

Table 2-2 provides a breakdown of the existing and future irrigable acreage by pressure zone.



Areas listed as 0% irrigated are anticipated to be agricultural, natural open space, or mining areas at year 2060 (the planning horizon for this study)

SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

IRRIGATION FACTORS BY AREA

FIGURE
2-2

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Table 2-2
Existing and Future Irrigable Acreage by Zone

Zone	Existing Irrigable Acreage	Future Irrigable Acreage
8N	0	65
9N	110	335
9W	0	35
10	220	630
10W	40	50
11W	55	220
11E	115	260
12E	30	125
Total	**570**	**1,720**

Table 2-3 contains the projected population and irrigable acreage through 2040. These projections are used to develop the Capital Facility Plan in Chapter 7.

Table 2-3
Growth Projections

Year	Projected Population	Projected Irr-ac
2020	14,242	570
2021	14,671	584
2022	15,113	597
2023	15,568	611
2024	16,037	626
2025	16,520	641
2026	17,017	656
2027	17,530	672
2028	18,058	687
2029	18,602	704
2030	19,162	720
2031	20,039	747
2032	20,957	774
2033	21,916	802
2034	22,920	831
2035	23,969	861
2036	25,066	893
2037	26,214	925
2038	27,414	959
2039	28,669	994
2040	29,982	1030

CHAPTER 3 WATER SOURCES AND DEMAND

This chapter presents an overview of existing and future source requirements and makes recommendations that will help the City meet these requirements as it grows.

EXISTING WATER SOURCES

Santaquin City has a wide array of sources that are used in the pressurized irrigation system as demand dictates and as supply allows. However, not all sources reliably produce on the day of peak demand. Sources can be limited by water rights, hydrologic capacity, or regulatory capacity. As such, it is important to define a reliable supply of water available during the period of peak demand and over the course of a season.

Key sources used in the system include surface water and well water from Summit Creek Irrigation Company, springs in Santaquin Canyon, Type 1 wastewater reuse, and Center Street Well. Physical infrastructure capacity, and peak day planning values, are summarized in Table 3-1 for each source.

Table 3-1
Existing Pressurized Irrigation Water Sources

Source	Pressure Zone(s)	Physical Flow Capacity (gpm)	Peak Day Planning Capacity (gpm)	Annual Flow Capacity (ac-ft)
Center Street Well[1]	10	560	490	390
Drinking Water System[2]	10W	392	190	140
Drinking Water System[2]	11W	2,450	1,170	180
Drinking Water System[2]	12E	1,560	750	120
Drinking Water System[2]	11E	900	700	570
Springs 2-5 bypass[3]	10	900	0	0
Spring 1	10	200	75	60
SCIC Wells[4]	10	1,300	575	470
SCIC Stream[4]	10	3,000		
Type 1 Reuse Ponds[1,5]	10	800	700	490
Total		**-**	**4,650**	**2,420**

1. Assumes that the pump runs 21 hours per day
2. Meters were assumed to be at physical capacity when velocity through the meter vault pipes reaches 10 ft/sec. Annual capacity is limited to the demand currently served in these zones. Peak day planning capacity was defined as the physical capacity divided by a diurnal peaking factor of 2.1. Annual capacity was defined as the current level of service demand within the zone served or the available amount, whichever is less.
3. Because the Springs bypass delivers excess drinking water to the PI system, its capacity is included in the capacity listed for the drinking water system in Zone 11E.
4. The City owns 666.5 shares in SCIC. The City reports a low-year flow rate of 0.7 ac-ft/share over a 184-day irrigation season (575 gpm and 470 ac-ft/yr).
5. 490 ac-ft of Type 1 water was used in 2019. This value is expected to increase as the City grows.

EXISTING WATER SOURCE DEMAND

Aerial imagery and water use data from Santaquin City were used to determine the pressurized irrigation water demand on a per-irrigable acre basis. Historic water use data is shown in Table 3-2.

Table 3-2
Historic Irrigation Water Use

Water Use Variable	Year		
	2017	2018	2019
Irrigable Acreage	540	555	570
Average Yearly Demand			
Total (ac-ft)	2,079	1,935	1,946
Per irr-ac (ac-ft/irr-ac)	3.85	3.49	3.41
Per irr-ac (gpd/irr-ac)[1]	6,818	6,174	6,046
Per irr-ac (gpm/irr-ac)[1]	4.7	4.3	4.2
Peak Day Demand			
Total (gpm)[2]	4,487	4,541	4,325
Per irr-ac (gpd/irr-ac)	11,964	11,783	10,926
Per irr-ac (gpm/irr-ac)	8.3	8.2	7.6

1. The average yearly demand shown assumes a 184-day irrigation season.
2. Calculated as the peak month average, with a factor of safety to account for the difference between peak month and peak day demands.

Analysis and Proposed Level of Service

While Santaquin City intends to provide adequate water supply to support healthy turf grass, the City does not intend to enable wasteful watering. The City has expressed willingness and desire to modify the existing billing structure to encourage residents to be more conservation-minded. While historic data is informative, the City is more interested in a level of service which is responsible and appropriate without being too restrictive or too excessive. As such, the following level of service parameters are proposed:

- **Average yearly source: 4.0 ac-ft/irr-ac**. This level of service is greater than the historical water use for years 2018 and 2019 and is consistent with irrigation duties accepted by the State of Utah.
- **Peak day source: 8.0 gpm/irr-ac.** This level of service is greater than the historical water use for 2019, and other cities which have implemented conservation-oriented rate structures have observed peak day source production well below it. This level of service is adequate without being excessively high or low.

This level of service is generally consistent with the City's current water dedication policy, with the exception of high-density residential developments. Chapter 3 of the drinking water system includes recommended revisions to the City's water dedication policy.

WATER SOURCE REQUIREMENTS

Existing and Future Peak Day Demand

Peak day demand is the water demand on the day of the year with the highest water use. It is used to determine required source capacity under existing and future conditions. Table 3-3 shows a summary of existing and future peak day demand requirements.

Table 3-3
Existing and Future Pressurized Irrigation Peak Day Demand

	Existing		Future	
Pressure Zone	**Irrigable Acreage**	**Demand (gpm)**	**Irrigable Acreage**	**Demand (gpm)**
8N	0	0	65	520
9N	110	880	335	2,680
9W	0	0	35	280
10	220	1,760	630	5,040
10W	40	320	50	400
11W	55	440	220	1,760
11E	115	920	260	2,080
12E	30	240	125	1,000
Total	**570**	**4,560**	**1720**	**13,760**

Existing Pump Stations

Santaquin City operates three PI pump stations. The Canyon Road Booster is the sole source of water to Zone 11E, while the SCIC and Type 1 reuse boosters supply source to Zone 10 and the system as a whole. The existing Santaquin PI pump stations are shown in Table 3-4.

Table 3-4
Existing Pressurized Irrigation Water Pump Stations

Name	From	To Zone	Pumps	Rated Capacity	Peak Day Demand (gpm)	Surplus (+) or Deficit (-)
400 N 200 W Booster	SCIC	10	2 @ 1,300 gpm	1,300 gpm	N/A[1]	N/A[1]
Canyon Road Booster	Zone 10	11E	2 @ 2,500 gpm	2,500 gpm	920	+1,580
Water Reuse Booster	Storage Ponds	10	2 @ 800 gpm	800 gpm	N/A[1]	N/A[1]

1. The 400 N 200 W booster and the Type 1 reuse booster are sources to the system, and thus were not individually evaluated for capacity, but were evaluated as part of the total system source capacity.

Existing and Future Average Yearly Demand

Average yearly demand is the volume of water used during an entire year, and is used to ensure the sources have enough volume to meet demand under existing and future conditions. Table 3-5 is a summary of the existing and future average yearly demand.

Table 3-5
Existing and Future Average Yearly Demand

Time Period	Irrigable Acreage	Average Yearly Demand (ac-ft)
Existing	570	2,280
Future	1,720	6,880

Comparison of Supply and Demand

Tables 3-6 and 3-7 show a comparison of demand and available source capacity for peak day and average yearly demand. Source capacity being used from the drinking water system is included in these tables, though excess drinking water capacity is not.

Table 3-6
Existing Pressurized Irrigation Water Demand and Source Capacity

Parameter	Peak Day (gpm)	Average Yearly (ac-ft)
Demand	4,560	2,220
Capacity	4,650	2,420
Surplus (+) or Deficit (−)	**+90**	**+200**

Table 3-7
Future Pressurized Irrigation Water Demand and Source Capacity

Parameter	Peak Day (gpm)	Average Yearly (ac-ft)
Demand	13,760	6,880
Existing Capacity	4,650	2,420
Surplus (+) or Deficit (−)	**-9,110**	**-4,460**

Table 3-7 demonstrates that the City needs more water shares to meet future peak day and average yearly demands. Santaquin City code specifies that developers must convey water rights to the City, or pay cash in lieu of water rights, in order to receive final approval. It is recommended that this practice continue to ensure sufficient water is available to meet average yearly demands. Further guidance on water rights is available in the City's water rights 40-year plan report. More source capacity is also needed to meet future peak day demands.

SOURCE - RECOMMENDATIONS

This section recommends water sources the City may pursue to ensure adequate capacity through year 2060. Table 3-8 shows a summary of the future sources required to meet estimated future demands at the level of service. Discussions on each source are included in the subsequent subsections.

Table 3-8
Planned Future Pressurized Irrigation Water Sources

Source	Pressure Zone(s)	Physical Flow Capacity (gpm)	Peak Day Planning Capacity (gpm)	Annual Flow Capacity (ac-ft)
Center Street Well[1]	10	560	490	390
Drinking Water System[2]	-	-	0	0
East Side Well[1]	11E	320	280	220
Springs 2-5 bypass[3]	10	900	0	0
Spring 1	10	200	70	60
SCIC Wells[4]	10	1,300	890	720
SCIC Stream[4]	10	3,000		
Type 1 Reuse	10	3,000	2,600	2,060[5]
ULS pipeline (shares owned)	10	-	9,170	908.5
ULS Pipeline or Canals (additional shares that must be acquired)	10			2,311.5
West Side Well[1]	10	300	260	210
Total		**-**	**13,760**	**6,880**

1. Assumes that the pump runs 21 hours per day
2. The PI system is planned to be fully independent, without relying on the drinking water system to provide source.
3. It is anticipated that the springs will not overflow by year 2060 due to increased drinking water demands.
4. The City expects to own about 1,030 shares in SCIC by year 2060. The City reports a low-year flow rate of 0.7 ac-ft/share over a 184-day irrigation season.
5. Projections for annual capacity are based on growth projections in the City's wastewater master plan. While the City has rights to reuse up to 5,300 ac-ft of water per year, it is not expected that the City will have sufficient inflows to the plant to reuse more than about 2,060 ac-ft/yr at the end of the 40-year planning horizon of this study. See Appendix D for more details on wastewater reuse.

Summit Creek Irrigation and Canal Company

Santaquin City anticipates obtaining approximately 49% of the total shares in SCIC by year 2060. Planning values listed in Table 3-8 are listed assuming a low-year supply of 0.7 ac-ft per share, although the amount supplied will be much greater in some years. Water in SCIC will be used to the extent that it is available.

Wells

Santaquin City requested an evaluation of two existing wells for use in the PI system.

The East Side Well is located in Zone 11E and was previously used in the drinking water system before water quality became unsuitable. It has a capacity of 320 gpm and a static water level of approximately 320 ft below ground surface. Approximately 300 ft of 10-inch pipe would need to be constructed through existing City streets before the well could be used.

The West Side Well is located near the City's existing Summit Ridge sports fields. It has a capacity of 300 gpm and a static water level of approximately 200 ft below ground surface. Approximately 700 ft of 8-inch pipe would need to be constructed through open space before the well could be used. The City has reported that the West Side Well would likely need to be re-drilled in order to be used.

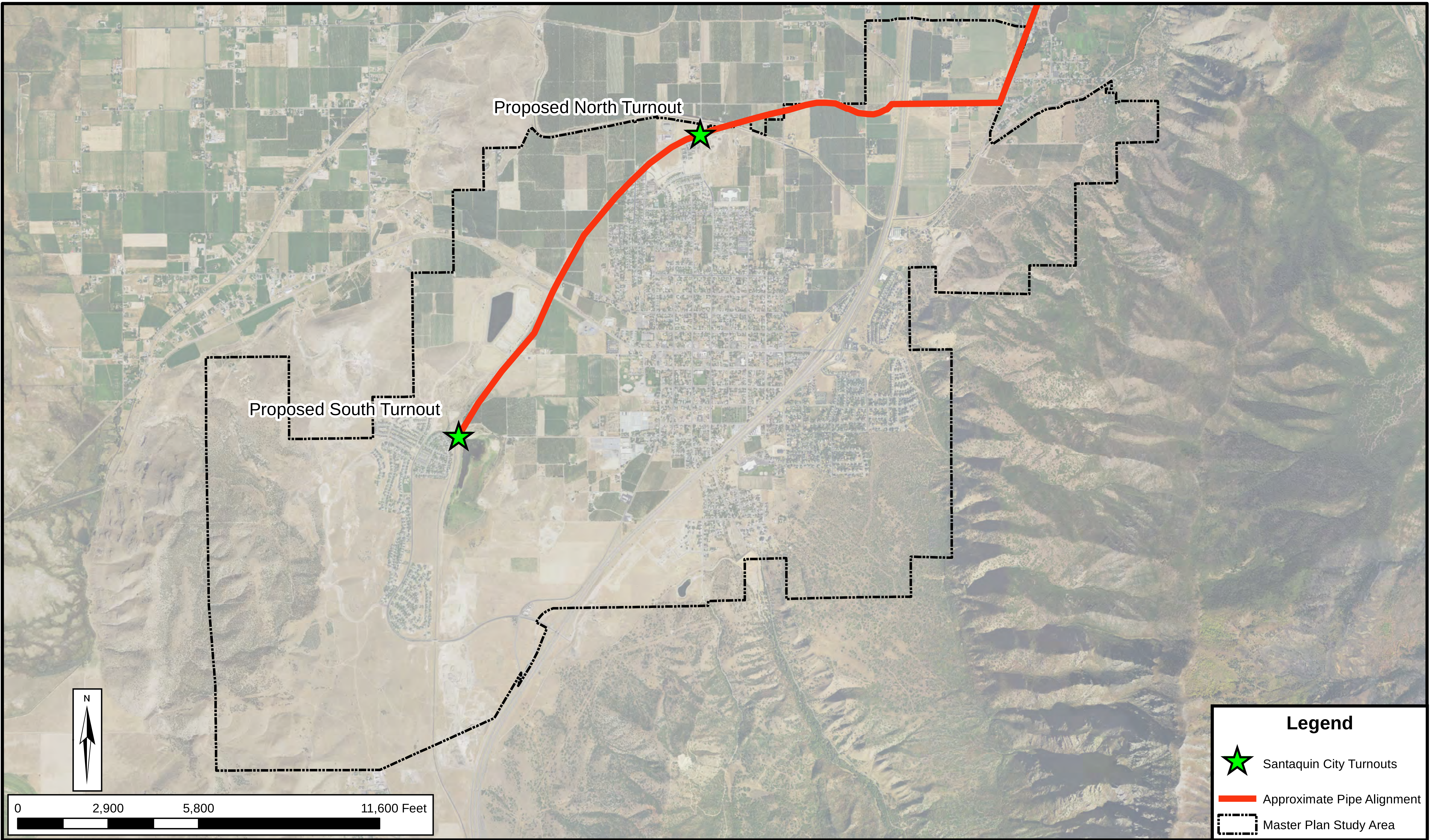
Both wells are recommended for use in the PI system, although lower-cost water should be prioritized when it is available. Wells used to take advantage of water reuse will be discussed in the subsequent "Wastewater Reuse" section.

CUWCD Utah Lake System Pipeline

CUWCD is planning to construct a pipeline for untreated water that will extend from the mouth of Spanish Fork Canyon to Santaquin City. This pipeline is more commonly known as the Utah Lake System pipeline, or ULS pipeline, and is expected to be completed within 6-10 years. The ULS pipeline will be pressurized at a head that will allow the City to fill water sources significantly higher than the pipeline itself. Figure 3-1 shows the proposed alignment of the ULS pipeline and the locations of future pipeline turnouts. The ULS pipeline appears to be the best source of water for areas of the City which have not historically been irrigated.

Santaquin has entered into an agreement with CUWCD to pay for a portion of the ULS pipeline's construction cost. The agreement specifies that Santaquin will pay this cost over a period of 50 years, starting with the year the ULS pipeline is operational. However, the agreement allows Santaquin City to delay their use of ULS water, and their payment, by up to 10 years, with no interest. Doing so would result in a larger annual payment, as the cost would be amortized over 40 years rather than 50. Because Santaquin does not have many other options for PI source water, delaying usage and payment is not recommended.

Under current agreements, Santaquin has been allocated 908.50 ac-ft of water to be delivered through the ULS pipeline. However, as shown in Table 3-8, the City is expected to require much more capacity than is currently owned. It is recommended that Santaquin explore opportunities to lease ULS water from other municipalities that have ownership.



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FUTURE ULS PIPELINE INFRASTRUCTURE

FIGURE 3-1

Date: 7/21/2020
Document Path: H:\Projects\415 - Santaquin\03.100 - Pressure Irrigation Master Plan\GIS\Working\PI Figure 3-1 Future ULS Pipeline.mxd

Canal Shares

It is recommended that the City consider acquiring shares from companies that can transfer water into the Strawberry High Line Canal (SHLC) as a source of water for the PI system. To use these shares, a turnout pond and pump station would need to be constructed at the north end of Zone 9. Such shares would be less expensive than water from the ULS pipeline, and could be used as a source of water for Zones 8 and 9.

As per current regulations, shares in the Strawberry High Line Canal Company (SHLCC) may not be used to irrigate land located outside of the original project boundary for the SHLC. The vast majority of Santaquin City is located outside of this project boundary, and presently cannot be served by shares in SHLCC. Thus, canal shares in other companies should be prioritized if the City opts to acquire shares in canal companies.

Wastewater reuse

The City's ability to reuse treated wastewater will expand as the population grows and influent to the wastewater treatment plant increases. It is recommended that the City maintain sufficient pumping capacity to use the full annual volume of treated wastewater. Several projects (discussed in detail in Chapter 7) are recommended to increase the City's ability to use treated wastewater.

Santaquin City has filed recharge and recovery applications to the State Engineer, in an attempt to use treated wastewater in City wells. The State has approved the recharge application, but not the recovery application. If the City is able to obtain approval for reuse, assumptions in this master plan need to be re-evaluated, as it may be more effective to use recovery wells.

The Type 1 reuse pump station has a capacity of 800 gpm. In 2019, the average pumped flow from the Winter Storage Ponds was about 600 gpm. As the City grows, wastewater influent will exceed the capacity of the existing Type 1 reuse pump station. Upgrades to the pump station are recommended in the Capital Facility Plan in Chapter 7.

Santaquin City has rights to reuse up to 5,300 ac-ft of treated wastewater. However, growth projections from the City's wastewater master plan indicate that the amount available for reuse will be far less than this throughout the planning period of this study. Details on the analysis of wastewater reuse supply and capacity are included in Appendix D.

Future Pump Stations

Recommended future pump stations are shown in Table 3-9.

Table 3-9
Future Pressurized Irrigation Water Pump Stations

Name	From Zone	To Zone	Peak Day Flow Served (gpm)	Peak Instantaneous Requirement (gpm)	Recommended Pumping Configuration
Zone 11W	10[1]	11W	2,440	2,440	2 @ 3,000 gpm
Zone 12E	11E	12E	1,000	2,100	1 @ 500 gpm 2 @ 1000 gpm VFD

1. The pump will be located in existing Zone 10W, which is planned to be part of future Zone 10

The Canyon Road pump station is currently equipped with two 2,500 gpm pumps, and has a bay in place for a third. An additional pump will eventually need to be installed.

CHAPTER 4 WATER STORAGE

EXISTING WATER STORAGE

The City’s existing pressurized irrigation water system includes two irrigation storage facilities with a total equalization storage capacity of 45.0 ac-ft. See Table 4-1.

Table 4-1
Existing Storage Capacity

Facility	Zone	Total Capacity (ac-ft)	Equalization Capacity (ac-ft)
Ahlin Pond[1]	10	41.5	19.5
Z11E PI Tank	11E	10.0	10.0
Total		**51.5**	**29.5**

1. The City has indicated a preference to use the top 7 feet of Ahlin Pond for equalization capacity. The remainder is reserved for recreation and to sustain aquatic life.

Ahlin pond is located in a City park and is used as a community fishery. To support aquatic life and recreation, the City has expressed a desire to utilize the top 7 feet of Ahlin Pond for equalization capacity, with the remainder being reserved as recreational capacity. As such, only 19.5 out of its total 41.5 ac-ft of capacity are available for use as equalization storage in the PI system.

EXISTING WATER STORAGE REQUIREMENTS

The purpose of the ponds in the PI system is to provide equalization storage for those periods where demand exceeds the source supply. The equalization storage requirement in the Santaquin PI system was defined as 80% of the peak day volume of water used at the level of service. This provides sufficient water to meet peak demands and incorporates additional safety to account for unforeseen high uses, decisions made by SCIC, and other unusual circumstances. The level of service for the PI system is 9,200 gal/irr-ac.

Equalization storage requirements were based on irrigable acreage and the proposed level of service. Therefore, under existing conditions, with 555 irrigable acres and a level of service of 9,200 gallons per irrigable acre, the required storage is 15.67 ac-ft. A breakdown of the required equalization storage by pressure zone is shown in Table 4-2.

Table 4-2
Existing Storage Requirements

Zone	Irr-ac	Storage Requirement (ac-ft)	Existing Capacity (ac-ft)	Given through PRVs (ac-ft)	Supplied from PRVs (ac-ft)	Supplied from DW System (ac-ft)	Deficiency (-) or Surplus (+) (ac-ft)
9N	110	3.11	0.0	0	3.11	0	+0.00
10	220	6.21	19.5	3.11	0	0	+10.18
10W	40	1.13	0.0	0	0	1.13	+0.00
11W	55	1.55	0.0	0	0	1.55	+0.00
11E	115	3.25	10.0	0	0	0	+6.75
12E	30	0.85	0.0	0	0	0.85	+0.00
Total	**570**	**16.09**	**29.5**	**3.11**	**3.11**	**3.53**	**+16.94**

Much of the existing equalization storage capacity is being provided by the drinking water system through crossover connections. However, this storage will eventually be needed in the drinking water system. The apparent surplus listed in Table 4-2 does not account for the fact that storage provided by the drinking water system is limited, and that, unlike in the drinking water system, zones in the PI system with higher elevation generally cannot supply zones of lower elevations, and therefore, cannot be counted as city-wide capacity.

FUTURE WATER STORAGE REQUIREMENTS

Table 4-3 presents the future irrigation storage requirements based on HAL's analysis of developed and developable area in each pressure zone.

Table 4-3
Future Storage Requirements

Zone	Irrigable Acreage	Storage Required (ac-ft)	Existing Capacity (ac-ft)	Surplus (+) or Deficiency (ac-ft)
8N	65	1.84	0.00	-1.84
9N	335	9.46	0.00	-9.46
9W	35	0.99	0.00	-0.99
10	630	17.79	19.50	+1.71
10W	50	1.41	0.00	-1.41
11W	220	6.21	0.00	-6.21
11E	260	7.34	10.00	+2.66
12E	125	3.53	0.00	-3.53
Total	**1720**	**48.56**	**29.50**	**-19.06**

Table 4-3 shows a future requirement of 3.53 ac-ft in Zone 12E and a future available surplus of 2.66 ac-ft in Zone 11E. Because all storage requirements for Zone 12E (which will be a boosted zone with no storage facility of its own) must be contained in Zone 11E facilities, this calculation shows a possible future deficiency in the system. However, modeling shows that the facility will operate properly under future conditions due to the safety factors built into the level of service and the ability to borrow equalization capacity in Zone 10 using the Canyon Road booster station. Accordingly, no projects to address this are proposed.

WATER STORAGE RECOMMENDATIONS

Two additional storage facilities are recommended for buildout conditions. Table 4-4 contains a summary of key attributes of these facilities.

Table 4-4
Recommended Future Storage Facilities

Zone	Minimum Size (ac-ft)	Approximate HGL when Full (ft)	Notes
10[1]	20.0	5200	20.0 ac-ft of capacity is recommended to provide capacity beyond 2060 and allow for better operation of the ULS pipeline. More capacity may be required, and the construction timeframe may need to be moved forward substantially, if additional areas to the north and/or west of the study area begin to develop. A detailed design review should be conducted prior to construction.
11W	10.0	5302	The City may wish to build additional capacity to provide flexibility and an increased possibility to serve future developments and proposed annexation areas to the northwest. A detailed design review should be conducted prior to construction.

1. The storage facility will be located in existing Zone 10W, which is planned to be a part of future Zone 10

Approximate locations for the proposed ponds are shown on the master plan map in Appendix A. Details on the construction timeframe of these projects are included in the Capital Facility Plan and discussed in detail in Chapter 7.

CHAPTER 5 WATER DISTRIBUTION

Santaquin's pressurized irrigation water distribution system consists of all pipelines, valves, fittings, and other appurtenances used to convey water from sources and storage tanks to water users. The existing water system contains approximately 69 miles of pipe with diameters of 4 inches to 24 inches. About 16 miles of these pipes are currently isolated from the PI system and are supplied from the drinking water system. Four pressure zones comprise the current system (Figure 1-1).

HYDRAULIC MODEL

Detailed information about hydraulic model development, model components, model demands, and model analysis methodology is included in the Santaquin City 2020 Drinking Water Master Plan Report. Information contained in that report is generally applicable to the PI model and is not repeated in this report document.

The pattern of water demand over a 24-hour period is called the diurnal curve or daily demand curve. HAL developed a diurnal curve for peak day conditions using SCADA data. The peaking factor is the ratio of peak instantaneous demand to peak day average demand. The diurnal curve used in this study is presented in Figure 5-1. The diurnal curve was input into the model to simulate changes in the water system throughout the day.

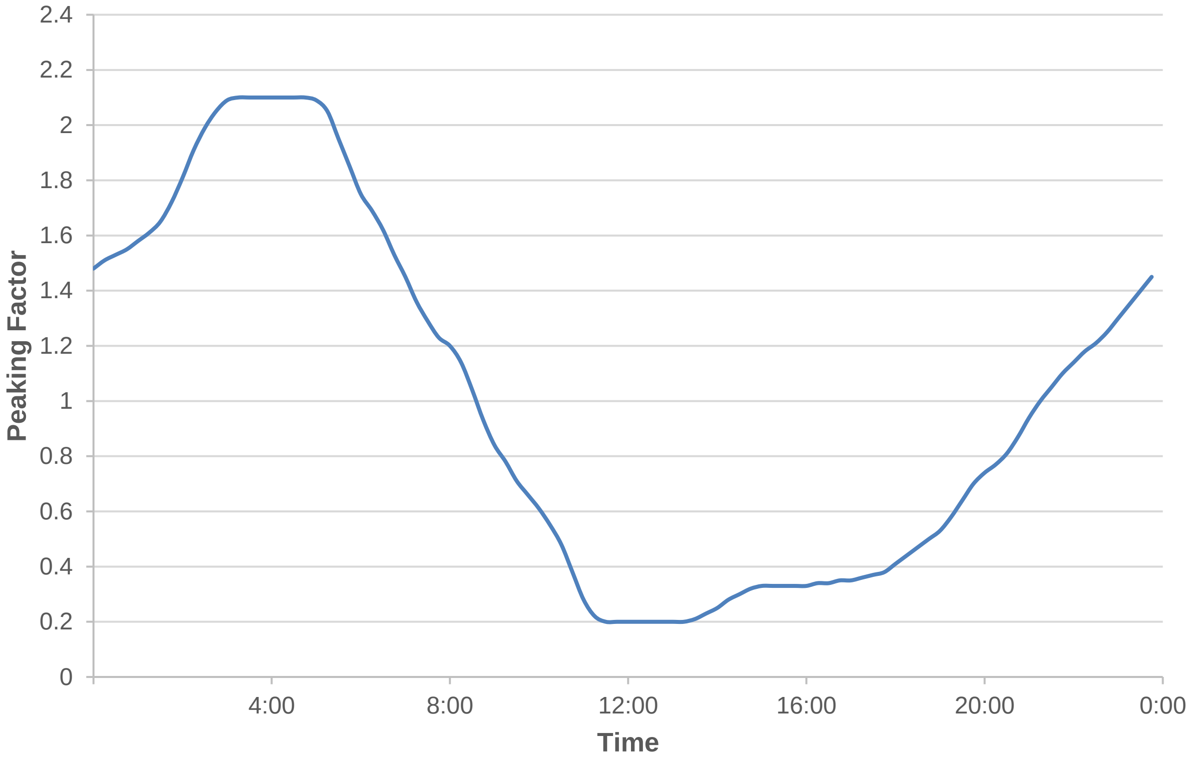


Figure 5-1: Santaquin Diurnal Curve

The City's time-of-day watering restrictions effectively curb midday water use, but also result in higher peak flows than might be seen in cities that do not have time-of-day restrictions. This leads to greater pressure swings and greater utilization of equalization storage. In general, watering activity is high from 10:00 PM to 8:00 AM.

LEVEL OF SERVICE AND DESIGN PARAMETERS

The level of service for distribution is to maintain a minimum pressure of 30 psi at peak instantaneous demand.

In designing the future system, pressure zones boundaries were defined with the intent to keep most pressures below 130 psi. Pipes were generally sized to keep diurnal pressure variation less than 20 psi. However, these are not considered to be strict level of service parameters.

ANALYSIS METHODOLOGY

HAL used the extended-period model to analyze the performance of the water system with current and projected future demands. An extended-period model represents system behavior over a period of time: tanks filling and draining, pumps turning on or off, pressures fluctuating, and flows shifting in response to demands. The model was used to analyze conditions, controls, operation, performance, and energy efficiency. Recommendations for existing and future conditions were checked with the extended-period model to confirm adequacy.

The model was used to analyze peak day, and peak instantaneous conditions. Each of these conditions represent an extreme condition. If level of service parameters are met under these extreme conditions, they will also be met under all other conditions the system will experience. Each operating condition is discussed in Table 5-1.

Table 5-1
Compliance of Existing
Distribution System with Level of Service

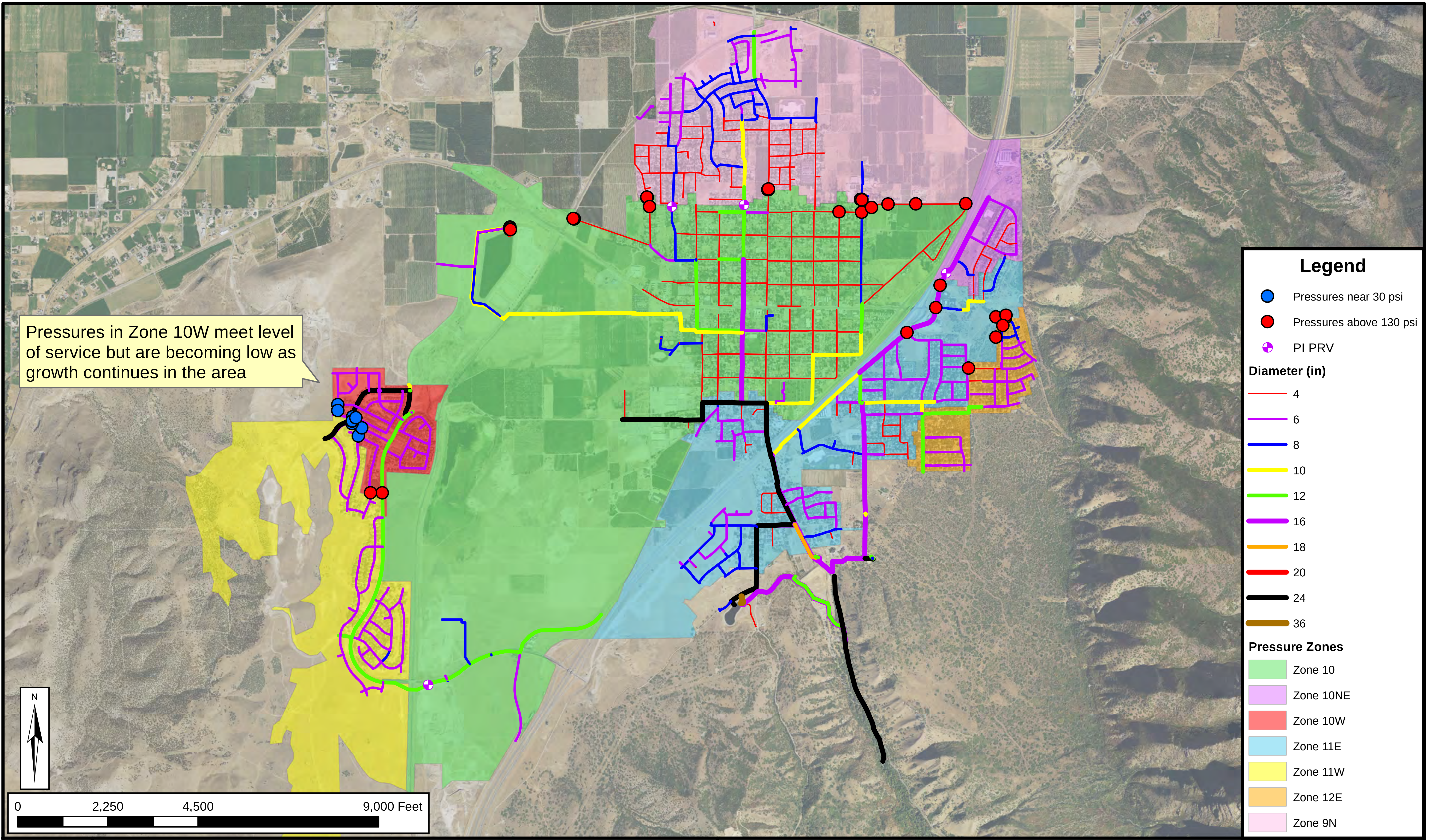
Condition	Requirement[1]	System Design Flow[2]	Status of Existing System[3]
Peak Instantaneous	Minimum 30 psi service pressure	9,324 gpm	System meets level of service; however, portions of Zone 10W nearly do not due to high head losses through the existing 4-inch diameter backflow preventer.

1. Requirements for PI systems are not governed by Utah law. The level of service parameter was set to produce acceptable performance for customers.
2. Peak day system flows are discussed in Chapter 3. Peak day flow was multiplied by a factor of 2.1, per the existing diurnal curve, to produce peak instantaneous flow.
3. For this study, irrigable acreage as of January 1, 2020 was established as the baseline for existing conditions

Figure 5-2 shows the modeled existing minimum and maximum system pressures.

Static Conditions

Future areas of the system will be designed to keep static pressures below 130 psi. No actions to correct existing high pressures are proposed in this master plan, because operators and existing customers are accustomed to these pressures.



Pressures in Zone 10W meet level of service but are becoming low as growth continues in the area

Date: 9/11/2020
Document Path: H:\Projects\415 - Santaquin\03.100 - Pressure Irrigation Master Plan\GIS\Working\PI Figure 5-2 Existing Pressures.mxd

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MODELED EXISTING HIGH AND LOW PRESSURES

FIGURE 5-2

Peak Day Pressure Swings

Large diurnal pressure fluctuations make it difficult for customers to design and operate sprinkler systems. To provide acceptable performance, the future system was generally designed to limit the maximum diurnal pressure swing to 20 psi on the peak day.

Modeling indicates that Zone 10W experiences pressure swings in excess of 20 psi due to high head losses through the single 4-inch diameter backflow preventer feeding the zone. This is anticipated to improve in the future as additional facilities are constructed.

Peak Instantaneous Pressures

Modeling indicates that Zone 10W experiences the lowest peak instantaneous pressures. At the higher elevations of the zone, peak instantaneous pressures approach 30 psi due to high head losses through the single 4-inch diameter backflow preventer feeding the zone. This is anticipated to improve in the future as additional facilities are constructed.

DISTRIBUTION SYSTEM RECOMMENDATIONS

Recommendations are based on output from the hydraulic model, which was calibrated using SCADA and field-measured data. Results from the model are available on a CD in Appendix F. Recommendations for distribution improvements were based on modeling results, as well as guidance provided by City personnel.

Zone 10W

Constructing a parallel 10-inch diameter backflow preventer to supplement the existing 4-inch diameter backflow preventer is recommended. This will allow the City to maintain the level of service as growth continues in this area. Details about this proposed project are included in the Capital Facility Plan in Chapter 7.

Distribution Piping

Pipes should be installed at a proper size as developments and master plan source and storage facilities are constructed. Careful review of proposed developments and projects is needed to ensure that their proposed water pipes are in compliance with the master plan.

CHAPTER 6 SYSTEM OPTIMIZATION

SOURCE PRIORITIZATION

To maximize energy efficiency and operational ease in the PI system, the recommended source prioritization scheme is as follows:

1. Surface water from Spring 1 and SCIC should be used to the extent that it is available.
2. Though it is expensive, Type 1 reuse water should be the next preferred source of water simply because the City is not able to discharge it, and it must be used.
3. Well water from SCIC should be the next preferred source.
4. Center Street Well should be the next preferred source.
5. Water from the drinking water system (including from the Springs 2-5 bypass) should be used only when other options are exhausted or not available. This water is more energy-intensive and will be needed in the drinking water system, especially as growth continues.

SCALING AND SEDIMENTATION

The City has reported deposits on pipe walls that are thin, brown, and somewhat hard. Testing has shown it to be primarily calcium carbonate (water hardness). Upstream of the City's PRVs, scales of this material (which are washed loose from upstream locations) accumulate, causing excessive head loss and difficulty operating some PRVs. In these problem areas, flushing is a recommended solution. A detailed flushing analysis is provided as a part of this master planning effort. It is included in Appendix E.

NON-REVENUE WATER

Every water system loses some water or at least cannot account for the fate of all water produced. This water, which is not billed for, is commonly known as non-revenue water. Mechanisms for non-revenue water include the following:

- Leaks from pipes or at tanks
- Water line breaks
- System flushing
- Pumping to waste
- Unmetered users

Water production data and billing data for years 2017 through 2019 was analyzed to quantify the non-revenue water produced in the Santaquin City PI water system. Results are summarized in Table 6-1.

Table 6-1
Non-Revenue Water in the Santaquin PI Water System

Year	Water Produced (ac-ft)	Water Billed	Non-Revenue Water (ac-ft)	Non-Revenue Percentage
2017	2,079	1,422	656	**32%**
2018	1,935	1,612	324	**17%**
2019	1,946	1,471	475	**24%**

The United States Environmental Protection Agency reports a typical rate of non-revenue water of 16% (EPA 2013). HAL often sees non-revenue water percentages of 15-30% in Utah. Water loss in the Santaquin PI system appears to fall within these limits. It is assumed that evaporation off irrigation ponds and leakage are the main sources of non-revenue water.

It is recommended that the City continue to put emphasis on accurately metering PI production and usage, in order to increase confidence in the data and to help prioritize improvements. It is also recommended that Santaquin plan to replace aging pipes, as this will prevent and repair leaks.

A water loss audit was performed as a part of this master planning effort. More detailed information on water loss is included in Appendix C.

CHAPTER 7 CAPITAL FACILITY PLAN

INTRODUCTION

The purpose of this section is to identify the pressurized irrigation facilities that are required, for the 20-year planning period, to meet the demands placed on the system by future development. Proposed facilities were sized to meet master plan requirements and located to accommodate 20-year growth projections. Each capital facility plan project will require a detailed design analysis before construction to ensure that the location and sizing is appropriate for the actual growth that has taken place since this Capital Facility Plan (CFP) was developed. Specific projects with estimated costs are presented at the end of this chapter.

GROWTH PROJECTIONS

Areas of expected growth within 10 years and within 20 years were identified based on existing development patterns, population projections, and discussions with City personnel. These areas are shown on Figure 7-1.

Most development pressure in Santaquin is occurring in the Summit Ridge Development, on the East Bench, and on the northern end of the City. Growth in each of these areas is expected to continue for more than 20 years. Scattered infill and redevelopment within the main town are also expected.

Changes to Expected Growth Areas

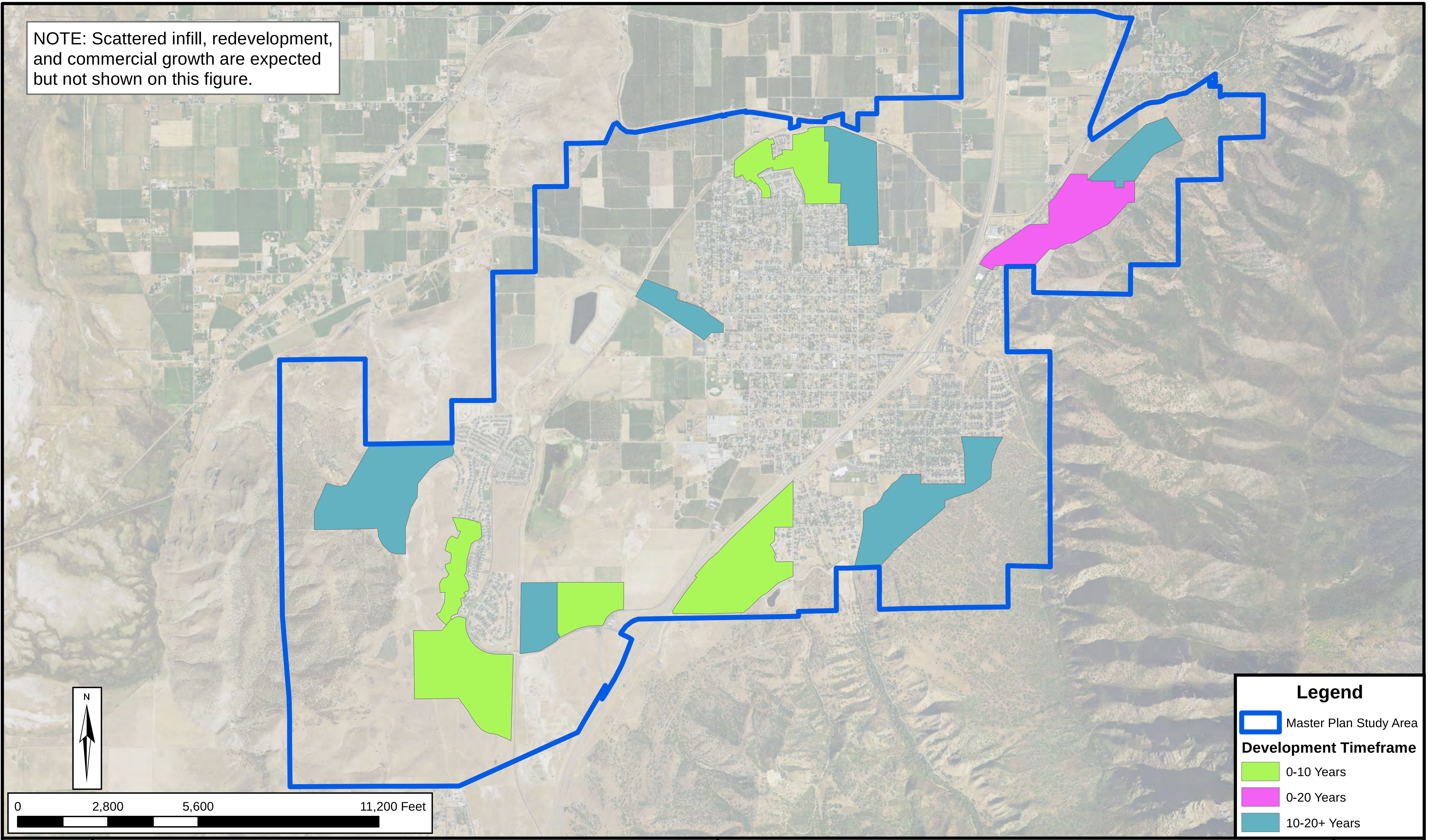
The Master Plan is intended to incorporate a reasonable degree of flexibility. Minor developments or infill developments not anticipated in the City's growth projections can generally be served after a site-level evaluation, without substantial changes to the master plan. If growth patterns change substantially from those predicted, however, it is recommended that the assumptions in this master plan be re-evaluated to ensure the City is planning properly for the growth that actually occurs.

Large Developments

For large developments that will be constructed in a number of phases over a number of years, it is recommended that the City require a utilities phasing plan as part of the development agreement. A utilities phasing plan clearly defines when and how key infrastructure will be constructed within the development. The utilities phasing plan should be negotiated in such a way that it will protect the City's financial interests and hold the developer responsible for supporting growth in that development – even if ownership changes.

In Santaquin, it is recommended that utilities phasing plans be required for the following types of developments:

- Developments larger than 10 acres
- Developments that will be constructed in multiple phases or issued multiple plats
- Areas being evaluated for annexation



NOTE: Scattered infill, redevelopment, and commercial growth are expected but not shown on this figure.

Date: 9/9/2020
Document Path: H:\Projects\415 - Santaquin\03.100 - Pressure Irrigation Master Plan\GIS\Working\PI Figure 7-1 growth areas.mxd

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SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

CAPITAL FACILITY PLAN (0 - 20 YEARS) PROJECTED AREAS OF DEVELOPMENT

FIGURE 7-1

In a typical utilities phasing plan, the construction of infrastructure is tied directly to the number of residential units (or square footage of nonresidential space) permitted to be constructed within the development. An ideal utilities phasing agreement for PI water might include the following components:

- PI water storage capacity must be provided before more than [#] units are permitted to be constructed within the development.
- Certain distribution pipes must be constructed before more than [#] units are permitted to be constructed within the development.

METHODOLOGY

Growth projections were used to forecast future water demands on a year-by-year basis, which were then compared to the capacity of existing source and storage facilities. When this analysis showed that existing facilities would not have capacity for the 20-year planning period, solutions were identified to ensure that the City can meet demands at the proposed level of service.

A hydraulic model, calibrated using SCADA and field-measured data, was developed for the purpose of assessing the system operation and capacity with future demands added to the system. The model was used to identify problem areas in the system and to identify the most efficient way to make improvements to distribution pipelines, sources, pumps, and storage facilities. Solutions and alternatives were discussed with City staff.

The drinking water system supplements the PI water system in certain areas of the City. This is intended to be a temporary arrangement, as drinking water supply is limited and will be increasingly needed to meet indoor demands. Some PI projects are recommended chiefly to relieve demands presently being placed on the drinking water system, and free up capacity for future growth within the drinking water system. Likewise, components of some planned drinking water projects will serve the PI system for a time. **This pressurized irrigation water capital facility plan assumes that all projects listed herein and in the drinking water capital facility plan (presented in a separate document) will be constructed in a timely manner, as identified in their respective master plans.** If this is not the case, the PI water projects in this chapter need to be re-evaluated.

The future system was evaluated in the same manner as the existing system, by modeling (1) peak instantaneous demands and (2) peak day demands.

RECOMMENDED PROJECTS AND COSTS

As discussed in previous chapters, source, storage and distribution system capacity expansion will be needed to meet the demands of future growth. Cost estimates have been prepared for the recommended projects and are summarized in the following tables and included in detail in Appendix G.

Unit costs for the construction cost estimates are based on conceptual level engineering. Sources used to estimate construction costs include:

1. “Means Heavy Construction Cost Data,” 2019
2. Price quotes from equipment suppliers
3. Recent construction bids for similar work

All costs are presented in 2020 dollars.

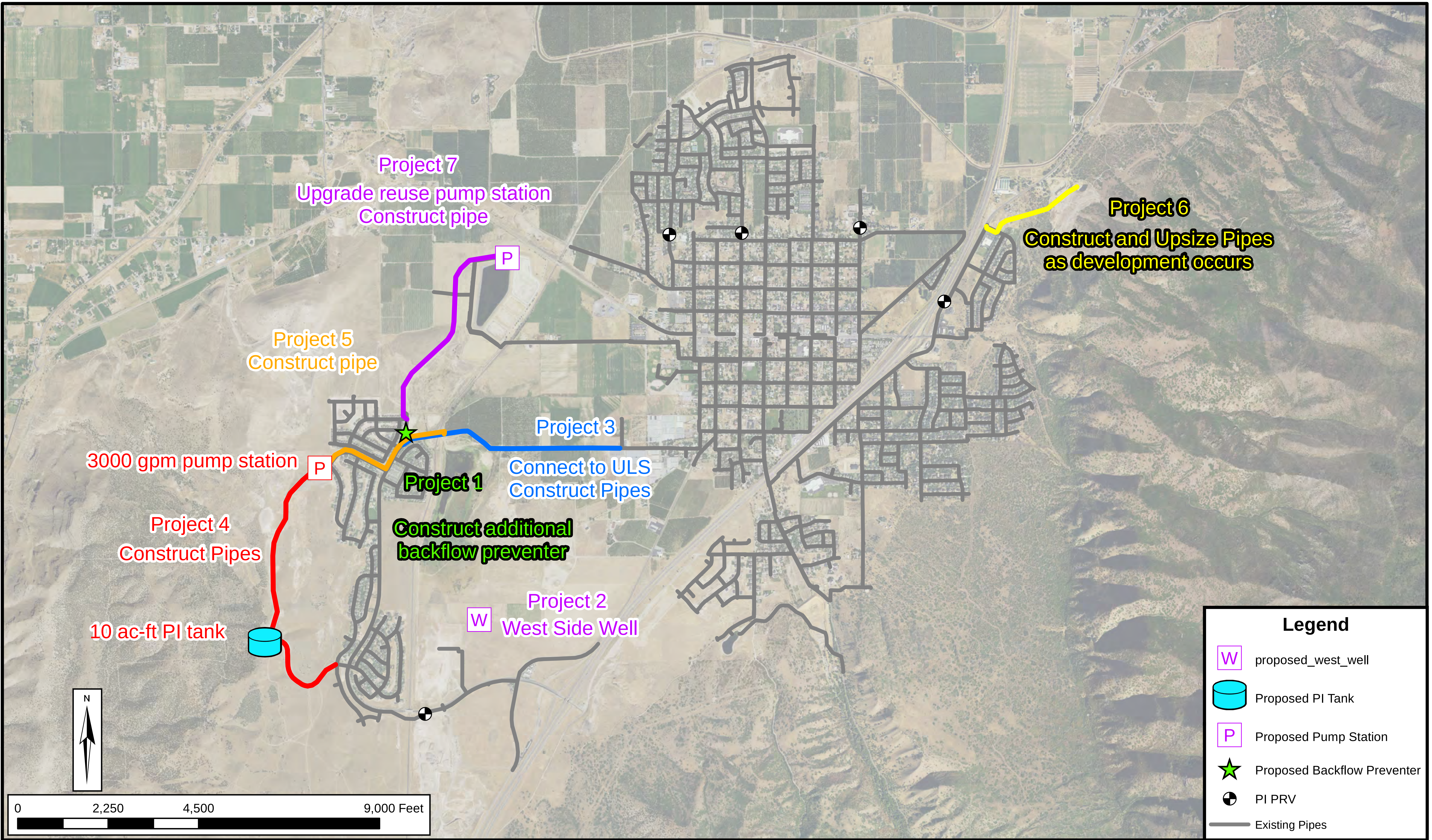
Precision of Cost Estimates

Master plan projects are a high-level representation of the infrastructure the City will need to construct in order to correct deficiencies or meet growth. However, due to the many unknown factors at this stage of design (such as alignment and depth of pipelines, utility conflicts, the cost of land and easements, construction methodology, types of equipment and material to be used, interest and inflation rates, permitting requirements, etc.), there is a significant level of uncertainty in estimated costs.

Every effort has been made to produce cost estimates which will help the City prepare a responsible budget that will meet the City's needs without being excessive or unreasonable. However, it is recommended that the City plan additional contingency into the budget when preparing to complete individual projects.

GROWTH-RELATED PROJECTS

A summary of the estimated cost of each growth-related project is included in Table 7-1. Projects are shown on Figures 7-2 and 7-3. Tables 7-2 through 7-4 include more detailed descriptions of the recommended projects, organized by project type (source, storage, or distribution).



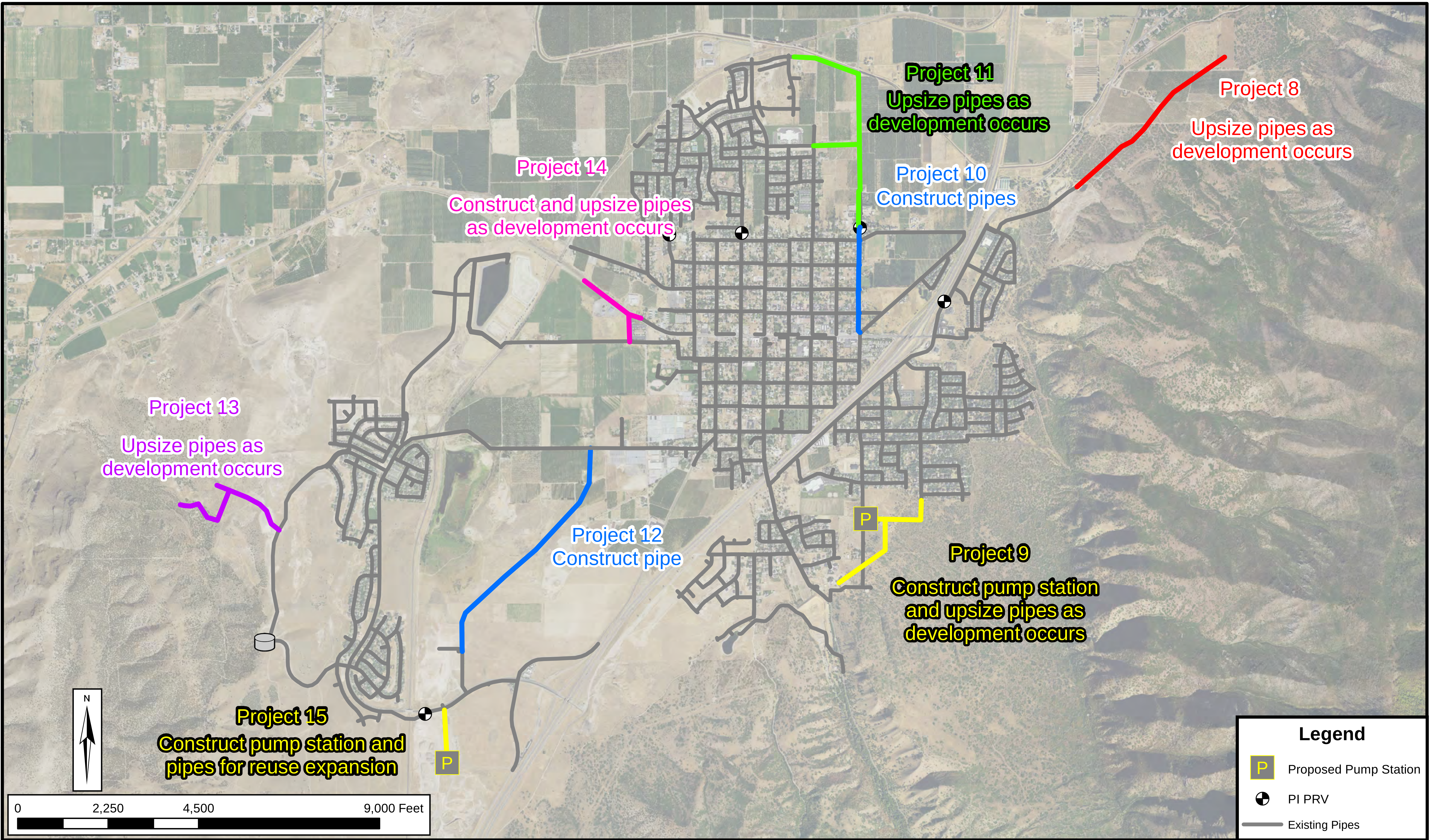
Date: 10/23/2020
Document Path: H:\Projects\415 - Santaquin\03.100 - Pressure Irrigation Master Plan\GIS\Working\PI Figure 7-2 CFP 0-10 Year Projects.mxd

HANSEN ALLEN & LUCE INC
ENGINEERS

SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

RECOMMENDED CAPITAL PROJECTS
0 - 10 YEAR TIMEFRAME

FIGURE
7-2



Date: 10/23/2020
Document Path: H:\Projects\415 - Santaquin\03.100 - Pressure Irrigation Master Plan\GIS\Working\PI Figure 7-3 CFP 10-20 Year Projects.mxd

HANSEN ALLEN & LUCE INC ENGINEERS

SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

RECOMMENDED CAPITAL PROJECTS
10 - 20 YEAR TIMEFRAME

FIGURE
7-3

Table 7-1
Estimated Costs for Growth-Related Projects

Trigger	Figure Number	Map ID[1]	Project Type(s) Included[2]	Estimated Phasing Year[3]	Cost
Development	7-2	1	Source	2021	$84,000
System Growth	7-2	2	Source	0-5 Years	$701,000
System Growth	7-2	3	Source, Distribution	2021	$1,596,000
System Growth	7-2	4	Source, Storage, Distribution	2021	$4,949,000
System Growth	7-2	5	Distribution	2026	$687,000
Development	7-2	6	Distribution	0-10 Years	$182,000
System Growth	7-2	7	Source	5-10 Years	$1,489,000
Development	7-3	8	Distribution	10-20 Years	$235,000
Development	7-3	9	Source, Distribution	10-20 Years	$1,194,000
System Growth	7-3	10	Distribution	10-20 Years	$470,000
Development	7-3	11	Distribution	10-20 Years	$338,000
Development	7-3	12	Distribution	10-20 Years	$1,096,000
Development	7-3	13	Distribution	10-20 Years	$267,000
Development	7-3	14	Distribution	10-20 Years	$134,000
System Growth	7-3	15	Source	10-20 Years	$1,126,000
				Subtotal 0 – 10 Years	$9,688,000
				Subtotal 10 – 20 Years	$4,860,000
				Total	**$14,548,000**

1. ID refers to the ID on Figures 7-2 and 7-3. Projects may be constructed in a different order than listed in the table, depending on the needs and priorities of the City.
2. See table 7-2 for source projects, 7-3 for storage projects and 7-4 for distribution projects. Some projects have source and/or storage and/or distribution components to them that must all be constructed concurrently.
3. The phasing year for development-driven projects is estimated, but development-driven projects are not necessary until the area develops. This may occur earlier or later than listed in this document.

Recommended source projects are shown in Table 7-2 and on Figures 7-2 and 7-3.

Table 7-2
Recommended Source Projects

Phasing Year	Figure Number	Map ID	Recommended Project	Cost
Development Driven	7-2	1	Construct an additional backflow preventer in Zone 10W to support new development.	$84,000
0-5 Years	7-2	2	Drill and equip a well to serve the western portion of Zone 10.	$701,000
2021	7-2	3	Install approximately 5700 ft of 24-inch water line in 500 W to provide source conveyance to the western portion of the City, and connect to the planned future ULS pipeline (when it is constructed). Half of the cost of this project is attributable to source conveyance, while half is attributable to distribution.	$798,000
2021	7-2	4	Construct a pump station to supply Zone 11W from Zone 10W. This pump station must be capable of taking source from the Zone 10 drinking water system during times that ULS water is unavailable. Must be constructed along with the storage and distribution components of project 4 (see Tables 7-3 and 7-4).	$900,000
5-10 Years	7-2	7	Increase the capacity of the Type 1 reuse booster station to accommodate increasing sewer inflows and provide additional source to the PI system. Includes approximately 5800 ft of 12-inch diameter pipeline.	$1,489,000
Development Driven	7-3	9	Construct a booster station to serve Zone 12E with PI water (includes approximately 600 feet of 16-inch pipe). Must be constructed along with the distribution component of project 9 (see Table 7-4).	$1,015,000
10-20 Years	7-3	15	Install a pump station to provide source from the planned south Type 1 reuse storage facility. Includes approximately 1300 feet of 12-inch pipe.	$1,126,000
TOTAL				**$6,113,000**

One storage project to support growth was identified and is shown in Table 7-3 and on Figure 7-2.

Table 7-3
Recommended Storage Project

Phasing Year	Figure Number	Map ID	Recommended Project	Cost
2021	7-2	4	Construct a 10 ac-ft PI tank or pond to serve Zone 11W. Must be constructed along with the source and distribution components of project 4 (see Tables 7-2 and 7-4).	$2,542,000
TOTAL				**$2,542,000**

Recommended distribution projects (including PRVs) are shown in Table 7-4 and on Figures 7-2 and 7-3.

Table 7-4
Recommended Distribution Projects

Phasing Year	Figure Number	Map ID	Recommended Project	Cost
2021	7-2	3	Install approximately 5700 ft of 24-inch water line in 500 S to connect to the future planned ULS connection and provide distribution capacity between the eastern and western portions of the system. Must be constructed along with the source component of Project 3 (see Table 7-2). Half of the cost of this project is attributable to source conveyance, while half is attributable to distribution.	$798,000
2021	7-2	4	Install approximately 7900 feet of 16-inch diameter pipeline to connect the planned Zone 11W storage and pumping facilities and provide distribution to the zone. Must be constructed along with the source and storage components of Project 4 (see Tables 7-2 and 7-3).	$1,507,000
2026	7-2	5	Install approximately 3600 feet of 16-inch diameter pipeline to provide a direct connection from the ULS pipeline to Zone 11W, to allow the City to bypass pumping.	$687,000
Development Driven	7-2	6	Install approximately 300 feet of 12-inch diameter pipe (to replace undersized lines) and upsize approximately 2300 feet of pipe to 12-inch diameter to provide service and future capacity in Zone 11E.	$182,000
Development Driven	7-3	8	Upsize approximately 1100 feet of pipe to 12-inch diameter and 3800 feet of pipe to 10-inch diameter to serve the northeastern portion of Zone 10.	$235,000
Development Driven	7-3	9	Upsize approximately 1400 feet of pipe to 12-inch diameter and 2200 feet of pipe to 10-inch diameter to serve Zone 12E. Must be constructed along with the source component of Project 9 (see Table 7-2).	$179,000
10-20 Years	7-3	10	Install approximately 2700 feet of 12-inch diameter pipe to provide increased conveyance to Zones 10 and 9N.	$470,000
Development Driven	7-3	11	Upsize approximately 5500 feet of pipe to 12-inch diameter and upsize approximately 1100 feet of pipe to 8-inch diameter to serve Zone 9N.	$338,000
10-20 Years	7-3	12	Install approximately 6300 feet of 12-inch diameter pipeline in a planned future road to serve the western portion of Zone 10.	$1,096,000
Development Driven	7-3	13	Upsize approximately 1700 feet of pipe to 16-inch diameter, 800 feet of pipe to 12-inch diameter, and 1500 feet of pipe to 10-inch diameter to serve growth and provide future capacity in Zone 11W.	$267,000
Development Driven	7-3	14	Install approximately 700 feet of 8-inch diameter pipe and upsize approximately 1700 feet of pipe to 8-inch diameter to serve growth and provide future capacity to the northwestern portion of Zone 10.	$134,000
			TOTAL	**$5,893,000**

OPERATIONS AND MAINTENANCE PROJECTS

To assist the City in operating their PRVs and removing hard water scaling from the PI system, two PI flushing stations are recommended (see Appendix E for details). An estimated cost for this project is described in Table 7-5.

Table 7-5
Recommended Operations Projects

Phasing Year	Recommended Project	Cost
City Priority	Install two flushing stations in the PI system.	$16,000
TOTAL		**$16,000**

FUNDING OPTIONS

Funding options for the recommended projects, in addition to water use fees, include: general obligation bonds, revenue bonds, State/Federal grants and loans, and impact fees. In reality, the City may need to consider a combination of these funding options. The following discussion describes each of these options.

General Obligation Bonds

This form of debt enables the City to issue general obligation bonds for capital improvements and replacement. General Obligation (G.O.) bonds would be used for items not typically financed through the Water Revenue Bonds (for example, the purchase of water source to ensure a sufficient water supply for the City in the future). G.O. bonds are debt instruments backed by the full faith and credit of the City which would be secured by an unconditional pledge of the City to levy assessments, charges or ad valorem taxes necessary to retire the bonds. G.O. bonds are the lowest-cost form of debt financing available to local governments and can be combined with other revenue sources such as specific fees, or special assessment charges to form a dual security through the City’s revenue generating authority. These bonds are supported by the City as a whole, so the amount of debt issued for the water system is limited to a fixed percentage of the real market value for taxable property within the City. G.O. bonds must be approved by a citizen vote.

Revenue Bonds

This form of debt financing is also available to the City for utility related capital improvements. Unlike G.O. bonds, revenue bonds are not backed by the City as a whole, but constitute a lien against the water service charge revenues of a Water Utility. Revenue bonds present a greater risk to the investor than do G.O. bonds, since repayment of debt depends on an adequate revenue stream, legally defensible rate structure, and sound fiscal management by the issuing jurisdiction. Due to this increased risk, revenue bonds generally require a higher interest rate than G.O. bonds, although currently interest rates are quite low. This type of debt also has very specific coverage requirements in the form of a reserve fund specifying an amount, usually expressed in terms of average or maximum debt service due in any future year. This debt service is required to be held as a cash reserve for annual debt service payment to the benefit of bondholders. Typically, voter approval is not required when issuing revenue bonds.

State or Federal Grants and Loans

Historically, both local and county governments have experienced significant infrastructure funding support from state and federal government agencies in the form of block grants, direct grants in aid, interagency loans, and general revenue sharing. Federal expenditure pressures and virtual elimination of federal revenue sharing dollars are clear indicators that local government may be left to its own devices regarding infrastructure finance in general. However, state or federal grants and loans should be further investigated as a possible funding source for needed water system improvements.

It is also important to assess likely trends regarding state or federal assistance in infrastructure financing. Future trends indicate that grants will be replaced by loans through a public works revolving fund. Local governments can expect to access these revolving funds or public works trust funds by demonstrating both the need for and the ability to repay the borrowed monies, with interest. As with the revenue bonds discussed earlier, the ability of infrastructure programs to wisely manage their own finances will be a key element in evaluating whether many pressurized irrigation funding sources, such as federal/state loans, will be available to the City.

Impact Fees

The Utah Impact Fees Act, codified in Title 11, Chapter 36a, of the Utah Code, authorizes municipalities to collect impact fees to fund public facilities. An impact fee is “a payment of money imposed upon new development activity . . . to mitigate the impact of the new development on public infrastructure” (Subsection 11-36a-102(8)). Impact fees enable local governments to finance infrastructure improvements without burdening existing development with costs that are exclusively attributable to growth.

Impact fees can be applied to water-related facilities under the Utah Impact Fees Act. The Act is designed to provide a logical and clear framework for establishing new development assessments. It is also designed to establish the basis for the fee calculation which the City must follow in order to comply with the statute. The fundamental objective for the fee structure is the imposition on new development of only those costs associated with providing or expanding water infrastructure to meet the capacity needs created by that specific new development. Impact fees cannot be applied retroactively.

An impact fee analysis has taken place as part of the 2020 master planning effort. It is described in a separate document.

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APPENDIX A

Pressurized Irrigation Water Master Plan Map

Date: 9/9/2020
Document Path: H:\Projects\415 - Santaquin\03.100 - Pressure Irrigation Master Plan\GIS\Working\PI Appendix A Buildout System.mxd

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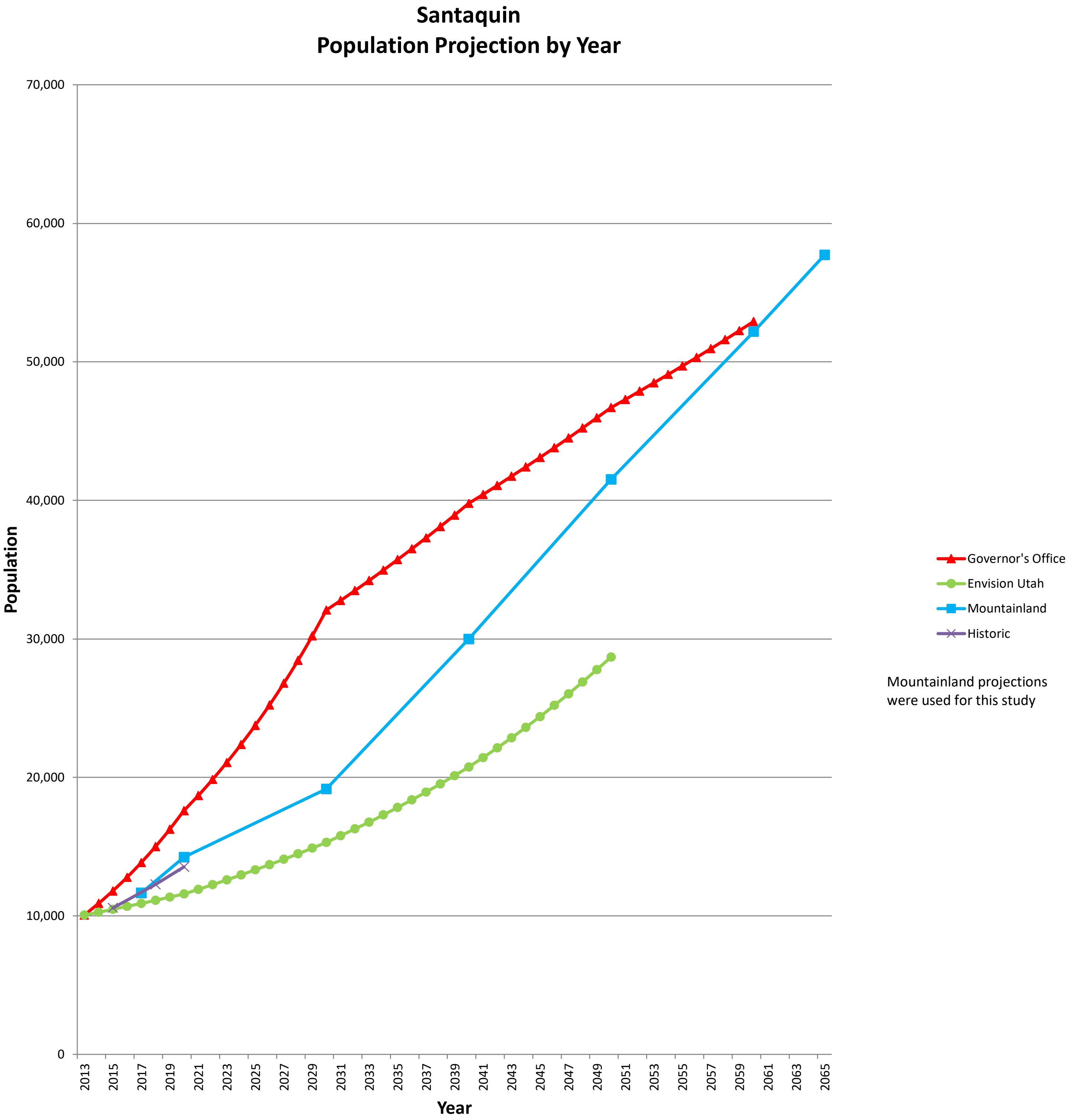
SANTAQUIN PRESSURIZED IRRIGATION MASTER PLAN

2060 SYSTEM CONCEPT MAP

APPENDIX A

APPENDIX B

Population Projections



Mountainland projections were used for this study

APPENDIX C

Water System Data and Calculations

Santaquin City
2020 Pressurized Irrigation System Master Plan
Existing and Future Requirements
09/11/2020 RJG

Level of Service Parameter	Per irr-ac
Peak Day Source (gpm)	8
Average Yearly Source (ac-ft)	4
Storage (gal)	9200

Service (Irr-ac)

Pressure Zone	Existing	10-yr	20-yr	2060
	Irr-ac	Irr-ac	Irr-ac	Irr-ac
8N	0	0	0	65
9N	110	135	225	335
9W	0	0	0	35
10	220	243	285	630
10W	40	40	40	50
11W	55	118	220	220
11E	115	138	155	260
11NE	0	0	0	0
12W	0	0	0	0
12E	30	30	89	125
12S	0	16	16	0
13E	0	0	0	0
14E	0	0	0	0
Totals	**570**	**720**	**1030**	**1720**

Peak Day Demand (gpm)

Pressure Zone	Existing	10-yr	20-yr	2060
8N	0	0	0	520
9N	880	1080	1800	2680
9W	0	0	0	280
10	1760	1944	2280	5040
10W	320	320	320	400
11W	440	944	1760	1760
11E	920	1104	1240	2080
11NE	0	0	0	0
12W	0	0	0	0
12E	240	240	712	1000
12S	0	128	128	0
13E	0	0	0	0
14E	0	0	0	0
Totals	**4560**	**5760**	**8240**	**13760**

Average Yearly Demand (ac-ft)

Pressure Zone	Existing	10-yr	20-yr	2060
8N	0	0	0	260
9N	440	540	900	1340
9W	0	0	0	140
10	880	972	1140	2520
10W	160	160	160	200
11W	220	472	880	880
11E	460	552	620	1040
11NE	0	0	0	0
12W	0	0	0	0
12E	120	120	356	500
12S	0	64	64	0
13E	0	0	0	0
14E	0	0	0	0
Totals	**2280**	**2880**	**4120**	**6880**

Storage (ac-ft)

Pressure Zone	Existing	10-yr	20-yr	2060
8N	0.00	0.00	0.00	1.84
9N	3.11	3.81	6.35	9.46
9W	0.00	0.00	0.00	0.99
10	6.21	6.86	8.05	17.79
10W	1.13	1.13	1.13	1.41
11W	1.55	3.33	6.21	6.21
11E	3.25	3.90	4.38	7.34
11NE	0.00	0.00	0.00	0.00
12W	0.00	0.00	0.00	0.00
12E	0.85	0.85	2.51	3.53
12S	0.00	0.45	0.45	0.00
13E	0.00	0.00	0.00	0.00
14E	0.00	0.00	0.00	0.00
Totals	**16.09**	**20.33**	**29.08**	**48.56**

AWWA Free Water Audit Software:
Reporting Worksheet

WAS v5.0

? Click to access definition
\+ Click to add a comment

Water Audit Report for: Santaquin
Reporting Year: 2019 1/2019 - 12/2019

Please enter data in the white cells below. Where available, metered values should be used; if metered values are unavailable please estimate a value. Indicate your confidence in the accuracy of the input data by grading each component (n/a or 1-10) using the drop-down list to the left of the input cell. Hover the mouse over the cell to obtain a description of the grades

All volumes to be entered as: ACRE-FEET PER YEAR

To select the correct data grading for each input, determine the highest grade where the utility meets or exceeds <u>all</u> criteria for that grade and all grades below it.

<----------- Enter grading in column 'E' and 'J' ---------->

Master Meter and Supply Error Adjustments

WATER SUPPLIED

			Grade	Value	Unit			Grade	Pcnt:		Value:	Unit
Volume from own sources:	+	?	7	1,945.940	acre-ft/yr	+	?			● ○		acre-ft/yr
Water imported:	+	?	n/a	0.000	acre-ft/yr	+	?			● ○		acre-ft/yr
Water exported:	+	?	n/a	0.000	acre-ft/yr	+	?			● ○		acre-ft/yr

Enter negative % or value for under-registration
Enter positive % or value for over-registration

WATER SUPPLIED: **1,945.940** acre-ft/yr

AUTHORIZED CONSUMPTION

Click here: ? for help using option buttons below

			Grade	Value	Unit	Pcnt:		Value:	Unit
Billed metered:	+	?	7	1,460.006	acre-ft/yr				
Billed unmetered:	+	?	n/a	0.000	acre-ft/yr				
Unbilled metered:	+	?	n/a	0.000	acre-ft/yr				
Unbilled unmetered:	+	?		24.324	acre-ft/yr	1.25%	● ○		acre-ft/yr

Default option selected for Unbilled unmetered - a grading of 5 is applied but not displayed

AUTHORIZED CONSUMPTION: ? **1,484.330** acre-ft/yr

Use buttons to select percentage of water supplied
<u>OR</u>
value

WATER LOSSES (Water Supplied - Authorized Consumption) **461.610** acre-ft/yr

<u>Apparent Losses</u>

			Grade	Value	Unit	Pcnt:		Value:	Unit
Unauthorized consumption:	+	?		4.865	acre-ft/yr	0.25%	● ○		acre-ft/yr

Default option selected for unauthorized consumption - a grading of 5 is applied but not displayed

			Grade	Value	Unit	Pcnt:		Value:	Unit
Customer metering inaccuracies:	+	?	7	0.000	acre-ft/yr	🟥	● ○		acre-ft/yr
Systematic data handling errors:	+	?		3.650	acre-ft/yr	0.25%	● ○		acre-ft/yr

Default option selected for Systematic data handling errors - a grading of 5 is applied but not displayed

Apparent Losses: ? **8.515** acre-ft/yr

<u>Real Losses (Current Annual Real Losses or CARL)</u>

Real Losses = Water Losses - Apparent Losses: ? **453.095** acre-ft/yr

WATER LOSSES: **461.610** acre-ft/yr

<u>NON-REVENUE WATER</u>

NON-REVENUE WATER: ? **485.934** acre-ft/yr

= Water Losses + Unbilled Metered + Unbilled Unmetered

SYSTEM DATA

			Grade	Value	Unit
Length of mains:	+	?	8	69.0	miles
Number of <u>active AND inactive</u> service connections:	+	?	8	3,299	
Service connection density:		?		48	conn./mile main

Are customer meters typically located at the curbstop or property line? Yes

<u>Average</u> length of customer service line: + ? (length of service line, <u>beyond</u> the property boundary, that is the responsibility of the utility)

Average length of customer service line has been set to zero and a data grading score of 10 has been applied

			Grade	Value	Unit
Average operating pressure:	+	?	5	89.0	psi

COST DATA

			Grade	Value	Unit
Total annual cost of operating water system:	+	?	6	$1,003,962	$/Year
Customer retail unit cost (applied to Apparent Losses):	+	?	8	$0.73	$/1000 gallons (US)
Variable production cost (applied to Real Losses):	+	?	4	$42.96	$/acre-ft

☐ Use Customer Retail Unit Cost to value real losses

<u>WATER AUDIT DATA VALIDITY SCORE:</u>

*** YOUR SCORE IS: 65 out of 100 ***

A weighted scale for the components of consumption and water loss is included in the calculation of the Water Audit Data Validity Score

<u>PRIORITY AREAS FOR ATTENTION:</u>

Based on the information provided, audit accuracy can be improved by addressing the following components:

1: Volume from own sources

2: Variable production cost (applied to Real Losses)

3: Billed metered

AWWA Free Water Audit Software:

System Attributes and Performance Indicators

WAS v5.0

Water Audit Report for: Santaquin
Reporting Year: 2019 1/2019 - 12/2019

*** YOUR WATER AUDIT DATA VALIDITY SCORE IS: 65 out of 100 ***

System Attributes:

Apparent Losses:	8.515	acre-ft/yr
+ Real Losses:	453.095	acre-ft/yr
= Water Losses:	461.610	acre-ft/yr
? Unavoidable Annual Real Losses (UARL):	86.55	acre-ft/yr
Annual cost of Apparent Losses:	$2,025	
Annual cost of Real Losses:	$19,465	Valued at **Variable Production Cost** Return to Reporting Worksheet to change this assumpiton

Performance Indicators:

Financial:	Non-revenue water as percent by volume of Water Supplied:	25.0%	
	Non-revenue water as percent by cost of operating system:	2.2%	Real Losses valued at Variable Production Cost
Operational Efficiency:	Apparent Losses per service connection per day:	2.30	gallons/connection/day
	Real Losses per service connection per day:	122.61	gallons/connection/day
	Real Losses per length of main per day*:	N/A	
	Real Losses per service connection per day per psi pressure:	1.38	gallons/connection/day/psi
	From Above, Real Losses = Current Annual Real Losses (CARL):	453.10	acre-feet/year
	? Infrastructure Leakage Index (ILI) [CARL/UARL]:	5.24	

* This performance indicator applies for systems with a low service connection density of less than 32 service connections/mile of pipeline

AWWA Free Water Audit Software:
User Comments

WAS v5.0

Use this worksheet to add comments or notes to explain how an input value was calculated, or to document the sources of the information used.

General Comment:	

Audit Item	Comment
Volume from own sources:	https://waterrights.utah.gov/asp_apps/viewEditSEC/secView.asp?SYSTEM_ID=11419
Vol. from own sources: Master meter error adjustment:	
Water imported:	
Water imported: master meter error adjustment:	
Water exported:	
Water exported: master meter error adjustment:	
Billed metered:	https://waterrights.utah.gov/asp_apps/viewEditSEC/secView.asp?SYSTEM_ID=11419
Billed unmetered:	
Unbilled metered:	
Unbilled unmetered:	

Audit Item	Comment
Unauthorized consumption:	
Customer metering inaccuracies:	
Systematic data handling errors:	
Length of mains:	As reported in Master Plan report.
Number of active AND inactive service connections:	3,299 active connections. The City reported that they have very few or no inactive connections.
Average length of customer service line:	
Average operating pressure:	Provided by the model.
Total annual cost of operating water system:	Provided by the City.
Customer retail unit cost (applied to Apparent Losses):	https://www.santaquin.org/government/fee_schedule
Variable production cost (applied to Real Losses):	Calculated from City's energy billing data. Calculated by Ridley.

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: **Santaquin**
Reporting Year: **2019** **1/2019 - 12/2019**
Data Validity Score: **65**

<table>
<tr><td rowspan="8">Own Sources
(Adjusted for known errors)
<i>1,945.940</i></td><td>Water Exported
<i>0.000</i></td><td colspan="4">Billed Water Exported</td></tr>
<tr><td rowspan="10">Water Supplied
<i>1,945.940</i></td><td rowspan="4">Authorized Consumption
<i>1,484.330</i></td><td rowspan="2">Billed Authorized Consumption
<i>1,460.006</i></td><td>Billed Metered Consumption (water exported is removed)
<i>1,460.006</i></td><td rowspan="2">Revenue Water
1,460.006</td></tr>
<tr><td>Billed Unmetered Consumption
<i>0.000</i></td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
<i>24.324</i></td><td>Unbilled Metered Consumption
<i>0.000</i></td><td rowspan="8">Non-Revenue Water (NRW)
485.934</td></tr>
<tr><td>Unbilled Unmetered Consumption
<i>24.324</i></td></tr>
<tr><td rowspan="6">Water Losses
<i>461.610</i></td><td rowspan="3">Apparent Losses
<i>8.515</i></td><td>Unauthorized Consumption
<i>4.865</i></td></tr>
<tr><td>Customer Metering Inaccuracies
<i>0.000</i></td></tr>
<tr><td>Systematic Data Handling Errors
<i>3.650</i></td></tr>
<tr><td rowspan="3">Water Imported
<i>0.000</i></td><td rowspan="3">Real Losses
<i>453.095</i></td><td>Leakage on Transmission and/or Distribution Mains
<i>Not broken down</i></td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks
<i>Not broken down</i></td></tr>
<tr><td>Leakage on Service Connections
<i>Not broken down</i></td></tr>
</table>

AWWA Free Water Audit Software: Dashboard

WAS v5.0

The graphic below is a visual representation of the Water Balance with bar heights propotional to the volume of the audit components

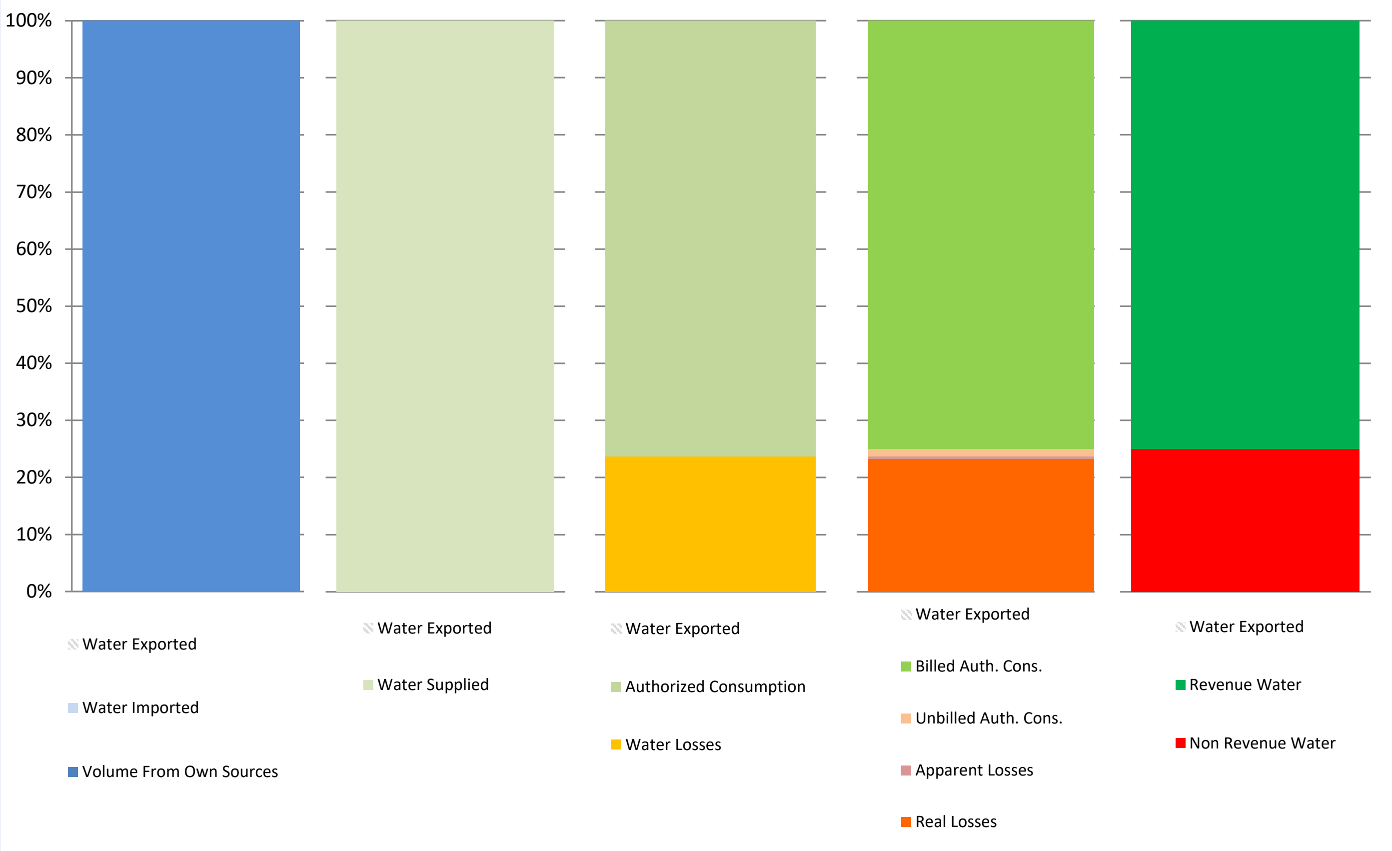
Water Audit Report for: Santaquin

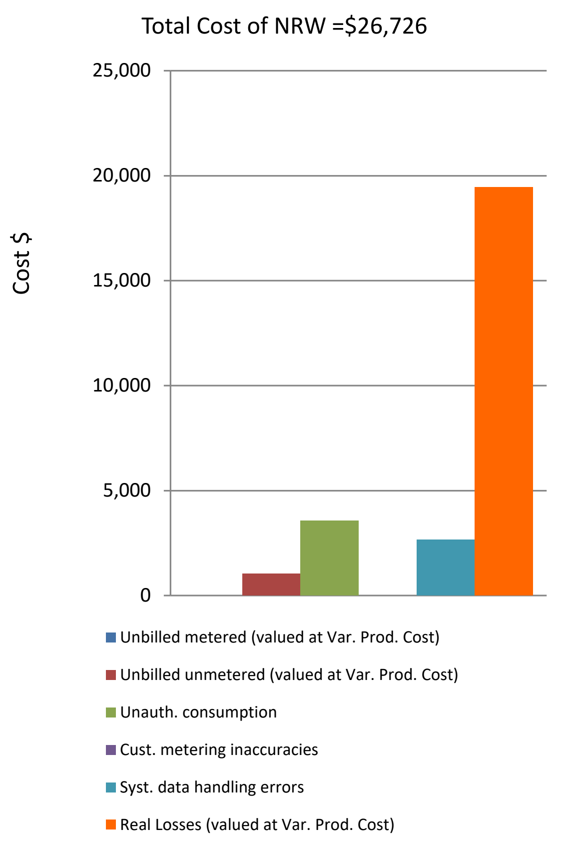
Reporting Year: 2019 | 1/2019 - 12/2019

Data Validity Score: 65

○ Show me the VOLUME of Non-Revenue Water

● Show me the COST of Non-Revenue Water





AWWA Free Water Audit Software: Determining Water Loss Standing

WAS v5.0

Water Audit Report for: Santaquin
Reporting Year: 2019 1/2019 - 12/2019
Data Validity Score: **65**

Water Loss Control Planning Guide

	Water Audit Data Validity Level / Score				
Functional Focus Area	**Level I** (0-25)	**Level II** (26-50)	**Level III** (51-70)	**Level IV** (71-90)	**Level V** (91-100)
Audit Data Collection	Launch auditing and loss control team; address production metering deficiencies	Analyze business process for customer metering and billing functions and water supply operations. Identify data gaps.	Establish/revise policies and procedures for data collection	Refine data collection practices and establish as routine business process	Annual water audit is a reliable gauge of year-to-year water efficiency standing
Short-term loss control	Research information on leak detection programs. Begin flowcharting analysis of customer billing system	Conduct loss assessment investigations on a sample portion of the system: customer meter testing, leak survey, unauthorized consumption, etc.	Establish ongoing mechanisms for customer meter accuracy testing, active leakage control and infrastructure monitoring	Refine, enhance or expand ongoing programs based upon economic justification	Stay abreast of improvements in metering, meter reading, billing, leakage management and infrastructure rehabilitation
Long-term loss control		Begin to assess long-term needs requiring large expenditure: customer meter replacement, water main replacement program, new customer billing system or Automatic Meter Reading (AMR) system.	Begin to assemble economic business case for long-term needs based upon improved data becoming available through the water audit process.	Conduct detailed planning, budgeting and launch of comprehensive improvements for metering, billing or infrastructure management	Continue incremental improvements in short-term and long-term loss control interventions
Target-setting			Establish long-term apparent and real loss reduction goals (+10 year horizon)	Establish mid-range (5 year horizon) apparent and real loss reduction goals	Evaluate and refine loss control goals on a yearly basis
Benchmarking			Preliminary Comparisons - can begin to rely upon the Infrastructure Leakage Index (ILI) for performance comparisons for real losses (see below table)	Performance Benchmarking - ILI is meaningful in comparing real loss standing	Identify Best Practices/ Best in class - the ILI is very reliable as a real loss performance indicator for best in class service

For validity scores of 50 or below, the shaded blocks should not be focus areas until better data validity is achieved.

Once data have been entered into the Reporting Worksheet, the performance indicators are automatically calculated. How does a water utility operator know how well his or her system is performing? The AWWA Water Loss Control Committee provided the following table to assist water utilities is gauging an approximate Infrastructure Leakage Index (ILI) that is appropriate for their water system and local conditions. The lower the amount of leakage and real losses that exist in the system, then the lower the ILI value will be.

Note: this table offers an approximate guideline for leakage reduction target-setting. The best means of setting such targets include performing an economic assessment of various loss control methods. However, this table is useful if such an assessment is not possible.

General Guidelines for Setting a Target ILI (without doing a full economic analysis of leakage control options)

Target ILI Range	Financial Considerations	Operational Considerations	Water Resources Considerations
1.0 - 3.0	Water resources are costly to develop or purchase; ability to increase revenues via water rates is greatly limited because of regulation or low ratepayer affordability.	Operating with system leakage above this level would require expansion of existing infrastructure and/or additional water resources to meet the demand.	Available resources are greatly limited and are very difficult and/or environmentally unsound to develop.
>3.0 -5.0	Water resources can be developed or purchased at reasonable expense; periodic water rate increases can be feasibly imposed and are tolerated by the customer population.	Existing water supply infrastructure capability is sufficient to meet long-term demand as long as reasonable leakage management controls are in place.	Water resources are believed to be sufficient to meet long-term needs, but demand management interventions (leakage management, water conservation) are included in the long-term planning
>5.0 - 8.0	Cost to purchase or obtain/treat water is low, as are rates charged to customers.	Superior reliability, capacity and integrity of the water supply infrastructure make it relatively immune to supply shortages.	Water resources are plentiful, reliable, and easily extracted.
Greater than 8.0	Although operational and financial considerations may allow a long-term ILI greater than 8.0, such a level of leakage is not an effective utilization of water as a resource. Setting a target level greater than 8.0 - other than as an incremental goal to a smaller long-term target - is discouraged.		
Less than 1.0	If the calculated Infrastructure Leakage Index (ILI) value for your system is 1.0 or less, two possibilities exist. a) you are maintaining your leakage at low levels in a class with the top worldwide performers in leakage control. b) A portion of your data may be flawed, causing your losses to be greatly understated. This is likely if you calculate a low ILI value but do not employ extensive leakage control practices in your operations. In such cases it is beneficial to validate the data by performing field measurements to confirm the accuracy of production and customer meters, or to identify any other potential sources of error in the data.		

APPENDIX D

Evaluation of Wastewater Reuse

Evaluation of Wastewater Reuse Flow Data

Influent and Effluent flow measurements from the Santaquin Water Reclamation Facility (WRF) were analyzed for year 2019 to determine the difference between the amount of wastewater treated and the amount used in the PI system. Key attributes of this data are summarized in Table 1.

Table 1: 2019 Water Reuse Data

Parameter	Quantity
Annual WRF influent (ac-ft)	711.39
Annual WRF effluent (ac-ft)	692.01
Annual Type 1 use (ac-ft)	490.26
Difference between influent and use (ac-ft)	221.13
Difference between influent and use (%)	**31%**

The wastewater reuse pump station has a capacity of 800 gpm and operates for approximately 165 days per year. Operating at this capacity, the maximum annual capacity of the pump station is about 583 ac-ft/yr.

Growth projections consistent with those in this master plan were used to identify which year will require an upgrade of the reuse pump station. A summary table of near-term growth is shown in Table 2.

Table 2: WRF Influent Projections

Year	Projected growth rate	Historic or Projected Influent (ac-ft/yr)	Historic or Projected Use (ac-ft/yr)	Pump Station Capacity	Surplus (+) or Deficit (-)
2019	3.5%	711.39	490	583	+93
2020	3.5%	733	505	583	+78
2021	3.5%	755	520	583	+63
2022	3.5%	777	536	583	+47
2023	3.5%	801	552	583	+31
2024	3.5%	825	568	583	+15
2025	3.5%	849	585	583	-2

As demonstrated in Table 2, capacity in the reuse pump station is exhausted after year 2024. By using the second pump to provide additional capacity, the City would be able to extend this capacity for another few years as needed. Accordingly, **it is recommended that the reuse pump stations be modified to add capacity between years 2025 and 2030**, depending on the needs and priorities of the City**.**

APPENDIX E

Flushing Analysis

MEMORANDUM

DATE: September 16, 2020
TO: Norm Beagley, P.E.
Santaquin City Engineering
1215 North Center Street
Santaquin, Utah 84655

FROM: Steven C. Jones, P.E.
Hansen, Allen & Luce, Inc. (HAL)
859 West So. Jordan Pkwy – Suite 200
South Jordan, Utah 84095

SUBJECT: PI System Flushing Analysis

PROJECT NO.: 415.03.100

PURPOSE

The purpose of this analysis is to provide recommendations to Santaquin City to help improve operations and manage sediment within the pipes of the City's pressurized irrigation (PI) system.

BACKGROUND

Santaquin City chiefly supplies Pressure Zone 9N through two PRVs; one located at approximately 400 N and 100 W, and the other located at approximately 400 N and 400 W. Each PRV is equipped with a strainer to prevent sediment and large obstructions from interfering with their operation. The Public Works operations crew typically cleans these strainers out once per week during the summer irrigation season. Failure to do so can result in impaired flows and pressures to Zone 9N, and interference with the operation of the PRVs. Although available data is limited, pressure data collected in Summer 2020 suggests that cleaning even once per week may not be frequent enough to maintain adequate service pressures during periods of high demand. Other PRVs within the PI system can also experience problems due to sedimentation, but problems typically occur on a much smaller scale, and those PRVs are cleaned less frequently.

Cleaning the PRV strainers is labor-intensive and time-consuming, so the City commissioned this study to explore ways to more effectively manage sediment within the system and improve operations.

AVAILABLE DATA AND ANALYSIS

The sediment that accumulates at the City's PRVs tends to be flat and thin. Its appearance suggests that it accumulates along a smooth surface and is later dislodged in small flakes. It is greenish brown in color and hard enough to break after bending slightly.

In July 2020, the Public Works crew performed a burn test on the sediment, and determined that it is almost entirely inorganic. HAL investigated the chemical properties of the sediment and discovered that it has properties consistent with calcium carbonate (water hardness). Considering Santaquin's water sources, this is not surprising.

Over the years, the City has observed two time periods during which the sedimentation problem is at its worst:

1. Shortly after the PI system is charged in the spring
2. Shortly after demands reach their summer peak

Jason Callaway reported to HAL in late August 2020 that the sedimentation problem at the PRVs appeared to have diminished, compared to earlier in the summer.

Several conclusions can be drawn from the above observations:

1. The sediment is not organic in origin
2. The sediment forms within the system pipes
3. Draining the PI system in the fall most likely causes the sediment to dry out and flake
4. Refilling the PI system in the spring most likely causes substantial amounts of the sediment to come loose from the walls of system pipes
5. High pipe velocities tend to mobilize the sediment and bring it to the PRVs
6. The sediment appears to form each year in a finite quantity (as evidenced by the fact that problems diminish in the late summer)

The following are still unknown:

1. The spatial extent of the area(s) where the sediment forms and dislodges
2. The source(s) of water which contribute(s) most to the formation of sediment

EVALUATION OF ALTERNATIVES

Table 1 shows some actions the City could take that could help manage sedimentation in the PI system, as well as their respective advantages and disadvantages.

Table 1
Potential Actions to Address Sedimentation

Actions	Advantages	Disadvantages
Treat source water to remove hardness	Treats root cause of sedimentation	Expensive to implement and maintain, would not address other types of sediment
Flush the system to remove sediment	Relatively easy to implement	Uses a significant amount of water, strainers still require some cleaning
Install self-cleaning filters upstream of the PRVs	Reduces maintenance time, improves PRV operations	Expensive to implement, site conditions may impose constraints

Treating source water is not recommended, as it would be more difficult and expensive to implement and maintain than simply cleaning the strainers each week. Self-cleaning filters would be an effective solution, and it is recommended that the City consider this as an option for future PRV stations, but cost and site constraints would likely make this option unfeasible for the existing PRVs. For those reasons, flushing is the recommended solution for existing PRVs.

FLUSHING - CONSIDERATIONS

The following should be carefully considered before implementing any flushing program:

- **Flooding** – Discharging large amounts of water to the street may flood private property. This concern cannot be ignored in Santaquin, where large areas of town do not have curb, gutter, and storm drainage pipes. Prior to constructing a flush station, it is recommended that Santaquin City test the drainage of the area in consideration using drinking water hydrants.
- **Traffic Impacts** – Flushing can interfere with traffic.
- **Water Hammer** – Crews that perform flushing must open and close flush valves with proper speed, to avoid water hammer.
- **Public Perception** – Without proper education, the public may perceive flushing as wasteful or irresponsible.
- **Service Pressures** – Flushing reduces customer service pressures. Flushing should be scheduled to minimize this impact.
- **Source and Storage Capacity –** The system must have enough source and storage capacity to supply water for flushing.
- **Effectiveness –** Flushing is a tool that is often used along with other methods to achieve a complete result. Flushing will most likely not eliminate the need for Santaquin to clean the strainers upstream of the PRVs. However, it will hopefully reduce the required frequency of cleaning.

PROPOSED LOCATIONS FOR FLUSHING STATIONS

Flushing stations are recommended to be located on the pipes directly upstream of the Zone 9N PRVs. Flushing through PRVs is not recommended, as it may cause their components to wear out faster. Prior to installing a flushing assembly, the City should ensure adequate drainage is available by testing with a fire hydrant.

These two flush stations will allow the City to flush a sizable portion of northern Zone 10 at a relatively low expense. If the City wishes to cover a wider spatial extent with the flushing program, additional flush stations will need to be installed.

DESIGN CRITERIA

The City’s hydraulic models indicate that velocities through the Zone 9N PRVs can reach nearly 5 ft/sec during times of peak demand. The fact that sediment regularly accumulates at these PRVs is evidence that velocities of 5 ft/sec are sufficient to mobilize the sediment. For that reason, flushing will be designed with the goal of achieving pipe velocities between 5 ft/sec and 10 ft/sec.

There will be some trial and error involved in determining the frequency of flushing required, and the volume of water that should be flushed each time. As a general rule, many flushing programs attempt to turn the volume of target pipelines over two or three times per flush. Santaquin may need to adjust flushing times upward or downward from this benchmark to achieve desired results. Drainage capacity may limit the amount of water that can be discharged at one time.

FLUSHING STATIONS

A standard fire hydrant assembly is the recommended form of the flush station, as it will deliver flows up to and beyond those required to achieve the target velocity. The crew can easily attach a hose to the assembly to direct water to ideal drainage locations. The hydrant should be painted black to indicate to firefighters that it should not be used for firefighting. The estimated cost for installation is $8,000 each, or $16,000 for the two recommended flushing stations.

IMPLEMENTATION OF THE FLUSHING PROGRAM

The following are recommended when flushing:

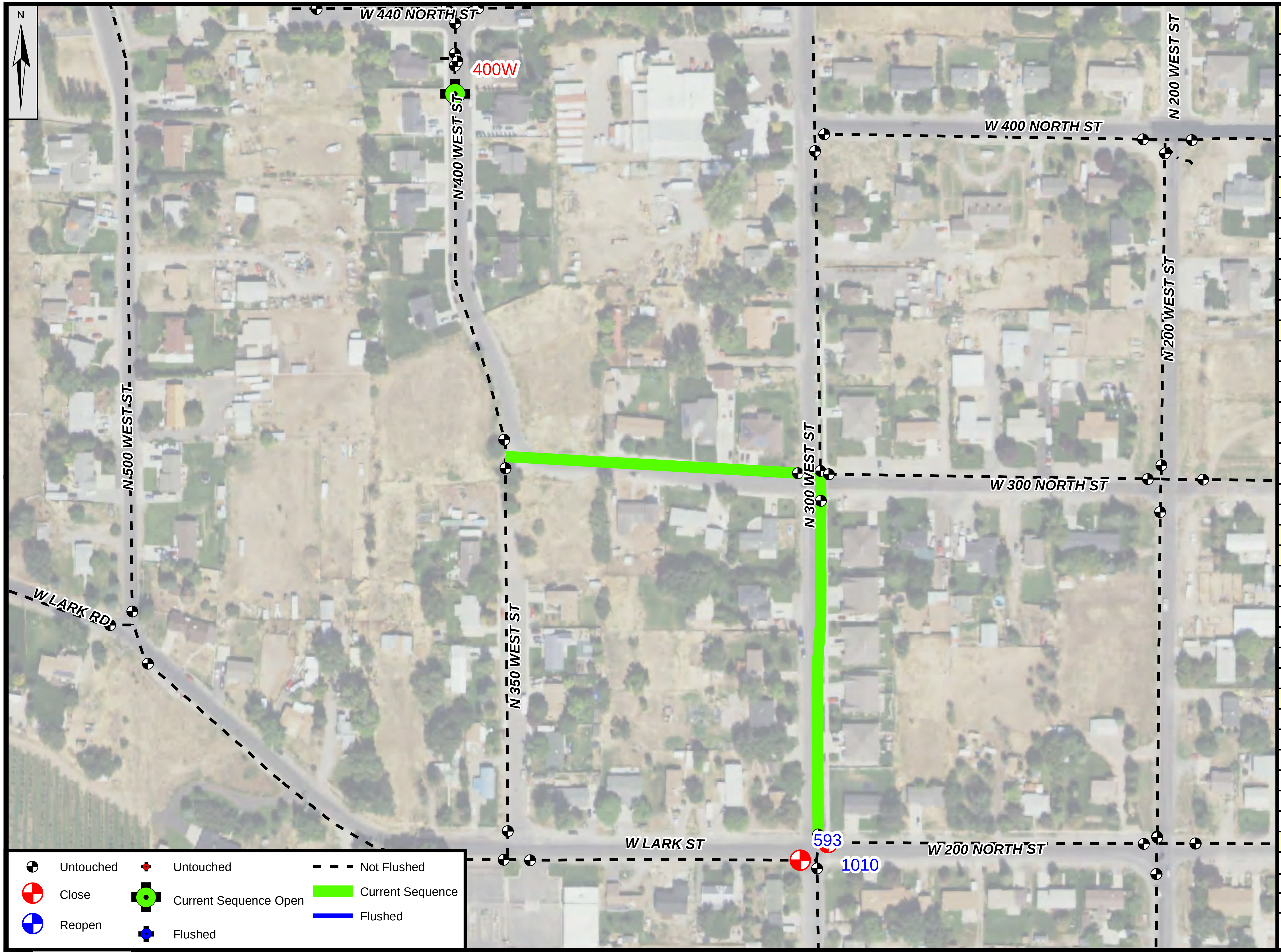
- Flushing should be avoided after recent rain or during any other times when drainage may be impaired
- Flushing should occur between the hours of 10:00 AM and 6:00 PM to take advantage of higher pressures and avoid disrupting service to customers
- The 400 N 200 W booster station from Summit Creek Irrigation Company should be turned off throughout the duration of flushing
- Crew members should carefully track which valves are open and which valves are closed, and ensure that all valves are reopened when flushing is complete
- Crew members should take detailed notes throughout flushing and take note of anything that appears effective, ineffective, or unexpected.

PROPOSED FLUSHING PLAN

The proposed flushing plan for Santaquin City is composed of seven sequences and is explained on the attached seven sheets. It was designed with an attempt to balance cost and effort with effectiveness in scouring pipes in the general area of the Zone 9N PRVs. The City should evaluate the proposed flushing plan and consider the following questions:

- Is adequate drainage available in the area of the proposed flush stations? If not, where can they be located?
- Does the proposed flushing program cover a wide enough spatial extent?
- Would it be beneficial to install additional flush stations and flush additional areas?

The proposed flushing plan can be modified to meet the needs of the City.



GENERAL		
Pipe Length (ft)	1147	
Volume Used (gal)	1499	
Volume Turnovers	2.0	
Flushing Duration (minutes)	6	
Date		
Start Time		
Stop Time		
HYDRAULICS	PREDICTED	FIELD
Flush Hydrant psi (pre)	129	
Residual Hydrant psi (begin)	78	
Residual Hydrant psi (end)	78	
Flush Hydrant psi (post)	129	
Flow Rate (gpm)	500	
Average Flush Velocity (fps)	7.1	
WATER QUALITY	INITIAL	FINAL
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		
OPERATION		
VALVES TO OPEN	FIELD NOTES	
VALVES TO CLOSE		
593 (593 in)		
1010 (1010 in)		
	COLOR	
HYDRANTS TO OPEN		
400W (1.5 in)		

Flush at 500 gpm max

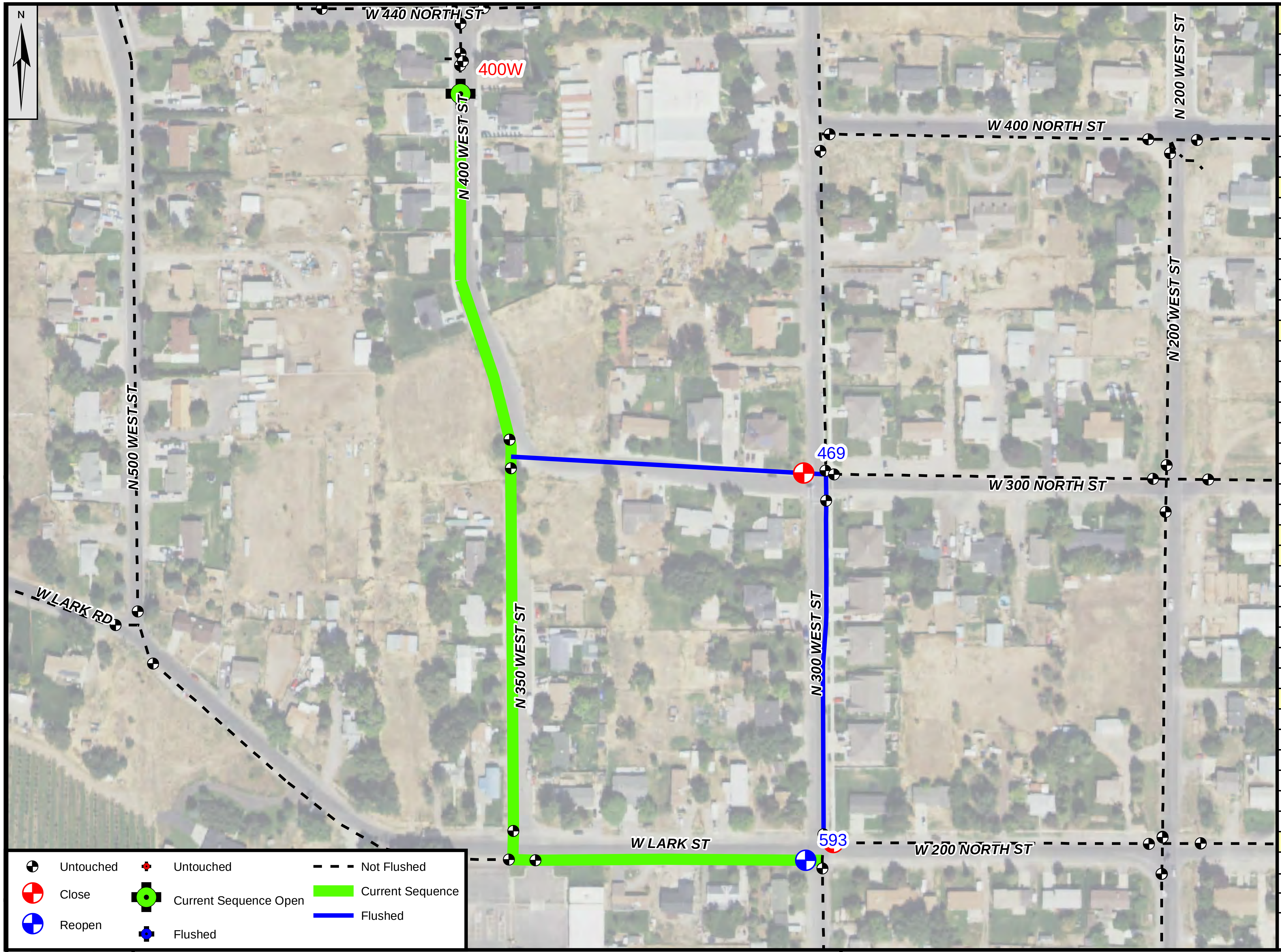
Date: 9/16/2020

HANSEN ALLEN & LUCE INC ENGINEERS

ZONE SAN-1

SEQUENCE 01

FIGURE
SAN-1-01



GENERAL		
Pipe Length (ft)	1817	
Volume Used (gal)	9493	
Volume Turnovers	2.0	
Flushing Duration (minutes)	6	
Date		
Start Time		
Stop Time		
HYDRAULICS	**PREDICTED**	**FIELD**
Flush Hydrant psi (pre)	129	
Residual Hydrant psi (begin)	89	
Residual Hydrant psi (end)	89	
Flush Hydrant psi (post)	129	
Flow Rate (gpm)	1590	
Average Flush Velocity (fps)	10.2	
WATER QUALITY	**INITIAL**	**FINAL**
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		

OPERATION	
VALVES TO OPEN	**FIELD NOTES**
593 (593 in)	
VALVES TO CLOSE	
469 (469 in)	
	COLOR
HYDRANTS TO OPEN	
400W (2.5 in)	

Flush at 1500 gpm max

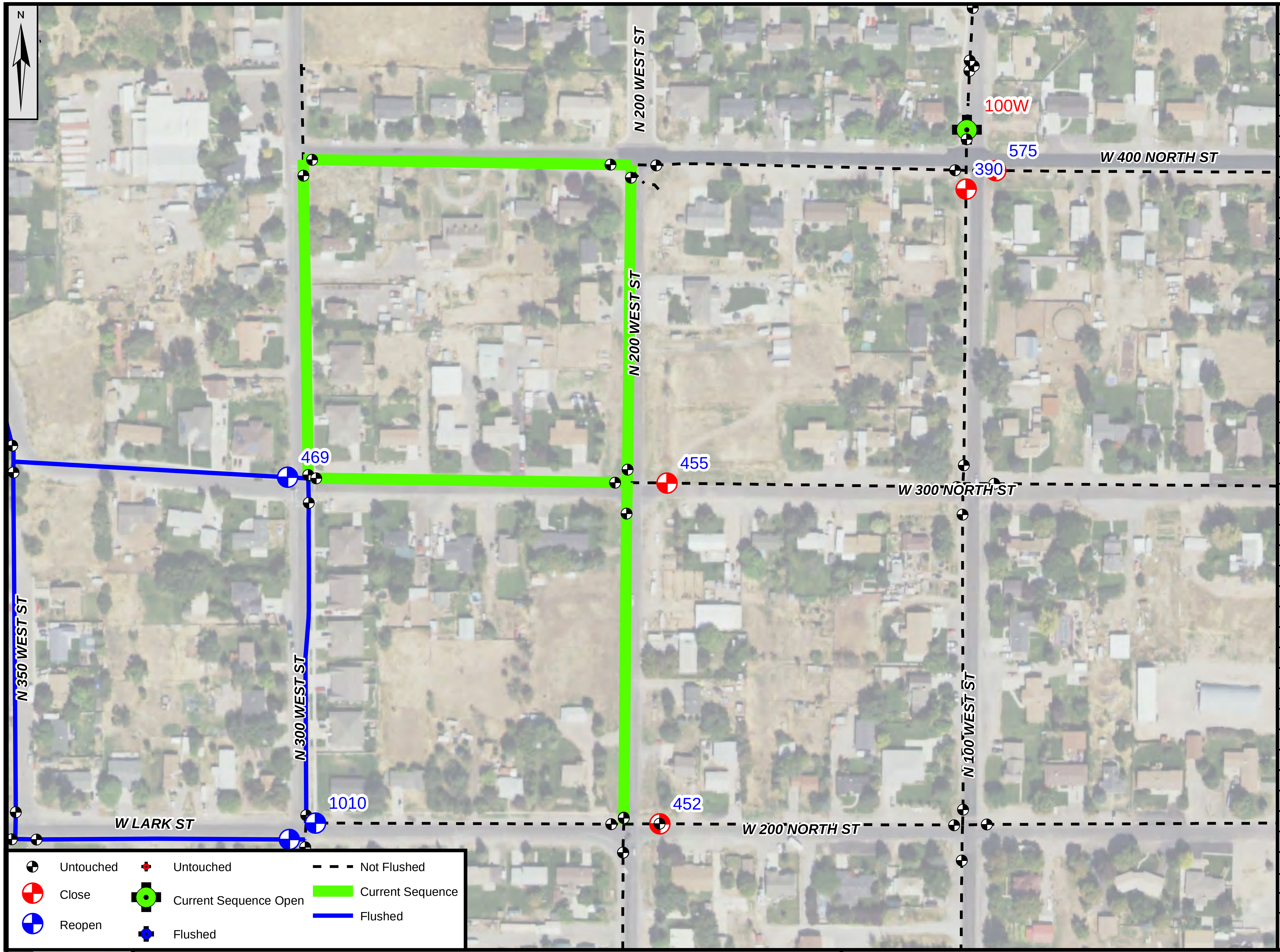
Date: 9/16/2020

HANSEN ALLEN & LUCE INC ENGINEERS

ZONE SAN-1

SEQUENCE 02

FIGURE
SAN-1-02



GENERAL		
Pipe Length (ft)	2913	
Volume Used (gal)	3804	
Volume Turnovers	2.0	
Flushing Duration (minutes)	12	
Date		
Start Time		
Stop Time		
HYDRAULICS	PREDICTED	FIELD
Flush Hydrant psi (pre)	125	
Residual Hydrant psi (begin)	62	
Residual Hydrant psi (end)	62	
Flush Hydrant psi (post)	125	
Flow Rate (gpm)	900	
Average Flush Velocity (fps)	8.2	
WATER QUALITY	INITIAL	FINAL
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		
OPERATION		
VALVES TO OPEN	FIELD NOTES	
469 (469 in)		
1010 (1010 in)		
VALVES TO CLOSE		
452 (452 in)		
455 (455 in)		
390 (390 in)	COLOR	
575 (575 in)		
HYDRANTS TO OPEN		
100W (2.0 in)		

Flush at 900 gpm max

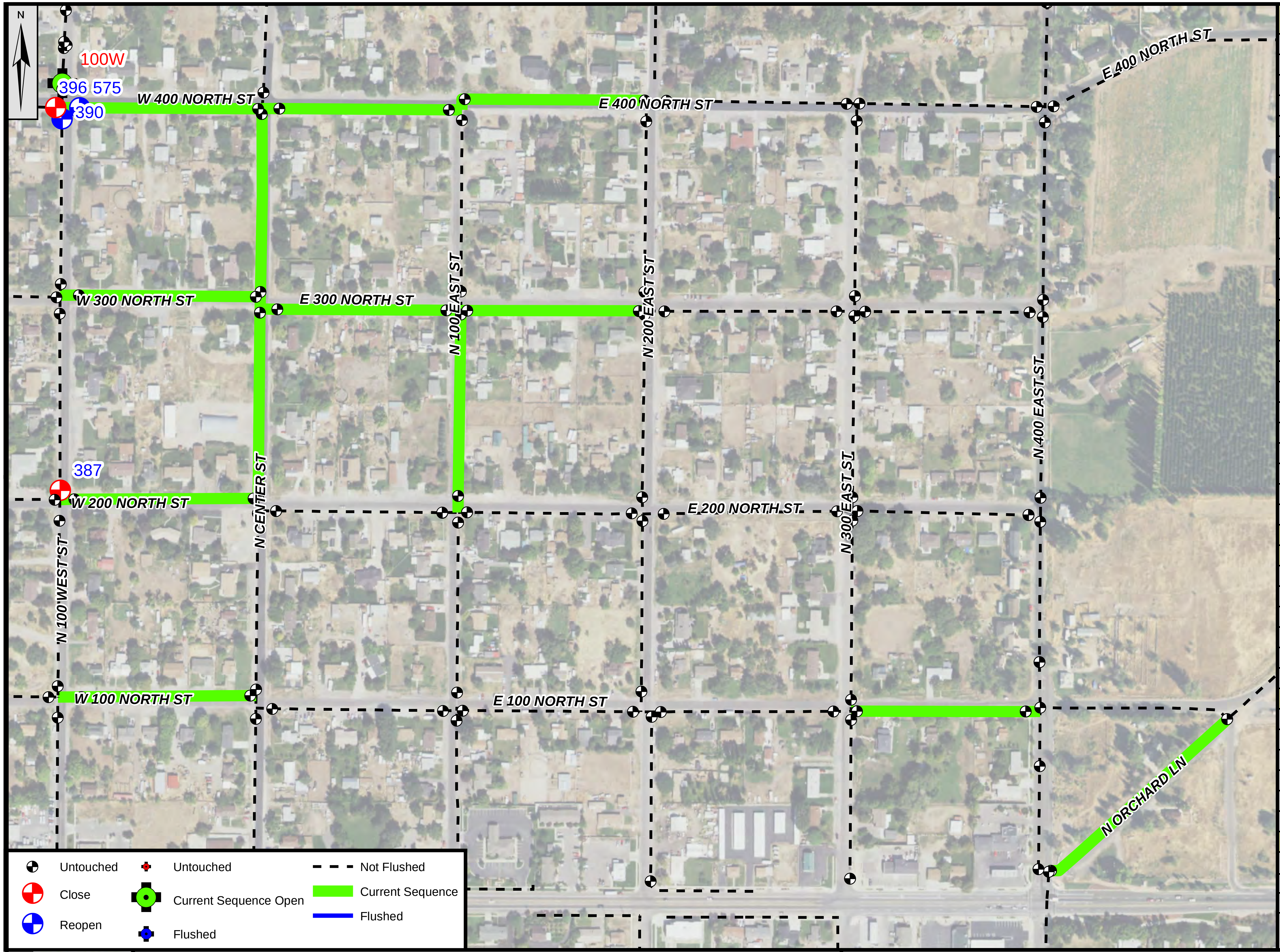
Date: 9/16/2020

HANSEN ALLEN & LUCE INC
ENGINEERS

ZONE SAN-1

SEQUENCE 03

FIGURE
SAN-1-03



GENERAL		
Pipe Length (ft)	7764	
Volume Used (gal)	11114	
Volume Turnovers	2.0	
Flushing Duration (minutes)	34	
Date		
Start Time		
Stop Time		
HYDRAULICS	**PREDICTED**	**FIELD**
Flush Hydrant psi (pre)	125	
Residual Hydrant psi (begin)	45	
Residual Hydrant psi (end)	45	
Flush Hydrant psi (post)	125	
Flow Rate (gpm)	1100	
Average Flush Velocity (fps)	7.6	
WATER QUALITY	**INITIAL**	**FINAL**
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		
OPERATION		
VALVES TO OPEN	**FIELD NOTES**	
575 (575 in)		
390 (390 in)		
VALVES TO CLOSE		
396 (396 in)		
387 (387 in)		
	COLOR	
HYDRANTS TO OPEN		
100W (2.5 in)		

Flush at 1100 gpm max

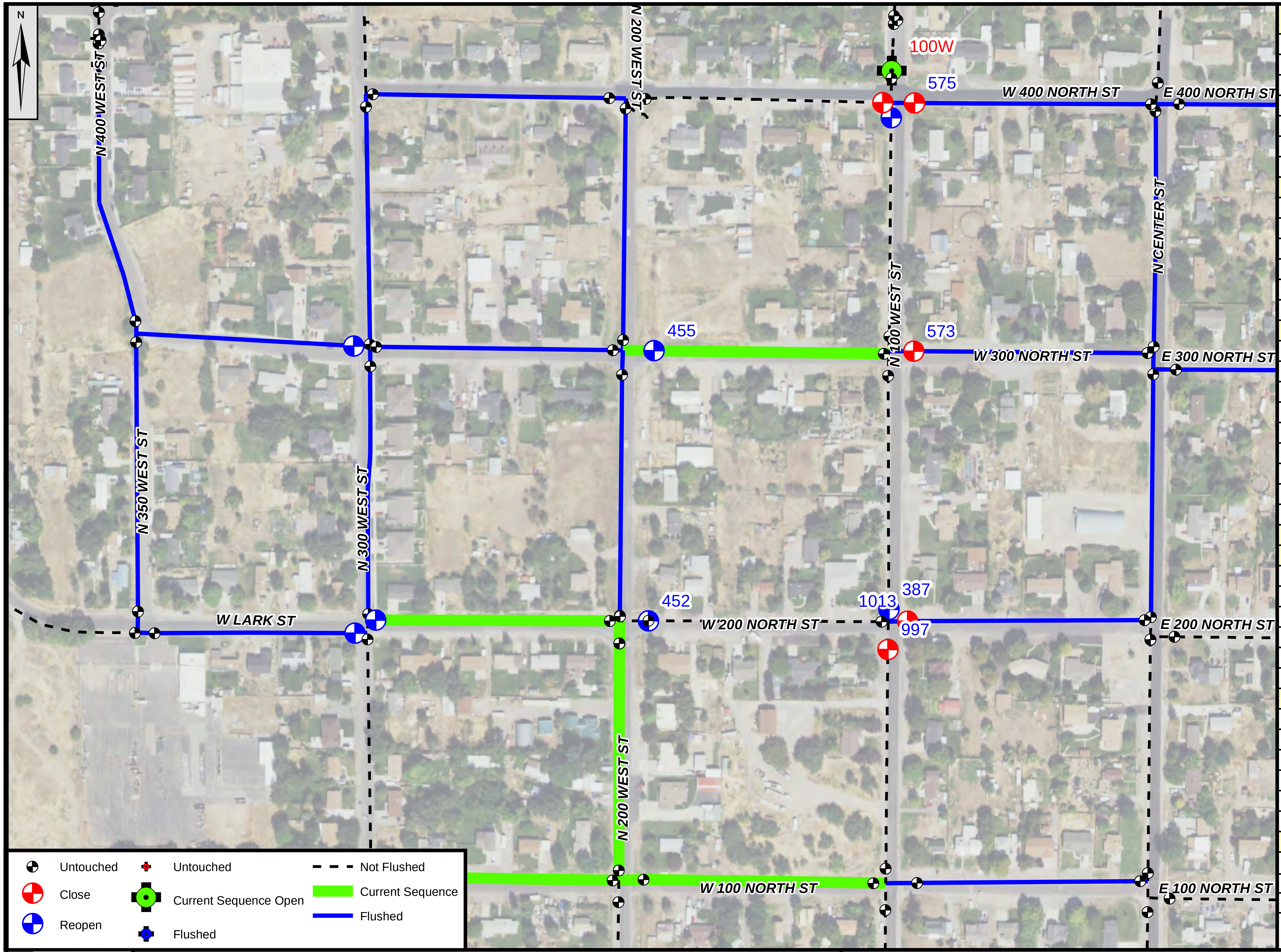
Date: 9/16/2020

HANSEN ALLEN & LUCE INC ENGINEERS

ZONE SAN-1

SEQUENCE 04

FIGURE
SAN-1-04



GENERAL		
Pipe Length (ft)	2923	
Volume Used (gal)	3816	
Volume Turnovers	2.0	
Flushing Duration (minutes)	13	
Date		
Start Time		
Stop Time		
HYDRAULICS	**PREDICTED**	**FIELD**
Flush Hydrant psi (pre)	125	
Residual Hydrant psi (begin)	76	
Residual Hydrant psi (end)	76	
Flush Hydrant psi (post)	125	
Flow Rate (gpm)	1100	
Average Flush Velocity (fps)	7.8	
WATER QUALITY	**INITIAL**	**FINAL**
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		
OPERATION		
VALVES TO OPEN	**FIELD NOTES**	
387 (387 in)		
452 (452 in)		
455 (455 in)		
VALVES TO CLOSE		
997 (997 in)		
1013 (1013 in)		
573 (573 in)	**COLOR**	
575 (575 in)		
HYDRANTS TO OPEN		
100W (2.5 in)		

Flush at 1100 gpm max

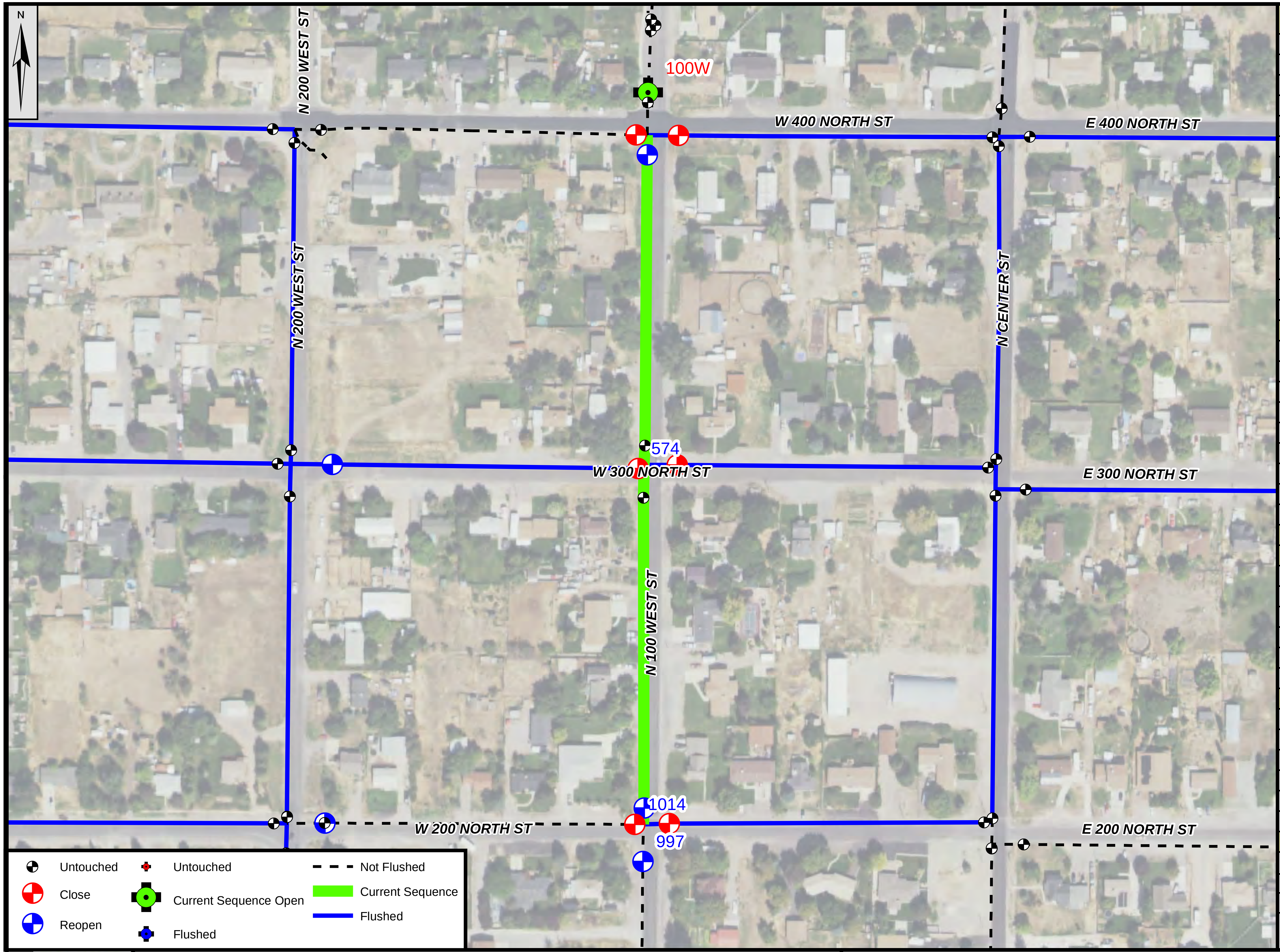
Date: 9/16/2020

HANSEN ALLEN & LUCE INC ENGINEERS

ZONE SAN-1

SEQUENCE 05

FIGURE
SAN-1-05



GENERAL		
Pipe Length (ft)	1246	
Volume Used (gal)	14648	
Volume Turnovers	2.0	
Flushing Duration (minutes)	8	
Date		
Start Time		
Stop Time		
HYDRAULICS	**PREDICTED**	**FIELD**
Flush Hydrant psi (pre)	125	
Residual Hydrant psi (begin)	119	
Residual Hydrant psi (end)	119	
Flush Hydrant psi (post)	125	
Flow Rate (gpm)	1800	
Average Flush Velocity (fps)	5.3	
WATER QUALITY	**INITIAL**	**FINAL**
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		

OPERATION	
VALVES TO OPEN	**FIELD NOTES**
997 (997 in)	
VALVES TO CLOSE	
1014 (1014 in)	
574 (574 in)	
	COLOR
HYDRANTS TO OPEN	
100W (2.5 in)	

Flush at 1800 gpm max

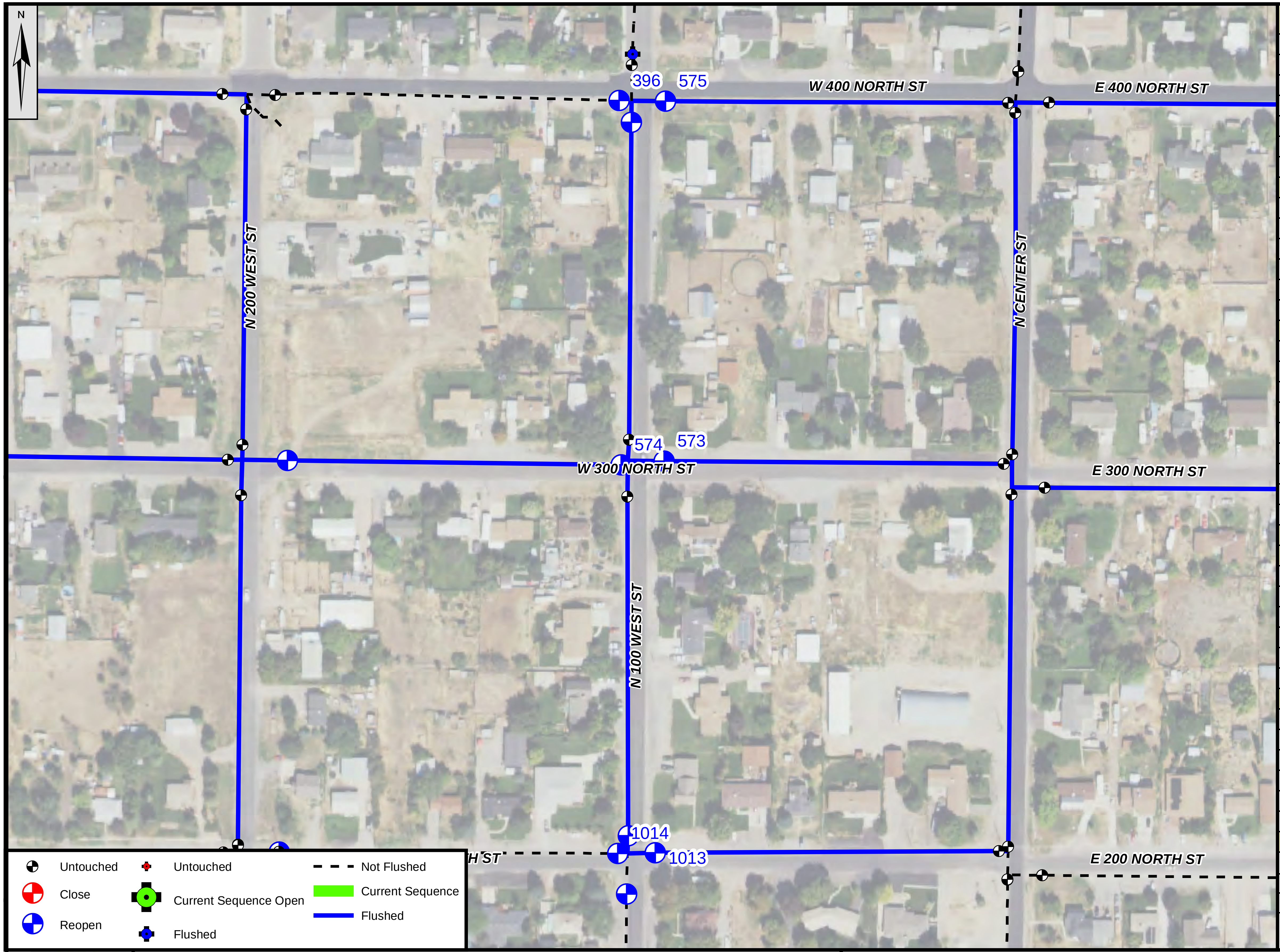
Date: 9/16/2020

HANSEN ALLEN & LUCE INC
ENGINEERS

ZONE SAN-1

SEQUENCE 06

FIGURE
SAN-1-06



GENERAL		
Pipe Length (ft)	0	
Volume Used (gal)	0	
Volume Turnovers	2.0	
Flushing Duration (minutes)		
Date		
Start Time		
Stop Time		
HYDRAULICS	**PREDICTED**	**FIELD**
Flush Hydrant psi (pre)		
Residual Hydrant psi (begin)	0.0	
Residual Hydrant psi (end)	0.0	
Flush Hydrant psi (post)		
Flow Rate (gpm)	0	
Average Flush Velocity (fps)	0	
WATER QUALITY	**INITIAL**	**FINAL**
Turbidity		
Disinfection Residual		
pH		
Iron		
Mangenese		
Odor		
HPC		
Color		
Other		
OPERATION		
VALVES TO OPEN	**FIELD NOTES**	
396 (396 in)		
1013 (1013 in)		
573 (573 in)		
575 (575 in)		
1014 (1014 in)		
574 (574 in)		
VALVES TO CLOSE		
	COLOR	
HYDRANTS TO OPEN		

Reopen Valves

Date: 9/16/2020

HANSEN ALLEN & LUCE INC
ENGINEERS

ZONE SAN-1

SEQUENCE 07

FIGURE
SAN-1-07

APPENDIX F

EPANET 2.0 Hydraulic Models and Model Calibration Data (see disk)

APPENDIX G

Cost Estimate Calculations

Santaquin City Capital Facility Plan
Pressurized Irrigation Water Recommended Improvements
Preliminary Engineers Cost Estimates

	Item	Unit	Unit Price	Quantity	Total Price
PI 1.	***Install Parallel Z10W Backflow Preventer***				
	Install Backflow Preventer	LS	$ 50,000	1	$ 50,000
	Piping to keep box out of street	LS	$ 20,000	1	$ 20,000
	Engineering & Admin. (10%)				$ 7,000
	Contingency (10%)				$ 7,000
	Total to Install Parallel Z10W Backflow Preventer				**$ 84,000**
PI 2.	***Zone 11W PI infrastructure***				
	10 ac-ft PI tank	Gal	$ 0.65	3258510	$ 2,118,032
	Zone 11W Pump Station	LS	$ 750,000	1	$ 750,000
	16" Water Line	LF	$ 159	7900	$ 1,256,100
	Engineering & Admin. (10%)				$ 412,413
	Contingency (10%)				$ 412,413
	Total to Zone 11W PI infrastructure				**$ 4,949,000**
PI 3.	***Zone 10 ULS infrastructure***				
	Connect to ULS pipeline	LS	$ 25,000	1	$ 25,000
	24" Water line	LF	$ 229	5700	$ 1,305,300
	Engineering & Admin. (10%)				$ 133,030
	Contingency (10%)				$ 133,030
	Total to Zone 10 ULS infrastructure				**$ 1,596,000**
PI 4.	***Connect Zone 11W to ULS***				
	16" Water Line	LF	$ 159	3600	$ 572,400
	Engineering & Admin. (10%)				$ 57,240
	Contingency (10%)				$ 57,240
	Total to Connect Zone 11W to ULS				**$ 687,000**
PI 5.	***Zone 11E Transmission***				
	12" Water line	LF	$ 145	300	$ 43,500
	Upsize water line to 12"	LF	$ 47	2300	$ 108,100
	Engineering & Admin. (10%)				$ 15,160
	Contingency (10%)				$ 15,160
	Total to Zone 11E Transmission				**$ 182,000**
PI 6.	***North Reuse Expansion***				
	Upgrade Pump Station	LS	$ 400,000	1	$ 400,000
	12" Water Line	LF	$ 145	5800	$ 841,000
	Engineering & Admin. (10%)				$ 124,100
	Contingency (10%)				$ 124,100
	Total to North Reuse Expansion				**$ 1,489,000**
PI 7.	***Zone 11E Transmission***				
	Upsize water line to 10"	LF	$ 38	3800	$ 144,400
	Upsize water line to 12"	LF	$ 47	1100	$ 51,700
	Engineering & Admin. (10%)				$ 19,610
	Contingency (10%)				$ 19,610
	Total to Zone 11E Transmission				**$ 235,000**
PI 8.	***Zone 12E Source and Transmission***				
	Zone 12E VFD Booster Station	LS	$ 750,000	1	$ 750,000
	16-inch Water line	LF	$ 159	600	$ 95,400
	Upsize water line to 10"	LF	$ 38	2200	$ 83,600
	Upsize water line to 12"	LF	$ 47	1400	$ 65,800
	Engineering & Admin. (10%)				$ 99,480
	Contingency (10%)				$ 99,480
	Total to Zone 12E Source and Transmission				**$ 1,194,000**
PI 9.	***Zone 10 Transmission***				
	12-inch Water line	LF	$ 145	2700	$ 391,500
	Engineering & Admin. (10%)				$ 39,150
	Contingency (10%)				$ 39,150
	Total to Zone 10 Transmission				**$ 470,000**
PI 10.	***Zone 9N Transmission***				

Santaquin City Capital Facility Plan
Pressurized Irrigation Water Recommended Improvements
Preliminary Engineers Cost Estimates

	Item	Unit	Unit Price	Quantity	Total Price
	Upsize water line to 8"	LF	$ 21	1100	$ 23,100
	Upsize water line to 12"	LF	$ 47	5500	$ 258,500
				Engineering & Admin. (10%)	$ 28,160
				Contingency (10%)	$ 28,160
				Total to Zone 9N Transmission	**$ 338,000**
PI 11.	***Western Zone 10 transmission***				
	12" Water Line	LF	$ 145	6300	$ 913,500
				Engineering & Admin. (10%)	$ 91,350
				Contingency (10%)	$ 91,350
				Total to Western Zone 10 transmission	**$ 1,096,000**
PI 12.	***Zone 11W Transmission***				
	Upsize water line to 10"	LF	$ 38	1500	$ 57,000
	Upsize water line to 12"	LF	$ 47	800	$ 37,600
	Upsize water line to 16"	LF	$ 75	1700	$ 127,500
				Engineering & Admin. (10%)	$ 22,210
				Contingency (10%)	$ 22,210
				Total to Zone 11W Transmission	**$ 267,000**
PI 13.	***Northwestern Zone 10 Transmission***				
	Upsize water line to 8"	LF	$ 21	1700	$ 35,700
	8" Water Line	LF	$ 109	700	$ 76,300
				Engineering & Admin. (10%)	$ 11,200
				Contingency (10%)	$ 11,200
				Total to Northwestern Zone 10 Transmission	**$ 134,000**
PI 14.	***South Reuse Expansion***				
	Booster Station	LS	$ 750,000	1	$ 750,000
	12" Water Line	LF	$ 145	1300	$ 188,500
				Engineering & Admin. (10%)	$ 93,850
				Contingency (10%)	$ 93,850
				Total to South Reuse Expansion	**$ 1,126,000**
PI 15.	***West Side Well***				
	Drilling and development (500 gpm)	LS	$ 384,000	1	$ 384,000
	Equipment and well house	LF	$ 200,000	1	$ 200,000
				Engineering & Admin. (10%)	$ 58,400
				Contingency (10%)	$ 58,400
				Total to West Side Well	**$ 701,000**

Total Costs $ 14,548,000

AVERAGE WATER PIPE COST PER FOOT

Diameter (in)	Diameter (ft)	Outside Diameter (ft)	Pipe Material & Installation (1)	Excavation	Imported Bedding Installed	Hauling Excess Native Mat'l	Trench Backfill Installed (3)	Trench Box per Day (2)	Average Daily Output	Trench Box Cost	Top Trench Width (ft)	Road Repair Width (ft)	Asphalt Cost	Service Lateral Cost	Fire Hydrant Cost	Valves & Fittings Cost	Pipeline Connection Costs	Conflicts (9)	Trench Dewatering (4)	Total Cost per Foot of Pipe	Adjusted Cost per foot	Cost Out of Street (3)	Diameter (in)
4	0.3	0.39	26.00	2.84	9.61	1.20	3.83	210.00	400	0.53	2.99	6.99	28.94	18.11	2.37	0.34	1.20	0.00	8.48	103	90	77	4
6	0.5	0.58	30.50	3.17	11.19	1.43	4.11	210.00	333	0.63	3.18	7.18	29.59	18.11	2.37	0.46	1.36	0.00	9.51	112	98	86	6
8	0.7	0.78	48.00	3.52	12.81	1.68	4.40	210.00	200	1.05	3.38	7.38	30.25	18.11	2.37	0.72	1.53	0.00	12.27	137	119	109	8
10	0.8	0.97	61.50	3.88	14.45	1.95	4.69	210.00	182	1.15	3.57	7.57	30.91	18.11	2.37	1.13	2.23	0.00	13.31	156	136	128	10
12	1.0	1.17	67.00	4.26	16.14	2.24	4.98	210.00	160	1.31	3.77	7.77	31.57	18.11	2.37	0.73	2.94	0.00	14.63	166	145	138	12
14	1.2	1.36	71.00	4.65	17.86	2.55	5.27	210.00	133	1.58	3.96	7.96	32.23	18.11	2.37	1.27	3.22	0.00	16.52	177	154	148	14
16	1.3	1.56	77.00	5.07	19.61	2.88	5.56	210.00	114	1.84	4.16	8.16	32.89	18.11	2.37	1.63	3.52	9.44	18.42	198	173	159	16
18	1.5	1.75	86.50	5.50	21.40	3.23	5.84	210.00	100	2.10	4.35	8.35	33.55	18.11	2.37	2.04	3.80	10.24	20.32	215	187	175	18
20	1.7	1.94	93.00	5.95	23.23	3.60	6.13	210.00	89	2.36	4.54	8.54	34.21	18.11	2.37	2.65	4.10	10.90	22.21	229	200	188	20
24	2.0	2.33	112.00	6.89	26.99	4.41	6.71	210.00	77	2.73	4.93	8.93	35.52	18.11	2.37	4.10	4.68	12.48	25.14	262	229	218	24

Reference: 2018 RS Means Heavy Construction Cost Data Updated by: JKN

Costs:

$ 20.85	/CY Native Trench backfill - sec. 31 23 23.16 (0200): Fill by borrow [sand, dead or bank x 1.21 O&P] w/o materials (27.94-18.6) and convert from loose to compacted volume. $11.20/LCY * 1.39 LCY/ECY (see Note 5)
$ 59.08	/CY Imported Select Fill - sec. 31 23 23.16 (0200), 31 23 23.20 (4266), 31 23 23.23 (8050): Sand, dead or bank w/ hauling and compaction. ($33.50/LCY + $5.10/LCY)*1.39 LCY/ECY + $5.50/ECY (see Note 5)
$ 6.10	/CY Excavation - sec. 31 23 16.13 (6372): 10-14 ft deep, 1 CY excavator, Trench Box.
$ 30.49	/SY 4" Asphalt Pavement - sec. 32 11 23.23 (0390), 31 23 23.20 (4268), 32 12 16.13 (0120), 32 12 16.13 (0380): 9" Bank Run GravelBase Course ($7.10/SY), 2" Binder ($9.30/SY), 2" Wear ($10.40/SY [4"=$19.80/SY]) and Hauling [Item 4268] ($7.35/LCY * 1.39LCY/ECY * 0.361CY/SY) (see Note 5)
$ 2.63	/LF 4" Asphalt cutting - sec. 02 41 19.25 (0015, 0020): Saw cutting asphalt up to 3" deep ($1.68/LF), each additional inch of depth ($0.95/LF)
$ 1,811.32	/EA Service Lateral Connection (see Note 7)
$ 4,734.51	/EA Fire hydrant assembly including excavation and backfill (see Note 8)
$ 7.16	/CY Hauling - sec. 31 23 23.20 (4262): 20 CY dump truck, 6 mile round trip and conversion from loose to compacted volume. $4.13/LCY * 1.39 LCY/ECY (see Note 5)
$ 210.00	/day Trench Box - sec. 31 52 16.10 (4500): 7' deep, 16' x 8'
$ 63.32	/CY Stabilization Gravel - sec. 31 23 23.16 (0050), 31 23 23.20 (4266), 31 23 23.23 (8050): Bank Run Gravel ($36.50/LCY * 1.39 LCY/ECY) plus compaction ($5.50/ECY) and hauling ($5.10/LCY * 1.39 LCY/ECY) (see Note 5)
$ 1,152.00	/day Dewatering - sec. 31 23 19.20 (1000, 1020): 4" diaphram pump, 8 hrs attended ($1,025/day). Second pump ($127/day)

NOTES:

(1) Assumes: class 50, 18' lengths, tyton push-on joint for DIP (33 11 13.15 3000-3180); Pressure Pipe class 150, SDR 18, AWWA C900 for PVC <14" & AWWA C905, PR 100, DR 25 for 14" and larger (33 11 13.25 4520-4550 3030-3200); butt fusion joints SDR 21, 40' lengths for HDPE ().
DIP and HDPE costs only go up to 24". PVC costs only go up to 48". All costs for pipe larger than 48" are Prestressed Concrete pipe (PCCP), 150 psi, 24' length (Pg 315).

(2) 7' deep trench box (16' x 8') - on page 263

(3) Backfill Material & Installation assumes in street. For out of street unit costs, the backfill material cost has been added in place of base course and asphalt.

(4) Dewatering assumes 1' stabilization gravel at the bottom of the trench plus dewatering pumps

(5) Conversion from loose to compacted volumes assumes 125 PCF for compacted density and 90 PCF for loose density. Or (125 PCF/ECY)/(90 PCF/LCY) = 1.39 LCY/ECY

(6) Conversion from cubic yards to square yards for hauling of asphalt paving assumed a total thickness of 13". 3 ft x 3 ft x (13 in)/(12 in/ft) = 0.361 CY/SY

(7) Service Lateral costs are based on Beaver Dam short and long service connections average ($1,660.98/connection), with 45.40 for curb replacement, 40.20 for sidewalk replacement, and 158.19 for additional asphalt all added to the short service connection. Used historical cost index to update to current dollars.

(8) Fire Hydrant assembly costs are based on Beaver Dam Water Projects plus 45.40 for curb replacement and 158.19 for additional asphalt ($4341.55 per FH). Used historical cost index to update to current dollars.

(9) Conflicts amounted to be 2% of the cost on the Springville 400 South Pipeline project. Use 5% of total cost per ft.

(10) Joint Restraint has NOT been included in this spreadsheet.

Abbreviations:

VLF	vertical lineal foot
PCF	pounds per cubic foot
LCY	loose cubic yard
ECY	embankment cubic yard

Utah City Cost Indices

SLC	88.5
Ogden	85.8
Logan	87
Price	85
Provo	87.2