PREPARED FOR:

OREM

PREPARED BY:

BOWEN COLLINS & ASSOCIATES

SEWER MASTER PLAN

MAY 2021

SEWER MASTER PLAN

May 2021

Prepared for:

OREM

Prepared by:

BOWEN COLLINS & ASSOCIATES

TABLE OF CONTENTS

Page No.

CHAPTER 1 – INTRODUCTION **1-1**
Introduction 1-1
Scope of Services 1-2
Acknowledgements 1-3
Project Staff 1-3

CHAPTER 2 – EXISTING SYSTEM FEATURES **2-1**
Introduction 2-1
Service Area 2-1
Topography 2-1
Sewer Collection system 2-3
  Sewer Collection Pipes 2-3
  Diversions 2-4
  Sewer Lift Stations 2-4
Orem City Water Reclamation Facility 2-5

CHAPTER 3 – FUTURE GROWTH AND FLOW PROJECTIONS **3-1**
Introduction 3-1
Domestic Sewer 3-1
Study Area 3-2
Traffic Analysis Zones 3-2
Orem City Residential and Nonresidential Populations 3-2
  Orem City Projections from Present to 2050 3-2
  Orem City Projections from 2050 to Build-out 3-4
  Projections for UVU – Nonresidential 3-4
Domestic Sewer Flow Projections 3-8
  Water Conservation 3-8
Sewer Flow Distribution 3-9
Infiltration 3-11
Inflow 3-13
Water Reclamation Facility Capacity 3-13

CHAPTER 4 – HYDRAULIC MODELING **4-1**
Introduction 4-1
Geometric Model Data 4-1
  Pipehole and Manhole Locations 4-1
  Modeled Pipes 4-1
  Pipe Flow Coefficients 4-2
  Sediment and Debris 4-2
  Lift Stations 4-2
  Potential Diversion 4-2
Flow Data 4-5
  Total Flow 4-5
  Timing of Flow 4-5

TABLE OF CONTENTS
(continued)

Page No.

Distribution of Flow ... 4-8
Calibration ... 4-8

CHAPTER 5 – SYSTEM EVALUATION ... 5-1
Evaluation Criteria ... 5-1
Existing System Analysis ... 5-1
Carterville Lift Station Infiltration ... 5-2
Future System Analysis ... 5-2
Pipe Deficiencies ... 5-6
Lift Station Deficiencies ... 5-7
Orem City Water Reclamation Facility ... 5-8

CHAPTER 6 – SYSTEM IMPROVEMENTS ... 6-1
Sewer Collection System Capacity Improvements ... 6-1
Projects Between 2020 and 2030 ... 6-3
SS 1. Carterville Lift Station ... 6-3
SS 2. Springwater Lift Station ... 6-3
SS 3. 1400 South, Chambery to Springwater Lift Station ... 6-3
SS 4. Springwater Force Main ... 6-3
SS 5. College Drive/1200 West and 800 South ... 6-3
SS 6. College Drive near 1200 South ... 6-3
SS 7. 1000 South/Orem Water Reclamation Facility ... 6-3
Projects Beyond 2030 ... 6-4
SS 8. Geneva Lift Station Pump Upgrade ... 6-4
SS 9. 1600 North 800 West ... 6-4
SS 10. 925 South 725 West ... 6-4
SS 11. 400 North 800 West ... 6-4
SS 12. 1200 West between 800 North and Center Street ... 6-4
SS 13. 1000 East near Center Street ... 6-4
Other Sewer Collection System Improvements ... 6-5
Water Reclamation Facility Improvements ... 6-5

CHAPTER 7 – CAPITAL IMPROVEMENT PLAN ... 7-1
System Rehabilitation and Replacement ... 7-1
Frequent Maintenance Areas ... 7-1
Concrete Pipe Assessment and Rehabilitation ... 7-2
System Rehabilitation and Replacement Priorities ... 7-5
Capital Improvements Budget ... 7-5
10-Year Capital Improvement Plans ... 7-6

TABLE OF CONTENTS
(continued)

LIST OF APPENDICES

APPENDIX A – LIFT STATION PUMP DATA
APPENDIX B – ROUTINE MAINTENANCE PROJECTS

TABLE OF CONTENTS
(continued)

LIST OF TABLES

No. Title **Page No.**

2-1 Sewer Collection System Sizes and Lengths 2-3
2-2 Sewer Collection System Materials 2-4
2-3 Summary of Sewer Lift Stations 2-5

3-1 Residential Population Projections 3-7
3-2 Nonresidential Population Projections 3-7
3-3 UVU Student Population Projections 3-7
3-4 Contribution of Sewer by User Type 3-8
3-5 Projected Maximum Average Month Total Domestic Sewer Flows 3-8
3-6 Dry Weather Sewer Flow Rates (mgd) 3-13

4-1 Manholes with Potential Overflow Directions 4-4
4-2 Hydraulic Modeling Scenario Total Daily Flow Volumes (mgd) 4-5
4-3 Hydraulic Model Diurnal Patterns 4-7
4-4 Hydraulic Modeling Scenario Peak Hour Flows (mgd) 4-7

5-1 Summary of Sewer Lift Stations 5-7

6-1 Cost Estimates of Sewer Collection system Improvements 6-5
6-2 Orem City Water Reclamation Facility CIP Projects 6-6

7-1 Estimated Cost of Maintenance Projects & Corresponding 7-1
7-2 Recommended Sewer Collection System Renewal Budget 7-6
7-3 Recommended Total Sewer System Annual Capital Improvement Budget 7-6
7-4 Orem City Sewer System Improvement Plan – 2020 Update 7-8

TABLE OF CONTENTS
(continued)

LIST OF FIGURES

No.	Title	On or Following Page No.
2-1	Existing Collection System	2-2
3-1	General Plan	3-3
3-2	Focused Growth Plans Including Redevelopment	3-5
3-3	Buildout ERC Density	3-6
3-4	Percent of Remaining Development Planned at Buildout	3-10
3-5	Carterville Lift Station 7-Year Seasonal Average of Operating Hours	3-11
3-6	Future Wastewater Production to Orem City Water Reclamation Facility	3-15
4-1	Model Trunk Lines and Flow Monitors	4-3
4-2	Diurnal Patterns in Orem City	4-6
4-3	Simulated Model Results vs Observed Flow at Sample Flow Monitor (ID16)	4-9
5-1	Peak Flow to Capacity for Existing Conditions	5-3
5-2	Peak Flow to Capacity for 2030 Conditions	5-4
5-3	Peak Flow to Capacity for Buildout Conditions	5-5
6-3	Recommended Improvement Projects	6-2
7-1	Pipes with Low Velocities and H2S Aeration Concern Areas	7-4
7-2	Orem City Sewer Capital Improvement Plan – 2020 Update	7-9

CHAPTER 1
INTRODUCTION

INTRODUCTION

In 2016, the City of Orem (the City) prepared master plans for their water, sewer, and storm drain systems. Each plan included identification of a detailed capital facility plan (projects needed to maintain quality service to residents) along with a financial implementation plan (needed rates and impact fees to complete the identified projects). The Sewer Master Plan was ultimately finalized and adopted in February of 2016. Since the completion of the previous master plan study, a number of changes have occurred that may affect the City's master plan and warrant additional consideration. Changes that need to be evaluated and addressed include:

- **Land Use Changes –** Since the preparation of the last master plan, several areas included as part of the City's service area have had land use planning changes that may affect future growth projections. This includes:
  - **Southwest Annexation Area –** The "Southwest Annexation Area" (the area roughly between 1400 South to 2000 South west of I-15) was officially annexed into the City in 2015. Land use plans have evolved in the area since its annexation with the most recent land use plan adopted in August of 2020. The land use plan better refined what areas will develop as residential or nonresidential and included changes in development around the announced City Temple site.
  - **Mountainland Association of Governments Updated Projections –** The Mountainland Association of Governments released revised growth projections for areas in the City in coordination with the Governor's Office of Management and Budget. In most cases, these projections are not significantly different than what was projected in the last master plan. However, there are a few areas of additional growth that have been identified and incorporated as part of the City's projections of residential and nonresidential populations.
  - **Other City Planning Changes –** In addition to the growth identified by the Mountainland Association of Governments projections, the City's planning department has also provided input on potential changes to the City's general plan and zoning where future growth may occur. This includes significant redevelopment potential along State Street, University Parkway, and a few other areas of the City. The changes have been incorporated as part of this master plan update.
- **Financial Conditions** – The financial implementation plan ultimately adopted by the City Council included a 7-year rate increase plan and used pay-as-you-go financing to minimize interest costs to the City. While this was a prudent decision at the time, a few changes in financial conditions have resulted in a desire to reconsider this approach. First, construction inflation over the last five years has been notably higher than historic averages. Second, bond interest rates have dropped to historically low levels. The combination of these two factors means that it may be more cost effective for the City to bond for some needed projects now rather than continue with the pay-as-you-go approach.

This sewer master plan report identifies recommended improvements that resolve existing and projected future deficiencies in the sewer collection system, as well as treatment known improvements at the Orem Water Reclamation Facility (OWRF) identified by the staff. The results of this study will be incorporated into a financial implementation plan to establish impact fees and sewer user rates for the City.

SCOPE OF SERVICES

The general scope of this project involved a thorough analysis of the City's sewer collection system and its abilities to meet the present and future sewer needs of its residents. As part of the Sewer Master Plan, BC&A completed the following tasks.

Task 1: Collected information as needed to develop the sewer master plan based on the City's general plan and existing facilities.

Task 2: Updated population projections and estimated growth in sewer flow to evaluate future growth needs.

Task 3: Updated a hydraulic computer model of the City sewer collection system to evaluate existing and projected future system deficiencies. This included calibrating the model using data from the City's existing GIS database and water meter data from the City.

Task 4: Identified existing operating deficiencies.

Task 5: Identified projected future operating deficiencies.

Task 6: Evaluated alternative improvements for resolving deficiencies identified in Tasks 4 and 5. This included evaluating alternatives looking at diversion locations and reuse opportunities.

Task 7: Developed a comprehensive capital facilities plan incorporating all required improvements identified for the sewer collection system. A master plan for the OWRF is scheduled to be completed in late 2021 for the City.

Task 8: Documented results of the previous tasks in a report with additional memoranda as needed. As part of this task, BC&A also made presentations to the City's public advisory committee and City Council in meetings throughout the project.

In addition to the tasks completed as part of the master plan, BC&A also provided support for a sewer rate analysis produced by another City consultant (Lewis Young Robertson & Burningham) as part of a separate report.

ACKNOWLEDGMENTS

The BC&A team wishes to thank the Public Works Advisory Committee as well as the following individuals from the City for their cooperation and assistance in working with us in preparing this report:

Chris Tschirki	Public Works Director
Neal Winterton	Water Resources Division Manager
Sam Kelly	City Engineer
Reed Price	Maintenance Division Manager
Giles Demke	Water Reclamation Section Manager

PROJECT STAFF

The project work was performed by the BC&A's team members listed below. Team member's roles on the project are also listed. The project was completed in BC&As' Draper, Utah office. Questions may be addressed to Keith Larson, Project Manager at (801) 495-2224.

Mike Collins	Principle in Charge
Keith Larson	Project Manager
Andrew McKinnon	Project Engineer
Andee Harris	Staff Engineer, Sewer Modeling
Mike Hilbert	Clerical

CHAPTER 2
EXISTING SYSTEM FEATURES

INTRODUCTION

As part of this Master Plan, BC&A has assembled an inventory of existing infrastructure within the sewer collection system. The purpose of this chapter is to present a summary of the inventory of Orem City's (the City) existing sewer collection system that can be used as a reference for future studies.

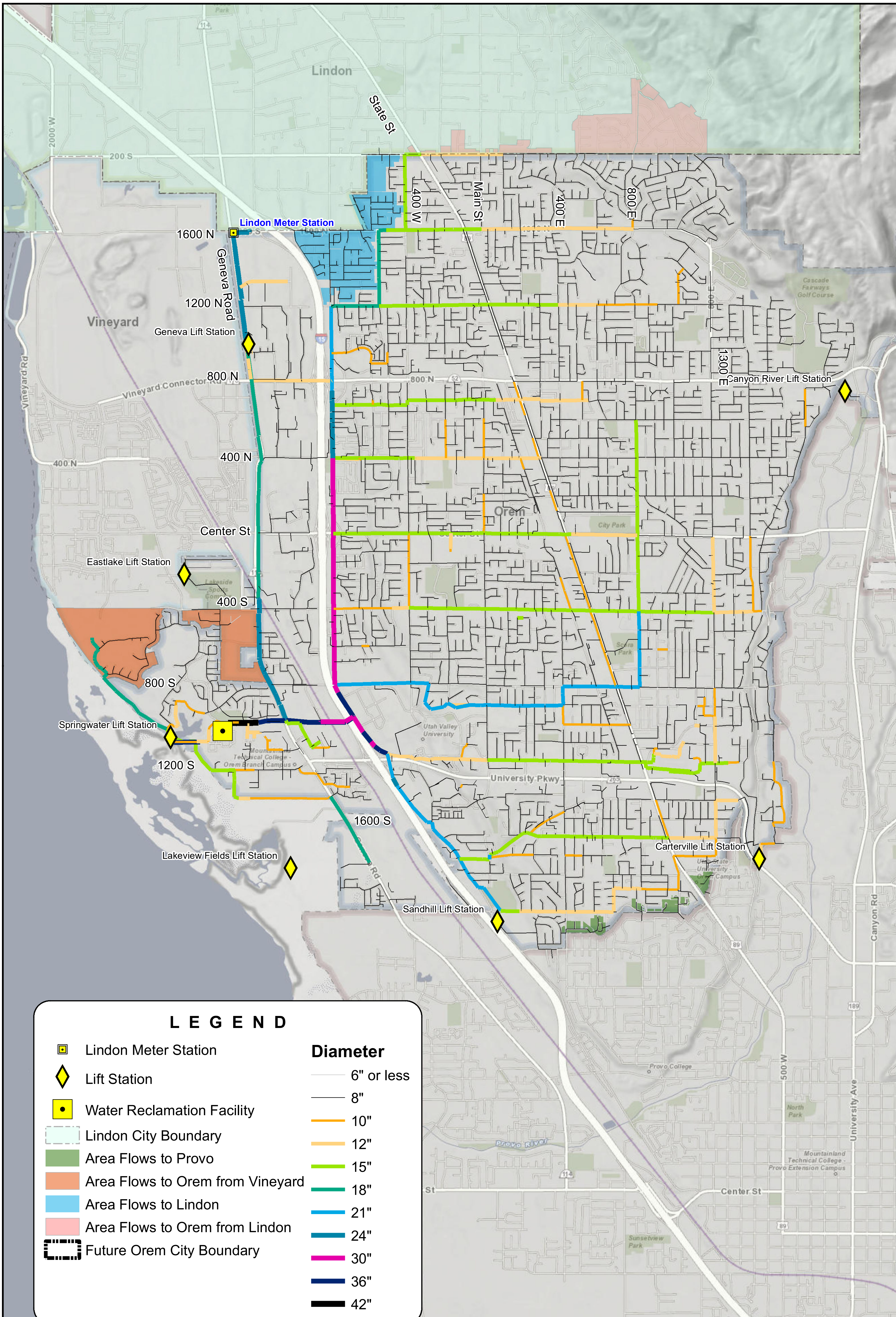
SERVICE AREA

The City sewer system service area as shown in Figure 2-1 is approximately 20 square miles and is bordered by the following: Mount Timpanogos to the east, Utah Lake and Vineyard to the west, Lindon City to the north, and Provo City to the south and east. The service area generally follows the corporate boundaries of the City; however, there are some areas that deviate from this general conclusion as a result of topography limitations and historic development patterns. This includes areas of Lindon City (to the north) and the Vineyard City (to the west) that are served by the City collection system. There are also small areas at the south end of the City that flow to the Provo City collection system. There are even a few small areas of the City's collection system that flow through parts of Lindon's collection system on their way to the OWRF. The areas where each of these situations apply are identified on Figure 2-1.

Wastewater from the City's sewer collection system service area is treated at the City Water Reclamation Facility. Additionally, the reclamation facility treats all of Lindon City's existing sewer, most of which is metered at the Lindon Meter Station indicated in Figure 2-1. In 2020, the total population served by the reclamation facility included approximately 98,625 permanent residents in the City with an additional 11,986 permanent residents from Lindon City and 223 permanent residents from Vineyard. In addition to permanent residents, the City also serves the Utah Valley University student and faculty population along with many other commercial, industrial, and institutional entities. The east side of the City is largely residential and is mostly built out. The west side of the City includes significant commercial/industrial entities, recently constructed multi-housing developments, and large areas of land currently under development or planned for development.

TOPOGRAPHY

The topography of the City generally slopes from northeast to southwest with the OWRF located at the southwest edge of the City (next to Utah Lake). Most of the City sewer collection system flows by gravity to the OWRF, but a few areas do require lift stations (7 total). All of the sewer flow from Lindon must be pumped through the City's largest lift station on Geneva Road.



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

EXISTING COLLECTION SYSTEM

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 2-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 2-1.mxd aharris 4/9/2021

SEWER COLLECTION SYSTEM

Major attributes of the various components of the sewer collection system are summarized in the following sections.

Sewer Collection Pipes

There are about 1.6 million feet (300 miles) of sewer pipe and over 7,000 manholes in the City Sewer System that are cataloged in the GIS database. Table 2-1 contains a summary of the sewer pipes for the City sewer collection system. As can be seen in the table, 80 percent of the pipe in the system is 8 inches in diameter. This represents the vast network of small collection mains in neighborhoods throughout the City.

Table 2-1
Sewer Collection System Sizes and Lengths

Diameter	Length (ft)	Length (mi)	Percentage
4*	3,974	0.75	0.25%
6	68,776	13.03	4.29%
8	1,262,771	239.16	78.82%
10	64,801	12.27	4.04%
12	53,027	10.04	3.31%
15	72,541	13.74	4.53%
18	21,089	3.99	1.32%
21	25,029	4.74	1.56%
24	11,931	2.26	0.74%
27	834	0.16	0.05%
30	9,495	1.80	0.59%
33	2,209	0.42	0.14%
36	4,087	0.77	0.26%
42	1,575	0.30	0.10%
Total	**1,602,139**	**303**	**100.00%**

*Service laterals are not included in the sewer collection system lengths.

Table 2-2 provides a summary of the pipe materials used in the City's sewer collection system. As indicated in the table, concrete pipe is the most common pipe material in the system. Roughly 10.14 percent of the system's pipe material is unknown. Given the age of the areas where pipe material is unknown, it is suspected that most of this pipe is also concrete. In the end, as much as two thirds of the sewer collection system may be concrete pipe.

Table 2-2
Sewer Collection System Materials

Pipe Material	Percentage
Concrete	57.07%
Unknown	10.14%
PVC	28.82%
Other*	3.97%

*Clay, ADS, cast iron, resin liners

The high percentage of concrete pipe in the City sewer collection system may create some challenges in the future. While concrete is generally a durable, long lasting material, it is extremely susceptible to corrosion associated with hydrogen sulfide gas (H_2S). As part of the City's long term maintenance plans, it will likely need to perform extensive rehabilitation to protect its existing concrete pipes from H_2S related corrosion. This is discussed in greater detail in subsequent chapters of this report.

Because of its resistance to H_2S related corrosion, PVC is now the preferred material of construction for most new sewer mains. As the City continues to rehabilitate and replace older existing lines, it is anticipated that the percentage of PVC will gradually increase.

Diversions

The City has a single diversion near UVU and I-15 that uses an overflow weir to send excess flow through a parallel pipe underneath I-15 and the UTA and Union Pacific railroad tracks. Both the overflow and main line are currently in use, but the overflow may also be used to prevent surcharging in wet weather flow conditions. In addition to this diversion, there are a number of manholes in the City that have potential overflow pipes that are primarily used for flushing lines and maintenance. These overflow diversions are discussed more in Chapter 4.

Sewer Lift Stations

There are 7 sewer lift stations in the City sewer collection system that are owned and operated by the City. The City's lift stations range in capacity from 300 to 1,200 GPM. Where possible, pump curves and as-built drawings were collected for each lift station and are included in Appendix A. A summary of the lift station data is listed in Table 2-3.

Table 2-3
Summary of Sewer Lift Stations

Name of Station	Address	Capacity (gpm)	Volume (cf)	Power (HP)	No. Pumps
Carterville Lift Station	1720 S 1030 E	350	230.2	20	2
Geneva Lift Station - to Geneva Road*	1002 N Geneva Rd	800	1,851	10	2
Geneva Lift Station - to 1200 West*		1,187		75	2
Springwater Lift Station	2100 W 1000 S	850	300	20	2
Future Southwest Lift Station	1920 W 1100 S	575** (1,150)	425	10	2 of 4
Eastlake Lift Station	1991 W 180 S	300	175	9.7	2
Canyon River Lift Station	155 N 1550 E	300	280	19.6	2
Sandhill Lift Station	2082 S Sandhill Rd	300	211	5.5	2
Lakeview Fields Lift Station*	1200 W 1785 S	356	1,053	20	2

*The Geneva and Lakeview Lift Stations are equipped with variable frequency drives which are used as a soft start.
**The Future Southwest Lift Station will come online in 2021 with 2 pumps with a capacity of 575 gpm, but 2 additional pumps will be added in the future to double the capacity of the Lift Station.

Note that the Geneva Lift station can discharge to two different gravity mains (1200 West and Geneva Road) that flow to the City's reclamation facility. One small pump runs for 15 hours or more per day while a larger one runs up to 2 hours per day during normal dry weather flow. The City normally discharges to Geneva Road. However, peak flows from Lindon can result in flows that exceed downstream capacity on Geneva Road. For these conditions, the City may pump to 1200 West using a separate force main.

OREM CITY WATER RECLAMATION FACILITY

The OWRF is located at 1797 West 1000 South and was first constructed in 1958. The OWRF includes a pretreatment headworks with screens that removes grit from the raw influent flow prior to flowing to primary clarifiers for primary treatment. The primary effluent is combined with return activated sludge and pumped to the secondary treatment process. The secondary treatment process includes biological nutrient removal (BNR) oxidation ditches and secondary clarifiers. After leaving the secondary clarifiers, the flow enters an ultraviolet (UV) disinfection system prior to leaving the facility and entering Powell Slough and finally Utah Lake. The facility also has a solids treatment system consisting of dissolved air flotation sludge thickening, 2 stage anaerobic digesters, return and water activated sludge systems and sludge belt presses. The OWRF has a peak month, average day capacity of 13.5 mgd, with a peak hydraulic capacity of 21.6 mgd. Funding for necessary OWRF improvements is included in the City's Capital Improvement Plan under the line item "system replacement" (see Chapter 7).

These capacities are based upon cursory review of data provided by City personnel. The City is currently in the process of conducting a facility study for the entire treatment process. The facility study will provide a comprehensive look at the entire treatment process and will identify cost effective alternatives for meeting the future needs of the City.

CHAPTER 3
FUTURE GROWTH AND FLOW PROJECTIONS

INTRODUCTION

Before attempting to hydraulically model and evaluate the City's sewer collection facilities, one must first have an accurate understanding of sewer flows. This includes an estimate of both the quantity and distribution of existing and future flows. The purpose of this chapter is to summarize the results, assumptions, and process of calculating both existing and future sewer flows.

There are three major components of sewer flow: domestic sewer, infiltration, and inflow. Each of these is discussed in detail in this chapter.

DOMESTIC SEWER

Domestic sewer includes all sewer produced by system customers, including residential, commercial, and industrial customers. There are several methods that can be used to estimate domestic sewer flow. This study develops domestic sewer flow projections based on both full time residential population and nonresidential population (aka employment population). The methodology of this study can be summarized as follows:

1. Define the service area.
2. Divide the service area into a number of smaller sub-areas using geographical information system (GIS) mapping. Traffic analysis zones developed by MAG were the primary unit for subdividing the City.
3. Project residential population for each sub-area based on existing and projected patterns of development.
4. Project employment and other nonresidential populations for each sub-area based on existing and projected patterns of development.
5. Adjust projections as required to accommodate areas of special growth consideration including Utah Valley University, University Place Redevelopment, the Southwest Annexation Area, and other areas identified by City planning personnel.
6. Estimate the domestic sewer contribution of each factor (residential and nonresidential) based on a statistical analysis of existing levels of development and historic water use in each sub-area.
7. Convert projections of residential and nonresidential development to sewer flow rates based on their historic contributions.

Each step of this process is summarized in the sections following.

STUDY AREA

The study area for this analysis is generally the same as the City's municipal boundary as shown in Figure 3-1 with additional flow inputs from Lindon City (which are conveyed to the City's treatment facility via Geneva Road) and Vineyard City. It is expected that the sewer collection system will continue to expand to provide service to new development within the City, but that services will not extend much beyond the City's current corporate boundaries and the small collection areas in Lindon and Vineyard currently served by the City's sewer collection system. The City's sewer collection system will eventually serve all areas in Vineyard south of 400 South.

TRAFFIC ANALYSIS ZONES

Division of the service area into smaller sub-areas is important for two reasons. First, it increases the accuracy of the population and flow projections by examining land use and development patterns at a smaller scale. Second, it yields projections that are distributed spatially across the service area, an important requirement for future modeling efforts.

For this study, sub-areas were defined based on Traffic Analysis Zones (TAZ). A TAZ is the smallest geographic unit used for residential and nonresidential population projections developed by the Mountainland Association of Governments (MAG). Nonresidential population data includes employees, retail, industrial, and other non-residents. TAZ boundaries are established on an arbitrary basis by MAG for travel demand modeling.

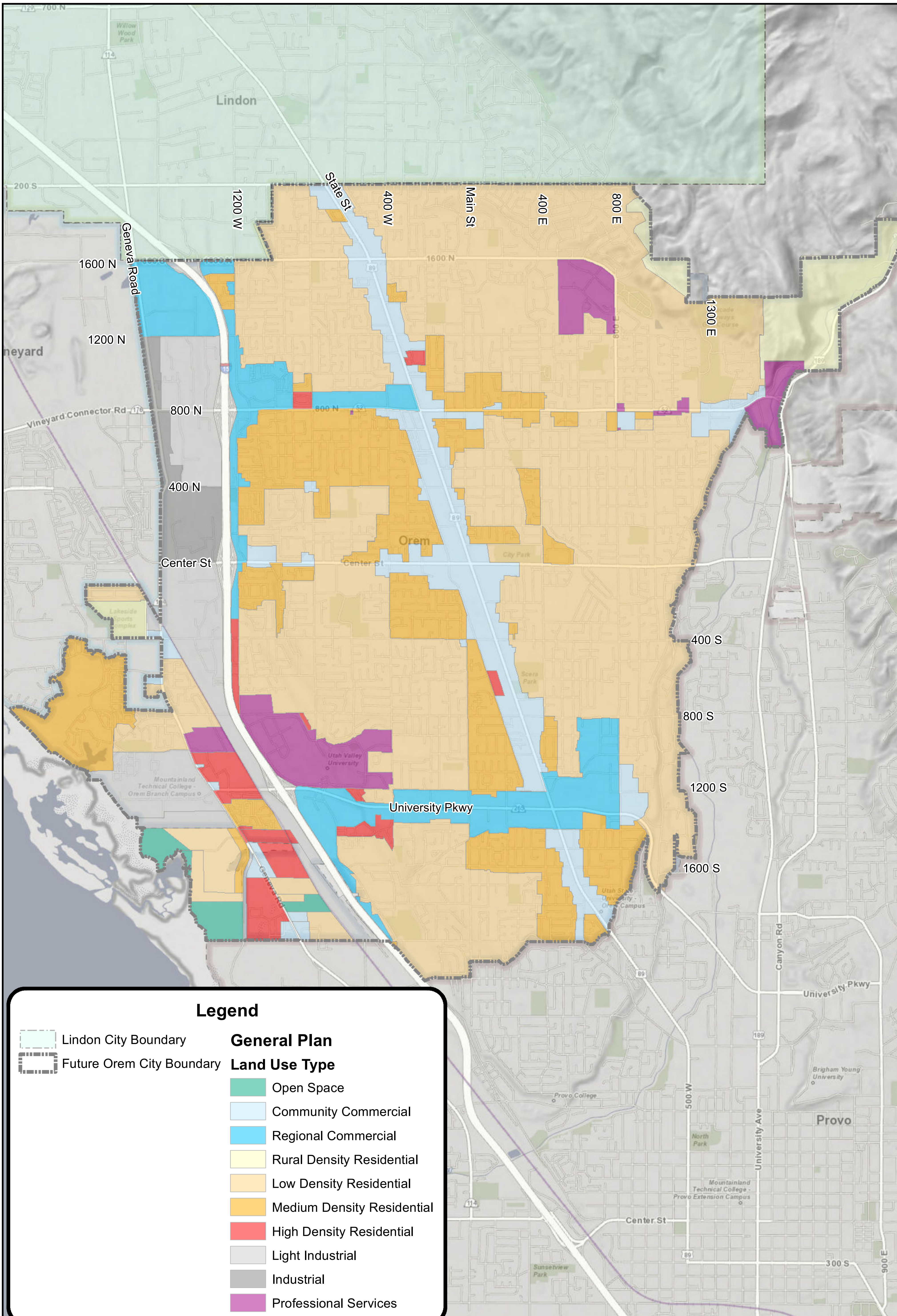
OREM CITY RESIDENTIAL AND NONRESIDENTIAL POPULATIONS

Residential and nonresidential projections were developed for two periods: Present to 2050, and 2050 to 2065. The methodology varies slightly for each period. The sections that follow describe in greater detail how the projections for each of these periods were developed.

Orem City Projections from Present to 2050

MAG prepares projections of population for every year starting in 2015 and continuing to 2050. Thus, the projections for this report from present to 2050 were initially taken directly from the MAG Population Projection Report, 2015 Baseline (2019 Update). This was done for both residential and nonresidential (employment) populations. The MAG projections were used to estimate both the total magnitude of growth and where the growth will occur in the City.

The only exception to this is the Southwest Annexation Area. The City has more detailed information on the planned development in this area than would have been available to those preparing the MAG projections. In this area, an equivalent residential population was developed based on the planning data provided by the City planning department. Based on the planning data, it was assumed that this area would be completely built out by the year 2030.



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

GENERAL PLAN

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 3-1a - general plan.mxd amckinnon 12/30/2020

Orem City Projections from 2050 to Build-out

The detailed MAG projections only extend to 2050. Because this does not cover the full planning window of this sewer master plan, growth beyond the year 2050 needs to be examined and incorporated into this study. A build-out estimate of growth was developed for each area of the City by augmenting the MAG projections with information from the City's planning department. Figure 3-2 shows areas of expected development and redevelopment as identified by the City's planning department. This includes focused growth plans in several areas of the City including:

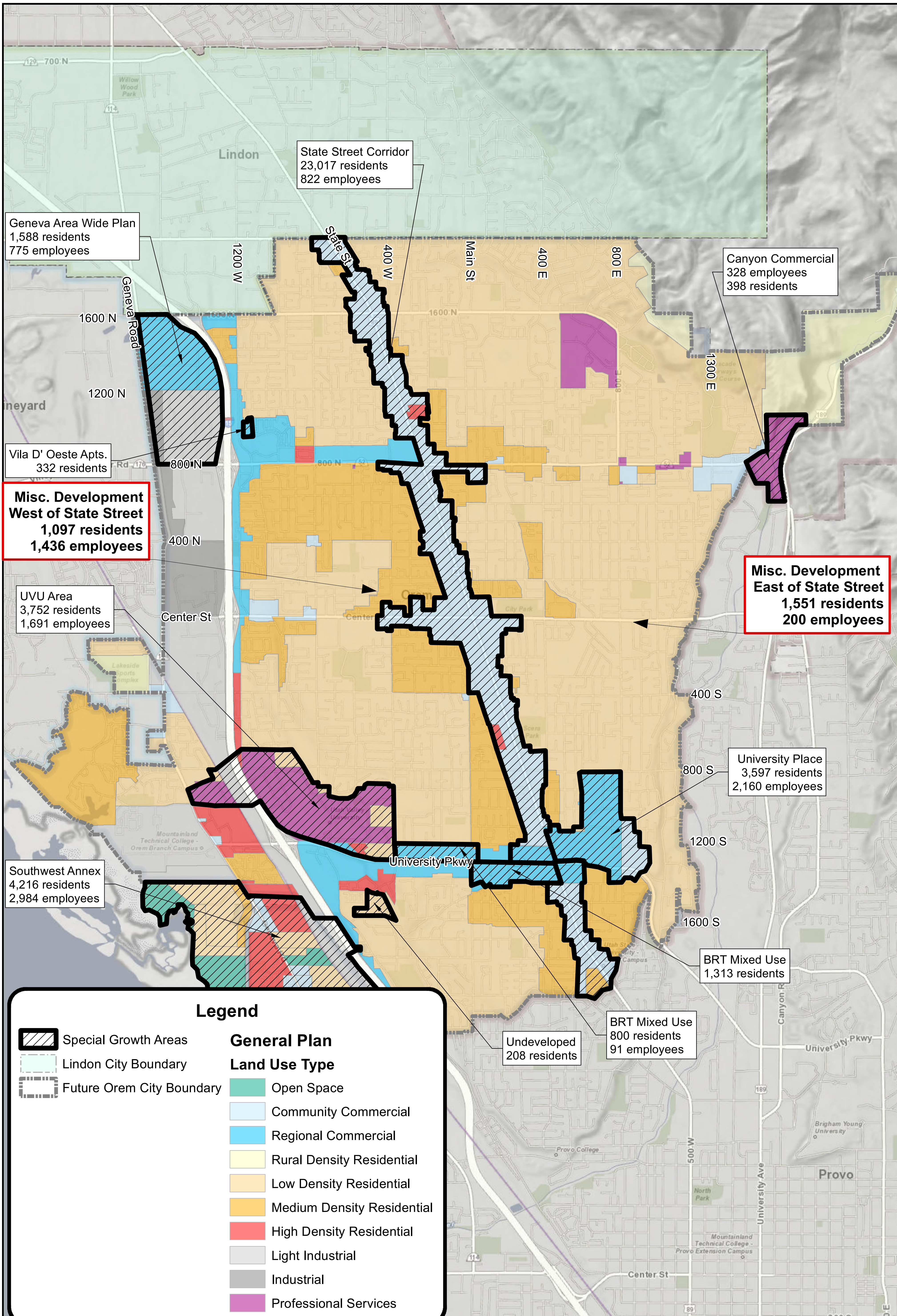
- State Street Corridor
- Utah Valley University
- Bus Rapid Transit Area along University Parkway
- University Place
- Canyon Commercial (mouth of Provo Canyon)
- Geneva Areawide Plan (between I-15 and Geneva Road)
- Various small properties elsewhere in the City

The projected buildout densities in these areas were compared to the estimated 2050 MAG projections. Where the City planning data suggested higher densities than identified by MAG, additional growth was added between 2050 and 2065 to match the City projections. Therefore, full development of the City at current planned densities is shown at 2065. Final densities in terms of equivalent residential connections (ERCs) at full development by TAZ are shown in Figure 3-3.

Projections for UVU – Nonresidential

Because Utah Valley University (UVU) makes up a significant portion of City-wide sewer production, and has a significant potential for growth, projections for UVU were treated separately from other nonresidential projections. Based on UVU's 2010 Master Building Plan, the square footage of buildings on the UVU campus is estimated to approximately double from 2010 to buildout in order to accommodate future student populations. As a result, sewer production for the campus is also expected to double over this period. Projections for UVU assume funding for expansion projects on campus will be uniform through 2065 so that a student population of approximately 53,000 students is reached in 2065, as shown in Table 3-3. It should be noted that the student population has been used to project sewer growth for UVU rather than building square footage because an accurate estimate of the existing or future building square footage was not available during this study. With either approach, the estimated sewer would be anticipated to double within the planning window.

The results of the residential and nonresidential projections described above are summarized in Tables 3-1 and 3-2.



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

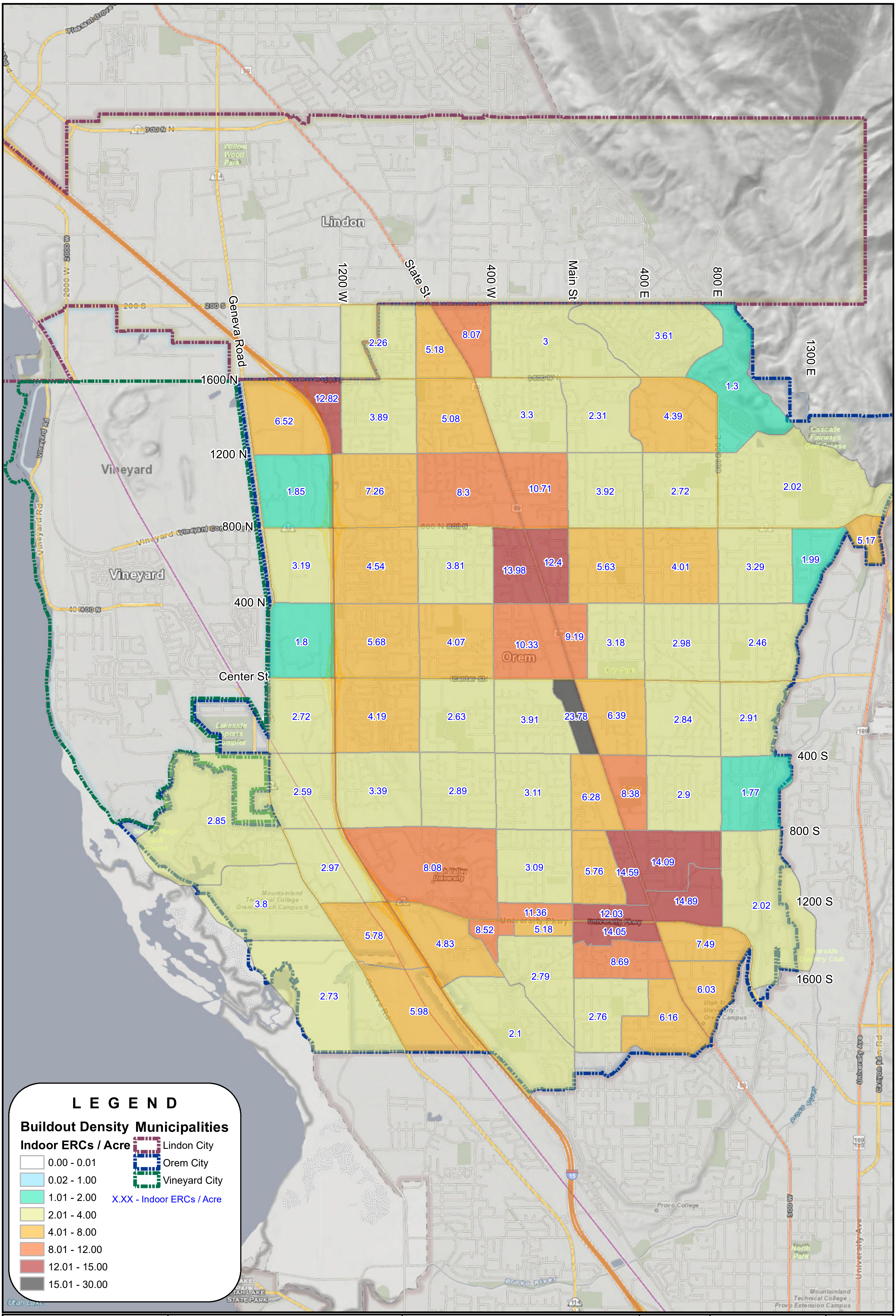
FOCUSED GROWTH PLANS INCLUDING REDEVELOPMENT

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-2

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 3-2a - Focused Growth Plans.mxd aharris 4/9/2021



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

BUILDOUT ERC DENSITY

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-3

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 3-3a - TAZ Density Final.mxd amckinnon 12/30/2020

Table 3-1
Residential Population Projections

Year	Orem Residential Population	Lindon Residential Population	Vineyard[1] Residential Population	Total Residential Population
2020	98,625	11,986	223	110,835
2030	109,374	12,602	526	122,501
2040	122,441	13,031	727	136,199
2050	133,429	13,106	788	147,323
2060	137,734	13,160	806	151,701
2065	139,887	13,188	824	153,899

[1]The estimated service area population from Vineyard includes all areas in Vineyard south of 400 South and is based on the residential population distribution derived from Mountainland Association of Governments Traffic Analysis Zones.

Table 3-2
Nonresidential Population Projections

Year	Orem[1] Nonresidential Population	Lindon Nonresidential Population	Vineyard[1] Nonresidential Population	Total Nonresidential Population
2020	65,373	13,492	51	78,916
2030	74,042	16,299	115	90,456
2040	73,564	18,356	121	92,041
2050	73,605	21,336	128	95,069
2060	77,827	23,190	134	101,152
2065	79,939	24,176	142	104,256

[1]The estimated service area population from Vineyard includes all areas in Vineyard south of 400 South and is based on the residential population distribution derived from Mountainland Association of Governments Traffic Analysis Zones.

Table 3-3
UVU Student Population Projections

Year	UVU Student Population[1]
2020	39,931
2030	42,749
2040	45,568
2050	48,386
2060	51,205
2065	52,614

[1]The student population indicated is based on a uniform growth rate through 2065.

DOMESTIC SEWER FLOW PROJECTIONS

The process of using residential and nonresidential population data to develop domestic sewer flow rates was completed by relating the residential and nonresidential indoor water use to sewer flow rates.

An analysis of indoor water usage for residents, nonresidents, and UVU was developed for the City using indoor water meter records. Based on sewer treatment facility flows, Lindon flows, and indoor water use data, it was possible to estimate the contribution of sewer by residential, nonresidential, and student populations. Based on the residential and nonresidential population data, indoor water meter data and total influent at the City's sewer treatment facility, an estimate of per capita domestic sewer for each user type was developed as summarized in Table 3-4.

Table 3-4
Contribution of Sewer by User Type

Component	Sewer Contribution (gpcd)
Residential Population	57.1
Non-Resident Population	35.4
UVU Population	10.0

Total domestic sewer contributions can therefore be estimated by multiplying the projected residential, nonresidential, and student populations by their respective per capita sewer contribution as summarized in Table 3-5.

Table 3-5
Projected Maximum Average Month Total Domestic Sewer Flows

Year	Residential Domestic Sewer Flow (mgd)	Nonresidential Domestic Sewer Flow (mgd)	UVU Domestic Wastewater Flow (mgd)	Total Domestic Sewer Flow (mgd)
2020	6.33	2.79	0.40	9.52[1]
2030	7.00	3.20	0.43	10.63
2040	7.78	3.26	0.46	11.49
2050	8.42	3.37	0.48	12.27
2060	8.67	3.58	0.51	12.76
2065	8.79	3.69	0.53	13.01

[1]The highest max month flow (highest average daily flow for a single month during the year) at the OWRF over the last 5 years was 9.61 mgd in 2017.

Water Conservation

It should be noted that the results in the tables above are based on historical indoor water usage and do not include any reduction in future sewer production associated with conservation. The City currently has a water conservation goal to reduce its per capita water usage (as measured in the year 2015) by 11 percent by the year 2030 and up to 19 percent by the year 2065. A reduction in sewer flow associated with this projected future conservation was not included for two reasons. First, the projections have been based on recent water use data that already reflects some conservation since the year 2015. Second, the water conservation goal of the City includes consideration of both indoor and outdoor water use. Past history would suggest that the majority of conservation will occur through the reduction of outdoor water use. As a result, the effects of water conservation on indoor water use will likely be comparatively small. Because of these two reasons, additional conservation in the future was conservatively ignored for modeling purposes in this study. However, it is possible that, as the City continues to reduce water use through conservation (as some recent indoor production and treatment facility flow suggests is occurring), there may be some effect on indoor water use and domestic sewer flows. This could potentially delay some projected future system deficiencies and associated system improvements. System flow monitoring will be a valuable tool to track changes in domestic sewer production over time and further assess the effects of indoor conservation.

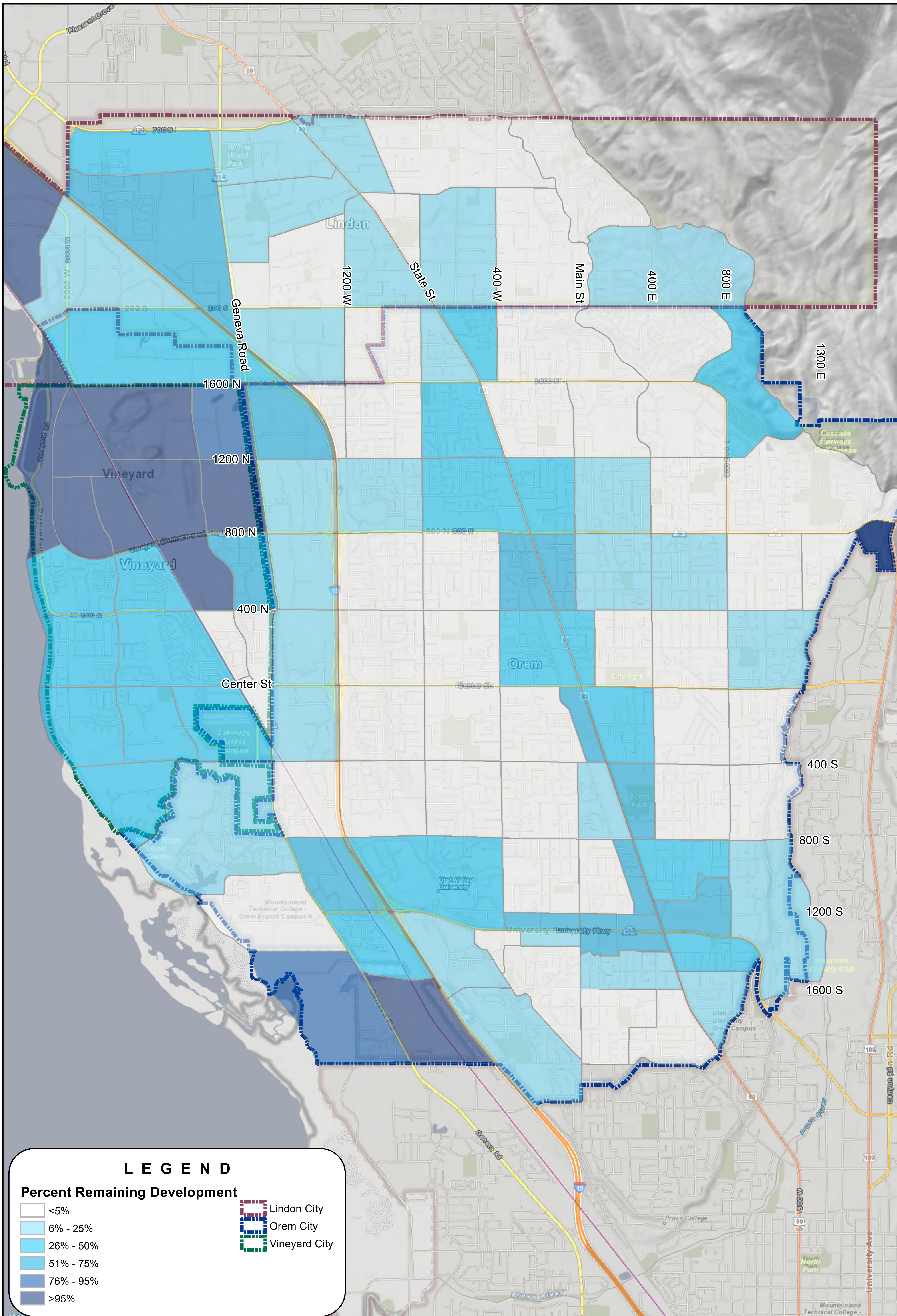
SEWER FLOW DISTRIBUTION

Table 3-5 summarizes total sewer projections for the City service area as a whole. For hydraulic modeling purposes, these flows must be distributed throughout the service area. Domestic sewer distribution in the City hydraulic model was performed in two steps[1]:

- First, flows associated with development prior to 2013 were distributed based on 2013 winter water use records and flow meters installed in collection lines. The City GIS system includes historic water use records for each meter in the City system. Winter water reads for each meter were attached to the nearest trunkline manhole in the model to calculate the portion of total domestic sewer flows associated with each manhole. This data was compared to flow meters installed in collection lines as discussed in more detail in Chapter 4 and adjusted to calibrate to available flow meter information.
- Second, growth since 2013 was then added to the City's hydraulic model using documented growth information from the City planning department from 2013 to 2020. Domestic sewer was added to the model using estimates of flow calculated using developed units and the per capita sewer contributions from Table 3-3.

Figure 3-4 shows the approximate percentage of remaining development within the City based on MAG and the City's planning department projections. The total increase in flow for each TAZ was calculated as described in the sections above. The growth was then distributed to the nearest trunkline manhole within each TAZ. In the case of UVU, increases in flow were assigned to a single manhole because most of the projected expansion will not necessarily require new sewer collection system pipes. The Southwest Annex was assumed to be fully developed by 2030 and growth in the area is based on the City's planning information for the area. For growth between 2050 and buildout, growth was distributed based on feedback from City planning within each TAZ area.

[1] Flows have been divided between development prior to 2013 and development after 2013 for calibration purposes. The most recent period for which detailed flow monitoring is available for calibration is 2013.



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

PERCENT OF REMAINING DEVELOPMENT PLANNED AT BUILDOUT

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 3-4

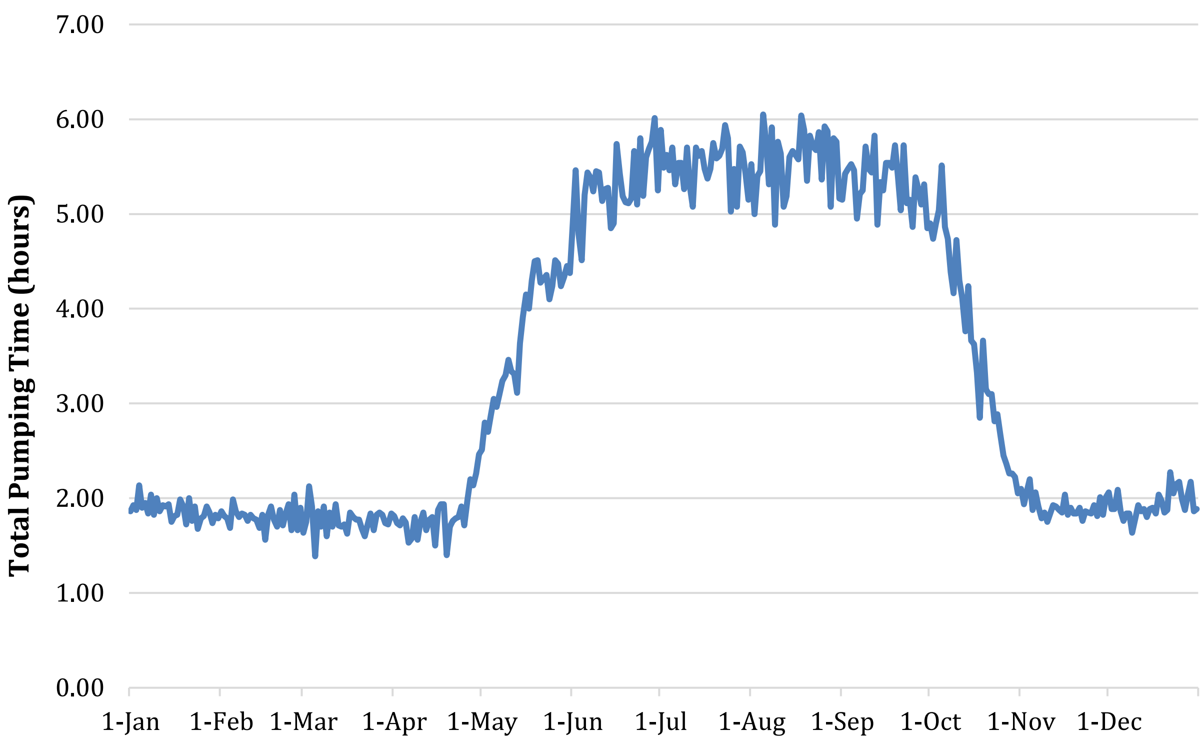
P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 3-4-Future Growth.mxd aharris 4/9/2021

INFILTRATION

Beyond domestic sewer contributions, the second component of sewer flow that must be considered is infiltration. Infiltration is defined as water that enters into the sewer system which is not directly or indirectly related to either domestic sewer or to a specific storm event. This flow can enter as a result of open pipe joints, cracks in pipes, pipes poorly connected at manholes, leaky lateral connections, roots, etc. Infiltration is generally a function of groundwater levels. Groundwater levels in the service area fluctuate depending on climate and season. Infiltration rates will correspondingly change seasonally but will generally be constant during a single 24-hour period. Temporary increases in the amount of water that enters the system after a storm because of an increase in ground water will be considered as inflow (as discussed in a subsequent section).

An example of seasonal infiltration in the City can be seen in the operation of the Carterville Lift Station as shown in Figure 3-5.

Figure 3-5
Carterville Lift Station 7-Year Seasonal Average of Operating Hours



As can be seen in the figure, infiltration increased during the irrigation season by almost five times, as evidenced by the increase in operating hours of the lift station from winter to summer. This is clearly the result of seasonal infiltration as the duration of the increase matches the duration of the irrigation season. It is worth noting that the Carterville Lift Station service area is influenced by groundwater from its proximity to both the Provo River and nearby irrigation canals. The Carterville Lift Station service area is the only area of the City with a clear seasonal infiltration pattern but it is likely that seasonal infiltration exists to lesser extent in many parts of the system.

Factors that can affect infiltration include pipe age, material, and number and condition of lateral connections. Age can contribute to infiltration in two ways. First, older pipes are more likely to be in poor condition. Cracks, separated joints, and other defects can contribute significantly to increased infiltration. Second, older pipes do not have the benefit of improvements in construction techniques that have occurred over time. Gasketed pipe joints, rubber boots at manholes and laterals, and other improvements have contributed greatly to reducing system infiltration over time.

Infiltration in the sewer collection system was identified primarily through temporary flow monitoring conducted by the City personnel over a number of years. Infiltration in the sewer collection system was identified by subtracting domestic flow developed using indoor water use records from the total average flow at flow monitors in the City. To account for seasonal fluctuations in infiltration, the highest average monthly flow over the last 10-years was used as the planning criteria for calibrating the existing condition model. The total infiltration included in the model for existing conditions is 0.94 mgd. It is worth noting that this infiltration rate has not been observed over the last 5 years. However, it was considered prudent to assume this level of infiltration could return depending on climate conditions.

For the City's entire sewer collection system, this equates to an infiltration rate of approximately 356 gallons per day per inch-diameter mile. For comparison, the American Society of Civil Engineers (ASCE) recommends an allowable infiltration rate for new construction of between 200 and 400 gpd/in-dia/mile. This would suggest that the City has relatively low infiltration for its relative age. This conforms to anecdotal information reported by the City personnel and may be the result of the topography and soil characteristics of the Orem bench that result in relatively large depths to ground water. For projecting future infiltration, the existing City-wide infiltration rate (infiltration/domestic flow ~ 10%) was applied to future growth uniformly.

Table 3-6 shows projected domestic flows and infiltration through 2065 based on the assumptions above.

Table 3-6
Dry Weather Sewer Flow Rates

Year	Projected Domestic Sewer Flows (mgd)	Estimated Infiltration (mgd)	Estimated Dry Weather Sewer Flows (mgd)
2020	9.52	0.94	10.46
2030	10.63	1.06	11.69
2040	11.49	1.15	12.65
2050	12.27	1.24	13.50
2060	12.76	1.29	14.05
2065	13.01	1.32	14.33

INFLOW

The third and final component of sewer flow that must be considered for sewer master planning is inflow. Inflow is defined as any water that enters into the sewer system which is directly or indirectly related to a storm event. It can come directly from storm runoff through improper connections to the sewer system, leaky manhole covers, roof drains connected to the system, etc. Storm events can also cause the ground water to raise temporarily, which can cause an increase in flow in the sewer system through the same mechanisms that result in groundwater infiltration during dry weather (cracked pipes, leaky laterals, etc.). Any temporary increase in sewer flow due to raising levels of ground water as a result of snowmelt or rain is considered inflow.

The effluent flows at the OWRF during the week of March 13, 2021 to March 18, 2021 were used along with the precipitation data gathered by the Provo Municipal Airport Weather Station to determine the effects that an inflow event may have on the City's system. The data included two storm events that produced up to .07 inches of precipitation. Resulting inflow at the treatment facility increased flows by roughly 22.4 percent for a short period. It is assumed that many sewer collection system pipes were affected similarly. From this data, it is clear that the City's system is affected by inflow even from relatively minor precipitation events. Other storm events have likewise shown inflow or effluent responses at the OWRF. However, there is insufficient data currently available to accurately estimate the magnitude and distribution of inflow events for individual pipes. Thus, instead of trying to assign specific flows associated with inflow, the system evaluation criteria will include a citywide capacity buffer of 25 percent. This is discussed in more detail as part of system evaluation criteria in Chapter 5.

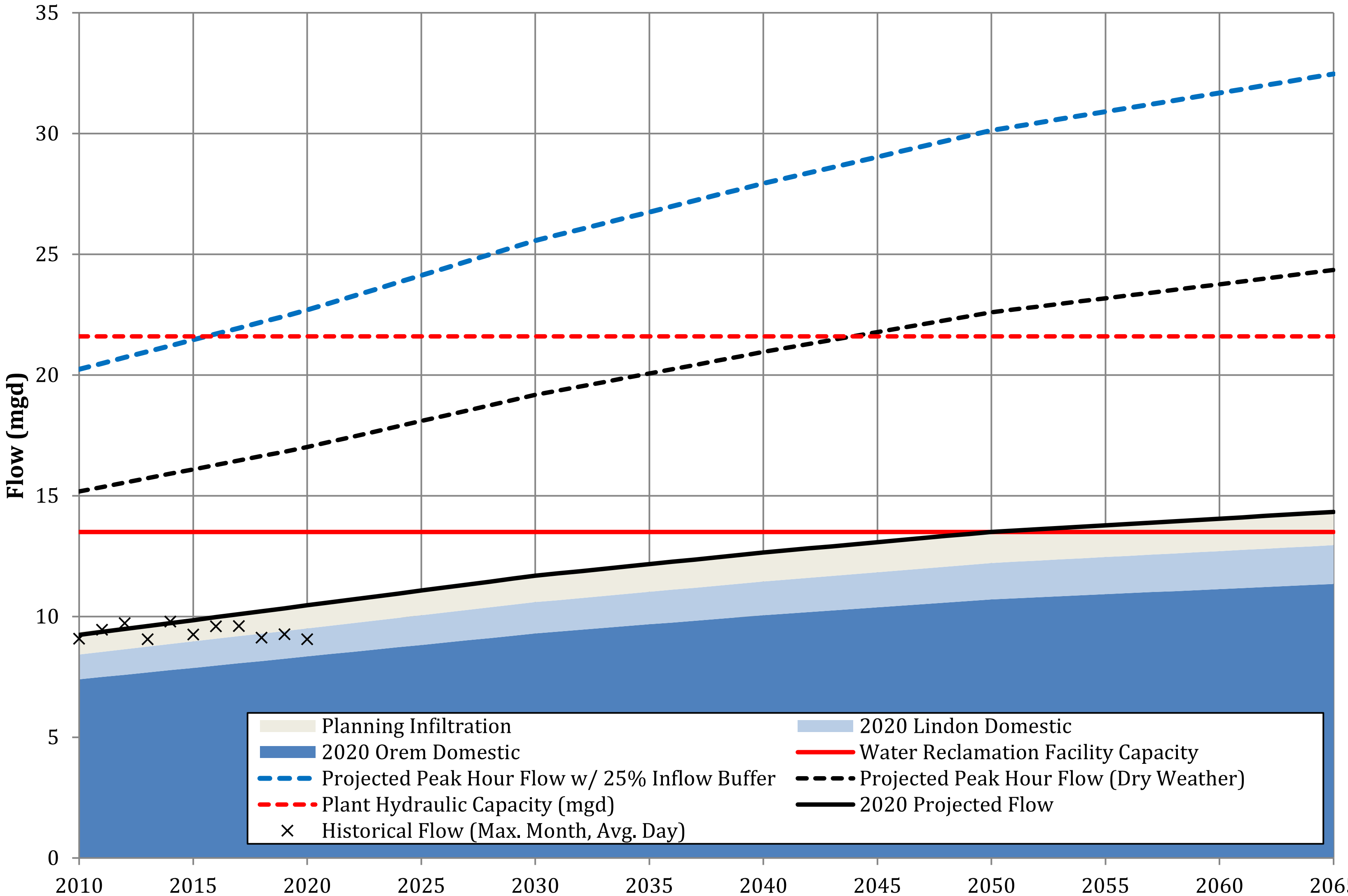
WATER RECLAMATION FACILITY CAPACITY

Based on the growth projections through build-out for the City sewer service area, Figure 3-6 summarizes projected flow into the City Water Reclamation Facility. While this analysis does not examine any of the details of the treatment process that must be considered when analyzing the adequacy of existing treatment facilities, it can provide some preliminary conclusions regarding overall capacity:

- As shown in the figure, average day capacity of the facility is not expected to be exceeded until after 2050.
- The facility's existing rated peak hydraulic capacity is capable of conveying existing flows plus an inflow event that totals just less than 25 percent of existing peak hour flows. It is recommended that the City gather additional long-term information regarding observed

inflows at the facility to determine the expected frequency of this size event. If this presents sufficient risk, additional improvements may be needed in the near future to either increase hydraulic capacity or reduce inflow

Figure 3-6
Future Wastewater Production to Orem City Water Reclamation Facility



CHAPTER 4
HYDRAULIC MODELING

INTRODUCTION

A critical component in identifying required areas in the City sewer collection system where pipes have capacity deficiencies is the development of a hydraulic computer model. An extended period simulation (EPS) hydraulic model was developed using Innoyze's InfoSWMM software. The purpose of this chapter is to present a summary of the methodology used to develop this model.

GEOMETRIC MODEL DATA

There are two major types of data required to develop a hydraulic model of a sewer system: geometric data and flow data. Geometric data consists of information on the location and size of system facilities including pipes, manholes, and lift stations. It also includes the physical characteristics of the facilities including pipe roughness, invert elevations at manholes, pump settings in lift stations, and a description of any diversions present. This information is generally collected from system inventory data or through direct field measurement. The following sections describe how geometric data was assembled for use in the hydraulic model.

Pipe and Manhole Locations

The City has spent considerable time assembling a GIS inventory of its existing sewer facilities. That database includes information on the location and size of manholes and pipes in the City sewer collection system. Based on direction from City personnel, pipe and manhole data was taken directly from the City's GIS database for use in the model. In some areas where manholes did not have reliable invert information, invert elevations were interpolated based on inverts upstream and downstream of areas without information. Areas with interpolated inverts have been documented in the hydraulic model.

Modeled Pipes

It was not deemed necessary to model all of the sewer pipes in the City sewer system. As smaller pipes are added to the model, the more refined the analysis becomes, but this requires additional time, effort, and expense (including higher annual software maintenance costs for hydraulic modeling). Hence, it is important to consider the required detail and available budget when selecting the sewer lines to model.

To optimize the level of effort, it was decided to include in the model all sewer pipes with a diameter of 10 inches or larger and 8-inch pipes serving areas greater than 200 acres. The pipes selected for modeling are shown in Figure 4-1. As service areas decrease in relative size (less than 200 acres), State minimum slope requirements result in capacities that exceed the potential sewer production for typical residential densities in the City. This means that deficiencies will not occur in pipelines with a diameter of 8-inch or smaller that serve an area smaller than 200 acres. As a result, modeling pipes that are serving areas smaller than this size will not add any additional meaningful results to the analysis.

Thus, for the purpose of this study, the pipes identified for modeling were considered adequate for assessing potential hydraulic deficiencies. It is possible that higher density developments may require additional 8-inch pipes to be modeled in the future. The final selection of sewer lines included in this model was reviewed by City personnel.

Pipe Flow Coefficients

Pipe flow coefficients used throughout the hydraulic model were assigned a Manning's roughness coefficient of 0.013. This is approximately equal to the roughness coefficient of concrete and clay pipe. While there are other materials in the system with lower published roughness coefficients (e.g. PVC), 0.013 was used throughout the system as a conservative approach for estimating pipe capacity. In addition, most collection pipes can develop thin layers of bacteria and solids (a slime layer) that result in relatively uniform roughness coefficients despite varying materials.

Sediment and Debris

Because of the transportable nature of grease and debris in a sewer collection system, it is not possible to identify the exact location and quantity of grease or debris accumulation in the system for any specific point in time. Similarly, the build-up and erosion rates of sediment in sanitary sewer systems are not always well understood. As a result, the detailed modeling of sediment, grease, and debris on a system wide basis is not feasible because of continually changing conditions. Therefore, no sediment was included in the various runs of the hydraulic model. Instead, the design and evaluation criteria for the City sewer collection system is based on "clean" pipes, with an allowance for capacity lost to the accumulation of sediment (see Chapter 5).

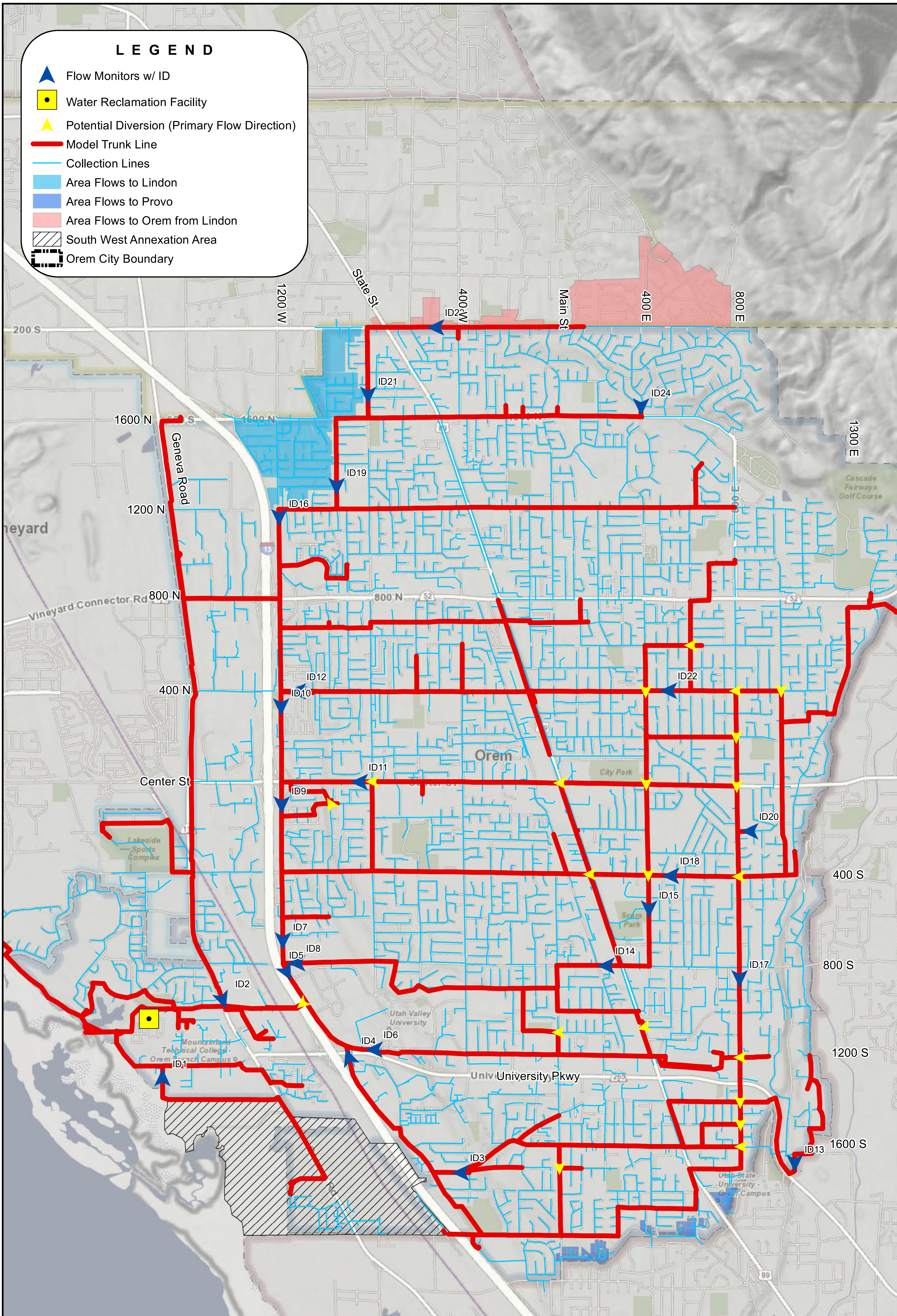
It should be noted that the hydraulic modeling software used to simulate the operation of the City sewer collection system does have the ability to set sediment depth in pipes. Therefore, if the City does collect detailed sediment data for a given section of pipe, the sediment may be added to the model and its effects evaluated. However, it should be emphasized that any sediment levels defined today will change in the future as flow conditions change.

Lift Stations

The City has 8 lift stations in its sewer collection system. Where pump curves were available, associated pump performance criteria were input into the model. Pump curves at other locations were estimated based on the required lift and flow capacity of the lift station as reported by City personnel.

Potential Diversion

The City has one diversion in its sewer collection system near UVU and I-15 where flow can be diverted into a parallel sewer main underneath the freeway and railroad tracks. In addition, there are a number of manholes that have two potential flow directions based on the available invert information provided by the City. In all cases, there is a primary flow direction where all flow is conveyed under typical conditions with a potential "overflow" direction primarily used for flushing lines and system maintenance. Table 4-1 lists the location of these potential diversions along with their primary flow directions which are also shown in Figure 4-1. These potential diversions were identified so that the hydraulic model would correctly simulate the proper flow path for sewer through the sewer collection system.



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

MODEL TRUNK LINES & FLOW MONITORS

NORTH:

SCALE: 0 1,250 2,500 Feet

FIGURE NO. 4-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 4-1 - Trunk Lines.mxd aharris 4/9/2021

Table 4-1
Manholes with Potential Overflow Directions

Manhole ID	Location	Main Flow Direction
17-0171	600 E 600 North (Overflow manhole to the south. All flow goes west).	West
26-0028	400 S 400 East (Overflow manhole to the west. All flow goes south).	South
17-0063	800 E 400 North (Overflow manhole to the south. All flow goes west).	West
17-0072	1000 E 400 North (Overflow manhole to the west. All flow goes south).	South
17-0089	200 N 800 East (Overflow manhole to the west. All flow goes south).	South
19-0086	1000 W 100 South (Overflow manhole to the west. All flow goes northwest).	Northwest
20-0173	800 W Center Street (Overflow manhole to the south. All flow goes west).	West
21-0136	400 E Center Street West (Overflow manhole to the west. All flow goes south).	South
21-0164	Center Street & State Street (Overflow manhole to the south. All flow goes west).	West
26-0154	400 S State Street West (Overflow manhole to the south. All flow goes west).	West
27-0033	800 E 400 South (Overflow manhole to the south. All flow goes west).	West
31-0028	1100 S Main Street (Overflow manhole to the south. All flow goes west).	West
31-0124	1070 S State Street (Overflow manhole to the north. All flow goes west).	West
32-0026	1200 S 800 East (Overflow manhole to the south. All flow goes west).	West
34-0110	1700 S Main Street (This is an overflow manhole to the North. All the flow goes to the south).	South
35-0021	1600 S 800 East (Overflow manhole to the south. All flow goes west).	West
35-0024	1500 S 800 East (Overflow manhole to the west. All flow goes south).	South
35-0026	1400 S 800 East (Overflow manhole to the west. All flow goes south).	South
22-0093	800 E Center St (Overflow manhole to the west. All flow goes south).	South
16-0139	400 North 400 E. (Overflow manhole to the west. All flow goes south).	South

FLOW DATA

Once all required geometric data was collected and a physical model of the system was developed, flow data was obtained to model the system hydraulics. Three types of flow information were required for hydraulic modeling: total magnitude of flow, timing of flow, and distribution of flow across the City service area. Each of these flow characteristics is discussed below.

Total Flow

Flow projections for the City service area were presented in detail in Chapter 3. Total flow for modeling scenarios examined here are summarized in Table 4-2.

Table 4-2
Hydraulic Modeling Scenario Total Daily Flow Volumes (mgd)

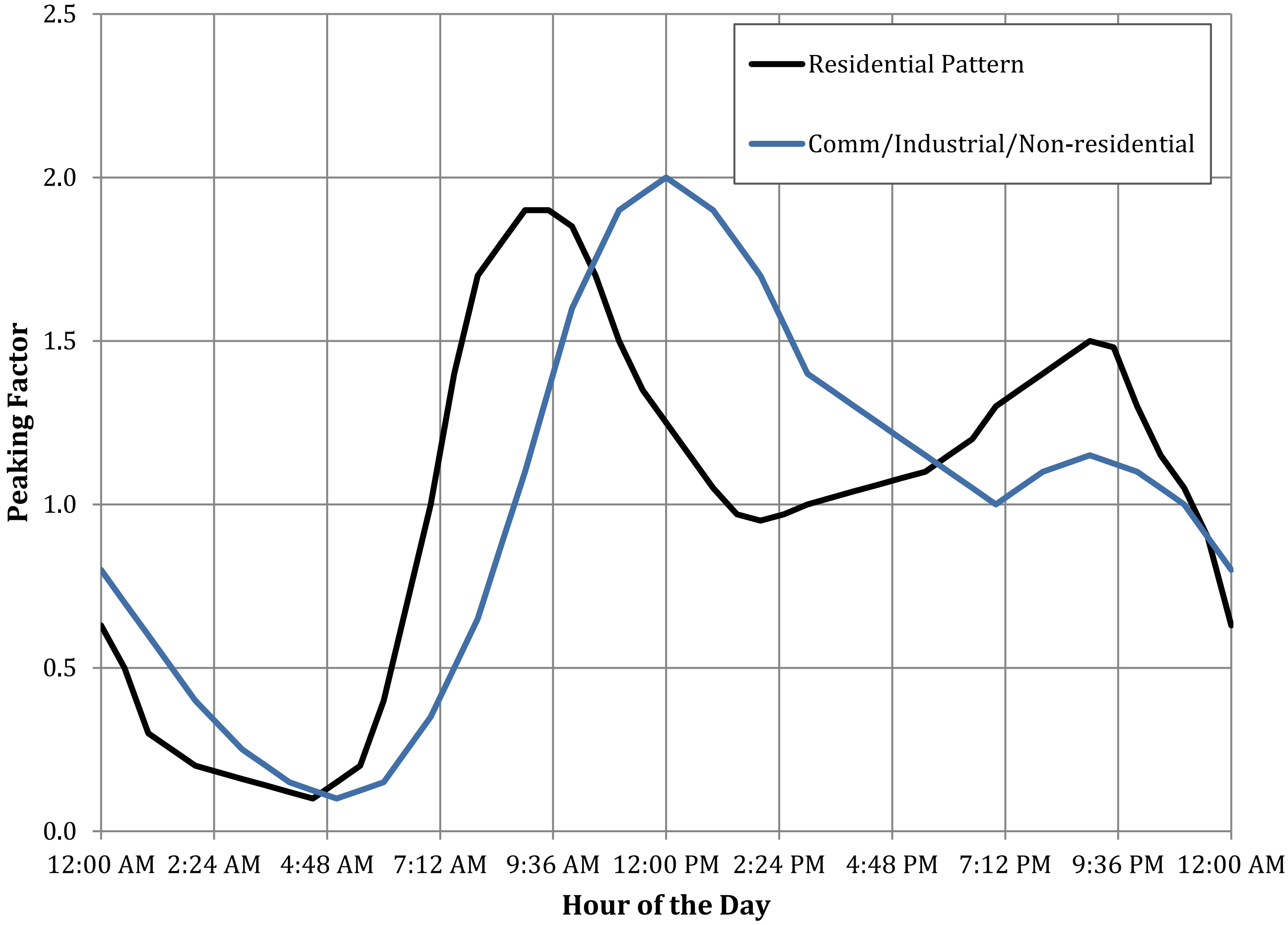
Scenario	Existing	2065
Dry Weather Flow/Infiltration	10.46	14.33

Timing of Flow

It will be noted that the volumes shown in Table 4-2 represent total flow over a 24-hour period. Since sanitary sewer flows vary throughout the day with varying indoor water demands, of much greater importance for the purposes of modeling sewer collection system capacity is the calculation of peak flows that occur during the day. To predict the magnitude and timing of peak flows in the model, it is important to understand how flow varies throughout the day. This is different for each component of sewer flow.

Domestic Sewer – The pattern of fluctuating domestic water use is often referred to as a diurnal pattern. These patterns vary depending on the type of user. For example, the typical diurnal pattern for residential sewer production is shown in Figure 4-2. This figure was developed by dividing measured flows from predominantly residential neighborhoods by each neighborhood's average daily flow, essentially normalizing flow measurements so they can be compared against each other. As can be seen in the figure, peak residential sewer production typically occurs around 9 a.m. as residents prepare for the work day, with a smaller peak occurring around 9 p.m. as residents clean up and prepare for bed. The average residential pattern shown in Figure 4-2 is the pattern used in the hydraulic model to predict flow for "residential" sewer flows. Figure 4-2 also includes a commercial/industrial diurnal pattern. While industrial flow patterns will largely be dependent on the type of industry, no flow monitoring data was available that could identify a strictly industrial flow pattern in the City. The commercial/industrial pattern shown in Figure 4-2 was developed using flow monitoring on Geneva Road near University Parkway. As can be seen in the figure, commercial/industrial flows generally peak around noon, the middle of a typical day shift.

Figure 4-2
Diurnal Patterns in Orem City



Infiltration – As discussed in Chapter 3, infiltration may vary on a seasonal basis but does not generally vary on a daily basis. Thus, it has been assumed that infiltration remains constant throughout the day in the sewer collection system model.

Inflow – For this study, inflow has not been modeled directly because of the wide variability in storm events and inflow response possible in the City. For design purposes, the City has included a capacity allowance in its design criteria to account for inflow into its sewer collection system (see Chapter 5).

Table 4-3 shows the peaking factors used for each hour that represent the patterns used in the hydraulic model.

Table 4-3
Hydraulic Model Diurnal Patterns

Hour	Residential	Commercial
12 AM	0.63	0.8
1 AM	0.3	0.6
2 AM	0.2	0.4
3 AM	0.16	0.25
4 AM	0.12	0.15
5 AM	0.15	0.1
6 AM	0.4	0.15
7 AM	1	0.35
8 AM	1.7	0.65
9 AM	1.9	1.1
10 AM	1.85	1.6
11 AM	1.5	1.9
12 PM	1.25	2
1 PM	1.07	1.9
2 PM	0.95	1.7
3 PM	1	1.4
4 PM	1.04	1.3
5 PM	1.08	1.2
6 PM	1.15	1.1
7 PM	1.3	1
8 PM	1.4	1.1
9 PM	1.5	1.15
10 PM	1.3	1.1
11 PM	1.05	1
12 AM	0.63	0.8

*Peaking factors represent patterns for larger diameter trunk lines. Peaking factors for lift stations and local utilities should use State of Utah minimum peaking factors or another standard.

Based on the diurnal patterns used above, peak flows simulated in the model as observed at the sewer treatment facility are summarized in Table 4-4.

Table 4-4
Hydraulic Modeling Scenario Peak Hour Flows* (mgd)

Scenario	Existing	2065
Dry Weather Flow	18.38	24.34**

*Peak hour OWRF inflow from extended period simulation which accounts for attenuation in the system.
**Peak Hour Flows are projected to surpass the existing hydraulic capacity of the OWRF (21.0 mgd) around 2045.

Distribution of Flow

With flow magnitude and timing estimated, the final step in developing flow data for the model is distributing it spatially across the City:

Domestic Sewer – Existing domestic sewer flows included in the hydraulic model were distributed based on 2013 winter water use data and development information from 2013 to 2020 for more recent development. More recent winter water use data was not used due to limited new flow monitoring or calibration data for comparisons. Winter water meter data collected across the City was assigned to the nearest manhole assuming that the sewer connections from the various water meters would flow to the same manhole. Metered demands which have some inherent inaccuracies with underreporting were factored up to match the estimated domestic production for the City as measured at the City's sewer treatment facility. Future growth of domestic sewer flow was distributed in the same manner based on growth as projected by TAZ or City planning (described in Chapter 3).

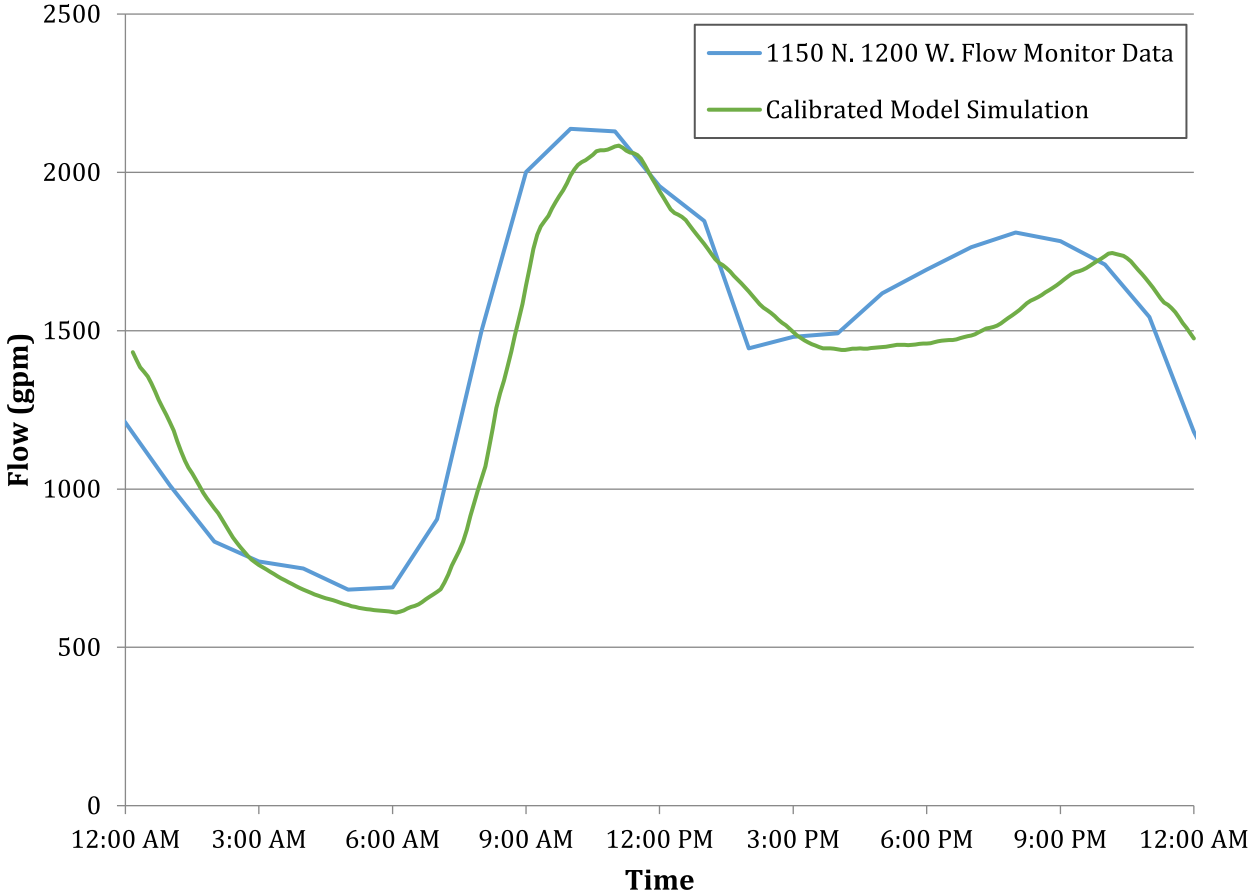
Infiltration – Existing infiltration was distributed using flow monitoring data collected by the City as part of the previous master plan. Because infiltration likely varied significantly over the wide range of dates when flow monitoring was collected, each flow monitoring site was compared to treatment facility data for the period of collection and a seasonally adjusted estimate of infiltration was developed for each flow monitoring site. The seasonally adjusted estimate was then distributed into the tributary area for the flow monitor sites.

CALIBRATION

The process of model calibration involves adjusting or modifying certain model parameters in order to better match the actual conditions of the sewer system. Calibration of the model was performed using available historical flow meter data from various locations throughout the City. Flow monitoring locations are shown in Figure 4-1. A comparison of model results against the historic flow monitoring results appears to indicate that, in general, the model is reproducing system conditions within a reasonable level of accuracy. However, model adjustments were made where possible in order to better match the historic monitoring results. Final results for one sample flow monitoring location are shown in Figure 4-3. As is the case with all model results of this type, model results produce a slightly smoother curve than the actual flow monitoring results.

It should be understood that the hydraulic model developed for this study relies on the available geometric and flow monitoring data provided by the City. As additional pipes are surveyed or new flow measurement data is collected, the hydraulic model should be updated and recalibrated to reflect the updated conditions. The City should continue to regularly update this hydraulic model based on new survey information to ensure it reflects current conditions.

Figure 4-3
Simulated Model Results vs Observed Flow at Sample Flow Monitor (ID16)



CHAPTER 5
SYSTEM EVALUATION

With the development and calibration of a hydraulic sewer model, it is possible to simulate sewer system operating conditions for both present and future conditions. The purpose of this chapter is to evaluate hydraulic performance of the sewer collection system and identify potential hydraulic deficiencies.

EVALUATION CRITERIA

In defining what constitutes a hydraulic deficiency, it is important to consider the assumptions made in estimating sewer flows in the model. As described in Chapters 3 and 4, the sewer flow included in the model is composed of two parts: domestic sewer flow and infiltration. This means that the model represents dry weather conditions only and does not include sewer flows associated with inflow. Additionally, estimates of domestic sewer flows and infiltration are based on available historic data. Because these estimates are based on average values and a limited data set, actual flows will fluctuate and may be greater than the model estimates. For example, infiltration during extremely wet years could be more than estimated in the model (e.g. 1983 was a statewide historically wet year that led to high infiltration and flooding in many areas, but 1983 is outside the historical flow records available at the facility). The criteria established for identifying deficiencies should be sufficiently conservative to account for inflow in the system and occasional domestic and infiltration flows higher than those estimated in the model. Thus, the following criteria have been established to identify capacity deficiencies in the system:

- **Pipe Capacity –** The most important deficiency to eliminate in the sewer system is inadequate capacity. For this master plan, it was decided to define a capacity deficiency as any point where the dry weather peak hour flow in the pipe is greater than 75 percent of the pipe's full flow capacity, which occurs when flow exceeds a depth of approximately 65 percent of the pipe's diameter. The remaining 25 percent of pipe hydraulic capacity was reserved for wet weather inflow and/or unaccounted for fluctuations in domestic flow and infiltration. In cases where short segments of relatively flat pipes exist, a maximum allowable depth of 65 percent of pipe diameter is used to define a pipe deficiency. A Manning's roughness value of 0.013 was used for all collection pipes to conservatively calculate capacity.
- **Lift Station Capacity –** A lift station capacity deficiency is defined as anytime dry weather peak hour flows exceed 85 percent of the lift station's primary pumping capacity. Providing extra capacity at lift station is for the same reasons as identified above for pipes but also accounts for loss of capacity over time associated with mechanical wear. It should be noted that this criterion is a little less conservative that the capacity criterion for pipe because all lift stations are required to have at least one backup pump in case of mechanical failure or significant inflow from wet weather events.

EXISTING SYSTEM ANALYSIS

Figure 5-1 displays the hydraulic capacity of the sewer system under existing peak hour flow conditions. Pipes in the figure are color coded to show the ratio of maximum depth in the pipe to the pipe's full depth. Based on peak flow and pipe capacities alone, there are a few isolated deficiencies scattered throughout the system. These deficiencies are generally due to pipes being laid on a flat slope, which decreases the full flow capacity.

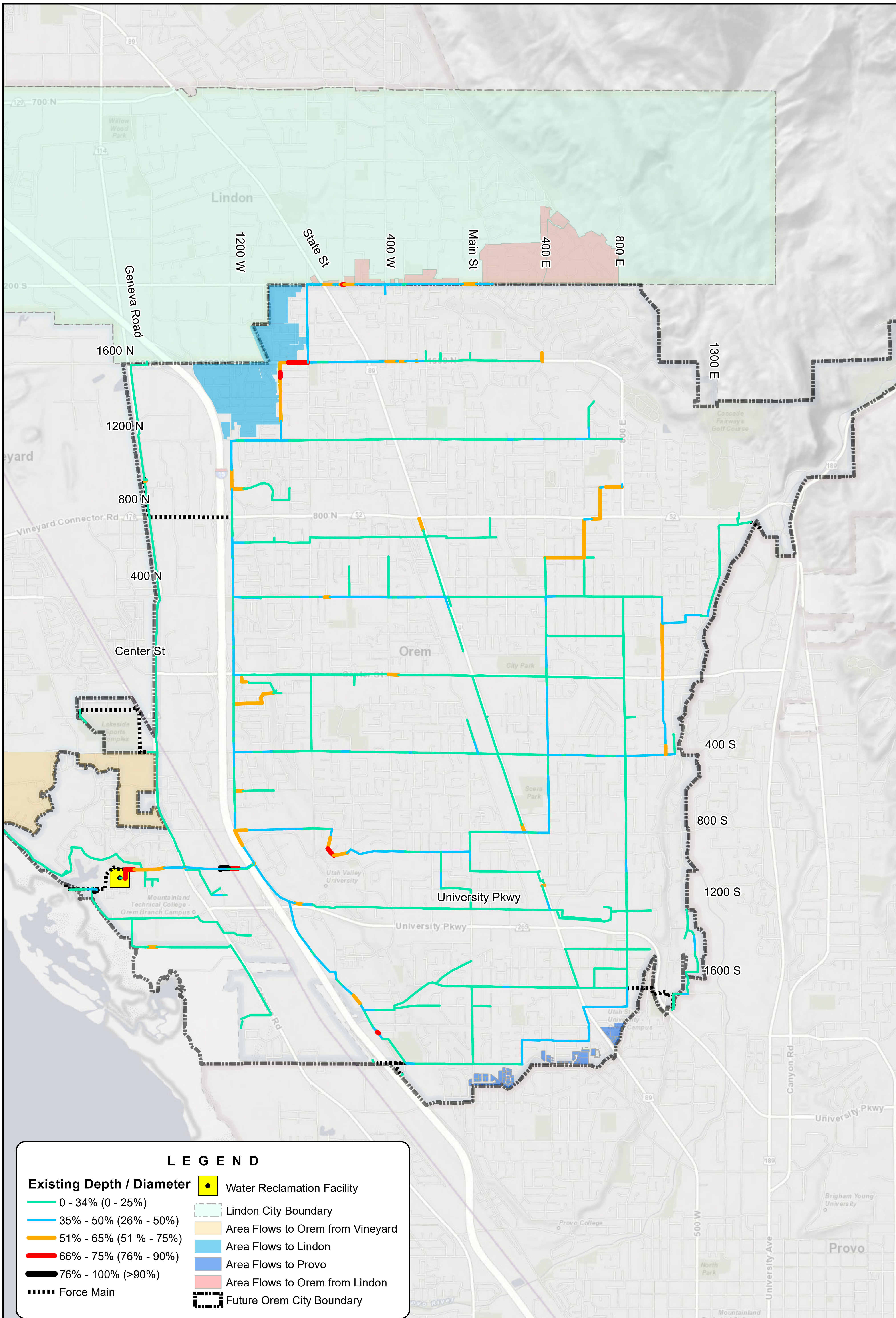
Short sections of flat pipe often do not represent a significant operational or maintenance issue for the system. The results shown in Figure 5-1 represent the maximum flow depth at any point along the length of the pipe. As long as the neighboring pipes have sufficient capacity, the extra depth caused by the flat slope will not result in surcharging problems for the system. Deficiencies observed in the existing system do not appear to pose a significant surcharge risk at this time, but will require monitoring as sewer flows continue to increase. No lift station deficiencies were observed in the existing sewer system under current conditions (2020).

Carterville Lift Station Infiltration

In general, Orem City (the City) has relatively low infiltration rates from groundwater intrusion into sewer collection pipes. The Carterville Lift Station service area appears to be the exception to these relatively low infiltration rates. As discussed in Chapter 3, metered flows through the Carterville Lift Station indicate that a significant portion of flow is attributable to infiltration. While no pipe capacity deficiencies were identified as a result of this excessive infiltration, this represents an area where the City could potentially reduce operation and maintenance costs if infiltration can be reduced through sewer line rehabilitation projects.

FUTURE SYSTEM ANALYSIS

Figures 5-2 and 5-3 show the hydraulic performance as calculated by the hydraulic model for sewer flows at projected conditions in 2030 and 2065 if no improvements are made to the existing system. These results assume that sewer flows associated with future development will flow to the nearest manhole in the existing system. While the majority of the system under 2030 and 2065 conditions has ample capacity, some significant deficiencies have been observed in the model results.



BOWEN COLLINS & ASSOCIATES

OREM CITY

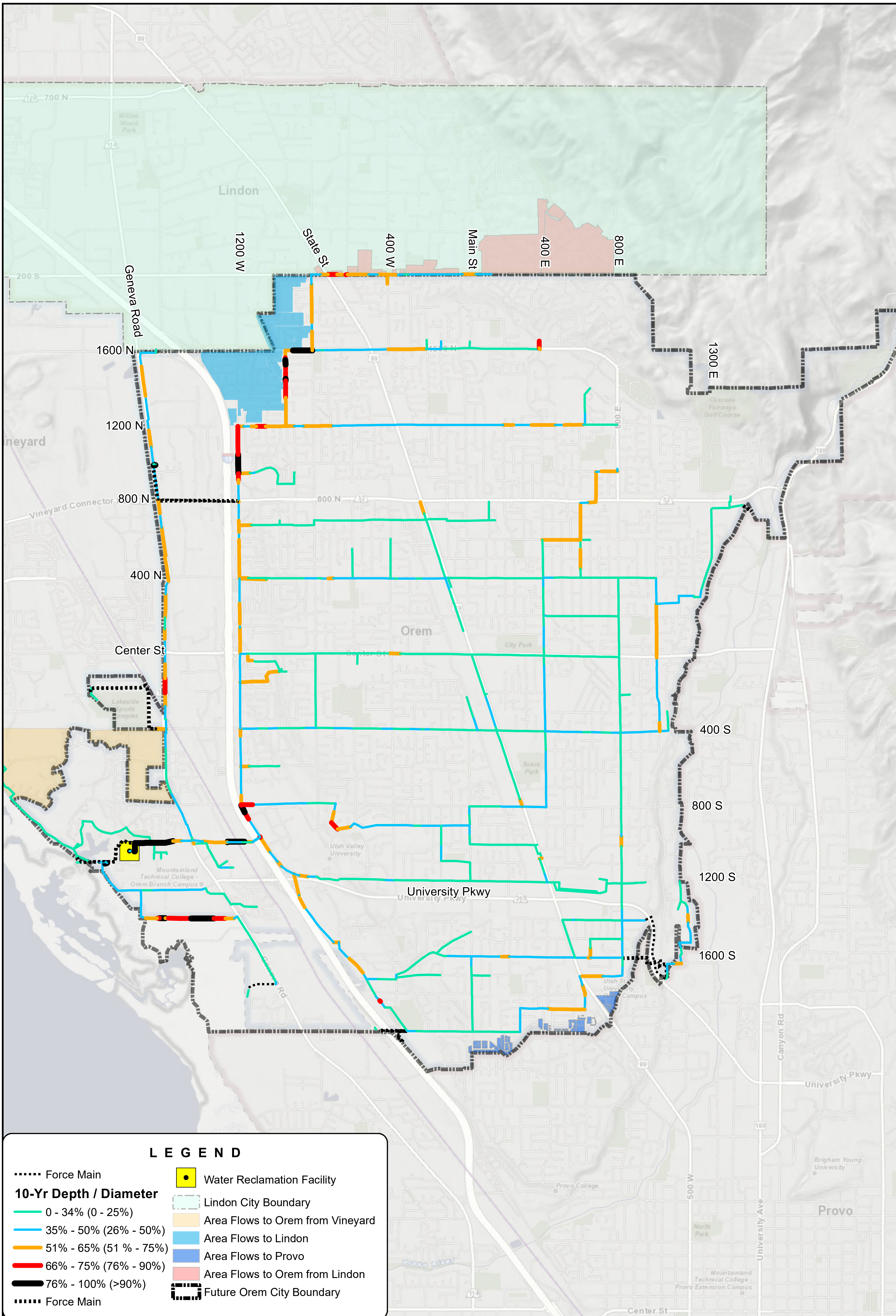
SEWER MASTER PLAN

PEAK FLOW TO CAPACITY FOR EXISTING CONDITIONS

FIGURE NO.

5-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 5-1 - Existing Capacity.mxd aharris 4/9/2021



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

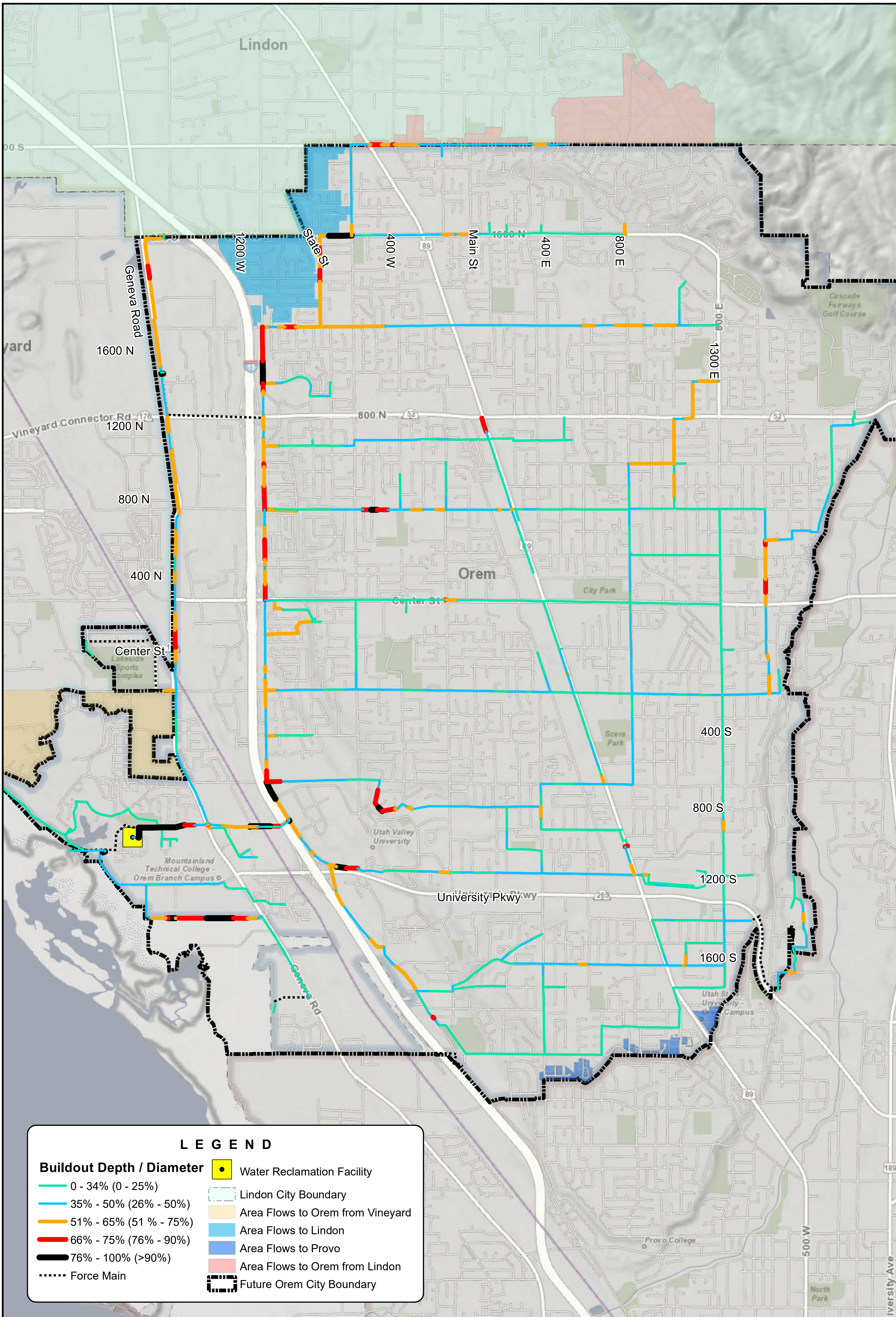
PEAK FLOW TO CAPACITY FOR 2030 CONDITIONS

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 5-2

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 5-2 - Future Capacity.mxd aharris 4/9/2021



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

PEAK FLOW TO CAPACITY FOR BUILDOUT CONDITIONS

FIGURE NO. 5-3

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 5-3 - Buildout Capacity.mxd aharris 4/14/2021

Pipe Deficiencies

As shown in Figures 5-2 and 5-3, model results for the sewer collection system at 2065 show a few isolated pipe capacity deficiencies which are mostly a result of pipes laid with shallow slopes. Sections of pipe marked in red or black deficiencies will likely require an improvement project as discussed below.

1200 West from 400 North to 800 North. Due to expected growth in Lindon and plans for the City to direct most of the flow at the Geneva Lift Station east to the 1200 West trunkline, is anticipated that a few pipe segments in this area will become deficient sometime beyond 2030 which is outside of this document's planning window.

2000 North near State Street. Model simulations have indicated a potential deficiency along 2000 North on the northernmost area of the City. It is estimated that this length of pipe will exceed its available capacity by the year 2030. This is primarily the result of proposed high density redevelopment along State Street.

1600 North 800 West. Model simulations have indicated that a growth related deficiency will occur in a few segments of pipe on 1600 North, downstream of the intersection of 1600 North and 800 West and one deficient segment along 1600 N. Based on the current projections and distribution of flows in the model, it is anticipated that this section of pipe will become deficient by approximately the year 2030. This is primarily the result of proposed high density redevelopment along State Street.

1200 West and 1200 North. Based on the current growth projections and distribution of flows in the City's sewer model, it is anticipated that this section of pipe will become deficient by approximately the year 2030. However, this is dependent on the timing of high density redevelopment along State Street as well as increased flows from the Geneva Lift Station.

1200 West from 450 North to Center Street. Due to expected growth upstream of this area, it is anticipated that multiple pipe segments will become deficient sometime beyond 2030 which is outside of this document's planning window.

College Drive/1200 West at 800 South. The section of pipe downstream of the manhole at 1200 West and 800 South is projected to become deficient sometime between 2026 and 2028.

925 South 725 West. Hydraulic model results indicate a potentially deficient section of pipe along 925 South and 725 West. It is estimated that this length of pipe will exceed its available capacity by the year 2030.

Southwest Annex Trunk. The existing sewer line which conveys sewer along approximately 1400 South west of Geneva Road to the Springwater Lift Station is expected to see a significant increase in flow as a result of projected development. Future model results indicate that there will be capacity deficiencies along significant portions of the trunk from Geneva Road to the Springwater Lift Station. Depending on growth in the area, it is estimated that the available capacity in this pipe will be exceeded sometime between 2025 and 2030.

College Drive & University Parkway. A deficiency has been projected at buildout in the pipe along College Drive near University Parkway and I-15. This deficiency appears to be the result of a transition from a steep slope to a flat slope as the 12-inch line runs into the large transmission line near 1-15 and University Parkway. This location will primarily be a concern for surcharging under wet weather conditions, but is not expected to cause deficiencies until sometime after 2030.

1000 South, Upstream of Water Reclamation Facility. The 42" pipe along 1000 South directly upstream of the treatment facility is shown as an existing deficiency that gets worse as future development contributes additional flow.

1000 East Center Street. Under Buildout conditions, two segments of pipe along 1000 East north of Center Street will become deficient due to increasing population projections. This deficiency is not expected until sometime after 2030.

Lift Station Deficiencies

Table 5-1 summarizes the projected 2065 flow to the lift stations in the City.

Table 5-1
Summary of Sewer Lift Stations

Name	Capacity (gpm)	Existing Dry Weather Peak Flow (gpm)[1]	2065 Dry Weather Peak Flow (gpm)[2]
Carterville Lift Station	500	343	370
Geneva Lift Station	1,990	1,102	***2,090***
Springwater Lift Station	850	289	467
Future Southwest Lift Station	575[3] (1,150)	282	1,053
Eastlake Lift Station	300	39	81
Canyon River Lift Station	300	2	55
Sandhill Lift Station	300	17	19
Lakeview Fields Lift Station	356	2	60

[1]A small area peaking factor was applied to domestic flow. Infiltration was then added to calculate the total dry weather peak flow.
[2] Italicized bold text indicates a deficiency.
[3]The Future Southwest Lift Station will come online in 2021 with 2 pumps with a capacity of 575 gpm, but 2 additional pumps will be added in the future to double the capacity of the lift station.

Geneva Road Lift Station. Primarily due to growth from Lindon City, 2065 model results indicate future deficiencies in the Geneva Lift Station. The lift station at Geneva Road and 800 North is currently equipped with 4 pumps. The pumps include a primary and backup 10 horsepower pump with a capacity of 800 gpm (833 gpm at 22 feet) that discharges into Geneva Road. When peak flows exceed the capacity of these pumps, excess flow can be pumped through a primary and backup 75 horsepower pump with a capacity of 1,190 gpm that discharge to 1200 West. The current combined capacity of Geneva Lift Station is 1,990 gpm. At buildout, peak hour flows are predicted to reach approximately 2,090 gpm, exceeding the current pumping capacity of the lift station. However, these peak hour flows are not expected to occur until sometime after 2040.

Orem City Water Reclamation Facility

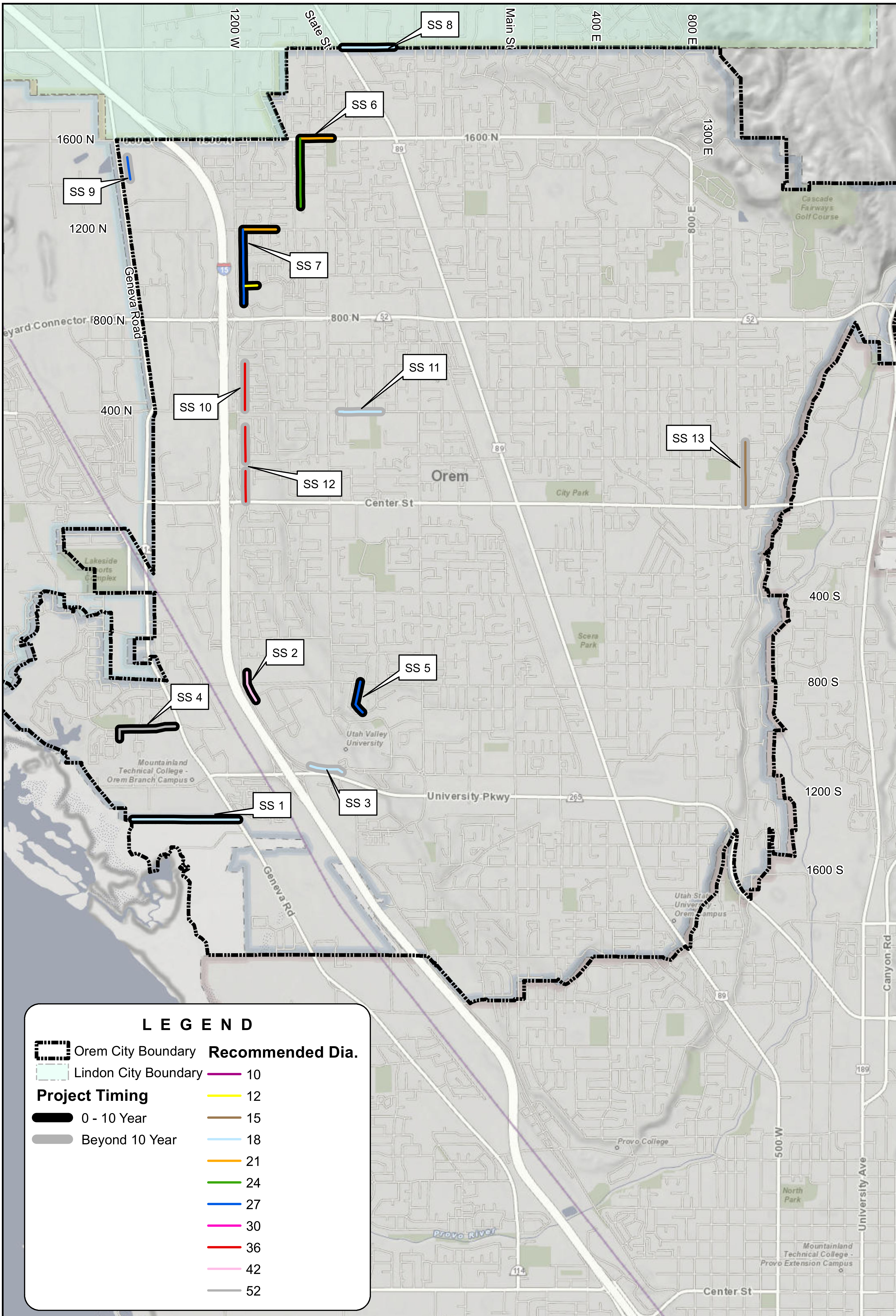
Growth projections in the City sewer service area are predicted to produce flows into the OWRF which could exceed both the average monthly capacity and peak flow capacity of the facility (see Chapter 3, Figure 3-5). Existing capacity appears to be adequate through at least 2050 on a peak month, average day basis, but wet weather events may begin to exceed peak hydraulic capacity without additional improvements. The City is in the process of preparing an evaluation of facility condition to better identify the timing of any potential improvements at the OWRF.

CHAPTER 6
SYSTEM IMPROVEMENTS

The hydraulic model results have identified potential deficiencies in the sewer system under existing and future conditions. This chapter covers system improvements intended to solve deficiencies as Orem City (the City) continues to grow. Once the detailed design of sewer facilities commences, the design capacity of these pipes or lift stations should be based on projected build-out flows. Improvements are organized in this chapter by type and location of improvement. The priority of each project has been based on the predicted timing of when the improvement will be needed.

SEWER COLLECTION SYSTEM CAPACITY IMPROVEMENTS

A number of sewer collection system improvements have been identified to resolve hydraulic deficiencies related to existing or projected sewer flows as shown in Figure 6-1. All projects shown below should be reanalyzed before the design process begins, as these recommendations are fairly conservative and are based on assumptions of high density redevelopment in various areas including many that may not be needed for many years. Temporary flow monitoring at proposed deficiencies is also recommended prior to beginning the design process. All of the projects, regardless of timing, are discussed below and have been shown in the Figure 6-1.



BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

RECOMMENDED IMPROVEMENT PROJECTS

NORTH: NORTH

SCALE: 0 1,250 2,500 Feet

FIGURE NO. 6-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 6-1 - System Improvements 4.13.21.mxd aharris 5/6/2021

Projects Between 2020 and 2030

SS 1. 1400 South, Geneva to Springwater Lift Station(s). The capacity of the existing 10-inch line which runs along 1400 South will be exceeded as a result of increased flow from new development. In order to convey the total flow for this service area, additional capacity must be provided. Replacing the existing line with a new 18-inch sewer main will provide the necessary capacity through build-out. It should be noted that the sizing of this pipe is being driven largely by a few sections of comparatively flat pipe. It may be possible to reduce the diameter to 15-inch if the pipe slope in these areas can be increased during design.

SS 2. College Drive/1200 West and 800 South. As shown in Figures 5-1 and 5-2, the 550 foot section of pipe on College Drive both upstream and downstream of the intersection of 1200 West and 800 South is shown as deficient under both existing and future flows. It is recommended that 1,260 feet of 30-inch and 33-inch line be replaced with a 42-inch line. If possible, increasing the slope of the line would be beneficial to reduce the required pipe diameter.

SS 3. College Drive near 1200 South. As a result of future growth in the City, a deficiency is projected under buildout conditions in the 12-inch sewer conduit on College Dr. and 1200 South on the east side of I-15. The recommended improvement for this section of pipe is to replace 820 feet of 12-inch pipe with new 15- or 18-inch pipe. Surcharge concerns at this location will primarily be a concern under wet weather conditions. Because there are no nearby connections, some surcharging at this location may not pose any significant concern. These pipes should be monitored after the first phase of redevelopment at the University Place to verify that this project is needed.

SS 4. 1000 South/Orem Water Reclamation Facility. By 2065, sewer flow through the pipe on 1000 South leading to the treatment facility will exceed 75 percent of the pipe's hydraulic capacity. The deficient section of pipe starts in the 36-inch pipe directly upstream of the OWRF. One option to eliminate this deficiency is to replace approximately 275 feet of the existing 36-inch pipe with 42-inch pipe, and replace the remaining length of 36-inch/42-inch pipe with a 48-inch/54-inch pipe. Depending on the age and condition of the existing pipe, this option may or may not be cost effective. Another option is to construct a parallel sewer main which would take any flow which exceeds the capacity of the main sewer trunk line.

SS 5. 925 South 725 West. A 1,200-foot section of the existing 21-inch pipe along 925 South starting at 725 West is projected to have a capacity deficiency under peak hour build-out flows. Replacing this pipe with a new 27-inch pipe will provide adequate capacity for sewer flows through buildout.

SS 6. 1600 North 950 West. Beginning at the intersection of 1600 North and 800 West, the existing sewer system consists of a 15-inch pipe on 800 West (east of the intersection) and an 18-inch pipe on 1600 North (south of the intersection. Model results show capacity deficiencies in both the section of pipe upstream and downstream of the intersection. Replacing 950 feet of 15-inch pipe with new 21-inch pipe and 1,800 feet of 18-inch pipe with new 24-inch pipe downstream would provide the necessary capacity to satisfy the City's evaluation criteria.

SS 7. 1200 North 1200 West. At the intersection of 1200 North and 1200 West, the existing sewer system consists of a 18-inch pipe upstream and 21-inch pipe downstream. Model results show capacity deficiencies in both of these sections along with a deficiency in a small portion of the 10-inch pipe on 950 North. Replacing the existing pipe with 21-inch pipe upstream of the intersection, 27-inch pipe downstream of the intersection, and 12-inch pipe along 950 North would provide the necessary capacity to eliminate deficiencies.

Projects Beyond 2030

SS 8. 2000 North State Street. The model shows a deficiency along 2000 North, just west of the State Street intersection. It is recommended that the existing 12- and 15-inch pipes be replaced with 18-inch pipe to accommodate the growing population in both Lindon and northern Orem. This deficiency is projected to occur between 2028 and 2030.

SS 9. Geneva Road near 1600 North. Just south of 1600 North on Geneva Road, the model shows that a small deficiency will occur sometime after 2030. This is likely due to the increasing population in Lindon, thus increasing the flow through the City's sewer system. It is recommended that the existing 24-inch pipe be upsized to at least a 27-inch pipe; however, this project may be the responsibility of Lindon City because it completely depends on Lindon City's future growth densities.

SS 10. 1200 West between 400 North and 800 North. Because the City has decided to restrict the amount of flow sent down the Geneva Road Trunkline, additional flows will be sent down the 1200 West trunkline as population increases. The additional flow will cause deficiencies along 1400 feet of the existing pipeline, but is not expected to occur until sometime after 2030. At that time, it is recommended that the existing 24-inch pipe be upsized to 36-inch. This again to accommodate the growing populations in both Lindon and the City.

SS 11. 400 North 800 West. At the intersection of 400 North and 800 West, the existing system consists of a 12-inch pipe upstream (to the east) which shows as deficient under buildout conditions. This project is not needed until sometime after 2030. Once this pipe reaches capacity, it is recommended that the current pipe diameter be upsized to a 18-inch diameter pipe to accommodate future growth near State Street.

SS 12. 1200 West between 800 North and Center Street. Along 1200 West there are multiple deficiencies that occur between 800 North and Center Street under buildout conditions due to population increase. It is recommended that the existing 30-inch pipe be replaced with a 36-inch pipe.

SS 13. 1000 East near Center Street. Under Buildout conditions, two segments of pipe along 1000 East near Center Street will become deficient due to increasing population projections. However, this deficiency is not expected until after 2030. It is recommended that the existing 8-inch pipe be replaced with 10-inch.

Table 6-1 shows a summary of all improvements listed above along with a cost estimate for each.

Table 6-1
Cost Estimates of Sewer Collection System Improvements

Project #	Project Description	Estimated Cost (2020 Dollars)
SS 1	1400 South, Geneva to Springwater Lift Station(s)	$1,218,930
SS 2	College Drive/1200 West and 800 South	$832,224
SS 3	College Drive near 1200 South	$321,390
SS 4	1000 South/Orem Water Reclamation Facility	$2,365,650
SS 5	925 South 725 West	$541,486
SS 6	1600 North 950 West	$1,255,659
SS 7	1200 North 1200 West	$1,693,797
SS 8	2000 North State Street	$587,908
SS 9	Geneva Road near 1600 North	$341,714
SS 10	1200 West between 400 North and 800 North	$1,056,357
SS 11	400 North 800 West	$470,327
SS 12	1200 West between 800 North and Center Street	$1,433,628
SS 13	1000 East near Center Street	$556,577
Total		**$12,675,646**

OTHER SEWER COLLECTION SYSTEM IMPROVEMENTS

In addition to the capacity related projects identified in the master plan model, the City will need to complete a number of condition related sewer collection system improvements over the next several years. Preparation of a detailed asset management plan to address rehabilitation and replacement needs is not part of this project. However, overall budgetary needs and recommendations for rehabilitation and replacement are discussed in Chapter 7.

WATER RECLAMATION FACILITY IMPROVEMENTS

A comprehensive evaluation of the City's reclamation facility was not included in the scope of this master plan. However, the City has identified a series of Water Reclamation Facility improvement projects that they would like to include in the capital facilities plan. Table 6-2 provides a summary of these projects. As noted previously, the City is currently beginning a new project to perform a comprehensive evaluation of reclamation facility needs. This table should be revisited and updated once that evaluation is complete.

Table 6-2
Orem City Water Reclamation Facility CIP Projects

Project Description	Estimated Cost	*Estimated Future Cost	Expected Timeline (Years)
Dewatering expansion	$640,000	$710,000	2022
Struvite elimination	$2,000,000	$2,210,000	2022
Replace back-up generator	$640,000	$710,000	2022
Replace existing solids presses	$2,000,000	$2,320,000	2023
Expand aeration basin in headworks	$510,000	$680,000	2026
Sludge disposal options – solar, central county treatment disposal site	$6,700,000	$8,980,000	2026
Concrete/membrane existing lagoons	$640,000	$1,040,000	2030
Co-generation technology	$1,340,000	$2,180,000	>2030
Total	**$13,810,000**	**$18,830,000**	

*An inflation rate of 5 percent per year was used to calculate the Estimated Future Cost of each project.

CHAPTER 7
CAPITAL IMPROVEMENT PLAN

Previous chapters of this report have identified improvements to resolve existing deficiencies and to accommodate sewer flow from future growth. Providing an acceptable level of service requires consistent and continual system monitoring and evaluation, with updates being made when necessary. The purpose of this chapter is to assemble a 10-year capital improvement program to implement the recommended improvements. This will include recommendations regarding levels of funding for system rehabilitation, replacement, and capital improvement projects.

SYSTEM REHABILITATION AND REPLACEMENT

In order to assemble a 10-year capital improvement plan, it is not adequate to consider only capacity related improvements. It is also necessary to budget for the expected rehabilitation and replacement of system components. This section examines known areas of needed rehabilitation and replacement for inclusion in the capital improvement plan. This is not a comprehensive evaluation of existing maintenance procedures or system conditions, nor is it a complete asset management plan. Instead, it is a collection of general observations assembled during the master planning process relative to system rehabilitation and replacement.

Frequent Maintenance Areas

In an effort to improve the condition of the existing sewer system, the City has previously compiled, and is currently updating, a list of potential projects that could be completed to eliminate problems that require frequent maintenance by City staff. Areas requiring frequent maintenance and a list of these maintenance projects can be found in Appendix B along with a breakdown of project priorities. Projects contained in the list include:

- Replacing deteriorated pipe
- Lining existing pipe (cast in place pipe)
- Pipe/manhole flushing
- Point repairs (such as at a joint)

A summary of the costs associated with these maintenance projects and the corresponding pay-back period is shown in Table 7-1 below.

Table 7-1
Estimated Cost of Maintenance Projects & Corresponding

Return on Investment Time Frame	Estimated Cost of Maintenance Projects (2020 dollars)
10 to 20 years	$1,040,000
20 to 40 years	$1,980,000
Greater than 40 years	$2,330,000
Total	**$5,360,000**

The return on investment time frame listed in Table 7-1 was developed by estimating the time and/or materials needed to perform maintenance for each facility requiring frequent maintenance. The annual cost associated with maintenance time and/or materials was then compared with the capital cost of eliminating the problem causing the need for frequent maintenance. The return on investment time frame reflects the number of years required before the capital cost of the improvement is paid back through reduced maintenance costs.

It is recommended that the City begin to complete the identified projects to eliminate frequent maintenance areas, starting with those that have the shortest return on investment. Even for those projects that have a longer return on investment, it is recommended that the City consider opportunities to complete some of these projects as opportunities arise. It is important to keep in mind that, as the system ages, these maintenance areas will continue to get worse and new areas will appear. Keeping up with maintenance projects and pipe replacement will help prevent the system from falling into disrepair and will reduce the amount that the City needs to spend in the long run.

Concrete Pipe Assessment and Rehabilitation

One major category of concern relative to sewer system rehabilitation and replacement is the corrosion of existing concrete pipe. H_2S gas in a sewer system can result in the formation of sulfuric acid (H_2SO_4) on pipe and manhole walls. Sulfuric acid can result in severe corrosion of ferrous metals and concrete. The top of a moist concrete pipe is a common area for the formation of sulfuric acid and corresponding corrosion. This is a significant concern for the City because a large portion of the City's sewer collection system is constructed of concrete pipe.

The City diligently inspects pipes on a regular basis to identify rehabilitation needs. A figure identifying collection pipes in the City with observed deficiencies such as sulfuric acid related corrosion, breaks or cracks in the line, offset joints, bellies, roots, and infiltration is included in Appendix B. Some of these observed deficiencies can be eliminated with maintenance, but others require repair and replacement. It is recommended that the City continue to diligently perform preemptive pipe inspections to identify areas where corrosion may be occurring.

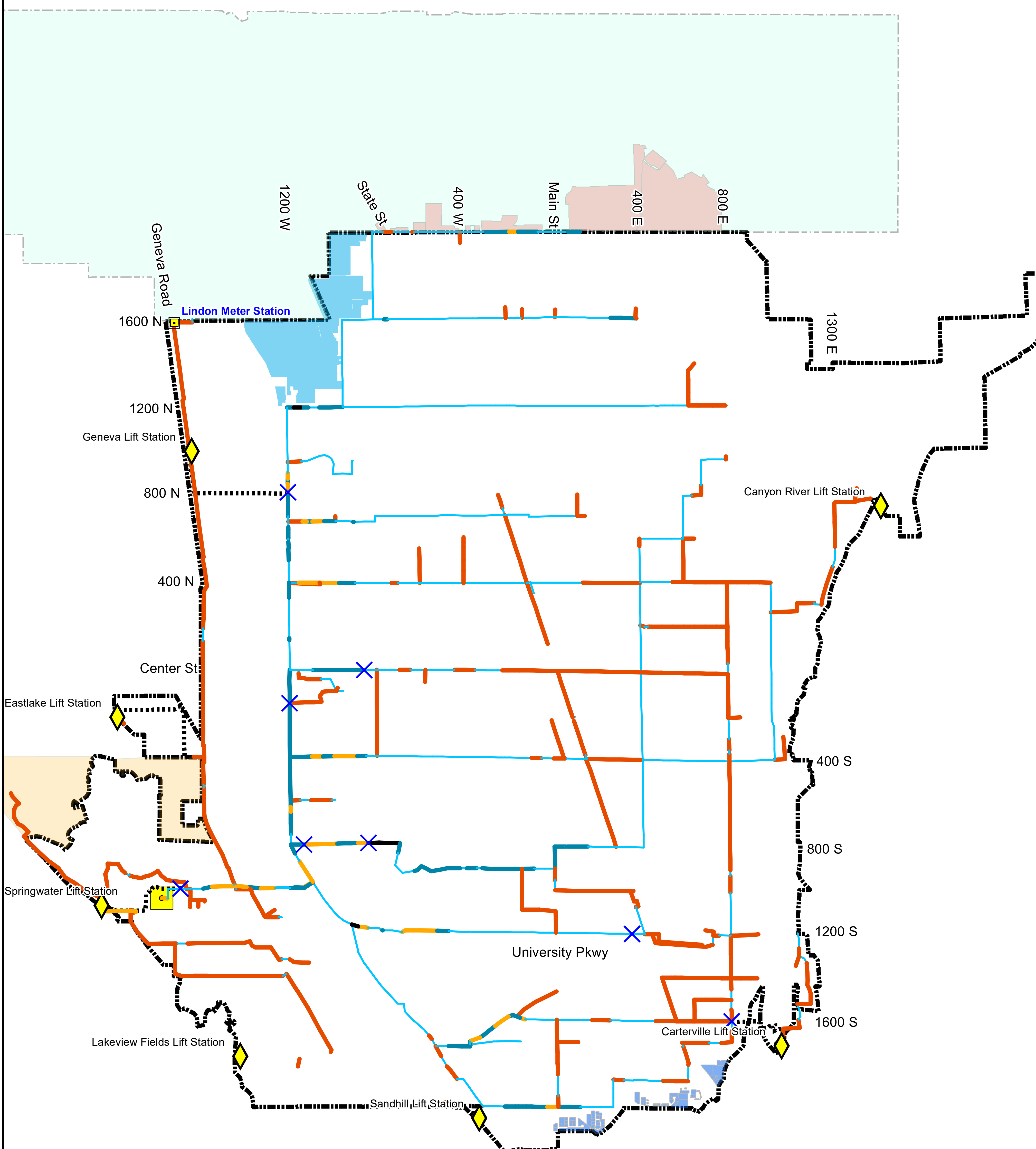
Figure 7-1 identifies some areas of the system where H_2S corrosion may be more likely. This is the result of two factors:

- ***Hydraulic Conditions –*** H_2S formation is affected by hydraulic conditions in two ways. First, where velocities are low, there is more potential for the accumulation of a slime layer with the bacteria that create H_2S. As a general guideline, pipes with velocities less than 2 ft/sec have a higher probability of developing the anaerobic conditions that generate H_2S. Second, where pipes have high velocities, there is a higher probability of aerating the sewer and releasing the H_2S gas that leads to damage of concrete pipe. Figure 7-3 indicates maximum flow velocities in sewer pipes for existing conditions. Of primary concern are those areas where long sections of low velocity flow are followed by a section with high velocity flow (the H_2S forms in the slow sections and is then released in the fast sections). Figure 7-3 identifies a few areas in the City where H_2S could potentially be aerated because of significant changes in velocity. However, there are many other factors that can contribute to pipe deterioration including changes of use (e.g. construction of restaurants) and increases or decreases in flow from changing demographics.
- ***Force Main Discharge –*** Other areas of concern for H_2S accumulation are at force main discharge locations. Because force mains flow full, very little corrosion will occur through

the force main pipe. However, because they are full, there is a larger H_2S producing slime layer. As the pipes discharge into gravity mains and the flow is aerated, H_2S gas can be released.

Where corrosion is observed, it is recommended that aggressive rehabilitation efforts be initiated to protect the pipe from further damage. If the corrosion has not yet damaged the structural integrity of the pipe, a cast-in-place pipe (CIPP) rehabilitation can often be done relatively inexpensively to protect the existing concrete and preserve the full design life of the pipe. If the corrosion has progressed to the point that the structural steel in the pipe is compromised, a more expensive structural rehabilitation or complete replacement of the pipe will be required.

Because H_2S presents a major risk to the City's sewer infrastructure, it is recommended that condition assessment of the City's existing infrastructure and prioritization of H_2S related rehabilitation be an immediate priority. With the initial dollars that become available for this purpose, it is recommended that the City use its own forces and/or contract with outside inspection companies to perform a complete inspection and inventory of the City's existing pipes. Using the information obtained through this inspection, the City can then develop an asset management plan to prioritize future rehabilitation activities.



LEGEND

- Potential Hydrogen Sulfide Aeration
- Lindon Meter Station

Max Velocity (ft/sec)

- 0.0 - 2.0
- 2.1 - 5.0
- 5.1 - 7.0
- 7.1 - 10.0
- >10.0
- Lift Station
- Force Main
- Water Reclamation Facility
- Area Flows to Orem from Vineyard
- Area Flows to Lindon
- Area Flows to Provo
- Area Flows to Orem from Lindon
- Future Orem City Boundary
- Lindon City Boundary

NOTE: Hydrogen sulfide is usually generated at lift stations with infrequent cycles and sewer pipes with low velocities (velocities less than 2 ft/sec). Hydrogen sulfide damage to pipelines can be exacerbated when wastewater is aerated at the discharge location of force mains or at changes in slope where velocities increase significantly. The "potential hydrogen sulfide aeration" areas identified in the figure represent areas where this may have a higher probability, but will not represent all areas with potential hydrogen sulfide concerns. Air samples and pipe inspections are the best way to identify hydrogen sulfide problem areas.

BOWEN COLLINS & ASSOCIATES

OREM CITY
SEWER MASTER PLAN

PIPES WITH LOW VELOCITIES AND HYDROGEN SULFIDE AERATION CONCERN AREAS

NORTH:

SCALE: 0 1,500 3,000 Feet

FIGURE NO. 7-1

P:\Orem City\2020 Master Plan Assistance\4.0 GIS\Sewer\Sewer-Figure 7-3 - H2S Potential Areas.mxd aharris 4/20/2021

System Rehabilitation and Replacement Priorities

Because funding is always limited, it is important to prioritize initial system rehabilitation efforts based on the potential consequence of a pipe not performing as designed. The following criteria may be helpful to the City personnel in identifying pipes that are most critical based on their relative importance in the sewer collection system:

- **Sewer Flow Rate –** Flow rate in a sewer pipe is the single most important indicator of the importance of a pipe. Generally speaking, the higher the flow rate, the larger the area which a pipe serves. Bypass pumping costs, the risk if property damage, environmental and regulatory consequences, the cost of pipe replacement, and problems from sewage up in the system are all more severe for larger flow rates. In a worst case scenario, if a pipe collapses or becomes blocked and surcharging in the pipe results in flows backing up into basements and streets, there is a much greater health hazard to the public with a high flow pipe.
- **Road Type** – It is much more difficult and costly to perform sewer line repairs on streets with dense traffic. Therefore, pipes located in high traffic areas should be considered more critical than lower traffic areas. For example, the cost of pipe failure along 800 North or State Street would be much greater than an equivalent sized pipe located on a residential street.
- **Pipe Depth –** The depth of the pipe can have a significant impact on the cost of repairs and rehabilitation of sewer pipe. Extensions on backhoes, very wide trenches, dewatering, etc. make repairs and maintenance much more expensive and time consuming on deeper pipes. Repairing such pipes under an emergency situation would only be that more difficult. For this reason, deep pipes should be prioritized over shallow pipes when planning a repair or maintenance schedule.

CAPITAL IMPROVEMENTS BUDGET

Before establishing a 10-year capital improvement plan, it is necessary to determine how much funding will be set aside each year for capital improvements. One of the best ways to identify a recommended level of funding is to consider system service life. As with all utilities, each component of a sewer system has a finite service life. Therefore, it is necessary to continually spend money towards the rehabilitation or replacement of these components. If adequate funds are not set aside for regular system renewal, the sewer collection system will fall into a state of disrepair and be incapable of providing the level of service that the City customers expect.

The City's sewer collection system is composed of about 1.6 million feet of pipe and over 7,000 manholes. The total cost to replace all of the pipes and lift stations in the City sewer collection system would be approximately $485 million based on 2020 construction costs. In reality, it will not be necessary to completely replace the entire system as it ages because of rehabilitation technologies (e.g. slip lining, cast-in-place pipe, etc.). Rehabilitation costs are much lower than replacement costs (20% to 60% depending on pipe diameter). If the City were able to rehabilitate the entire system rather than replace components, it would drastically reduce the "replacement value" to $115 million. Unfortunately, it is generally not possible to rehabilitate all system components due to either condition or capacity issues. Some pipes are beyond saving with rehabilitation, while others may require upsizing or correction of grade issues; all of these scenarios would require a replacement.

To account for the limitations on rehabilitation, BC&A recommends a renewal budget derived from a combination of rehabilitation and replacement using an approximate design life of 80 years. Table

7-2 shows a comparison of the required annual budget based on replacement, rehabilitation, and the recommended combination of both values.

Table 7-2
Recommended Sewer Collection System Renewal Budget

System Renewal	Annual Budget (2020 Dollars)*
Replacement of all system components	$6,060,000
Rehabilitation of all system components	$1,440,000
50% replacement **50% rehabilitation**	**$3,750,000**

*1.25% of complete system "replacement" which assumes an average 80 year life cycle for all system components (pipes, pump stations, etc.)

In addition to the sewer collection system, a yearly budget should also be designated for the renewal of the Water Reclamation Facility. The total cost to replace the OWRF would be approximately $175 million. Since the OWRF is comprised of various components such as civil and structural (design life of 80-100 years), as well as mechanical and electrical (design life of 15-25 years), an overall design life of 50 years was used as a weighted average based on industry practice. Table 7-3 shows the total recommended capital improvement budget for the sewer collection and treatment system.

Table 7-3
Recommended Total Sewer System Annual Capital Improvement Budget

Component	Value
Sewer collection system	$3,750,000
Water Reclamation Facility	$3,510,000
Total	$7,260,000

The recommended long term budget is to fund the system at approximately $7.2 million in 2020 dollars. This is a significant increase from funding in 2016, which was approximately $2 million. The City has increased the funding to $5.8 million since that time, and should continue increasing it until the funding has reached $7.2 million (adjusted for inflation).

10-YEAR CAPITAL IMPROVEMENT PLANS

Based on the City's identified project needs and recommended level of capital investment, BC&A has developed a potential capital improvement plan covering the next 10 years. This 10-year plan is shown in Figure 7-2 and detailed in Table 7-4.

As shown in the figure, the proposed improvement plan includes a number of years in which the proposed capital expenditures are in excess of annual revenues. During these years, it is expected that the additional capital expenditures will be met through a combination of bond proceeds and cash reserves of the City. While the final plan for bonding will be developed as part of the rate study, there are projects worth approximately $9.8 million 2022 and $2.8 million in 2027 that may be considered as multigenerational projects that would be appropriate for bond funding.

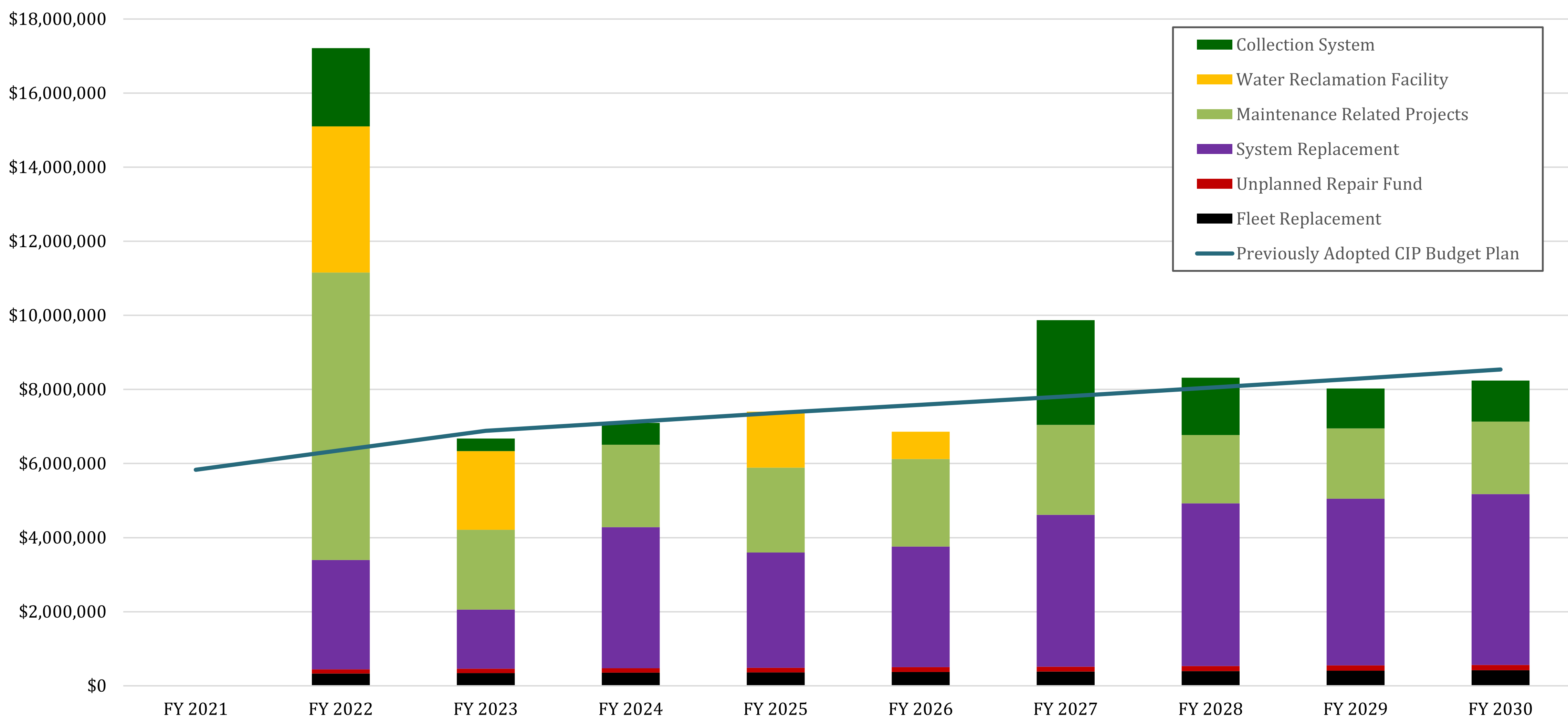
To facilitate understanding of the proposed plan, system improvement projects have been grouped into the following major budget categories:

- **Sewer collection system Capacity Improvements –** Sewer collection system capacity improvements include projects needed to remedy existing deficiencies in the sewer collection system or to increase capacity to accommodate future growth. Projects included within the next 10-years are those projects with existing deficiencies or deficiencies projected to occur within the next 10-years without improvements. Because these improvements are driven by projected growth, there is not much flexibility in when they can be completed. Shifting these project by a year or two is probably the most movement that can be accommodated.
- **Water Reclamation Facility –** The overall capacity at the OWRF appears to be adequate for many years. However, there are a number of components at the OWRF that will need to be upgraded or replaced within the next 10-years to continue to provide adequate service for the City. Projects to be included within the next 10-years were identified by City personnel. While there is some flexibility in the timing of these projects, unduly postponing their completion will lead to difficulty meeting treatment standards at the OWRF.
- **Maintenance/ H_2S Related Projects –** Maintenance and H_2S related projects include those projects identified above that are associated with frequent maintenance, observed condition issues, or H_2S corrosion. There is significant flexibility in when these projects are completed. In the case of the frequent maintenance issues, the City could postpone all these projects indefinitely and just keep performing the maintenance. However, once projects are completed, the City can start realizing the savings associated with reduced maintenance costs. In the case of observed condition issues, the City might also postpone the improvements, but this will result in significant future expenditures. As discussed previously, maintenance issues will continue to surface as the system infrastructure ages, and the City will benefit by continuing to stay up to date on maintenance.
- **Vehicle (Fleet) Replacement –** City personnel have developed a schedule for vehicle replacement based on approximate use, depreciation, and reliability for maintenance vehicles in the City. These costs are expected to remain relatively constant (adjusted for inflation) as the City replaces vehicles at regular intervals.
- **Unplanned System Repairs –** Because the City cannot predict precisely when and where pipe failure may occur in the system, a budget item needs to be included in the recommended capital fund plan that is dedicated to unplanned repairs. Though the amount shown is relatively small, this money will then be available to address repairs to be performed when a deficiency is observed in the system. These likely would include point repairs that appear to be of an urgent nature in the system.
- **System Replacement/Renewal –** After accomplishing all of the specific improvements identified above, any remaining capital improvement budget would be dedicated to system replacement. System replacement costs will include identifying those areas of the City's sewer collection system that appear to be aging and in need of repair or replacement. This budget item will include pipes identified via the City's inspection program that need lining or replacement as well as needed OWRF improvements.
- **SW Annex Improvements –** It will be noted that no costs have been shown in the plan for improvements associated with the Southwest Annex. These projects have been left out of the City's 10-year capital improvement budget because they will be funded and constructed by developers. Impact fees are being collected in these areas for improvements, but these impact fees will be remitted to the annex developers that are constructing the improvements.

Table 7-4
Orem City Sewer System Improvement Plan – 2020 Update

Project Identifier	Project Description	Estimated Total Cost (2020 Dollars)	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030
SS 1	Replace 3,108 feet of existing 10-inch line with 18-inch line in North SW Annex (Chambery to Springwater)	$1,218,930	$1,255,497								
SS 2	Replace 900 feet of existing 27-inch/30-inch line with 42-inch line along College Drive at 800 South	$832,224	$857,191								
SS 3	Replace 820 feet of existing 12-inch pipe with 18-inch pipe along College Drive at 1200 South	$321,390		$340,963							
SS 4	Replace 2,110 feet of existing 36-inch pipe with 42-, 48-, & 54-inch pipe to the Treatment Plant	$2,365,650						$2,824,710			
SS 5	Replace 1,030 feet of existing 18-inch pipe with 27 inch pipe along 925 S and 725 West St	$541,486			$591,696						
SS 6	Replace 2,760 feet of existing 15-inch pipe with 21 & 24-inch pipe along 1600 N and 950 West	$1,255,659							$1,544,302		
SS 7	Replace 3,560 feet of existing 18 & 21-inch pipe with 12, 21, & 27-inch pipe along 1200 North and 1200 West	$1,693,797								$1,072,826	$1,105,010
OWRF 1	Expand aeration basin in headworks	$510,513	$525,828								
OWRF 2	Dewatering Expansion	$638,141	$657,285								
OWRF 3	Struvite Elimination Project	$2,042,051	$2,103,312								
OWRF 4	Replace back-up generator	$638,141	$657,285								
OWRF 5	Replace existing solids presses	$2,000,000		$2,121,800							
OWRF 6	Sludge disposal options - solar, central county treatment disposal site	$1,340,000				$1,508,182					
OWRF 7	Concrete/membrane existing lagoons	$638,141					$739,780				
M 1	Frequent Maintenance Related Projects	$5,356,809	$2,758,757	$568,304	$585,353	$602,914	$621,001	$639,631			
M 2	H2S Rehabilitation Program	$16,854,369	$5,000,000	$1,591,350	$1,639,091	$1,688,263	$1,738,911	$1,791,078	$1,844,811	$1,900,155	$1,957,160
System Replacement	Replace system as needed	$27,522,478	$2,952,611	$1,594,633	$3,807,669	$3,111,693	$3,258,653	$4,098,130	$4,395,427	$4,501,194	$4,610,135
Repairs	Unplanned repair fund	$990,000	$113,300	$116,699	$120,200	$123,806	$127,520	$131,346	$135,286	$139,345	$143,525
Fleet Replacement	Fleet maintenance and replacement	$2,909,709	$333,000	$342,990	$353,280	$363,878	$374,794	$386,038	$397,619	$409,548	$421,834
	TOTAL	**$69,669,486**	**$17,214,066**	**$6,676,739**	**$7,097,288**	**$7,398,736**	**$6,860,660**	**$9,870,933**	**$8,317,446**	**$8,023,068**	**$8,237,664**

Figure 7-2
Orem City Sewer Capital Improvement Plan - 2020 Update



Finally, it should be noted that this document is a working document. Some of the recommended improvements identified in this report are based on the assumption that development and/or potential annexation will occur in a certain manner. If future growth or development patterns change significantly from those assumed and documented in this report, the recommendations may need to be revised. The status of development should be reviewed at least every five years. This report and the associated recommendations should also be updated every five years.

APPENDIX A

Lift Station Pump Data

PEAK HOURLY FLOW

ERU =	600	
Peaking Factor =	1.9	(Orem Sewer Master Plan - 2016, pg 4-5)
Estimated I/I =	10%	
Peak Use =	408 GPD/ERU	(2018 SS Impact Fee Doc, Figure 2.3)
Peak Hrly Flow =	511,632 GPD	
Peak Hrly Flow =	355.3 gpm	

EAST WET WELL

Length =	8 feet
Width =	9.25 feet
Volume/ft =	74 cf/ft
Volume/ft =	553.5 gal/ft

WEST WET WELL

Diameter =	10 feet
Volume/ft =	78.5 cf/ft
Volume/ft =	587.5 gal/ft

REQUIRED OPERATING STORAGE

Start/hour =	7.5
# of Pumps =	2
Total Start/hr =	15
T =	4
Peak Flow =	355.3 gpm
V=T*Q/4	
Volume =	355.3 gallons
Volume =	47.5 cubic feet

PROVIDED OPERATING STORAGE

HWL =	4496 feet	
Pump Off =	4495 feet	
Δ =	1 feet	
Storage =	140.8 cubic feet	(Assumes grout in West Wet Well is an average 0.3 feet high)
Storage =	1,052.9 gallons	(Grout in East Wet Well is below the pump off elevation)
Storage OK =	1,052.9 > 355.3	

EMERGENCY STORAGE

Top of Emergency Storage Elevation =	4499.8 feet
Lead Pump On Elevation =	4496 feet
Δ =	3.8 feet
Wet Well Storage =	579.7 cubic feet
Wet Well Storage =	4335.8 gallons
16" Diameter Pipe Storage =	6.7 cubic feet
16" Diameter Pipe Storage =	50.2 gallons
Total Emergency Storage =	586.4 cubic feet
Total Emergency Storage =	4386.0 gallons

REQUESTED EMERGENCY STORAGE

Requested 15 minutes at Peak Flow	
Storage at 15 minutes =	5,329.5 gallons
Deficiency =	943.5 gallons
Provided Emergency Storage =	12.34 minutes

ADDITIONAL EMERGENCY STORAGE FROM LIFT STATION TO FIRST LATERAL

Pipe Inside Diameter =	8.4 inch	(8-inch diameter PVC SDR35)
Length of Pipe =	600 feet	(distance to first lateral)
Pipe Invert near first lateral =	4501.9 feet	
Top of pipe elevation =	4502.6 feet	
Area of pipe =	0.385 sq. ft	
Volume of Storage in Pipe =	230.9 cubic feet	
Volume of Storage in Pipe =	1,727.2 gallons	

WET WELLS ADDITIONAL EMERGENCY STORAGE

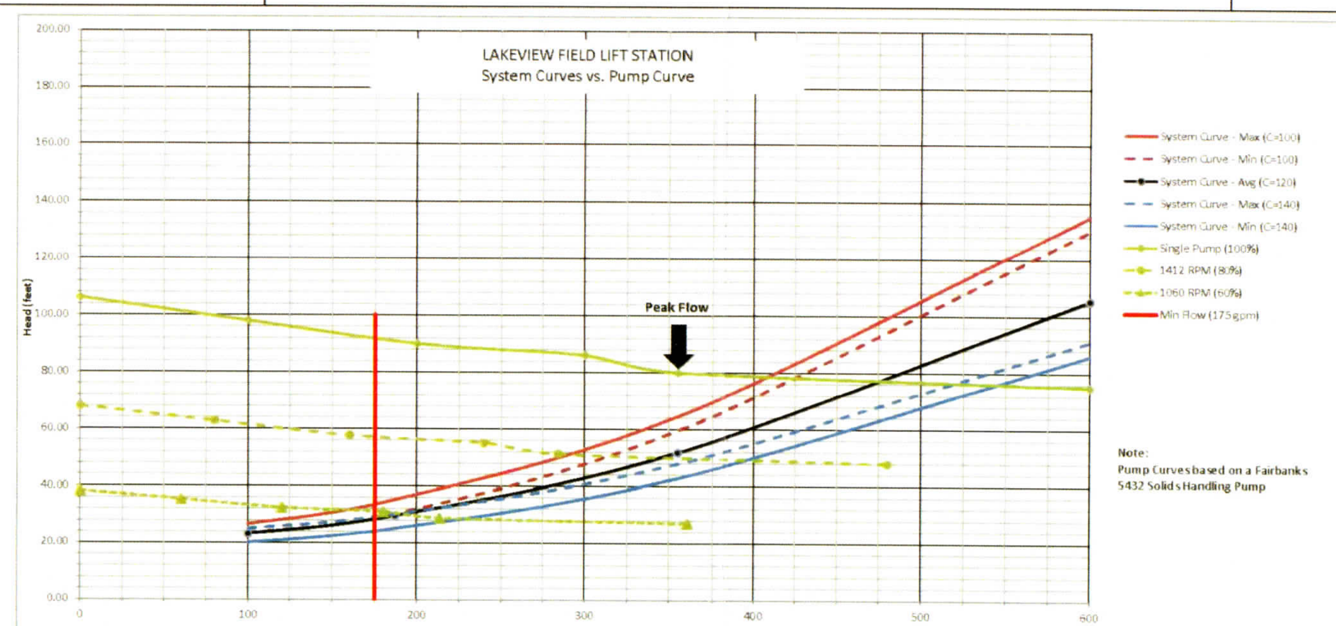
Top of Pipe at First Lateral =	4502.6 feet
Top of Emergency Storage Elevation =	4499.8 feet
Δ =	2.8 feet
Additional Storage Volume =	427.1 cubic feet
Additional Storage Volume =	3,194.8 gallons
Total additional Emergency Storage =	4,921.98 gallons
Additional Emergency Storage Time =	13.85 minutes
Total Emergency Storage Time =	26.20 minutes

PUMP RUN TIME

Operating Storage =	1,052.9 gallons	
At Peak Flow:		
Lead Pump Run Time =	8.80 minutes	Assumes pump at full speed at 475 gpm and peak flow at 355.3 gpm based on average system curve (C=120)
At Average Flow:		
Average Flow =	139.2 gpm	(3.34 ppl/home at 100 gpcd with 600 homes)
Lead Pump Run Time =	3.14 minutes	Assumes pump at full speed at 475 gpm based on average system curve (C=120)

Pump run times will vary based on system hydraulics.

Pump will be operated by VFD which will vary the pump speed and will therefore vary the pump run times.



06/12/2019
APPROVED FOR CONSTRUCTION
C.E. SRK PRD
P.D.E. PLNNR
P.M. WASTE WATER

IMPROVEMENTS INSTALLED WITHOUT CITY INSPECTION WILL BE REJECTED

HANSEN ALLEN & LUCE INC ENGINEERS

REGISTERED PROFESSIONAL ENGINEER No. 182750 MICHAEL M. CHAMBERS STATE OF UTAH

DESIGNED	MMC
DRAFTED	BKC
CHECKED	MEA
DATE	FEBRUARY 2019

PROJECT ENGINEER

NO. DATE REVISIONS BY APVD

SCALE

OREM

LAKEVIEW FIELDS LIFT STATION
GENERAL
HYDRAULIC CALCULATIONS

SHEET G-3

421.01.100

GENERAL DESIGN CRITERIA

CARTERVILLE L.S.

BACKGROUND AND ESTIMATED SEWER FLOWS:

THE CARTERVILLE LIFT STATION IS A LONG DISTANCE FROM THE TREATMENT PLANT AND ITS LACK OF EMERGENCY STORAGE ALLOWS FOR LITTLE RESPONSE TIME WHEN ISSUES OCCUR. THE WET WELL AND DRY PIT ARE BOTH UNDER THE BUILDING, AND THE ONLY ACCESS TO THE WET WELL IS A MANHOLE COVER INSIDE THE BUILDING NEAR THE DOORWAY. THE GRAVITY INLET TO THE WET WELL IS ALSO PROBLEMATIC. AN INLET SCREEN HAS BEEN PLUGGED FOR SOME TIME. RATHER THAN FLOW THROUGH THE SCREEN INTO THE WET WELL, WATER FLOWS THROUGH THE TOP LEG OF AN UPSTREAM TEE INTO THE WET WELL, CAUSING FREQUENT CLOGGING AND SEDIMENT BUILDUP IN THE INFLUENT LINE. WITH THESE EXISTING ISSUES, REPLACING THE LIFT STATION IS THE PREFERRED SOLUTION.

DESIGN ERU = 952 CURRENT ERU = 276
REQUIRED STORAGE TIME = 60 MINUTES (DUE TO LONG DISTANCE FROM THE TREATMENT PLANT)
AVERAGE PROJECTED INFLOW = 120 GPM
STORAGE VOLUME REQUIRED = 960 FT^3

REQUIRED OPERATING STORAGE

START/HOUR = 6 MAX
NUMBER OF PUMPS = 1 DUTY & 1 STANDBY
PUMP FLOW RATE = 350 GPM @ 150 FT OF HEAD
LEAD PUMP ON ELEVATION = 4619 FT
LAG PUMP ON ELEVATION = 4620 FT
PUMP OFF ELEVATION = 4617.22 FT
OPERATING BAND = 1.78 FT

OPERATING STORAGE PROVIDED
SUMP VOLUME = 230.2 FT^3
SUMP VOLUME = 1722 GALLONS

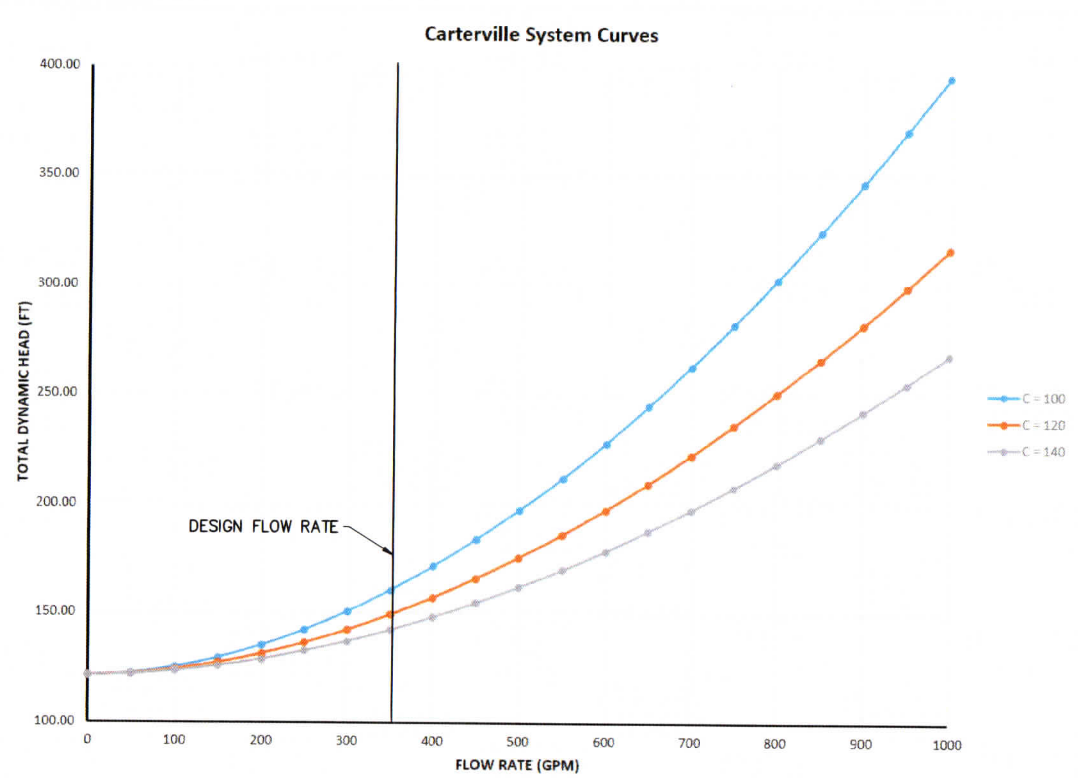
EMERGENCY STORAGE PROVIDED

WETWELL STORAGE PROVIDED (ABOVE SUMP TO OVERFLOW)
LENGTH = 21 FT
WIDTH = 5.6 FT
DEPTH = 10.5 FT
STORAGE VOLUME = 1235 FT^3
STORAGE VOLUME = 9237 GALLONS

EXISTING WETWELL AND DRY WELL STORAGE PROVIDED
LENGTH = 16 FT
WIDTH = 11 FT
DEPTH = 14.5 FT
STORAGE VOLUME = 2552 FT^3
STORAGE VOLUME = 19,090 GALLONS

EMERGENCY STORAGE AT AVERAGE PROJECTED INFLOW
IN NEW WETWELL = 77 MINUTES
IN EXISTING WETWELL = 159 MINUTES
TOTAL = 236 MINUTES

- AVERAGE PER-CAPITA DAILY FLOW IS 59.6 GALLONS (2016 OREM SEWER MASTER PLAN PREPARED BY BOWEN COLLINS AND ASSOCIATES)
- ASSUMED INFILTRATION IS 15% OF DOMESTIC FLOW OR 9 GPD/PERSON
- PEAKING FACTOR IS 1.9 (2016 OREM SEWER MASTER PLAN)



GENERAL DESIGN CRITERIA

SPRINGWATER L.S.

BACKGROUND AND ESTIMATED SEWER FLOWS:

THE SPRINGWATER LIFT STATION IS ALSO OLD BUT IS GENERALLY IN BETTER SHAPE THAN THE CARTERVILLE LIFT STATION. IT IS LOCATED NEAR THE WATER RECLAMATION FACILITY ON THE GOLF COURSE AND ADJACENT TO A POND. DUE TO PROJECTED GROWTH WITHIN ITS SERVICE AREA, CURRENT CAPACITY OF THE LIFT STATION WILL NOT SUPPORT THE PROJECTED 2060 PEAK LOADS. ONE OF THE EXISTING GRAVITY LINES THAT EMPTIES INTO THE WET WELL CROSSES UNDER PART OF THE POND PER CITY GIS DATA. DUE TO THE EXPENSE OF REBUILDING OR RELOCATING THAT GRAVITY MAIN, THE PROJECT TEAM CHOSE SOLUTIONS THAT DO NOT IMPACT THE LINE UNDER THE POND. AN ADVANTAGE TO THE PROPOSED IMPROVEMENTS IS THAT OVERFLOW CAN BE STORED IN THE PIPE BETWEEN THE OLD AND NEW LIFT STATION AND EXCESS FLOW CAN BE DIVERTED TO THE OLD LIFT STATION. THE DESIGN WILL KEEP THE EXISTING LIFT STATION AND INSTALL A SECOND LIFT STATION AT THE TREATMENT PLANT. THIS NEW LIFT STATION WILL TAKE FLOW FROM THE SOUTH OF THE TREATMENT PLANT, WHILE THE EXISTING LIFT STATION WILL TAKE FLOW FROM THE NORTH.

DESIGN ERU = 3,800 CURRENT ERU = 581
REQUIRED STORAGE TIME = 25 MINUTES
AVERAGE PROJECTED INFLOW = 500 GPM
STORAGE VOLUME REQUIRED = 1671 FT^3

REQUIRED OPERATING STORAGE

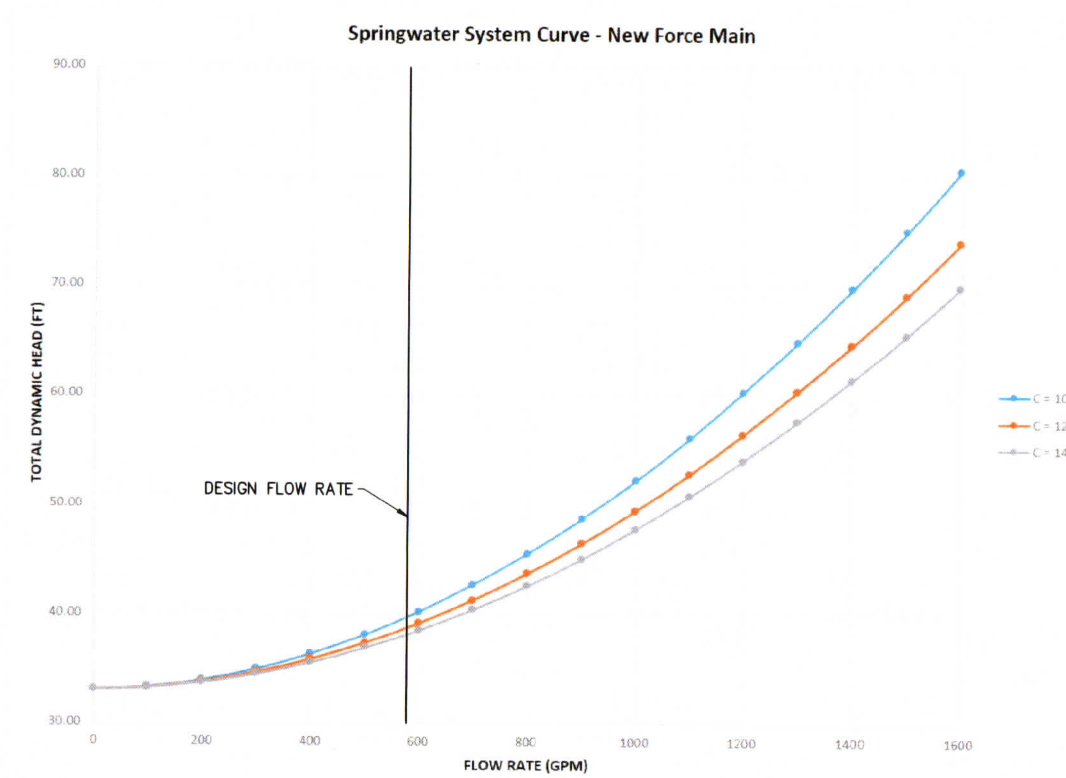
START/HOUR = 6 MAX
NUMBER OF PUMPS = 1 DUTY & 1 STANDBY (OPTION TO ADD TWO ADDITIONAL PUMPS FOR FUTURE FLOWS)
PUMP FLOW RATE = 575 GPM @ 38 FT OF HEAD
LEAD PUMP ON ELEVATION = 4,489.55 FT
LAG PUMP ON ELEVATION = 4,490.55 FT
PUMP OFF ELEVATION = 4,486.87 FT
OPERATING BAND = 2.68 FT

OPERATING STORAGE PROVIDED
SUMP VOLUME = 425.4 FT^3
SUMP VOLUME = 3,182 GALLONS

EMERGENCY STORAGE PROVIDED

WETWELL DIMENSIONS PROVIDED (ABOVE SUMP TO OVERFLOW)
LENGTH = 21 FT
WIDTH = 10.42 FT
DEPTH = 6 FT
STORAGE VOLUME = 1,312 FT^3
STORAGE VOLUME = 9,822 GALLONS

EMERGENCY STORAGE AT AVERAGE PROJECTED INFLOW
TIME = 20 MINUTES



PROFESSIONAL ENGINEER No. 8740928-2202 G. PARRY OSBORN, JR. STATE OF UTAH

SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 · FAX 801.523.0990
www.sunrise-eng.com

OREM CITY

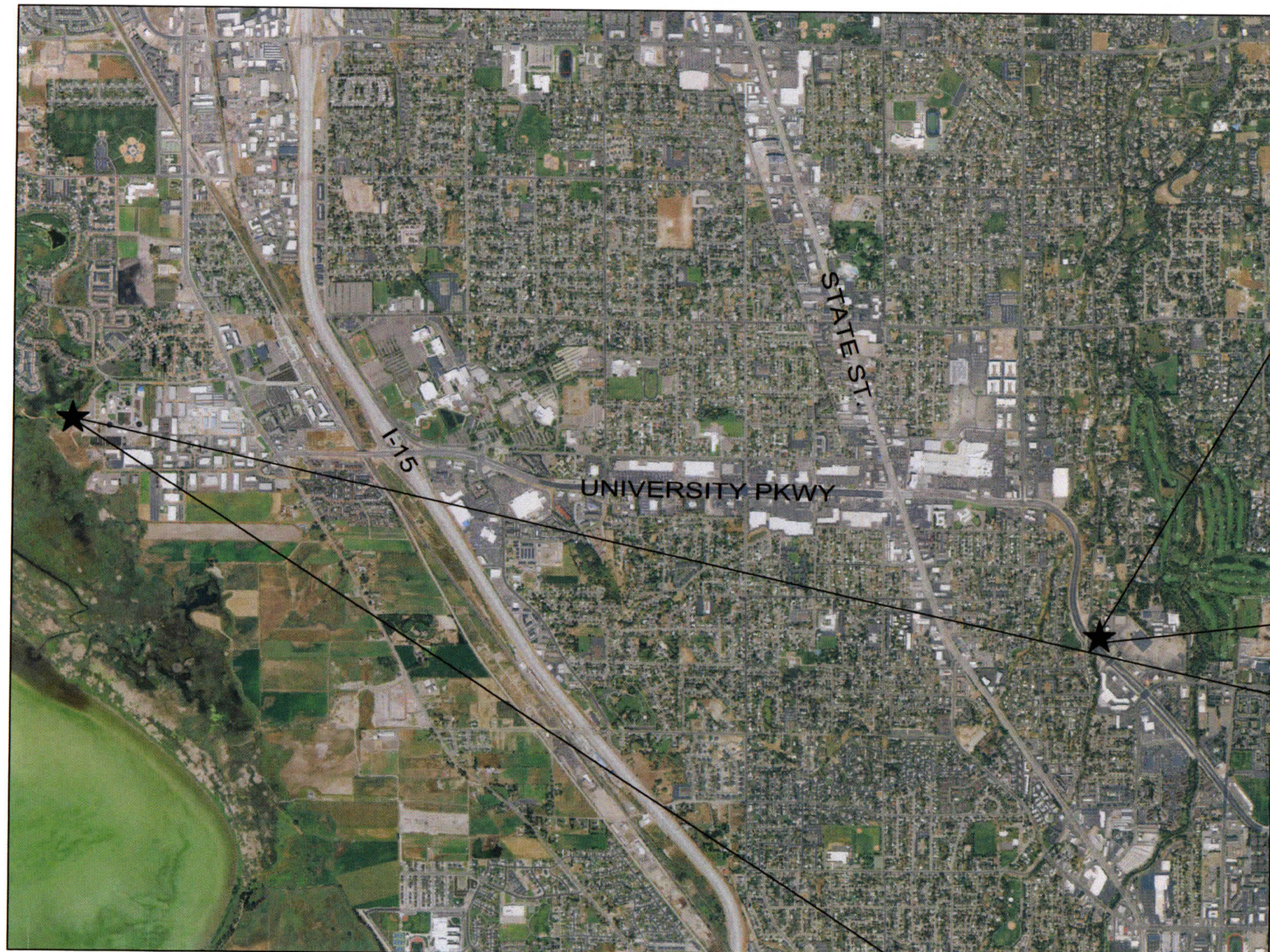
CARTERVILLE & SPRINGWATER LIFT STATIONS

DESIGN CRITERIA

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
06711	P.O.	C.E.	R.W.	4 of 84	G4

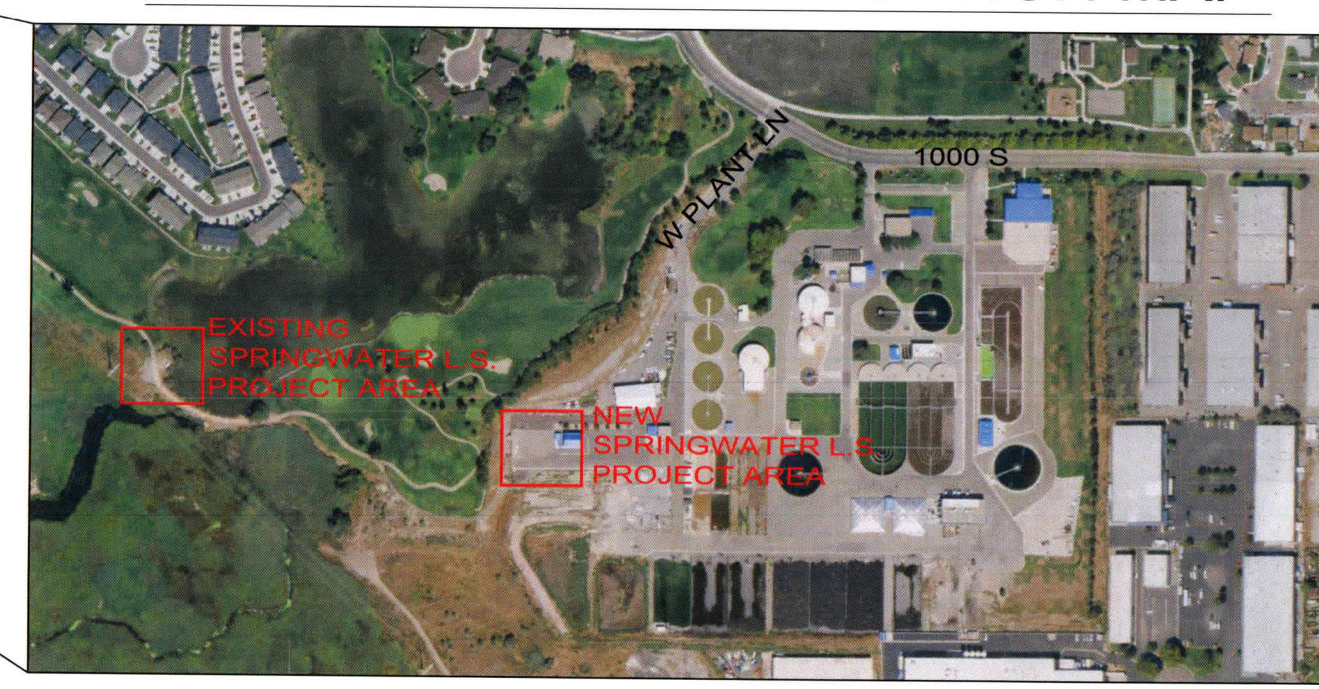
P:\Orem City\06711 Carterville and Springwater Lift Stations\DWG\06711 - GEN.dwg Sep 15, 2020 3:59pm posborn

AREA MAP



CARTERVILLE L.S. LOCATION MAP

SPRINGWATER L.S. LOCATION MAP



PROFESSIONAL ENGINEER No. 8740929-2202 G. PARRY OSBORN, JR. STATE OF UTAH

SUNRISE ENGINEERING
6875 SOUTH 900 EAST
SALT LAKE CITY, UTAH 84047
TEL 801.523.0100 · FAX 801.523.0990
www.sunrise-eng.com

OREM CITY

CARTERVILLE & SPRINGWATER LIFT STATIONS

AREA AND LOCATION MAPS

SEI NO.	DESIGNED	DRAWN	CHECKED	SHEET NO.	
06711	P.O.	C.E.	D.A.	2 of 84	G2

P:\Orem City\06711 Carterville and Springwater Lift Stations\DWG\06711 - GEN.dwg Sep 22, 2020 4:11pm posborn

Geneva Lift Station

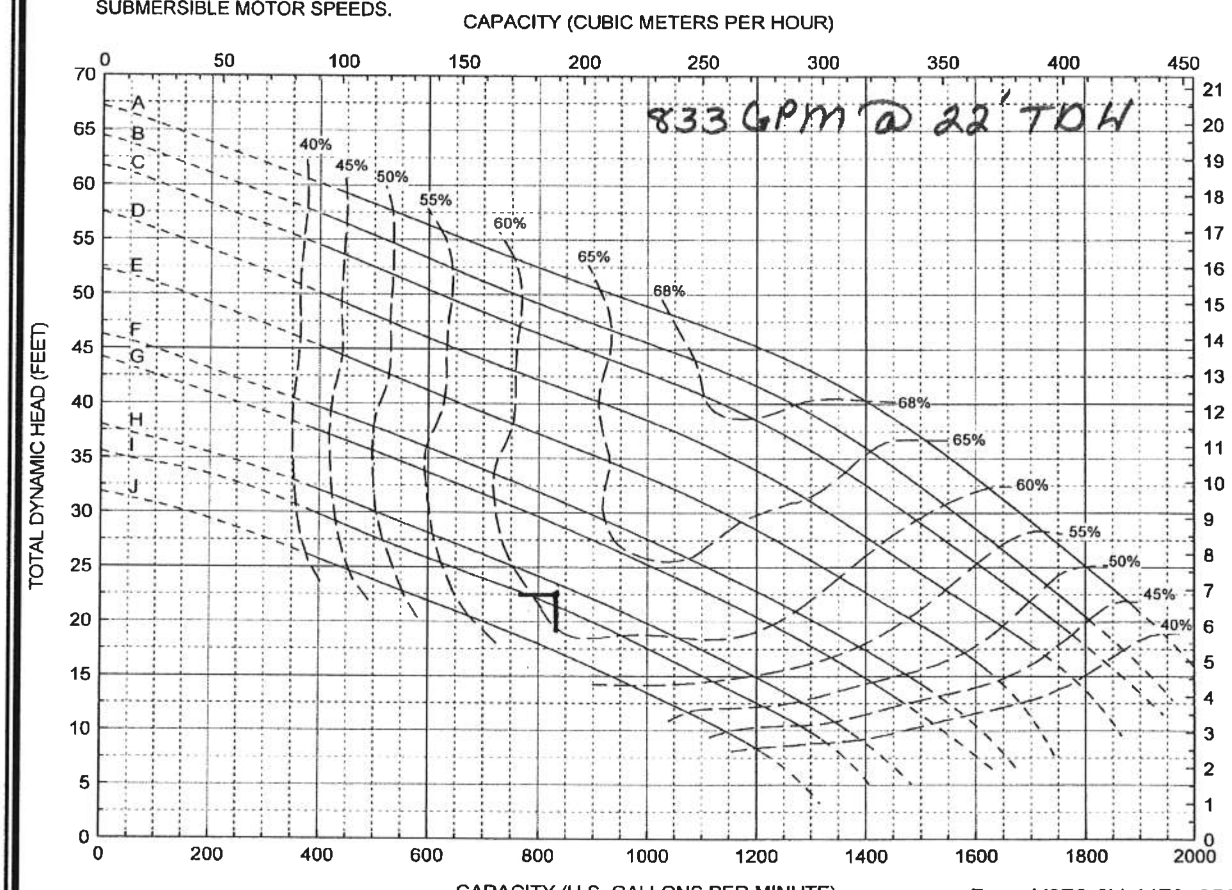
Vaughan E Series Chopper Pump PERFORMANCE CURVE

Models:
HE6U8
PE6U8 ◁
SE6U

Back-Pull-Out Casing
4-Blade Impeller
6" Discharge
8" Suction

CURVE	POWER (HP)	SPEED (RPM)	IMPELLER DIAMETER
A	25	1155	11.80" (300 mm)
B	25	1155	11.50" (292 mm)
C	20	1160	11.20" (284 mm)
D	20	1160	10.90" (277 mm)
E	15	1160	10.50" (267 mm)
F	15	1160	10.00" (254 mm)
G	15	1160	9.80" (249 mm)
▷ H	10	1140	9.40" (239 mm)
I	10	1140	9.20" (234 mm)
J	7.5	1150	8.80" (224 mm)

DO NOT OPERATE PUMP IN DOTTED PORTION OF CURVES. CURVES SUBJECT TO CHANGE WITHOUT NOTICE. EFFICIENCIES SHOWN ARE NOMINAL BOWL. GUARANTIED MINIMUM EFFICIENCIES PER H.I. LEVEL B. CURVES ARE BASED ON SUBMERSIBLE MOTOR SPEEDS.



Form V370-6V-1170 05/07

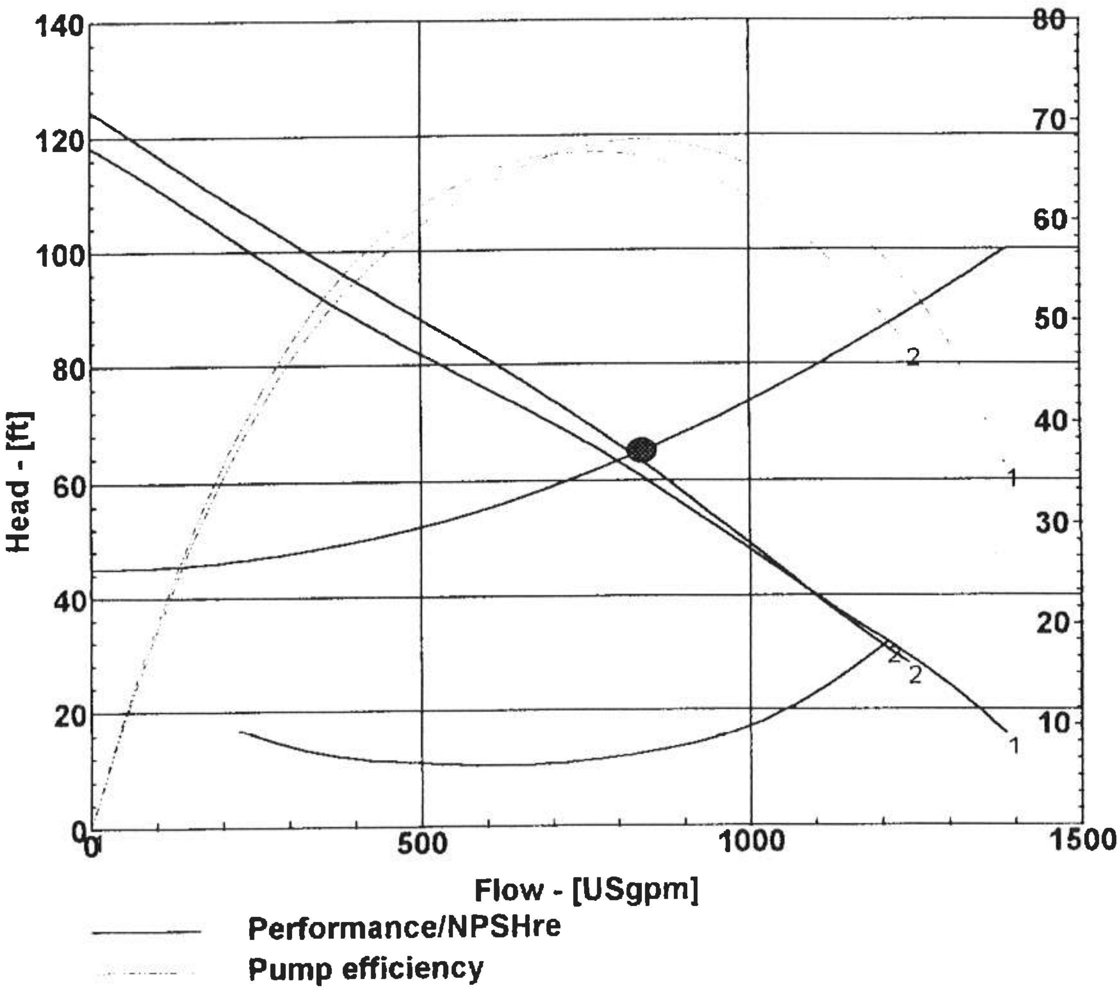
FLYGT

Springwater Lift Station

Duty Analysis - Performance curves

Project: Pump Station Upgrade

Created by:: DAVID L. HUTCHINSON



1. CP 3152 - 63-454-00-5350 20 hp 275 mm
2. CP 3152 - 63-454-00-5360 23 hp 275 mm

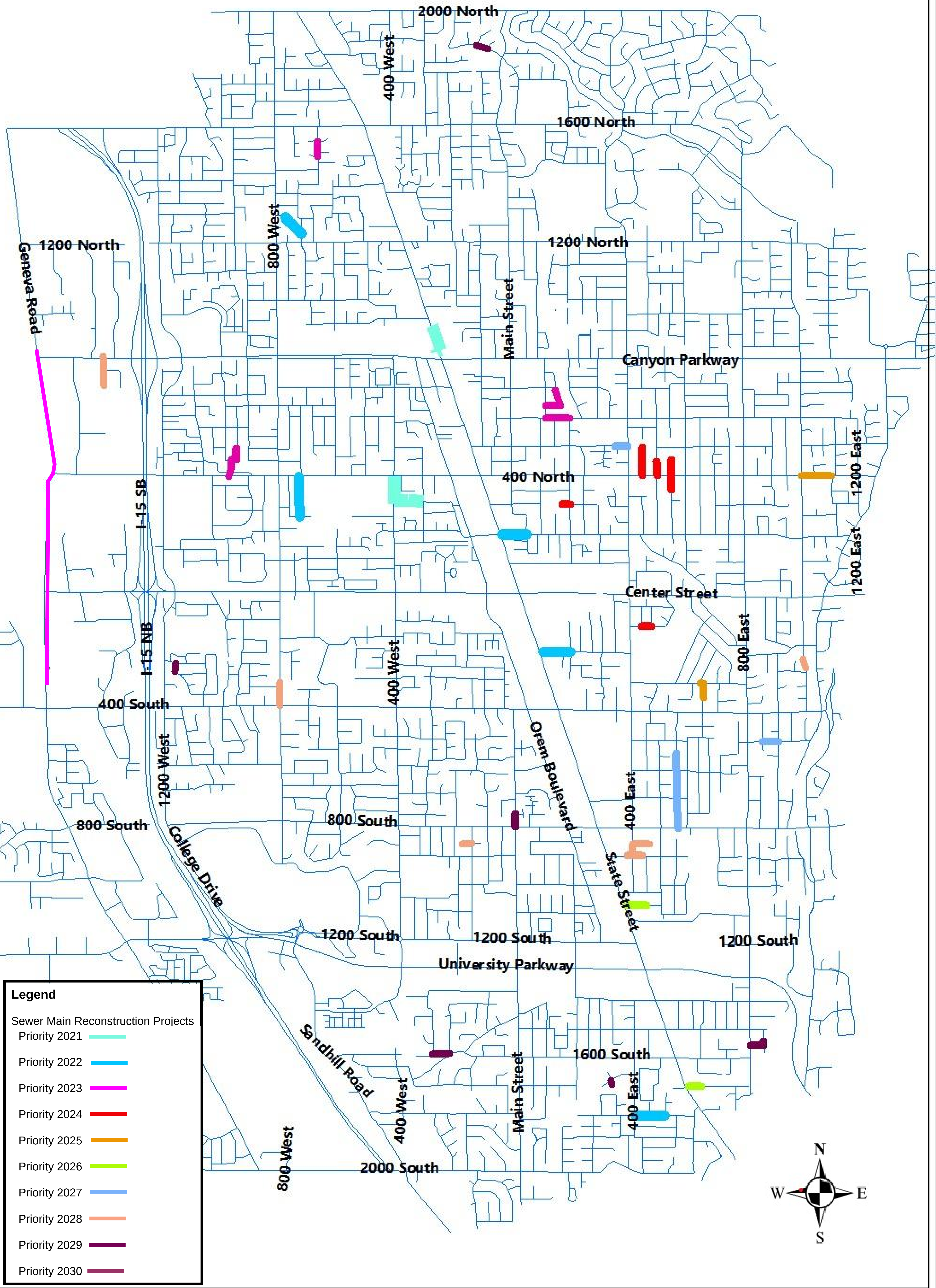
APPENDIX B

Routine Maintenance Projects

Sewer Main Reconstruction & Completed Lining Projects

Updated 03/11/2021

Sewer Main Reconstruction Areas Prioritize by Year.



Routines and problem areas completed.

Updated: 3/11/2021

Abandon 2007-2008
Repaired- 2019-2020

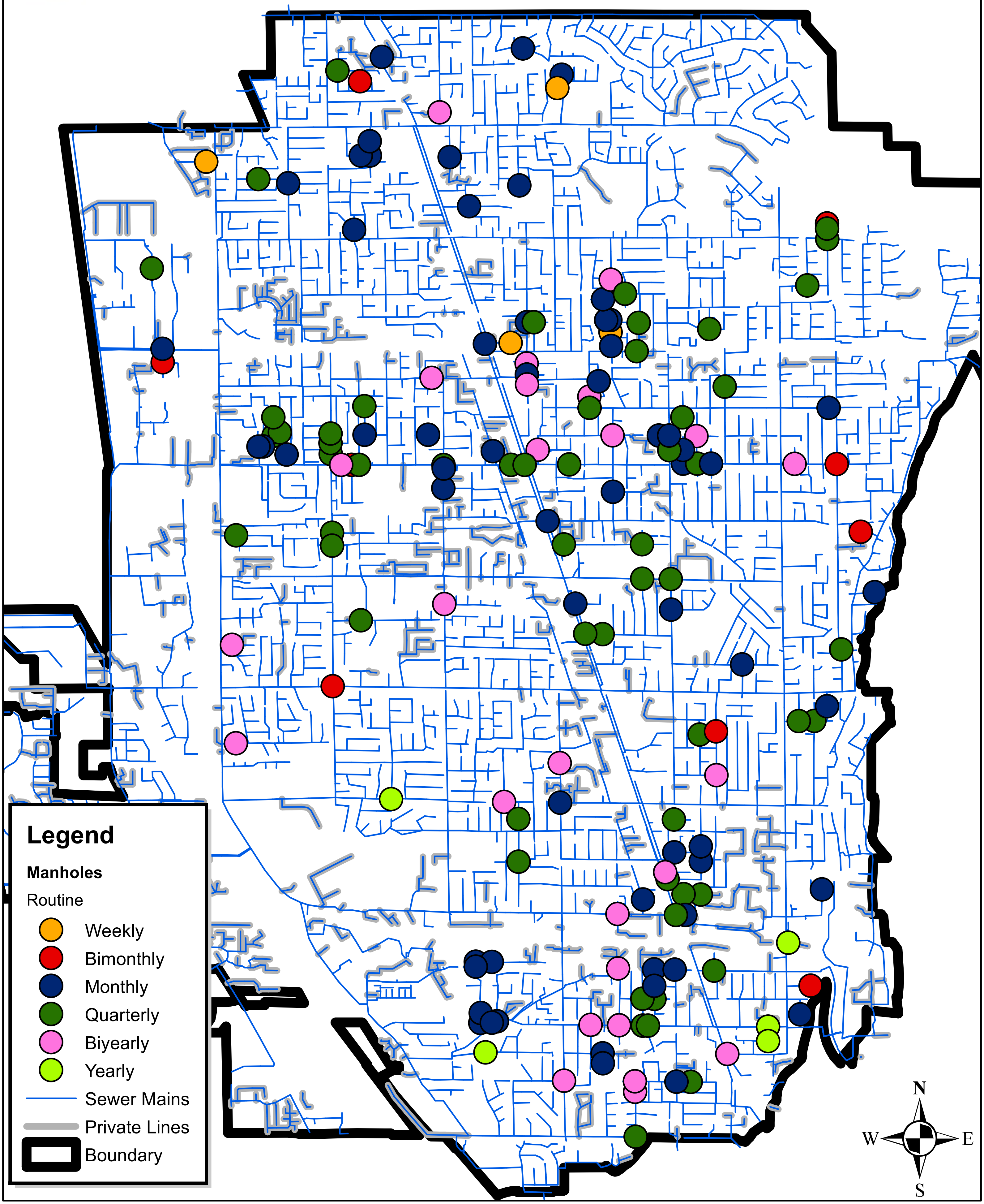
Lined 2006 - 2007
Lined 2012 - 2013
Lined 2017 - 2018
Lined 2019 - 2020
Lined 2020 - 2021

Replaced 2007 - 2008
Replaced 2016 - 2017
Replaced 2018 - 2019
Replaced 2019 - 2020
Replaced 2020 - 2021

Address	Distance, Direction, and Size	Problem, replace or liner.	Pay Off Period (Years)	Total
WELLS FARGO BLDG. 800 N.	Flush manhole	Lat. In m/h needs trough work (in progress).	0.13	$1,500
1450 S 895 EAST	Flush manhole	8" and 2- 4" lat. In m/h trough work allready tried	0.28	$1,500
997 NORTH 75 EAST	Flush	2-laterals into m/h, needs trough work (in progress).	0.28	$1,500
159 NORTH 1080 EAST	Flush manhole	3-laterals in m/h. Trough work ? (in progress)	0.28	$1,500
1100 SOUTH PALISADE	8" Lines	Low flows and off-set joint.	0.28	$1,500
1150 SOUTH 435 EAST	Flush manhole	4" lat. Into m/h. Needs trough work (In progress)	0.37	$1,500
555 WEST 1200 SOUTH	8" Line 376'	1200 s. trunk line blocks 8" line flow. Trough work ?	0.37	$1,500
1150 NORTH 910 EAST	8" Line 325'	Line in good cond. Roots in Lateral, point repair needed	0.37	$1,500
100 NORTH 800 WEST	8" 302'	Line has tree roots, point repairs needed.	0.37	$1,500
320 WEST 100 SOUTH	Flush manhole	4" lat. Into m/h. needs trough work (in progress)	0.56	$1,500
457 SOUTH 950 EAST	Flush manhole	Flush m/h,4" lat. In m/h. Trough work needed.	0.56	$1,500
413 NORTH OREM BLVD.	8" Line	Flush manhole, 8' ties into manhole (low flow)	0.56	$1,500
900 NORTH 70 WEST	6" Lines E-326'/S-689'	East line roots and break (Point repair) South line Lined	0.67	$1,500
450 NORTH 400 EAST	8" Line 237'	This line is in good cond. Found lite roots Trough work	1.11	$1,500
542 SOUTH 560 EAST	Flush manhole	Line Changes from 8" to 6" in manhole	1.37	$16,000
570 NORTH 1016 WEST	Flush manhole	Lateral comes into m/h, flush as needed. Trough work	1.67	$1,500
475 EAST 1140 SOUTH	8" line 148'	Line showing aggregation. "Liner"	2.08	$16,808
1150 SOUTH 500 EAST	8" line 150'	Line showing aggregation. "Liner"	2.09	$16,900
WEST ENTRANCE MACY'S+B52	8" line 275'	Line showing aggregation "Liner"	2.80	$22,650
400 SOUTH 800 WEST	Flush manhole	15"& 8" line into m/h. 15" plugs off 8" flow into m/h.	3.07	$16,560
NORTH ENTRANCE MACY'S	8" line 220'	8" line from north ties into 8" mall line.	3.22	$26,120
400 NORTH 725 WEST	6" line 389'	Multi. breaks, tree roots, prot. Lat. "Liner"	3.25	$26,338
500 NORTH MONT. DR.	8" 246'	Line in fair cond. Has severe bellies "replace"	3.75	$65,842
1800 SOUTH 400 EAST	8" line 679'	Line has several bad bellies. "Replace"	3.82	$41,234
200 NORTH STATE STREET	8" Line 260'	Line has aggregation "Liner'	4.07	$21,960
500 NORTH 360 EAST	8" line W-64'/6" line S-125'	S. line low flow (bellies) W. line agg. Showing "Liner"	4.62	$18,694
693 NORTH ATLANTIS dr.(150e)	6" Line 379'	Line has off-set joints,prot. lateral. "Liner"	4.80	$25,918
420 NORTH 950 WEST	6" Lines S-244'	North line replaced. East line lined. South line "Line"	4.87	$32,848
1500 NORTH 650 WEST	8" Line 215'	Line in good cond. Low flows, poss. Lining	4.91	$19,890
710 NORTH 100 WEST	6" Easement line 400'	Line @ min. grade, liner for flow.	4.96	$26,800
910 NORTH 200 EAST	E-6" W-8"	East line new (Skip Dunn) West line "Liner"	5.01	$20,304
310 NORTH 400 WEST	8" Line 225'	Line has lots of off-set joints. "Liner"	5.02	$20,350
500 NORTH 400 EAST	6" Line 247'	Line showing aggregation "Liner"	5.03	$20,374
300 WEST 1600 SOUTH	8" Line 237'	Line showing wear, has grease in it.	5.16	$20,902
150 NORTH 800 WEST	8" Line 420'	Line in good cond. with off-set joints.	5.43	$29,320
245 WEST 1600 SOUTH	8" Line 275'	Line showing wear, has grease in it.	5.59	$22,650
500 SOUTH 900 EAST	8" Line 300'	Showing severe aggregation. "Liner"	5.88	$23,800
1742 SOUTH 145 EAST FLUSH	Flush manhole	4 lat. Into m/h. Trough work done, flush as needed.	5.93	$16,000
1550 SOUTH 850 EAST	Flush manhole	8", 6", & 4" lat. Into manhole. Flushed as needed.	5.93	$16,000
1830 NORTH 600 WEST	Flush manhole	Trough work done, flush as needed.	5.93	$16,000
1500 NORTH 680 WEST	Flush manhole	3-lat. Into m/h. Trough work done, flush as needed.	5.93	$16,000
500 NORTH 680 WEST	Flush manhole	6" & 8" line in m/h. Flush as needed, trough work ?	5.93	$16,000
270 NORTH 1030 WEST	8" Lines. West line-138'	N & S lines good cond. West line needs "Lining"	6.01	$32,448
320 EAST 1500 SOUTH	8" Line (N,S&E) S-355'	South line needs lining (broken pipe &roots)	6.50	$26,330
500 SOUTH 850 EAST	8" Line 370'	Showing severe aggregation. "Liner"	6.67	$27,020
1600 SOUTH 100 EAST	8" Line 392'	Line has breaks and tree roots. "Liner"	6.92	$28,032
1564 SOUTH 300 WEST DROP MANHOLE	8" Line 600'	Line showing wear, has grease in it.	6.96	$37,600
980 NORTH 188 EAST	6" Lines W-205'/E-100'	Lines in poor condition, holes and breaks "Liner"	7.11	$28,810
1600 SOUTH 280 EAST	8' Line 635'	Line is thinning, severe aggregation "Liner"	7.26	$39,210
165 SOUTH 705 WEST	8" Line 666'	Line has numerous cracks. "Liner"	7.53	$40,636
390 NORTH 400 WEST	6" Line 136'	6" Line and very low flow. "Liner"	8.04	$21,712
1600 SOUTH MAIN	15" Line 656'	Has severe roots, breaks and agg."Liner"	8.65	$46,736
450 NORTH 900 WEST	6" line 283'	Beverly West sub. Project. Lines to be replaced.	8.75	$70,845
400 NORTH 550 EAST	6" Line North / 8" Line South	N. Line pipe missing. S. Line breaks "Liner" both.	8.81	$47,556
400 EAST CENTER	8" Line 378'	15' line coming in from north restricts 8" line from east	8.89	$16,000
400 NORTH 1000 EAST	8" line 297'	Line showing mod. Agg. & bellies "replace"	9.56	$77,419
900 NORTH 100 WEST	8" Line	First 156' Bellies "Replace" Next 181' Agg. "Line"	9.95	$53,738
300 SOUTH - 650 EAST	8" line (E&W) 80' (W)	W. line bellies & aggregation "Replace"	10.43	$28,160
800 NORTH 297 EAST	6" Line 124'	Line from m/h 11-0238 to 11-0205 severe agg. "Liner"	11.27	$15,208
2000 SOUTH 250 EAST	8" Line 103'	Protruding lat./broken pipe/low flow. Work order.	11.85	$16,000
400 NORTH 850 EAST	8" Line 140'	Line has several breaks, unsure of overall cond. of line.	12.18	$16,440
753 SOUTH 1080 EAST	8" Line 170'	Line in fair cond. Few off-set joint and infil. @ Lateral.	13.20	$17,820
1600 SOUTH 235 WEST	8" line 121'	Line has bad bellie "Replace"	13.88	$37,467
480 NORTH 800 WEST	6' Line 400'	6" Easement line. Roots ! It's being treated.	14.89	$26,800
1600 SOUTH 311 EAST	8" Line 237'	Line has small bellies and off-set joints. (Easement)	15.48	$20,902
1400 SOUTH 200 EAST	8" Line 242'	Line showing aggregation "Liner"	15.65	$21,132
1550 NORTH 650 WEST	8" Line 246'	Line in fair cond. Has bellie over 200' "Replace"	16.26	$65,842
1200 NORTH 1000 EAST	8" Line 250'	Line has bad bellies, slow flow. "Replace"	16.48	$66,750
400 NORTH 760 WEST	8" Line 430'	Roots ! It's being treated.	16.54	$29,780
570 NORTH 450 EAST	8" Line 257'	Line has low flow, laid flat. "Replace"	16.87	$68,339
1400 NORTH 950 WEST	8" Line 259'	Line has multiple bellies. "Replace"	16.99	$68,793
800 SOUTH 600 WEST	8" Line 285'	Line in good cond. Needs point repair (work order).	17.12	$23,110
885 NORTH 75 EAST (memo)	6" Lines N-427' E-365'	Line to the north is Lined. Line east needs "Liner"	17.50	$94,475
1880 NORTH 90 WEST	8' Line 270'	Line has lots of bellies "Replace"	17.60	$71,290
875 NORTH 550 EAST	Flush manhole	Lateral comes into m/h, flush as needed.	17.78	$16,000
1600 SOUTH 800 EAST	8" Line 281'	Line has bellies & aggregation "Replace"	18.22	$73,787
1600 SOUTH 200 EAST	8"Line 322'	Line is showing aggregation. "Liner"	18.38	$24,812
850 SOUTH 150 WEST	8" Line 204'	Several small bellies and showing aggregation.	18.80	$25,384
1700 SOUTH 270 WEST	8" Line 267'	Line laid flat w/bellies. "Replace"	18.92	$76,609
947 NORTH 75 EAST	6" Line 315'	Line is in good shape but has multi. breaks, "Liner"	19.19	$77,725
400 NORTH 400 WEST	8" Line 548'	Roots ! It's being treated.	19.56	$35,208
450 NORTH 450 EAST	8" Line 313'	Line has bellies and off-sets "Replace"	20.01	$81,051
500 NORTH 450 WEST	8" Lines N-242' / S-140'	Line North good cond. Line South small bellie & low flow	20.13	$108,714
800 NORTH 1370 WEST	8"Line 319'	Line has bellies and aggregation "Replace"	20.35	$82,413
600 NORTH MONTERY DR.	8" 323'	Line has bellies and cracks "Replace"	20.57	$83,321
400 NORTH 450 EAST	8" Line 325'	Line has bellies and off-sets "Replace"	20.69	$83,775
400 NORTH 160 WEST	12" Line 322'	Line showing severe aggrigation. "Liner"	20.76	$28,032
810 NORTH STATE STREET	6" Lines N-490'/E-89'	N. line, laid flat with bellies "Replace" E. line "Liner"	22.05	$119,088
300 NORTH 200 EAST	8" Line 195'	Line has bellies & breaks "Replace"	22.32	$60,265
526 NORTH 980 WEST	8" Line 357'	Line has bellies and off-sets "Replace"	22.48	$91,039
100 SOUTH 400 WEST	8" Line 364'	Bellies and aggregation "Replace"	22.87	$92,628
1800 NORTH 760 WEST	8" Line 488'	Line has bellies and laid flat "Replace"	23.48	$126,776
1011 SOUTH 150 WEST	8" Line 517'	Severe bellies and aggregation "Replace"	23.59	$127,359
1224 NORTH 710 WEST (crest)	8" Line 382'	Line has 4 severe bellies. "Replace"	23.88	$96,714
1800 SOUTH 250 EAST	8" Line E-214' W-289'	Both lines showing aggregation "Liner"	24.55	$33,138
430 NORTH 800 WEST	6" Line E-415'/8" line N-257'	Line N. bellies and breaks "replace"/ Line E. ?	24.97	$168,544
840 NORTH 75 EAST	6" Lines E-250' N-324'	Line the North, needs "Liner"	25.82	$139,410
400 SOUTH 800 WEST	10" Line 545'	Bellies, 400 S. trunk line slows 800 W. line	26.07	$140,800
1650 SOUTH 740 EAST	8" Line 112'	Line has tree roots. Work order.	26.24	$35,424
1800 SOUTH MAIN	8" Line 339'	Line is showing aggregation "Liner"	28.44	$25,594
800 NORTH 200 EAST	6" Line 617'	Line has bellies & aggregation. "Replace w/8" line.	29.75	$160,655
888 NORTH 275 EAST	6" Lines E-266'/N-16'	East line off-set joints "Replace" South line low flow.	42.57	$76,630
245 SOUTH 1000 EAST	10" Line 203'	Line has bad bellies & roots "Replace"	43.50	$58,720
150 NORTH 1150 WEST	8" Line 232'	Line has several bad bellies. "Replace"	46.42	$62,664
1151 WEST 600 SOUTH	8" Line 339'	Line is in fair cond. A few open joints and laid crooked	55.83	$75,376
1030 NORTH 910 EAST	8" Line 297'	The first 266' lined. The remainder needs to be "replaced"	57.35	$77,419
1000 NORTH 250 EAST	8" Lines N-329'/E-324'	North line good cond. East line severe belly "Replace"	61.89	$83,548
1700 SOUTH STATE/EAST	10 " Line 309'	Line has numerous bellies. "Replace"	62.34	$84,160
1600 SOUTH 740 EAST	8" Line 340'	Line has small bellies, good cond.	64.58	$87,180
850 SOUTH 400 EAST 6" LINE USE TIP ONLY	6" Line 382'	Line has several long bellies. "Replace"	68.24	$92,130
600 NORTH 120 EAST	6" Line 550'	Line has bellies and off-set joints. "Replace" w/8"	77.92	$140,250
500 NORTH 1020 WEST	6" Line 681'	This line has been lined. No further action required.	82.23	$185,017
200 SOUTH STATE / east side	8"/6" Line 413'	Line has crack, aggregation. "Replace"	83.87	$150,967
660 NORTH 600 EAST	8"Lines N-287'/E-289'	E- line good (point repair). N- line agg. & bellies "Replace"	84.86	$152,752
400 NORTH 500 EAST	8" Lines N-323'/S-300'	North line bellies & roots "Replace" South line ok.	87.46	$157,421
400 NORTH 720 WEST	6" Line 1,427'	This line has been lined. No further action required.	91.22	$164,200
1838 SOUTH250 EAST	8" Lines 198' / 155'	Lines good. Lateral in mh's is the problem.	106.81	$96,131
800 SOUTH 200 WEST	8" Line 395'	Line in good cond. Small belly	110.74	$99,665
			Total	**$5,995,657**

Updated 03/11/2021

Current Frequent Maintenance Areas



updated 1/20/2021

Completed 2019 - Sewer Main Lining Projects Routine Elimination and H2S Rehabilitation

Pipe Segments	GPS #	Pipe ID	Up Stream M/H Address	Down Stream M/H Address	Flow Direction	Problem,	# of Manholes to be lined	Size	Length	Liner
1	11-0005	5002	48 W 700 NORTH	710 N100 WEST	West 400'	Line @ min. grade, liner for flow. Found tree	0	6	400.00	$15,200.00
2	34-0013	6478	320 E 1550 SOUTH	320 E 1500 South	NORTH	Line needs lining (broken pipe &roots) Tv'd li	0	8	355.10	$8,877.50
3	34-0081	41	1600 S 50 EAST	1600 S MAIN	WEST	Has severe roots, breaks and agg."Liner" This	0	15	349.30	$20,958.00
4	34-0083	42	1600 S 100 EAST	1600 S 50 EAST	WEST	Line has breaks and tree roots. "Liner" This li	0	15	307.10	$18,426.00
5	30-0104	270	1350 Off-ramp	1200 S Onramp	NORTH	There are no laterals in this line. Found infiltr	0	21	339.30	$33,930.00
6	30-0103	271	1400 S On-ramp	1350 Off-ramp	NORTH	There are no laterals in this line. Found agreg	0	21	272.30	$27,230.00
7	30-0102	272	1450 S Freeway	1400 S On-ramp	NORTH	There are no laterals in this line. Found aggre	0	21	157.70	$15,770.00
8	30-0101	273	1500 S Freeway	1450 S Freeway	NORTH	There are no laterals in this line. this line is sh	0	21	109.40	$10,940.00
9	33-0141	7042	851 W 1250 SOUTH Hamptor	1400 S On-ramp	WEST	Severe Aggregation	1	8	98.80	$2,470.00
10	22-0021	1712	636 E 100 NORTH	100 N 600 EAST	WEST	Roots In pipe and in laterals	0	8	252.30	$6,307.50
11	20-0179	5119	Orem Rec. Parking Lot	685 W 165 SOUTH		Found cracked pipe throughout with aggregat	0	8	334.50	$8,362.50
12	20-0104	5120	685 WEST 165 SOUTH	705 W 165 SOUTH	WEST	Found cracked pipe throughout with aggrega	0	8	332.90	$8,322.50
13	20-0033	5118	705 W 165 SOUTH	747 W 165 SOUTH	WEST	Found cracked pipe throughout with aggrega	0	8	333.20	$8,330.00
14	20-0032	4365	747 W 165 SOUTH	165 S 800 WEST	WEST	Found cracked pipe throughout with aggrega	0	8	341.60	$8,540.00
15	31-0015	1243	1100 S 150 WEST	1006 S 150 WEST	NORTH	cracks throughout it and is showing severe a	0	8	517.80	$12,945.00
16	25-0159	204	800 S 725 WEST	800 S 758 WEST	WEST	Severe Aggregation	0	21	320.80	$32,080.00
17	25-0158	203	800 S 758 WEST	800 S 800 WEST	WEST	Severe Aggregation	0	21	316.00	$31,600.00
18	25-0157	202	800 W 800 SOUTH	900 W 800 SOUTH	WEST	Severe Aggregation	0	21	326.20	$32,620.00
19	25-0155	201	900 W 800 SOUTH	950 W 800 SOUTH	WEST	Severe Aggregation	0	21	317.70	$31,770.00
20	25-0154	200	950 W 800 SOUTH	975 W 800 SOUTH	WEST	Severe Aggregation	0	21	148.80	$14,880.00
21	25-0217	7179	975 W 800 SOUTH	1000 W 800 SOUTH	WEST	Severe Aggregation	0	21	72.20	$7,220.00
22	25-0153	199	1000 W 800 SOUTH	1025 W 800 SOUTH	WEST	Severe Aggregation	0	21	204.70	$20,470.00
23	24-0097	6267	1025 W 800 SOUTH	1030 W 800 SOUTH	WEST	Severe Aggregation	0	21	199.50	$19,950.00
24	24-0164	6266	1030 W 800 SOUTH	1034 W 800 SOUTH	WEST	Severe Aggregation	0	21	224.80	$22,480.00
25	24-0098	198	1034 W 800 SOUTH	1100 W 800 SOUTH	WEST	Severe Aggregation	0	21	388.00	$38,800.00
26	24-0099	197	1100 W 800 SOUTH	1165 W 800 SOUTH	WEST	Severe Aggregation	0	21	398.00	$39,800.00
27	24-0100	196	1165 W 800 SOUTH	1200 W 800 SOUTH	WEST	Severe Aggregation		8	396.00	$9,900.00
28	15-0016	4992	733 W 600 NORTH	745 W 600 NORTH	WEST	Severe Aggregation	0	6	36.30	$907.50
29	20-0174	6477	76 N 800 WEST	800 W Center Street North Si	SOUTH	Found tree roots throughout with severe agg	0	8	338.40	$8,460.00
30	33-0028	625	230 W 1600 SOUTH	257 W Hidden Hollow	WEST	Severe Aggregation	1	15	252.90	$15,174.00
31	33-0052	36	257 W Hgidden Hollow	263 W Hidden Hollow	WEST	Severe Aggregation	1	15	85.20	$5,112.00
32	33-0054	34	263 W Hidden Hollow	287 W Hidden Hollow	WEST	Severe Aggregation	1	15	162.20	$9,732.00
33	33-0055	33	287 W Hidden Hollow	330 W Hidden Hollow	WEST	Severe Aggregation	1	15	224.00	$13,440.00
34	33-0143	5971	330 W Hidden Hollow	347 W Hidden Hollow	WEST	Severe Aggregation	1	15	223.90	$13,434.00
35	33-0056	600	347 W Hidden Hollow	1681 S 350 West (Shed)	WEST	Severe Aggregation	1	15	128.60	$7,716.00
36	33-0061	614	1681 S 350 West (Shed)	1695 S 398 West (Easement)	WEST	Severe Aggregation	1	15	291.50	$17,490.00
37	33-0096	615	1695 S 398 WEST (Easement)	1695 S 400 West (Easement)	WEST	Severe Aggregation	2	15	31.40	$1,884.00
38	33-0085	32	1695 S 400 WEST (Easement)	1707 S 400 West	SOUTH	Severe Aggregation	1	15	84.50	$5,070.00
39	33-0084	31	1707 S 400 WEST	1719 S 400 West	SOUTH	Severe Aggregation	1	15	68.90	$4,134.00

Pipe Size	Feet	Estimated Price/Ft	$610,732.50
6"	436.30	$38.00	$16,579.40
8"	3,300.60	$25.00	$82,515.00
10"	0.00	$28.00	$0.00
12"	0.00	$48.00	$0.00
15"	2,209.50	$60.00	$132,570.00
18"	0.00	$70.00	$0.00
21"	3,795.40	$100.00	$379,540.00
24"	0.00	$150.00	$0.00
Total FT	9,741.80	Estimated Price/MH	
Manholes	12	$3,200.00	$38,400.00
Total Segments	39	Total	$649,604.40

Completed 2019 - Sewer Main Lining Projects
Routine Elimination and H2S Rehabilitation

Pipe Segments	GPS #	Pipe ID	Up Stream M/H Address	Down Stream M/H Address	Flow Direction	Problem	Lined or Replace (RR)	Pipe Size	Length	Cost /Line	Laterals
1	15-0109	2253	150 N 800 W	100 N 800 W	South	Severe Roots throughout this line	Line	8	302.60	$9,078.00	4
2	33-0038	1111	225 W 1400 S	249 W 1400 S	West	Found aggregation and grease through	Line	8	229.70	$6,891.00	3
3	33-0040	5898	249 W 1400 S	261 W 1400 S	West	Found aggregation and grease through	Line	8	92.20	$2,766.00	3
4	33-0130	5897	255 W 1400 S	300 W 1400 S	West	This line is showing aggregation & has g	Line	8	288.30	$8,649.00	3
5	33-00139	1110	300 W 1400 S	1410 S 300 W	South	This line is showing aggregation & has g	Line	8	120.00	$3,600.00	2
6	33-0042	1098	300 W 1410 S	1429 S 300 W	South	This line is showing aggregation & has g	Line	8	253.50	$7,605.00	4
7	33-0045	1097	1429 S 300 W	1435 S 300 W	South East	This line is showing aggregation & has g	Line	8	131.40	$3,942.00	0
8	33-0046	1096	1435 S 300 W	1450 S 300 W	South	This line has a groove right above the fl	Line	8	112.40	$3,372.00	3
9	33-0047	1094	1450 S 300 W	1511 S 300 W	South	This line is showing aggregation and th	Line	8	304.46	$9,133.80	3
10	33-0049	1093	1511 S 300 W	1564 S 300 W-Drop M/H	South	This line is aggregation with a little gre	Line	8	353.90	$10,617.00	9
11	33-0036	1070	1564 S 300 W (Drop M/H)	300 W 1600 S	South	Line is showing aggregation. Found gr	Line	8	237.50	$7,125.00	2
12	33-0029	703	235 W 1600 S	230 W 1600 S	East	Line is showing aggregation and has a b	line	8	100.20	$3,006.00	1
13	31-0116	1514	1100 S 500 East	500 E 1120 South	South	Line is showing aggregation and grease	Line	8	148.20	$4,446.00	2
14	20-0060	5672	165 S 400 West	100 S 400 West	North	This line is showing aggregation. This lir	Line	8	364.90	$10,947.00	3
15	34-0089	4878	300 E 1600 S	1632 S 350 E	North	This line has roots and is showing aggre	Line	8	223.10	$6,693.00	5
16	34-0180	4877	1632 S 350 E	1655 S chapel Circle	North	This line has roots and is showing aggre	Line	8	327.40	$9,822.00	4
17	34-0002	933	1350 S 200 East	200 E 1400 S	South	Line is showing severe aggregation. Lini	Line	8	242.40	$7,272.00	1
19	34-0003	932	200 E 1400 S	200 E 1417 S	South	Line has grease and is showing severe a	Line	8	117.70	$3,531.00	1
20	35-0020	677	676 E 1700 S	646 E 1700 S	West	Found cracked pipe in 3 places in this li	Line	10	301.90	$12,679.80	6
21	27-0072	1542	749 S River Breeze Dr	1080 E 753 South	South	This line has offset joints that allows wa	Line	8	170.90	$5,127.00	2
22	27-0071	1543	749 S 1080 EEasemt. Riv.b.d	749 S River Breeze Dr Easemt. Riv.b.d	West	Sewer line #1543 is in fair condition, Ho	Line	8	82.90	$2,487.00	0
23	27-0070	1544	689 S 1050 East Easemt	749 S 1080 E	West (hill)	This line has cracks,broken sections and	Line	8	75.90	$2,277.00	0
24	27-0062	1545	1054 E 690 South	689 S 1050 East Easemt		This sewer line is in fair condition. How	Line	8	101.30	$3,039.00	1
25	34-0034	985	1538 S 100 E	1600 S 100 E	South	Line is showing aggregation and roots g	Line	8	392.00	$11,760.00	8
26	31-01444	5311	1275 S 200 E	200 E 1200 S	North	This line is showing aggregation. Lining	Line	8	432.10	$12,963.00	1
27	34-0111	1041	1755 S Main Street	1800 S Main Street	North	This line is showing aggregation. Saw lig	Line	8	339.30	$10,179.00	8
28	06-0090	2990	910 W 1400 North	950 W 1400 N	West	This line has aggregation and needs to l	Line	8	259.60	$7,788.00	4
29	15-0229	5054	785 N 450 W	430 N 800 West	West	Found several places with cracks & ligh	Line	6	152.00	$4,377.60	3
30	14-0007	4267	570 N 980 W	526 N 980 West	South	Line has roots and light aggregation. Lir	Line	6	357.10	$10,284.48	10
31	150-158	5608	892 W 400 North	900 W 400 North	South	Found several place with cracks as well	Line	8	65.90	$1,977.00	0
32	14-0040	4964	270 N 1030 West	265 N 1030 W (Easement)	West	Found cracked pipe with light roots at 1	Line	8	138.00	$4,140.00	0
33	14-0062	4966	265 N 1030 W (Easement)	325 N 1030 W (Easement)	North	Line has sever aggregation and roots th	Line	8	298.60	$8,958.00	3
34	14-0061	4965	325 N 1030 W (Easement)	370 N 1060 W (Easement)	North	Line has sever aggregation and roots th	Line	8	315.50	$9,465.00	3
35	14-0060	5187	370 N 1060 W (Easement)	1081 W 400 N	North	This line has tree roots throughout it. R	Line	8	159.90	$4,797.00	1
36	14-0068	5188	1081 W 400 N	1060 W 400 N S	West	Found light roots at 55.5' & 60.4'	Line	10	63.40	$2,662.80	0
37	14-0041	5128	337 N 1030 W	270 N 1030 W	South	Found tree roots at 209' and again fron	Line	8	427.30	$12,819.00	5
38	14-0039	2181	230 N 1030 W	270 N 1030 W	North	This line has roots coming in in 6-7 plac	Line	8	274.40	$8,232.00	7
40	11-0071	3439	930 N 100 W	900 N 100 W	South	This line is showing aggregation. There	Line	8	156.50	$4,695.00	1
41	16-0145	5591	No manhole	400 N 500 E	North	This line has several small bellies. Foun	Line	8	300.90	$9,027.00	5
42	11-0079	3431	25 W 900 N	76 W 900 N	West	Pipe is showing aggregation, cracks and	Line	6	326.80	$9,411.84	3
43	11-0142	3404	900 N 350 E	864 N 350 E	South	Found roots coming in on alot of the jo	Line	8	338.00	$10,140.00	6

44	11-0134	3507	1000 N 300 E	250 E 1000 N	West	There is a belly from the downstream M	Line	8	324.20	$9,726.00	6
45	12-0127	5669	600 E 700 N	696 N 600 E	South	These lines have severe aggregation, be	Line	8	128.30	$3,849.00	1
46	12-0201	5670	696 N 600 E	660 N 600 E	South	These lines have severe aggregation	Line	8	159.40	$4,782.00	3
47	12-0129	3555	660 N 600 East	653 N 600 East	South	These lines have severe aggregation, r	Line	8	171.90	$5,157.00	2
48	12-0126	3554	653 N 600 East	600 E 640 North	South	These lines have severe aggregation, ro	Line	8	77.60	$2,328.00	1
49	12-0130	3553	600 E 640 North	600 E 600 North	South	These lines have severe aggregation, ro	Line	8	250.00	$7,500.00	3
50	12-0065	6761	720 N 1000 E	698 N 1000 E	South	This line is showing aggration and tree	Line	8	128.00	$3,840.00	0
51	12-0190	3528	698 N 1000 E	680 N 1000 E	South	This line is showing aggration and tree	Line	8	139.90	$4,197.00	2
52	34-0001	934	200 S 1400 S	200 S 1417 S	South	Line has grease and is showing severe a	Line	8	117.70	$3,389.76	1
53	20-0023	5593	105 S 800 W	134 S 800 W	South	Found several light cracks in this line as	Line	10	204.50	$6,135.00	3
54	20-0221	7248	134 S 80 W	165 S 800 W	South	This line is showing moderate aggregat	Line	10	198.80	$5,964.00	1
55	20-0024	5594	165 S 800 W	210 S 800 W	South	This line is showing moderate aggregat	Line	10	332.10	$9,963.00	3
56	20-0025	5595	210 S 800 west	239 S 800 W	South	This line is showing aggregation.	Line	10	115.60	$3,468.00	2
57	20-0152	172	750 W Center St	800 W Center st	West	This line is showing aggregation	Line	15	322.70	$15,489.60	6
58	20-0173	124	Center St 800 W	Center St 853 W	West	This line is showing aggregation.	Line	15	379.10	$18,196.80	0
59	20-0153	173	700 w Center St	750 W Center St	West	This line is showing aggregation.	Line	15	362.70	$17,409.60	3
60	20-0154	174	645 W Center St	700 W Center St	West	This line is showing aggregation.	Line	15	330.60	$15,868.80	2
61	20-0155	175	600 W Center St	645 W Center St	West	This line is showing aggregation.	Line	15	329.40	$15,811.20	0
62	20-0156	176	580 W Center St	600 W Center St	West	This line is showing aggregation.	Line	15	135.00	$6,480.00	0
63	20-0157	177	520 W Center St	580 W Center St	West	This line is showing aggregation.	Line	15	203.30	$9,758.40	0
64	20-0176	178	500 W Center St	520 W Center St	West	This line is showing aggregation.	Line	15	337.48	$16,199.04	0
65	20-0175	179	450 W Center St	500 W Center St	West	This line is showing aggregation.	Line	15	340.40	$16,339.20	1
66	20-0177	658	500 W Center St	400 W Center St	West	This line is showing aggregation.	Line	15	260.30	$12,494.40	0
67	20-0158	180	400 W Center St	360 W Center Street	West	This line is showing aggregation	Line	15	330.20	$15,849.60	0
68	20-0177	657	400 W Center Street	400 W Center Street (w)	West	This line is showing aggregation	Line	15	28.10	$1,787.16	
69	16-0095	605	163 W 400 North	175 W 400 North	West	This line is showing aggregation	Line	12	120.00	$5,040.00	1
70	16-0210	649	175 W 400 N	400 N Orem Boulevard	West	This line is showing aggregation	Line	12	248.10	$10,420.20	3
71	15-0192	650	400 N Orem Boulevard	243 W 400 North	West	This line is showing aggregation	Line	12	150.90	$6,337.80	3
72	15-0044	5842	243 W 400 North	255 W 400 North	West	This line is showing aggregation	Line	12	95.80	$4,023.60	1
73	15-0208	5843	255 W 400 North	280 W 400 North	West	This line is showing aggregation	Line	12	76.30	$3,204.60	1
74	15-0041	146	347 W 400 N orth	355 W 400 North	Weat	This line is showing aggregation	Line	12	21.40	$898.80	0
75	15-0040	145	355 W 400 North	370 W 400 North	West	This line is showing aggregation	Line	12	169.20	$7,106.40	1
76	15-0039	144	370 W 400 North	400 W 400 North	West	This line is showing aggregation	Line	12	145.70	$6,119.40	0
77	15-0038	143	400 W 400 North	450 W 400 North	West	This line is showing aggregation	Line	12	292.78	$12,296.76	2
78	15-0037	142	450 W 400 North	500 W 400 North	West	This line is showing aggregation	Line	12	372.60	$15,649.20	5
79	15-0036	141	500 W 400 North	550 W 400 North	West	This line is showing aggregation	Line	12	293.30	$12,318.60	3
80	15-0035	139	550 W 400 North	600 W 400 North	West	This line is showing aggregation	Line	12	372.50	$15,645.00	5
81	15-0035	140	550 W 400 North	555 W 400 North	West	This line is showing aggregation	Line	12	42.00	$2,016.00	0
82	15-0033	138	600 W 400 North	660 W 400 North	West	This line is showing aggregation	Line	12	366.80	$15,405.60	3
83	15-0032	137	660 W 400 North	720 W 400 North	West	This line is showing aggregation	Line	12	306.40	$12,868.80	3
84	15-0031	136	720 W 400 North	725 W 400 North	West	This line is showing aggregation	Line	12	181.60	$7,627.20	0
85	15-0030	533	725 W 400 North	760 W 400 North	West	This line is showing aggregation	Line	12	240.50	$10,101.00	0
86	15-0211	135	760 W 400 North	783 W 400 North	West	This line is showing aggregation	Line	15	122.90	$5,899.20	0
87	15-0028	134	783 W 400 North	800 W 400 North	West	This line is showing aggregation	Line	15	122.70	$5,889.60	0
88	15-0027	133	800 W 400 North	850 W 400 North	West	This line is showing aggregation	Line	15	315.70	$15,153.60	0
89	15-0026	132	850 W 400 North	900 W 400 North	West	This line is showing aggregation	Line	15	325.60	$15,628.80	3

90	15-0025	131	900 W 400 North	955 W 400 North	West	This line is showing aggregation	Line	15	475.60	$22,828.80	0
91	14-0043	130	955 W 400 North	1010 W 400 North	West	This line is showing aggregation	Line	15	156.60	$7,516.80	0
92	14-0044	129	1010 W 400 North	1030 W 400 North	West	This line is showing aggregation	Line	15	230.10	$11,044.80	0
93	14-0045	128	1030 W 400 North	1060 W 400 North	West	This line is showing aggregation	Line	15	202.80	$9,734.40	0
94	14-0046	127	1060 W 400 Norh	1130 W 400 North	West	This line is showing aggregation	Line	15	461.10	$22,132.80	0
95	14-0047	126	1130 W 400 North	1150 W 400 North	West	This line is showing aggregation	Line	15	176.10	$8,452.80	0
96	14-0048	546	1150 W 400 North	1200 W 400 North	West	This line is showing aggregation	Line	15	296.60	$14,236.80	0
97	11-0034	3364	703 N Orchard Drive	693 N Atlantis	West	This line has aggregation, cracks and br	Line	8	327.40	$9,822.00	0
								Pipe Size	**Feet**	**Estimated Price/Ft**	
								6"	**835.90**	**$28.80**	**$24,073.92**
								8"	**10,103.26**	**$30.00**	**$303,097.80**
								10"	**851.00**	**$42.00**	**$35,742.00**
								12"	**3,495.88**	**$48.00**	**$167,802.24**
								15"	**6,245.08**	**$63.60**	**$397,187.09**
								Total FT	**21,531.12**	**Estimated Price/MH**	**$927,903.05**
								Manholes	**0**	**$3,200.00**	**$0.00**
								Laterals Reconnect	**208**	**$129.00**	**$26,832.00**
								Total Segments	**97**	**Total**	**$954,735.05**

16	06-0117	492	690 W 1200 North	700 W 1200 North	West	This line is showing aggregation.	Line	18	62.70	$4,389.00	0
17	06-0118	493	660 W 1200 North	690 W 1200 North	West	This line is showing aggregation.	Line	15	284.10	$17,046.00	1
18	06-0119	494	650 W 1200 North	660 W 1200 North	West	This line is showing aggregation.	Line	15	52.20	$3,132.00	0
19	06-0120	495	625 W 1200 North	650 W 1200 North	West	This line is showing aggregation.	Line	15	156.30	$9,378.00	2
20	06-0121	496	600 W 1200 North	625 W 1200 North	West	This line is showing aggregation.	Line	15	181.90	$10,914.00	2
21	06-0122	497	541 W 1200 North	600 W 1200 North	West	This line is showing aggregation.	Line	15	323.80	$19,428.00	4
									3,916.00	**$264,137.00**	**31**
South- 400 S Street											
1	25-0171	362	400 S 800 West	400 S 850 West	West	This line is showing aggregation.	Line	12	343.10	$16,468.80	5
2	25-0175	361	400 S 850 West	400 S 900 West	West	This line is showing aggregation.	Line	12	253.30	$12,158.40	6
									596.40	**$28,627.20**	**11**
South- 2000 S Street											
1	37-0032	294	2000 S Main Street	50 W 2000 S	West	This line is showing aggregation.	Line	12	323.1	$15,508.80	2
2	37-0015	6292	50 W 2000 S	50 W 2000 South (W)	West	This line is showing aggregation.	Line	12	19.4	$931.20	0
3	37-0147	293	50 W 2000 South (W)	100 W 2000 South	West	This line is showing aggregation.	Line	12	302.7	$14,529.60	2
4	37-0016	655	100 W 2000 South	125 W 2000 South	West	This line is showing aggregation.	Line	12	179.6	$8,620.80	0
5	37-0105	656	150 W 2000 South	150 W 2000 South	West	This line is showing aggregation.	Line	12	152.2	$7,305.60	0
6	37-0017	292	150 W 2000 South	180 W 2000 South	West	This line is showing aggregation.	Line	12	245.2	$11,769.60	1
7	37-0018	291	180 W 2000 South	188 W 2000 South	West	This line is showing aggregation.	Line	12	87.5	$4,200.00	0
8	37-0019	290	188 W 2000 South	255 W 2000 South	West	This line is showing aggregation.	Line	12	257.10	$12,340.80	5
9	36-0001	5397	255 W 2000 South	255 W 2000 South	West	This line is showing aggregation.	Line	12	75.20	$3,609.60	1
10	36-0037	7052	255 W 2000 South	279 W 2000 South	West	This line is showing aggregation.	Line	12	327.70	$15,729.60	6
11	36-0002	289	279 W 2000 South	370 W 2000 South	West	This line is showing aggregation.	Line	12	335.90	$16,123.20	3
									2,305.60	**$110,668.80**	**20**
South- 1600 S Street											
1	34-0081	40	Main Street & 1600 South	50 W 1600 South	West	This line is showing aggregation.	Line	15	327.50	$19,650.00	2
2	34-0080	39	50 W 1600 South	120 W 1600 South	West	This line is showing aggregation.	Line	15	328.40	$19,704.00	4
3	34-0079	7061	120 W 1600 South	1600 S 150 West	West	This line is showing aggregation.	Line	15	165.00	$9,900.00	3
4	34-0079	597	1600 S 150 West	Lakewood & 1600 South	West	This line is showing aggregation.	Line	15	149.30	$8,958.00	0
									970.20	**$58,212.00**	**9**
North- 640 W Street											
1	15-0095	2231	543 N 640 West	640 W 500 North	South	This line has roots and aggregation.	Line	8	275.00	$6,875.00	6
									275.00	**$6,875.00**	**6**
North- 350 E Street											
1	11-0147	3403	864 N 350 East	350 East 800 North	South	Found light roots just outside of Mh at lateral a	Line	8	335.00	$8,375.00	4
2	11-0141	3414	951 N 350 East	900 N 350 East	South	Line is showing aggregation and roots	Line	8	343.30	$8,582.50	6
									678.30	**$16,957.50**	**10**
North- 900 N Street											
1	11-0146	3411	900 N 400 East	900 N 350 East	West	Line is showing aggergation. Line is Line has tre	Line	8	329.80	$8,245.00	5
									329.80	$8,245.00	5
North- 700 N Street											
1	11-0040	3366	282 E 700 North	232 E 700 North	West	Found roots in 15 joints from 135.7' to top of li	Line	8	403.70	$10,092.50	12
									403.70	**$10,092.50**	**12**
North - Nue Vue & Orchard Dr Streets											
1	11-0046	4581	269 E Nue Vue Cr	633 N Orchard Drive	West	Line has aggreation, cracks and broken section	Line	6	210.00	$7,980.00	6
2	11-0033	4582	633 N Orchard Drive	703 N Orchard Drive	North	Line has aggreation, roots and broken sections.	Line	8	472.20	$11,805.00	10
3	16-0161	4580	Orchard Drive & 600 North	633 N Orchard Drive	North	Line has aggreation. Lining needed	Line	8	292.80	$7,320.00	5
									975.00	**$27,105.00**	**21**

Completed 2019 - Sewer Main Lining Projects Routine Elimination and H2S Rehabilitation

Pipe Segments	GPS #	Pipe ID	Up Stream M/H Address	Down Stream M/H Address	Flow Direction	Problem	Lined or Replace (RR)	Pipe Size	Length	Cost /Line	Laterals
South	**South - 900 S Street**										
1	30-0049	213	900 S 400 West	440 W 900 South	West	This line is showing aggregation.	Line	21	209.80	$20,980.00	1
2	30-0094	589	440 W 900 South	520 W 900 South	West	This line is showing aggregation.	Line	21	395.60	$39,560.00	2
3	30-0113	590	520 W 900 South	UVU Parking lot 004	West	This line is showing aggregation.	Line	21	245.80	$24,580.00	0
4	30-0132	6719	UVU Parking lot 004	UVU Parking lot 005	West	This line is showing aggregation.	Line	21	249.20	$24,920.00	0
5	30-0133	6720	UVU Parking lot 005	597 W 925 South	West	This line is showing aggregation.	Line	21	187.70	$18,770.00	1
6	30-0082	212	597 W 925 South	605 W 925 South	West	This line is showing aggregation.	Line	21	144.20	$14,420.00	0
7	30-0080	211	605 W 925 South	617 W 925 South	West	This line is showing aggregation.	Line	21	177.00	$17,700.00	2
8	30-0079	210	617 W 925 South	635 W 925 South	West	This line is showing aggregation.	Line	21	86.60	$8,660.00	1
9	30-0077	209	635 W 925 South	683 W 925 South	West	This line is showing aggregation.	Line	21	372.70	$37,270.00	3
10	30-0076	208	683 W 925 South	700 W 925 South	North	This line is showing aggregation.	Line	21	157.60	$15,760.00	2
11	30-0074	207	700 W 925 South	904 S 725 West	North	This line is showing aggregation.	Line	21	161.00	$16,100.00	2
12	30-0073	206	904 S 725 West	850 S 725 West	North	This line is showing aggregation.	Line	21	390.80	$39,080.00	7
13	30-0072	205	850 S 725 West	800 S 725 West	North	This line is showing aggregation.	Line	21	394.30	$39,430.00	4
									3,172.30	**$174,000.00**	**21**
Nort	**North- 675 N Street**										
1	10-0093	591	700 N 800 West	670 N 800 West	South	This line is showing aggregation.	Line	15	169.00	$10,140.00	1
2	10-0091	161	670 N 800 West	831 W 675 North	West	This line is showing aggregation.	Line	15	254.50	$15,270.00	3
3	10-0082	6647	831 W 675 North	847 W 675 North	West	This line is showing aggregation.	Line	15	70.30	$4,218.00	1
4	10-0009	160	847 W 675 North	675 N 900 West (E)	West	This line is showing aggregation.	Line	15	333.70	$20,022.00	7
5	10-0081	159	675 N 900 West €	675 N 900 West (W)	West	This line is showing aggregation.	Line	15	18.80	$1,128.00	0
6	10-0080	158	675 N 900 West (W)	916 W 675 North	West	This line is showing aggregation.	Line	15	131.10	$7,866.00	1
7	09-0026	157	916 W 675 North	945 W 675 North	West	This line is showing aggregation.	Line	15	134.90	$8,094.00	4
8	09-0025	156	945 W 675 North	675 N 980 West	West	This line is showing aggregation.	Line	15	273.80	$16,428.00	4
9	09-0023	155	675 N 980 West	1021 W 675 North	West	This line is showing aggregation.	Line	15	338.40	$20,304.00	6
10	09-0029	154	1021 W 675 North	675 N 1060 West	West	This line is showing aggregation.	Line	15	359.10	$21,546.00	8
									2,083.60	**$125,016.00**	**35**
North- 1200 N Street											
1	05-0016	479	1125 W 1200 North	1134 W 1200 North	West	This line is showing aggregation.	Line	18	79.40	$5,558.00	0
2	05-0022	480	1101 W 1200 North	1125 W 1200 North	West	This line is showing aggregation.	Line	18	177.60	$12,432.00	3
3	05-0017	481	1050 W 1200 North	1101 W 1200 North	West	This line is showing aggregation.	Line	18	318.40	$22,288.00	4
4	05-0018	482	1050 W 1200 North (e)	1050 W 1200 North	West	This line is showing aggregation.	Line	18	11.90	$833.00	0
5	05-0028	483	1015 W 1200 North	1050 W 1200 North (e)	West	This line is showing aggregation.	Line	18	242.30	$16,961.00	0
6	05-0163	6666	1005 W 1200 North	1015 W 1200 North	West	This line is showing aggregation.	Line	18	88.60	$6,202.00	0
7	05-0030	484	980 W 1200 North	1005 W 1200 North	West	This line is showing aggregation.	Line	18	162.20	$11,354.00	0
8	05-0031	485	950 W 1200 North	980 W 1200 North	West	This line is showing aggregation.	Line	18	219.60	$15,372.00	2
9	06-0108	486	900 W 1200 North	950 W 1200 North	West	This line is showing aggregation.	Line	18	285.40	$19,978.00	2
10	06-0097	487	850 W 1200 North	900 W 1200 North	West	This line is showing aggregation.	Line	18	333.00	$23,310.00	4
11	06-0098	488	800 W 1200 North	850 W 1200 North	West	This line is showing aggregation.	Line	18	340.00	$23,800.00	3
12	06-0109	489	760 W 1200 North	800 W 1200 North	West	This line is showing aggregation.	Line	18	244.50	$17,115.00	2
13	06-0110	490	750 W 1200 North	760 W 1200 North	West	This line is showing aggregation.	Line	18	20.40	$1,428.00	0
14	06-0234	491	746 W 1200 North	750 W 1200 North	West	This line is showing aggregation.	Line	18	62.80	$4,396.00	0
15	06-0116	6885	700 W 1200 North	746 W 1200 North	West	This line is showing aggregation.	Line	18	268.90	$18,823.00	2

North- 750 E Street											
1	17-0149	2886	580 N 700 East	500 N 700 East	South	Line has aggregation, roots and hole that needs	Line	8	396.30	$9,907.50	8
									396.30	**$9,907.50**	**8**
North- 470 N & 1200 E Street											
1	17-0113	3307	1168 E 470 North	470 N 1120 East	West	Line has aggregation found cracked pipe at the	Line	8	247.40	$6,185.00	5
2	17-0112	3304	470 N 1120 East	435 N 1120 East	South	Line has aggregation and roots through out	Line	8	240.30	$6,007.50	2
									487.70	**$12,192.50**	**7**
North- 810 N Street											
1	12-0023	3610	840 E 840 North	800 E 840 North		Line has aggregation, roots and broken pipe	Line	8	283.10	$7,077.50	1
									283.10	**$7,077.50**	**1**
North- 600 E Street											
1	12-0145	5225	600 E 800 North	795 N 600 East	South	Severe aggregation	Line	8	26.60	$665.00	0
2	12-0183	5226	795 N 600 East	735 N 600 East	South	Severe aggregation	Line	8	364.80	$9,120.00	2
3	12-0144	3573	735 N 600 East	600 E 700 North	South	Severe aggregation	Line	8	121.00	$3,025.00	0
4	17-0171	3354	600 E 600 North	Pleasant Drive & 600 North		Severe aggregation	Line	8	348.30	$8,707.50	5
									860.70	**$21,517.50**	**7**
North- 600 N Street											
1	16-0186	3357	Pleasant Drive & 600 North	500 E 600 North	West	Severe aggregation	Line	8	329.20	$8,230.00	4
2	16-0205	3355	450 E 600 North	600 N 400 East	West	Severe aggregation	Line	8	336.40	$8,410.00	4
3	17-0171	3354	600 E 600 North	Pleasant Drive & 600 North	West	Severe aggregation	Line	8	348.37	$8,709.25	5
									1,013.97	**$25,349.25**	**13**
North - 800 E Street											
1	27-0090	1577	560 S 800 East	605 S 800 East	South	Severe aggregation	Line	8	329.30	$8,232.50	3
2	27-0089	1572	605 S 800 East	647 S 800 East	South	Severe aggregation throughout it and cracked p	Line	8	312.50	$7,812.50	0
3	27-0088	1571	647 S 800 East	700 S 800 East	South	Severe aggregation throughout it and cracked p	Line	8	348.30	$8,707.50	4
4	27-0087	1562	700 S 800 East	771 S 800 East	South	Severe aggregation	Line	8	331.30	$8,282.50	3
5	27-0086	1561	771 S 800 East	800 E 800 South	South	This line needs to be lined, found cracks, roots,	Line	8	343.20	$8,580.00	3
6	27-0006	5438	800 E 800 South	859 S 800 East	South	Found light roots in several places in this line. F	Line	10	326.10	$9,130.80	3
7	32-0039	1549	859 S 800 East	900 S 800 East	South	Line has aggregation and cracks through out	Line	10	326.00	$9,128.00	3
8	32-0040	1322	931 S 800 East	931 S 800 East	South	Line has aggregation,roots & broken pipe at the	Line	10	183.50	$5,138.00	2
9	32-0041	1321	931 S 800 East	945 S 800 East	South	Line is showing aggregation	Line	10	146.30	$4,096.40	2
									2,646.50	**$69,108.20**	**23**
South- 950 S Street											
1	31-0152	4334	850 S 181 W	850 S 150 W	East	This line has several small bellies and is showing	Line	8	205	$5,125.00	5
2	31-0055	5314	142 W 850 South	850 S 150 West	West	Found cracks in this line at each connection. Re	Line	6	150	$5,700.00	4
									355	**$10,825.00**	**9**
North- 1200 W Street											
1	09-0047	265	776 N 1200 West	760 N 1200 West	South	This line is showing aggregation.	Line	24	266.10	$39,915.00	0
2	09-0046	264	760 N 1200 West	720 N 1200 West	South	This line is showing aggregation.	Line	24	70.90	$10,635.00	1
3	09-0045	593	720 N 1200 West	675 N 1200 West	South	This line is showing aggregation.	Line	24	163.20	$24,480.00	1
4	09-0044	594	675 N 1200 West	650 N 1200 West	South	This line is showing aggregation.	Line	24	166.20	$24,930.00	1
5	09-0043	595	650 N 1200 West	640 N 1200 West	South	This line is showing aggregation.	Line	24	71.10	$10,665.00	0
									737.50	**$110,625.00**	**3**
South- 1450 S Street											
1	34-0025	927	100 E 1430 S	86 E 1475 South	West	This line is flaky and very aggregate. Found a cr	Line	8	138.30	$3,457.50	2
2	34-0050	926	86 E 1475 South	1450 S 74 East	West	Hole in pipe at 34', looks like from a fence post,	Line	8	120.60	$3,015.00	4
3	34-0037	925	1450 S 74 East	1450 S 50 East	West	Lining Needed.	Line	8	171.50	$4,287.50	0
4	34-0038	924	1450 S 50 East	16 E 1450 South	West	Lining Needed	Line	8	276.00	$6,900.00	2

5	34-0047	922	16 E 1450 South	16 E 1450 South	West	Lining Needed	Line	8	53.00	$1,325.00	1
6	34-0048	921	16 E 1450 South	Main 1450 South	West	Lining Needed	Line	8	47.00	$1,175.00	0
7	34-0049	684	Main 1450 South	53 W 1460 South (under Grass	West	Lining Needed	Line	10	355.60	$9,956.80	7
8	34-0181	685	53 W 1460 South (under Grass	80 W 1512 South	West	Lining Needed	Line	10	255.20	$7,145.60	2
9	34-0055	26	80 W 1512 South	100 W Hidden Hollow (easeme	West	Lining Needed	Line	10	123.50	$3,458.00	1
10	34-0057	5169	100 W Hidden Hollow (easeme	145 W Hidden Hollow Drive	West	Lining Needed	Line	10	451.20	$12,633.60	4
11	34-0068	27	145 W Hidden Hollow Drive	1600 S Hidden Hollow Drive	West	Lining Needed	Line	10	410.70	$11,499.60	0
									2,402.60	**$64,853.60**	**23**
South -720 S Street (Easement)											
1	26-0069	5365	387 E 720 South	250 E 720 South	West	Lining needed	Line	6	478.27	$18,174.26	7
									478.27	**$18,174.26**	**7**

Pipe Size	**Feet**	**Estimated Price/Ft**	
6"	**838.27**	**$38.00**	**$31,854.26**
8"	**7,773.27**	**$25.00**	**$194,331.75**
10"	**2,578.10**	**$28.00**	**$72,186.80**
12"	**2,902.00**	**$48.00**	**$139,296.00**
15"	**4,052.10**	**$60.00**	**$243,126.00**
18"	**2,917.70**	**$70.00**	**$204,239.00**
21"	**3,172.30**	**$100.00**	**$317,230.00**
24"	**737.50**	**$150.00**	**$110,625.00**
Total FT	**24,233.74**	**Estimated Price/MH**	
Manholes	**0**	**$3,200.00**	**$0.00**
Laterals Reconnect	**282**	**$120.00**	**$33,840.00**
Total Segments	**108**	**Total**	**$1,346,728.81**

DRAPER, UTAH OFFICE
154 E 14075 S
DRAPER, UTAH 84020
PHONE: 801.495.2224

BOISE, IDAHO OFFICE
776 E RIVERSIDE DRIVE
SUITE 250
EAGLE, IDAHO 83616
PHONE: 208.939.9561

ST. GEORGE, UTAH OFFICE
20 NORTH MAIN
SUITE 107
ST.GEORGE, UTAH 84770
PHONE: 435.656.3299

OGDEN, UTAH OFFICE
2036 LINCOLN AVENUE
SUITE 104
OGDEN, UTAH 84401
PHONE: 801.495.2224

BOWEN COLLINS
& ASSOCIATES

WWW.BOWENCOLLINS.COM