2020

WASTEWATER COLLECTION MASTER PLAN

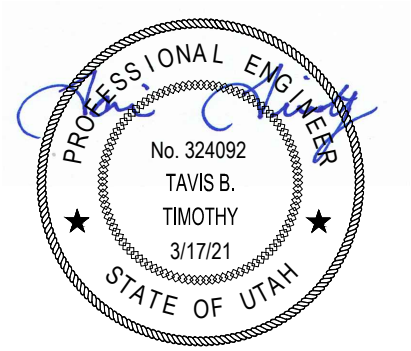
Addendum

HIGHLAND CITY

Highland City Public Works
Highland City
December, 2020

HIGHLAND CITY

WASTEWATER COLLECTION SYSTEM MASTER PLAN
2020 AMENDMENT



Project Manager

December 2020

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EXECUTIVE SUMMARY

INTRODUCTION

The original Wastewater Collection Master Plan (WWMP) was prepared in 2007. Since the initial planning effort, the City population has grown by nearly 50%. The City has also constructed a number of capital improvement projects outlined in the WWMP. Consequently, the City desired an update to their Capital Facility Plan and additional wastewater collection planning for the undeveloped parcels in the City. This document was prepared as an amendment to the 2007 WWMP, as a sizeable amount of information contained therein is still pertinent.

This Executive Summary provides a brief overview of the efforts and recommendations provided within this amendment.

PURPOSE

The purpose of this master plan amendment is to evaluate the existing and future wastewater collection system needs. The evaluation will provide necessary capital facilities to meet existing deficiencies and future growth demands.

WASTEWATER SYSTEM MODELING

A new hydraulic model was created with data provided from the original model, GIS information, and updated residential loading. The original 2007 level of service of 350 gallons per day (gpd) per equivalent residential unit (ERU) was found to be reasonable for the updated modeling. 350 gpd/ERU was utilized in developing wastewater loading. Autodesk Storm and Sanitary Analysis (SSA) was selected as the modeling software. Three separate modeling scenarios were developed:

Model 1) Existing system with existing loading to determine existing deficiencies.
Model 2) Existing system with build-out loading to determine deficiencies from new growth.
Model 3) Proposed system with build-out loading to adequately size pipelines for build-out flows.

COLLECTION SYSTEM EVALUATION

Highland's existing collection system is comprised of gravity lines, pressurized force mains and sewage pump stations. The City's sanitary sewer lines ultimately flow into Timpanogos Special Service District's trunk lines that transport sewage to their wastewater reclamation facility. The existing system was evaluated with the hydraulic model to determine likely line capacity issues. Once a line was determined to have limited existing capacity it was field verified with City staff. Deficient lines were then analyzed with future buildout loading to determine an adequate size for the pipeline improvement. Pump stations were evaluated against build-out flows anticipated at the facility.

CAPITAL FACILITY PLAN

Improvements to the collection system were placed within a Capital Facility Plan (CFP). The CFP was developed to assist Highland in budgeting for recommended improvements. The following table provides a description of the improvements, anticipated construction dates and an estimate of probable costs.

CAPITAL FACILITY PLAN
TABLE ES-1

ID	PROJECT DESCRIPTION	ANTICIPATED CONSTRUCTION YEAR	CONSTRUCTION COST ESTIMATE
1	12" Pipe Replacement in 10480 North	2025	$ 419,000
2	12" Pipe Replacement in Country Club Drive	2022	$ 1,050,000
3	12" Pipe Replacement in Dry Creek Circle	2022	$ 398,000
4	Pheasant Hollow Pump Station	2022	$ 987,000
5	Victor's View Gravity Line	2021	$ 737,000
6	12" Pipe Replacement in 6800 West	10+ Yrs. - TBD	$ 708,000

The cost estimates presented are budget level and reflect current 2020 pricing. They include a 20% allotment for contingencies and 15% for engineering, construction management services and administration costs.

CHAPTER 1

INTRODUCTION

BACKGROUND

The original Wastewater Collection Master Plan (WWMP) was prepared in 2007. Since the initial planning efforts, the City population has grown by nearly 50%. The City has also constructed a number of capital improvement projects outlined in the 2007 WWMP. Consequently, the City desired an update to their Capital Facility Plan and additional wastewater collection planning for the undeveloped parcels in the City. This document was prepared as an amendment to the 2007 WWMP, as a sizeable amount of information contained therein is still pertinent.

PURPOSE

The purpose of this master plan amendment is to evaluate the existing and future wastewater collection system needs. The evaluation will provide necessary capital facilities to meet existing deficiencies and future growth demands.

As an amendment to the 2007 WWMP, only updated and pertinent items are included in this document.

CHAPTER 2

EXISTING WASTEWATER COLLECTION SYSTEM

SERVICE AREA

This master plan is a study of Highland City's wastewater collection system. The study area therefore includes the area within the municipal boundaries of the City and areas likely to be annexed.

EXISTING WASTEWATER COLLECTION SYSTEM

The existing Highland City wastewater collection system consists of both gravity and force main pipelines, manholes and several pump stations as shown in Figure 2-1. The majority of pipe sizes are 8-inch diameter and 10-inch diameter with a few trunk lines being 12-inches. The city's wastewater outfalls into Timpanogos Special Service District's (TSSD) large collector pipes that then gravity flows to the TSSD treatment facility. Table 2-1 summarizes the existing wastewater pump station information and capacities. The rated capacity listed in the table is based on information provided by the City.

TABLE 2-1
EXISTING HIGHLAND CITY-OWNED WASTEWATER PUMP STATIONS

IDENTIFICATION	LOCATION	RATED CAPACITY
Highland Hollow Pump Station	7200 W 10500 N	225 gpm
Pheasant Hollow Pump Station	9700 N 5300 W	300 gpm
The Greens on the Highlands Pump Station	4790 W 10600 N	205 gpm
Dry Creek Bench Pump Station	6151 W 11630 N	850 gpm
Victor's View Pump Station	6673 W 10770 N	200 gpm

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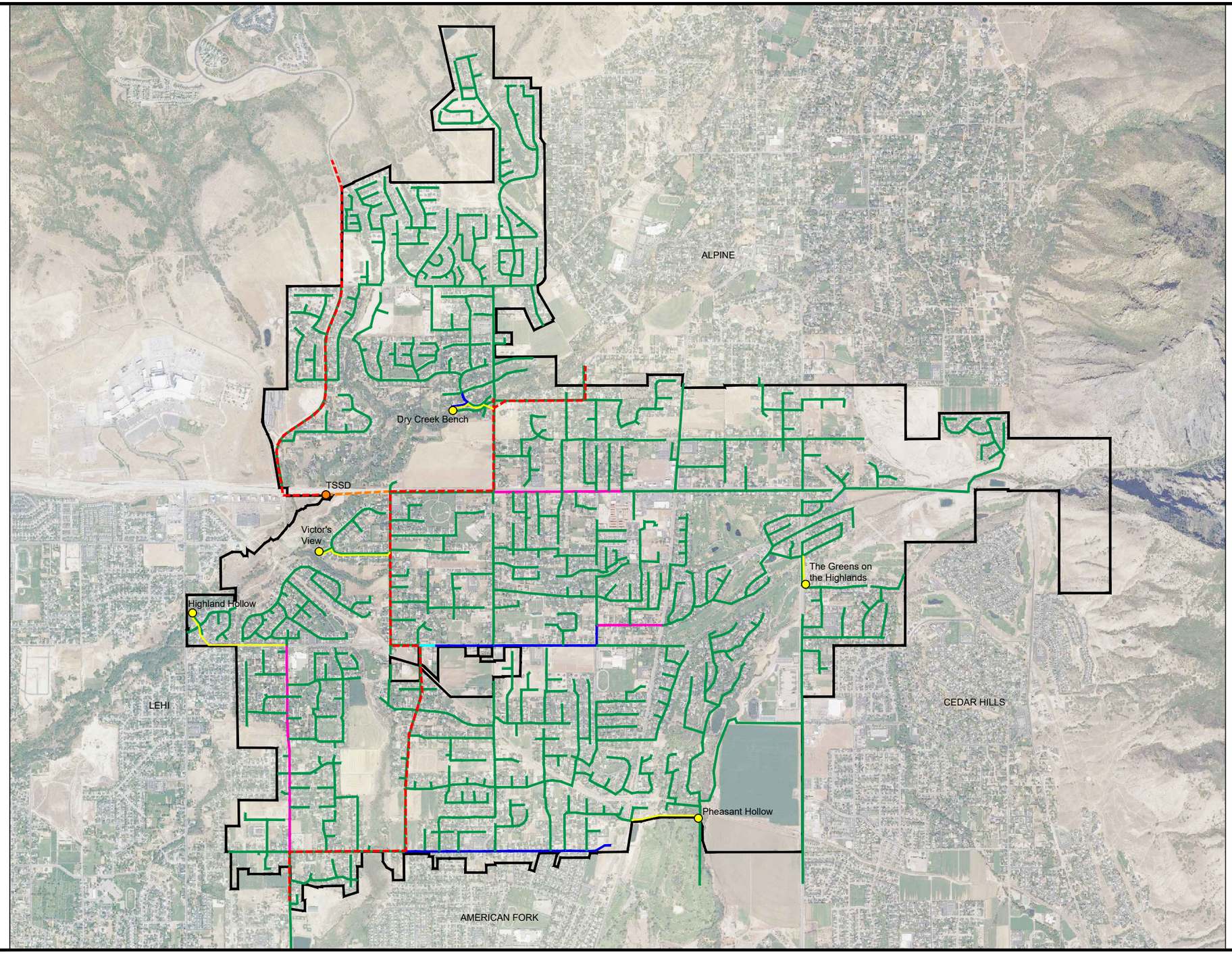

FILE NAME: USERS\BRADF\DROPBOX\HIGHLAND CITY\SSMP UPDATE\FIGURE 2-1.DWG

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HIGHLAND CITY WWMP 2020 AMENDMENT
EXISTING SYSTEM MAP

FIGURE 2-1

CHAPTERS 3 & 4

FLOW MONITORING & CHARACTERIZATION

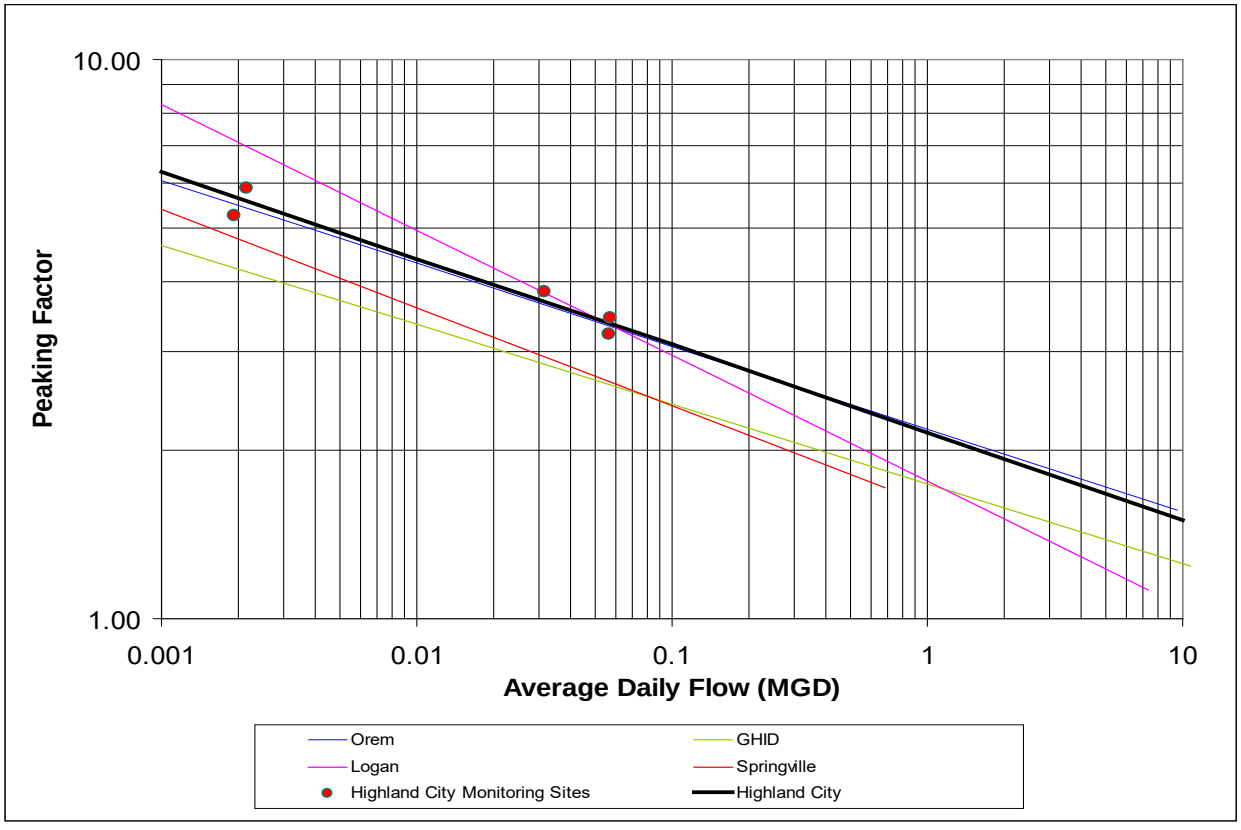
FLOW MONITORING SINCE 2007

Since the original flow monitoring completed for the 2007 WWMP, the City has requested additional monitoring on specific trunk lines. The monitoring was utilized to evaluate the need for replacement of lines recommended in the WWMP. Monitoring took place in 2016 and 2018. Overall, the recent flow monitoring found that the conclusions provided in the WWMP are still reliable.

PEAKING FACTORS

The peaking factor is the ratio between the peak hourly flow and the average daily flow. Flow monitoring data and TSSD data provide that the peaking factor determined in 2007 for Highland is still reasonable. This is likely due to the fact that Highland City is mostly a residential community with the majority of new development, since 2007, being single family residential. The peaking factor curve developed for Highland City in 2007 is provided in Figure 4-1.

FIGURE 4-1
PEAKING FACTOR COMPARISON



The peak day flow in gpm can also be determined with the following equation:

$$Peak\ Day\ Flow = Avg\ Day\ Flow \times 2.1517 \times (ERCs \times 350 / 1{,}000{,}000)^{-0.156}$$

INFLOW, INFILTRATION & EXTRAORDINARY FLOWS

It was determined to maintain the original WWMP recommendation of 25 gpd in addition to the average wastewater flow to account for infiltration, inflow, and extraordinary flows. The City has been lining older concrete pipes in order to decrease infiltration. However, extraordinary flows still require the 25 gpd addition to the average flow.

UNIT FLOWS

Residential

Residential wastewater flows are those flows discharged by the plumbing system of a typical residence. Residential wastewater consists of the discharges from sinks, bathtubs, showers, and toilets. Residential wastewater unit flows are typically expressed as gallons per capita per day (gpcd).

The State of Utah standard for designing sewers is 100 gpcd for a wastewater unit flow if no other data are available, which includes infiltration. Flow monitoring and TSSD data provide that the WWMP's recommendation of 55 gpcd is still valid. Residential unit flow is then 55 gpcd for residential wastewater flow plus 25 gpcd to account for infiltration, inflow and extraordinary flow events. An 80 gpcd residential wastewater unit flow with 4.37 people per household was used for the existing wastewater collection system model and for the future build-out model. A 350 gpd/ERC was determined as the level of service for the system.

Non-Residential

Commercial, institutional and industrial (hereafter referred to as non-residential) wastewater flows typically vary from residential flows both in terms of quantity and diurnal pattern. For this master plan, the existing non-residential wastewater connections were converted into ERUs based on water use. Using 2018 winter billing data, each non-residential wastewater connection was assigned ERUs by dividing the average water use by the average water use of a residential connection. Non-residential connections using about the same or less water than a residential unit were assigned an ERU of one.

CHAPTER 5

LAND USE, POPULATION AND WASTEWATER FLOW PROJECTIONS

PLANNING PERIOD

Highland City selected a build-out development condition for the master planning effort. This approach eliminates consideration of time.

FLOW PROJECTIONS FOR HIGHLAND CITY

It was determined through lot counts and non-residential water meter data that there were currently 4,616 ERUs in the study area. A map showing the existing system demands and the location where those demands were loaded in the model can be found in Appendix A Figure 100. For the purposes of this amendment, an 80 gpcd residential wastewater unit flow with 4.37 people per household was used for the existing wastewater collection system model and for the future build-out model. The current population of Highland is approximately 20,000.

The future flows were estimated by delineating undeveloped areas throughout the City where future development is likely. The future number of ERUs was estimated based on zoning and discussion with the City. Generally, for residential areas a density of 1.45 ERU/acre was assumed (30,000 ft^2 per ERU). Several of the delineated undeveloped areas are zoned as "Mixed Use". The assumed densities for these areas ranged from 0.7 ERU/acre to 6 ERU/acre and were based on input from the City. A map of the assumed densities and estimated future ERUs for each of the undeveloped areas are shown in the Appendix A Figure 101. Figure 101 also shows the location where the model was loaded with the estimated future demands. The future SSA model included the total of the existing demands and the future demands at the assumed rate of 350 gpd/ERU.

A total of 6,497 ERUs were calculated to represent build-out. Average day wastewater flow for the City at build-out was estimated to be 2.27 million gallons per day (MGD).

Flow projections for Wastewater Pump Stations

Flow projections were determined at each pump station in the City to determine current adequacy. Flow projections for each pump station are summarized in Table 5-1.

TABLE 5-1
FLOW PROJECTIONS AT PUMP STATIONS

LOCATION	ADDRESS	EXISTING PUMP STATION CAPACITY	EXISTING FLOWS (GPM)		BUILD-OUT FLOWS (GPM)	
			Average Daily Flow	Peak Flow	Average Daily Flow	Peak Flow
Highland Hollow Pump Station	7200 W 10500 N	225 gpm	11	44	12	48
Pheasant Hollow	9700 N 5300 W	300 gpm	176	528	250	750
The Greens on the Highlands	4790 W 10600 N	205 gpm	12	48	13	52
Dry Creek Bench	6151 W 11630 N	850 gpm	212	635	272	825
Victor's View	6673 W 10770 N	200 gpm	15	60	16	65

The only pump station that appears to have deficient capacity for predicted growth is the Pheasant Hollow Pump Station. This pump station will provide service to the newly approved Ridgeview Development and will need to be improved.

CHAPTER 6

WASTEWATER COLLECTION SYSTEM MODELING

MODEL SELECTION

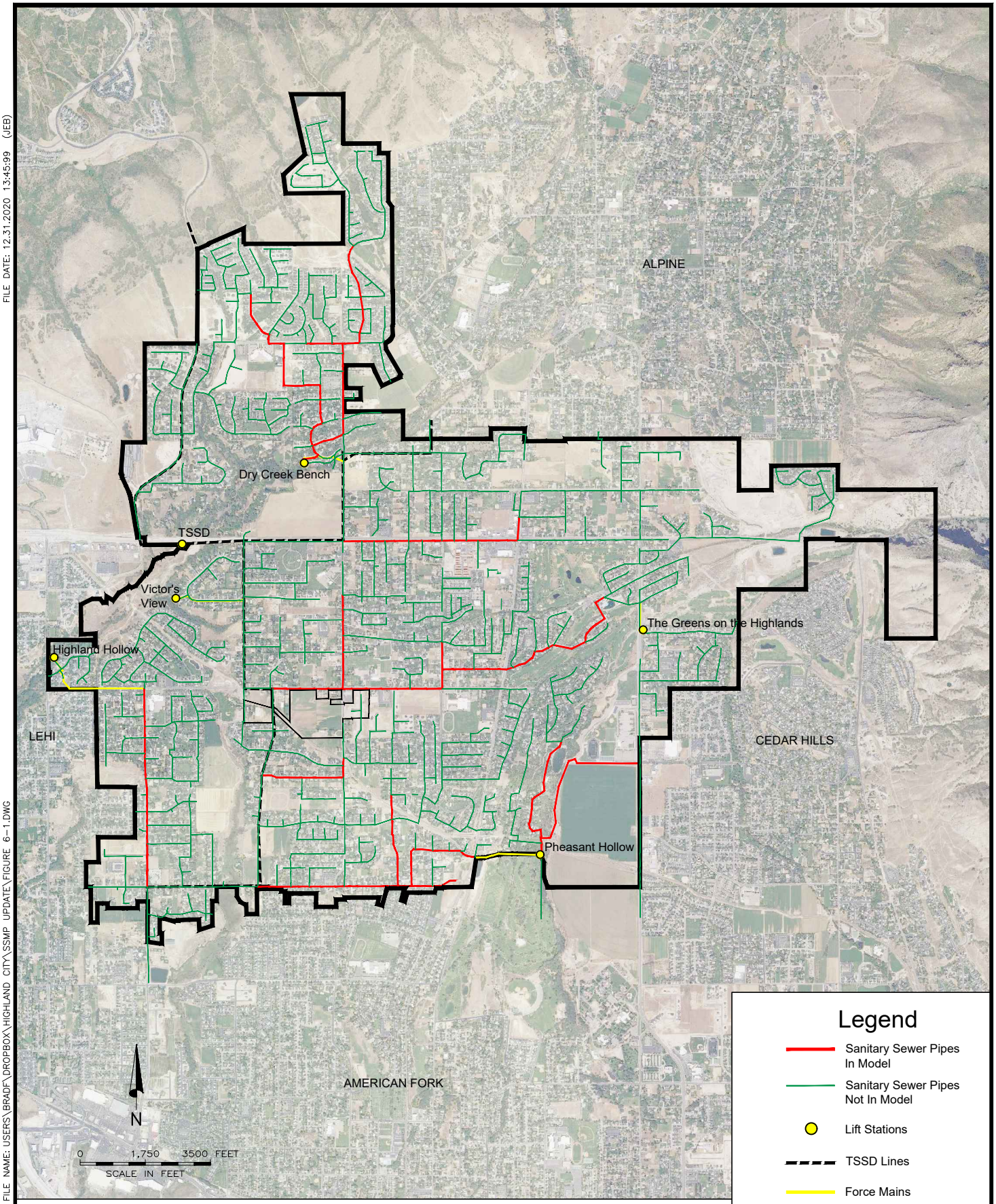
At the time of the 2007 Master Plan, the City did not have a preference for a wastewater collection system model to be used. Originally Hansen, Allen & Luce, who published the 2007 Master Plan, selected SewerCAD v5.0 by Haestad. Since that time the model has been converted to Autodesk Storm and Sanitary Analysis (SSA). SSA and SewerCAD provide similar modeling capabilities. The two programs are fairly easy to use, provide GIS compatibility, and profiling capabilities. SSA is free with a typical AutoCAD subscription, which the City already maintains. To avoid higher software costs and annual maintenance fees associated with SewerCAD, the switch to SSA was made.

SYSTEM LAYOUT

Only the main collection pipelines receiving wastewater flow from the identified collection areas were included in the model because smaller collector lines are considered insignificant to the model. Typically these smaller lines are found within residential neighborhoods.

MODELING CRITERIA

The criteria and values adopted for this modeling effort are included in Table 6-1.



FILE NAME: USERS\BRADF\DROPBOX\HIGHLAND CITY\SSMP UPDATE\FIGURE 6-1.DWG

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HIGHLAND CITY WWMP 2020 AMENDMENT MODELED COLLECTION PIPELINES

FIGURE 6-1

TABLE 6-I
MODELING CRITERIA

CRITERIA	VALUE OR ASSUMPTION
Residential Unit Flows	• 80 gpcd average residential unit flow (including 55 gpcd for wastewater + 25 gpcd for infiltration, inflow and extraordinary flows) decided upon with input from City staff after reviewing several sources of data.
Non-residential Unit Flows	• Non-residential includes commercial, industrial and institutional. • Non-residential flows were determined from average indoor water use. • Converted to ERUs.
Daily Flow Variation	• Flow Hydrographs were developed from measured flow data to compare daily flow variations and peaking factors to other Cities. • A peaking factor curve was developed from the Highland City flow monitoring data.
Annual Flow Variation	• No consistent annual flow variation pattern was assumed. Modeled flow conservative enough to account for annual flow variation.
Long Term Flow Variation	• Constant growth until build-out • No adjustment made for drought, etc.
Infiltration	• Included in 80 gpcd residential unit flow • Future infiltration will remain constant.
Inflow	• Included in 80 gpcd residential unit flow
Extraordinary Flows	• Magnitude and timing of extraordinary flows did not justify adjustment to modeled peak flows. • Included in 80 gpcd residential unit flow
Planning Period	• Build-out
Land Use & Population Projections	• Highland City Zoning –provided by Highland City.
Wastewater Flow Projections	• Projected ERU x 4.37 capita per ERU x (55 gpcd for wastewater + 25 gpcd for infiltration, inflow and extraordinary flows)
Pipe	• Roughness Coefficient - Gravity Sewer - n = 0.013 / Force Main - C = 130 • Minimum Slope = Greater than 0.006 whenever possible, 0.00334 ft/ft for 8-inch, 0.00248 ft/ft for 10-inch, 0.00194 ft/ft for 12-inch. • Minimum Velocity = 2.0 feet per second (fps) for all pipe diameters. • Maximum Flow occurs at d/D = 0.93 (all pipe diameters). • Recommended Maximum d/D = 0.70 for pipe diameters 15 inches and greater. • Recommended Maximum d/D = 0.50 for pipe diameters less than 15 inches.
Pump Stations	• Constant speed pump station – Discharge flow equal to firm or rated capacity (capacity with largest pump not operating). • Pump discharge is represented in the model by the rated capacity input at the outlet of the force main into the gravity sewer. The rated capacity replaces the peaked unit flow tributary to the pump station.

MODEL SCENARIOS

Three modeling scenarios were developed and evaluated for the Highland City wastewater collection system as shown in Table 6-2. Figures demonstrating each scenario are found in the Appendix B.

TABLE 6-2
MODEL SCENARIOS

SCENARIO	DESCRIPTION
Existing	The Existing Scenario was used to identify deficiencies in the wastewater collection system under 2020 conditions, and to establish a baseline for future evaluation.
Future	The Future Scenario was used to identify deficiencies in the existing wastewater collection system under build-out development conditions.
Master Plan	This scenario was used to verify the effectiveness of the capital improvements recommended in Chapter 8.

EXISTING SYSTEM DEFICIENCIES

Deficiencies identified in the Existing Scenario model are summarized in Table 6-4. Pipe capacity deficiencies are shown in Figures within the appendix. Existing deficiencies are also a problem under future conditions, including those related to wastewater flow velocity.

TABLE 6-4
EXISTING SYSTEM DEFICIENCIES

ID	LOCATION	DEFICIENCY
1	10480 N from 5600 W to Alpine Hwy	Existing modeled peak flow reaches a **d/D of 50%** in the existing 10-inch diameter pipe. However, the City may need to upsize to 12-inch with upsize of Country Club Line (#2). (Projected peak flow at build-out **d/D of 60%+** in the existing pipe) City to monitor.
2	Country Club Drive from Alpine Hwy to Country Club	Existing modeled peak flow reaches a **d/D of 70%** in the existing 8-inch diameter pipe. (Projected peak flow at build-out **d/D of 90%** in the existing pipe) City has witnessed full pipe when Country Club flushes pool.
3	Dry Creek Circle	Existing modeled peak flow reaches a **d/D of 65%** in the existing 8-inch diameter pipe. (Projected peak flow at build-out reaches a **d/D of 100% i**n the existing pipe). City is concerned with existing peak flows during storm events and peak flows. Manholes show existence of near full flows.

FUTURE SYSTEM DEFICIENCIES

The deficiencies identified in the future model are predicted problems that will occur if development occurs as projected by the City or identified operational deficiencies go un-resolved. Deficiencies identified in the Future Scenario model are summarized in Table 6-5. All of the previously identified Existing Deficiencies are also deficiencies at build-out.

TABLE 6-5
FUTURE SYSTEM DEFICIENCIES

ID	LOCATION	DEFICIENCY
4	Pheasant Hollow Pump Station	The existing pump station does not have capacity for the proposed Ridgeview Development. It is anticipated that no more than 200 ERUs of capacity are available at present.
5	Victor's View Gravity Line	The Victor's View pump station is nearing its life cycle for replacement. The pump station continually has had problems maintaining suction and has flooded basements in the past. The proposed improvement will be to remove the pump station and connect to a gravity line stub in the North Canterbury subdivision. The gravity line will require a bridge structure to cross a ravine.
6	6800 West from 10050 N to 9650 N	Projected future peak flow reaches a **d/D of 75%** in the existing 10-inch diameter pipe. This line has been identified in the past WWMP. However, after field visits and evaluations, it does not appear that there is an issue. The City will monitor the location to determine if an improvement is truly necessary.

CHAPTER 8

RECOMMENDED IMPROVEMENTS

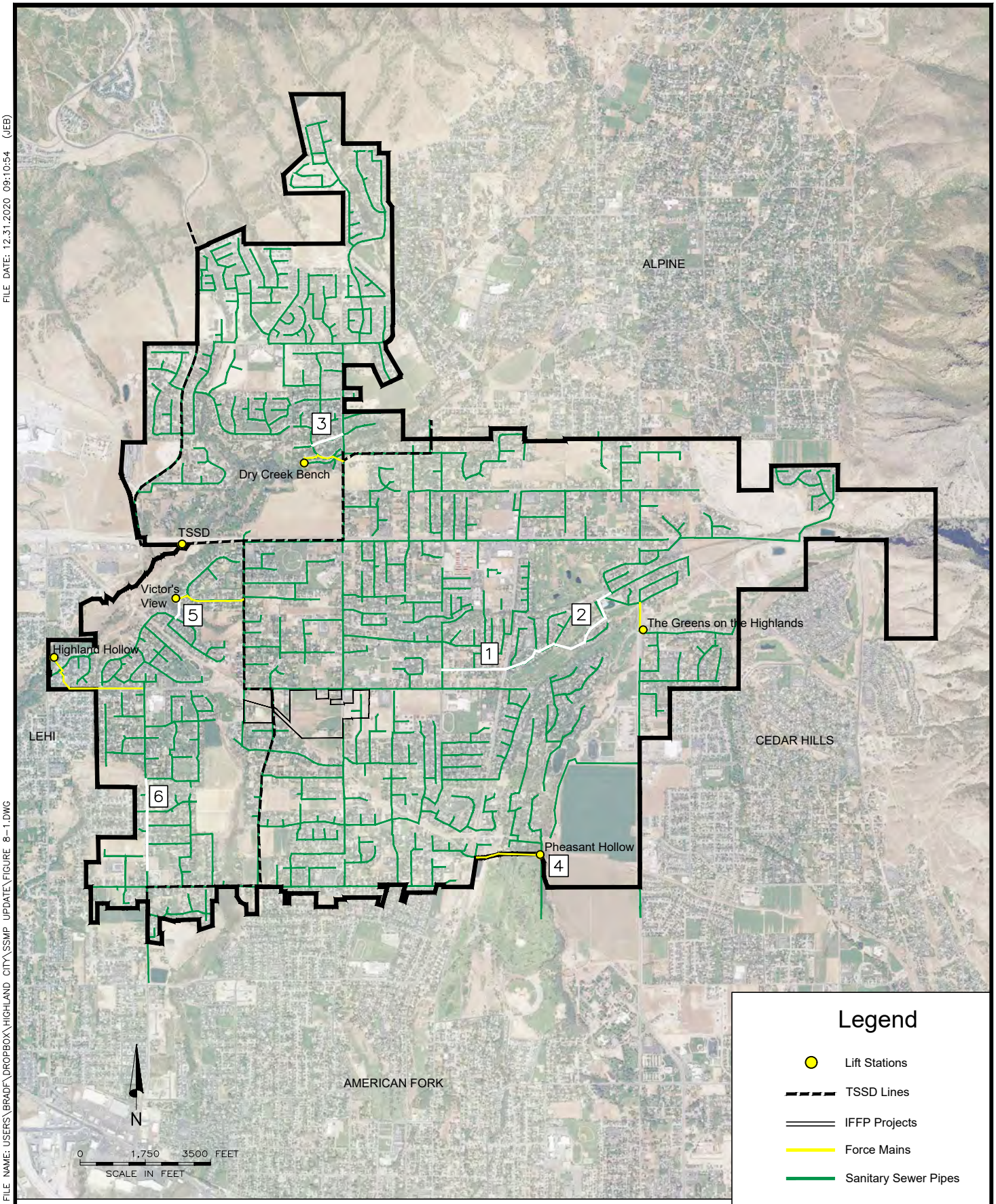
CAPITAL IMPROVEMENT PLAN

Table 8-1 identifies the recommended capital improvements to correct deficiencies in the wastewater collection system. Figure 8-1 provides the location of the recommended improvements.

CAPITAL FACILITY PLAN
TABLE 8-1

ID	PROJECT DESCRIPTION	ANTICIPATED CONSTRUCTION YEAR	CONSTRUCTION COST ESTIMATE*
1	12" Pipe Replacement in 10480 North	2025	$ 419,000
2	12" Pipe Replacement in Country Club Drive	2022	$ 1,050,000
3	12" Pipe Replacement in Dry Creek Circle	2022	$ 398,000
4	Pheasant Hollow Pump Station	2022	$ 987,000
5	Victor's View Gravity Line	2021	$ 737,000
6	12" Pipe Replacement in 6800 West	10+ Yrs. - TBD	$ 708,000

(*) All costs include 15% for engineering, administration costs, and 20% for contingencies. All costs are shown in 2020 dollars.



FILE NAME: USERS\BRADF\DROPBOX\HIGHLAND CITY\SSMP UPDATE\FIGURE 8-1.DWG

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HIGHLAND CITY WWMP 2020 AMENDMENT CAPITAL FACILITY PLAN

FIGURE 8-1

APPENDIX A

MODEL LOADING FIGURES

Note:
Sewer Basins labeled with total # of ERUs

213
0
85
116
111
76
25
190
55
161
205
0
161
91
20
285
98
63
319
98
139
266
58
112
84
46
106
77
126
97
99
238
52
136
66
90
62
84
168
88
49

N

0 0.5 1 2 Miles

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES
GRID, IGN, and the GIS User Community

Legend

- Sewer Basins
- Loading Locations
- SSA Model Pipes

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SSA Model Loading Locations

FIGURE
100

Note:
Undeveloped areas labeled with estimated total # of future ERUs

40
79.7
24.2
38
6.6
19
48.5
30
23.5
8.6
45.2
7.3
97.9
14.5
4.3
115.9
14.8
23.5
14.9
74.6
5.6
29.3
80
11.6
11.1
11
5.5
16.2
37
4
69.5
9.3
55.6
69.5
50
23.9
3.1
4
74.8
18.3
11.3
650
4.4
42.2
2.3
49.9
7.7
27
3.4

N

0 0.5 1 2 Miles

alGlobe, GeoEye, Earthstar Geograp
nd the GIS User Community

Legend

ERU per Acre

- 0.7
- 1.25
- 1.42
- 1.45
- 2.0
- 5.33
- 6.0
- Future_Loading_Locations

Date: 10/29/2020
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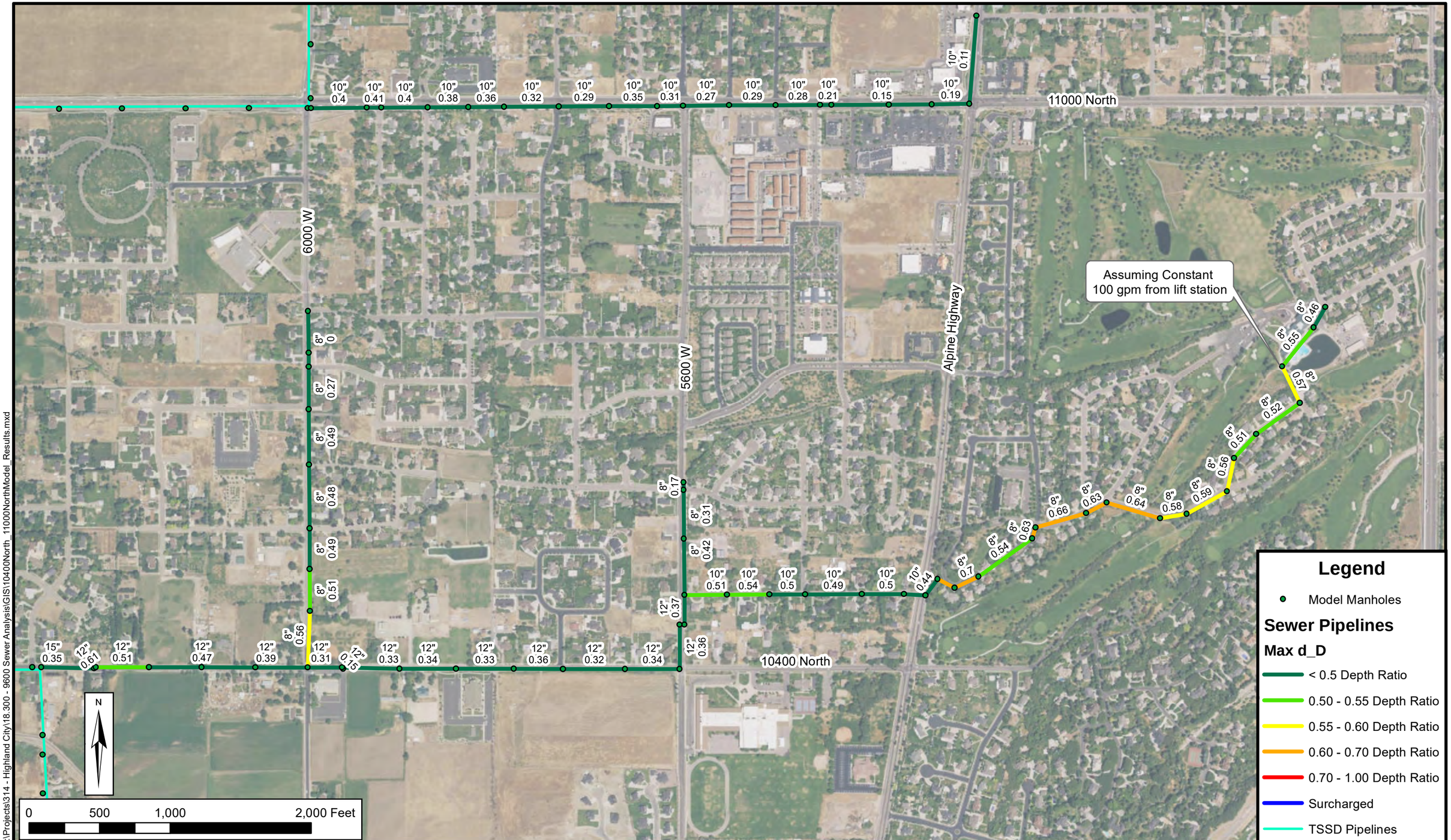
Future Demand Assumptions

FIGURE 101

APPENDIX B

MODEL SCENARIO FIGURES



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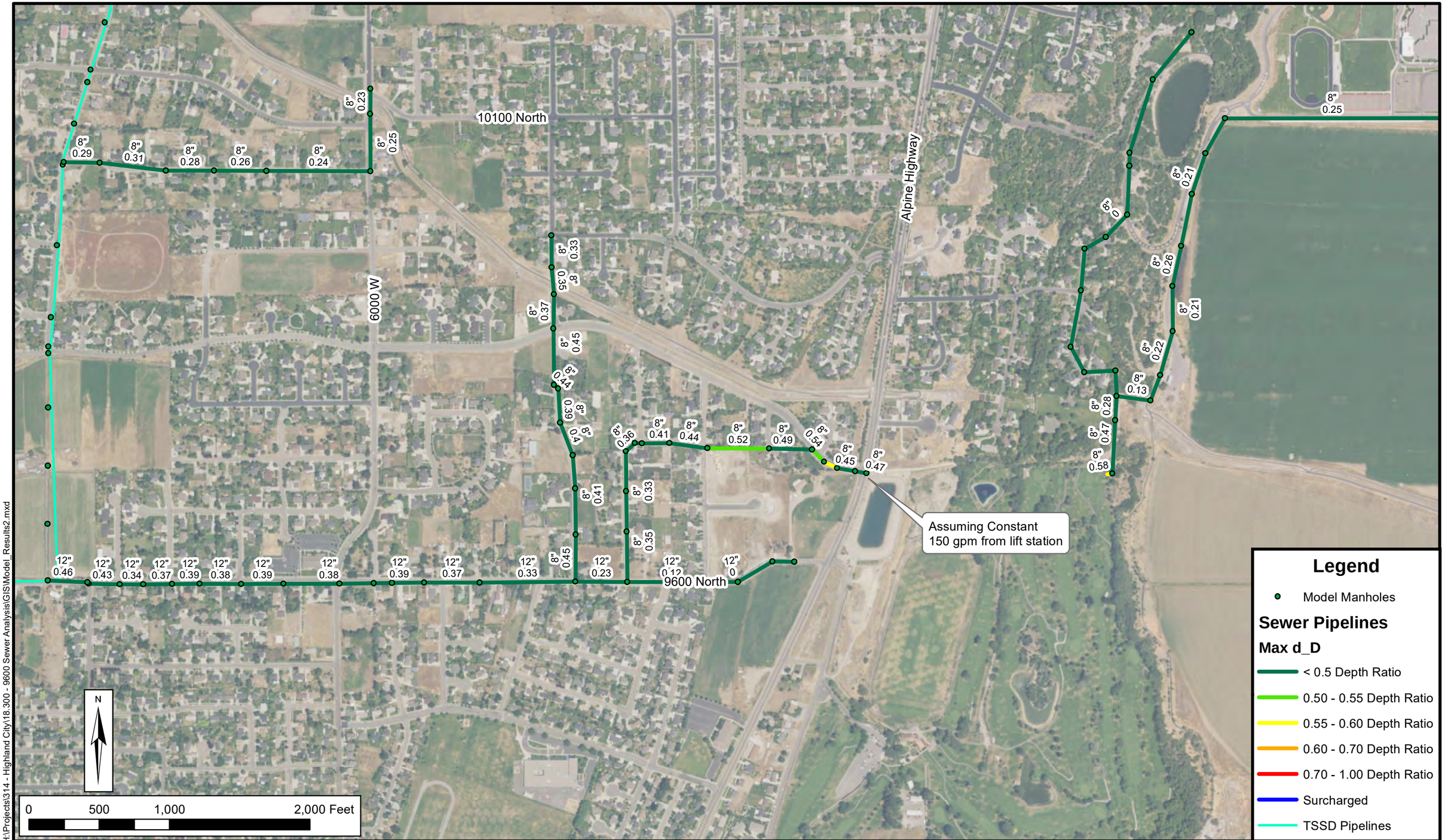
Existing Conditions
10400 North and 11000 North Sewer Lines

FIGURE
1



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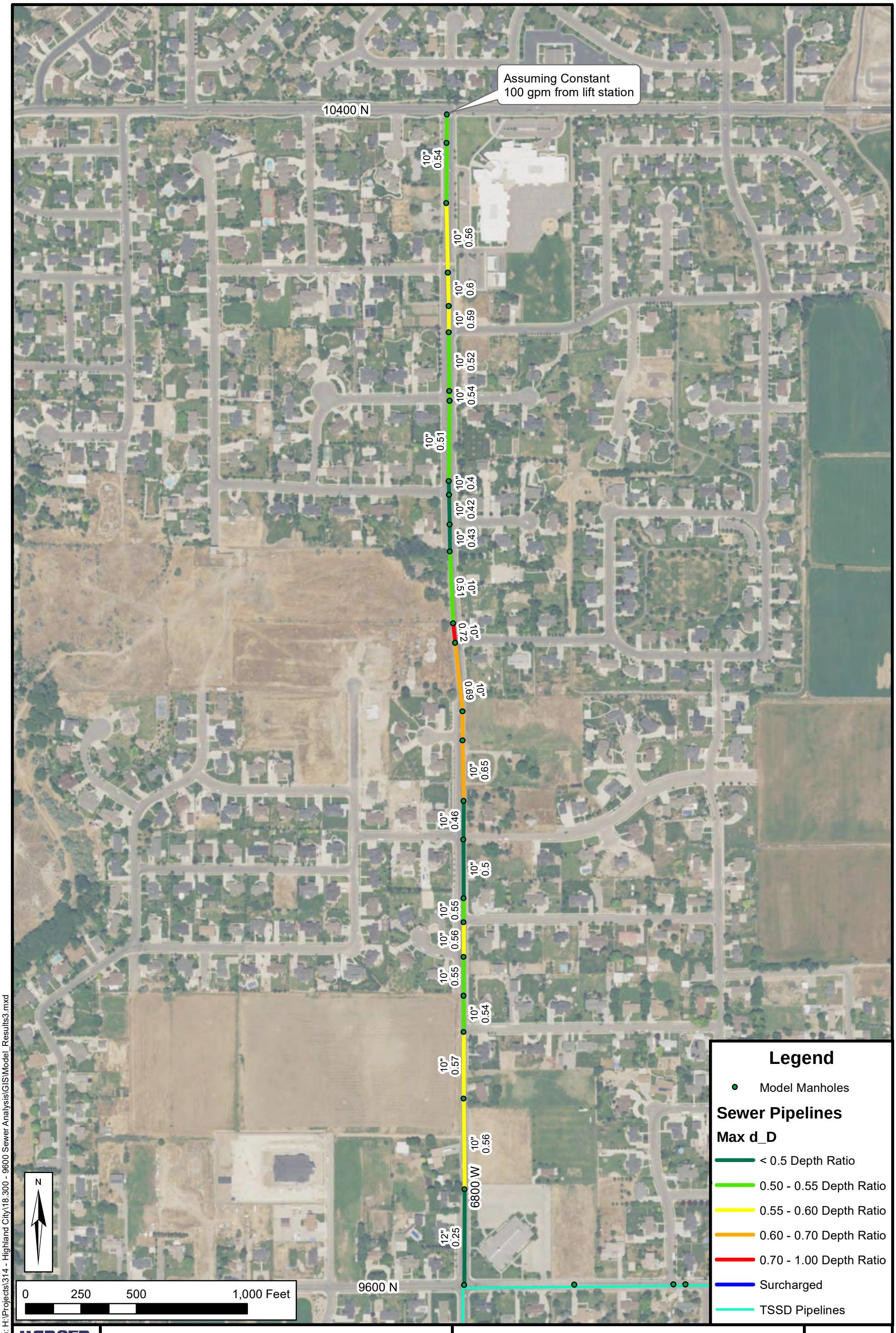
Existing Conditions
10000 North and 9600 North Sewer Lines

FIGURE
2



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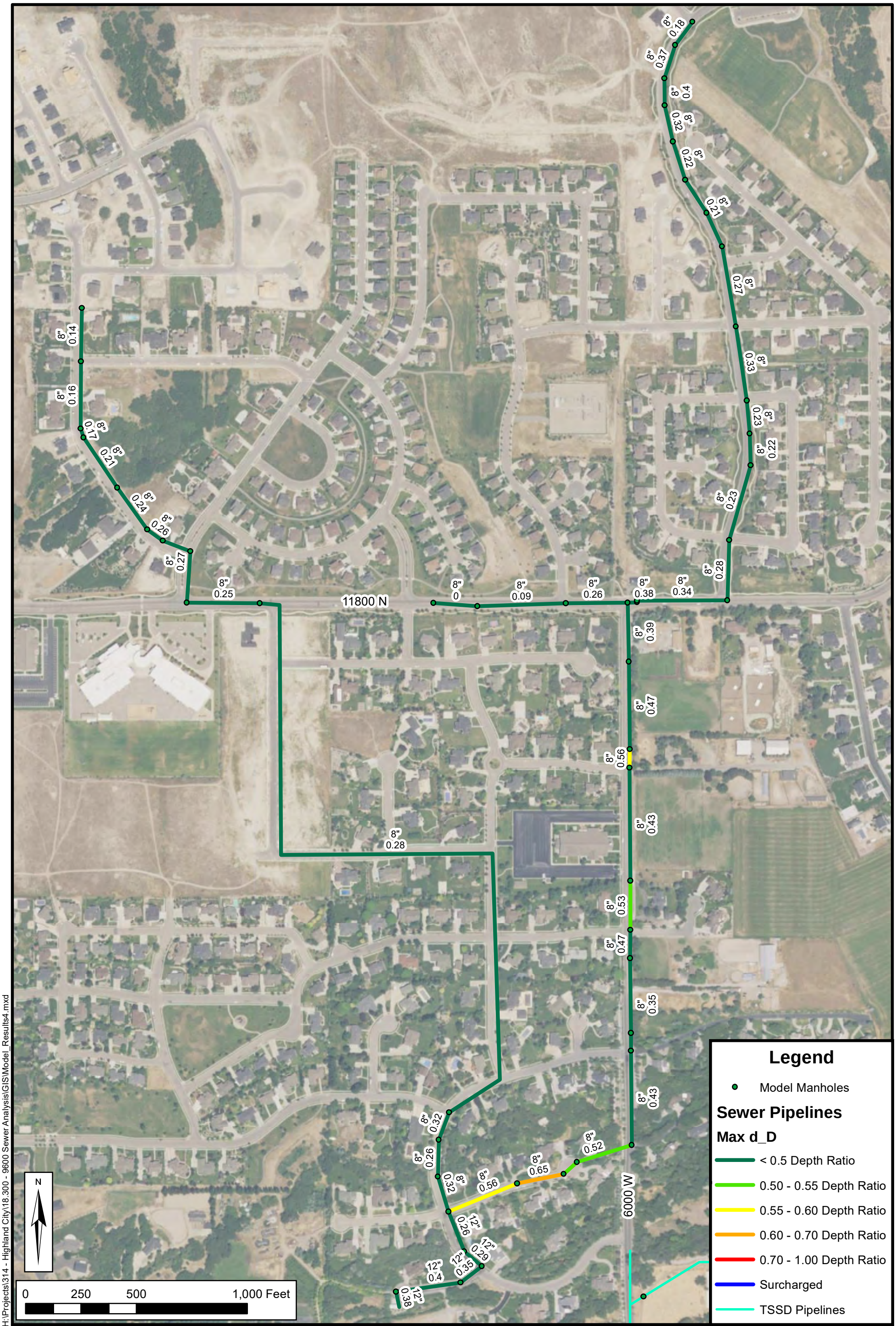
Existing Conditions
6800 West Sewer Line Analysis

FIGURE
3



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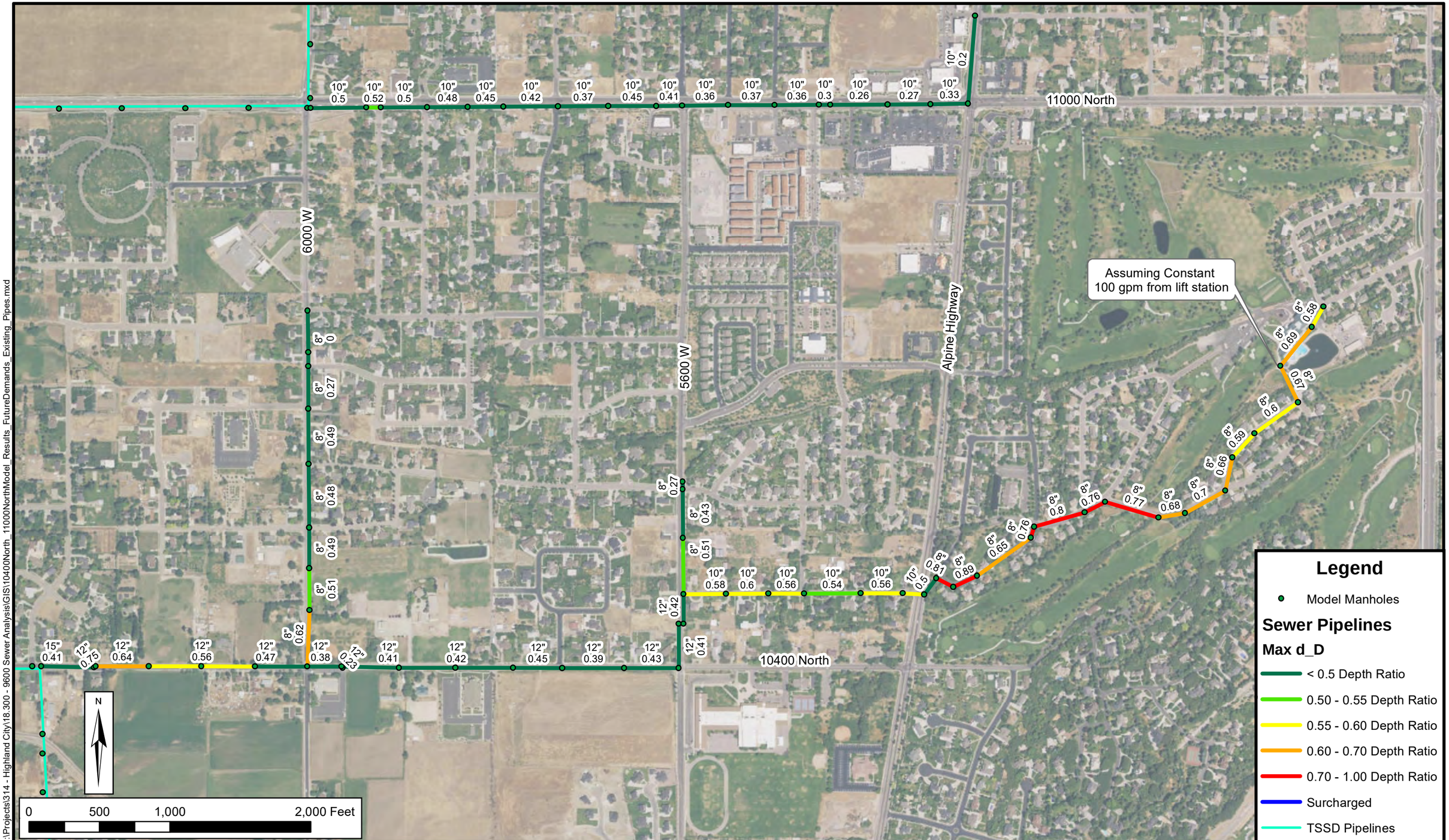
Highland City

Existing Conditions
6000 West Sewer Line Analysis

FIGURE
4



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Future Demands Existing Pipes
10400 North and 11000 North Sewer Lines

FIGURE
5

10100 North

6000 W

Alpine Highway

9600 North

Assuming Constant
500 gpm from lift station

N

0 500 1,000 2,000 Feet

Legend

- Model Manholes

Sewer Pipelines

Max d_D

- < 0.5 Depth Ratio
- 0.50 - 0.55 Depth Ratio
- 0.55 - 0.60 Depth Ratio
- 0.60 - 0.70 Depth Ratio
- 0.70- 1.00 Depth Ratio
- Surcharged
- TSSD Pipelines

Date: 10/29/2020
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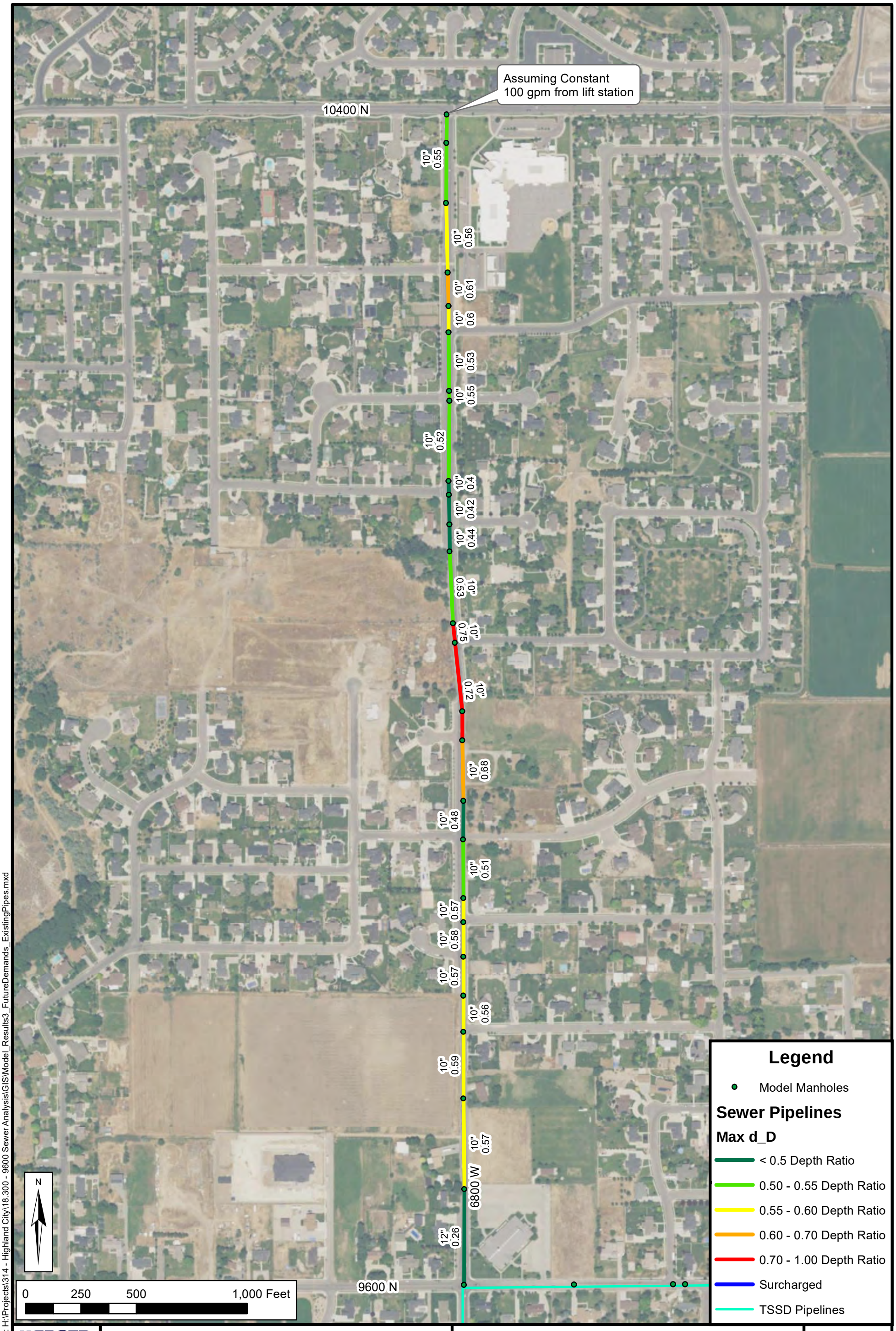
Highland City

Future Demands Existing Pipes
10000 North and 9600 North Sewer Lines

FIGURE
6



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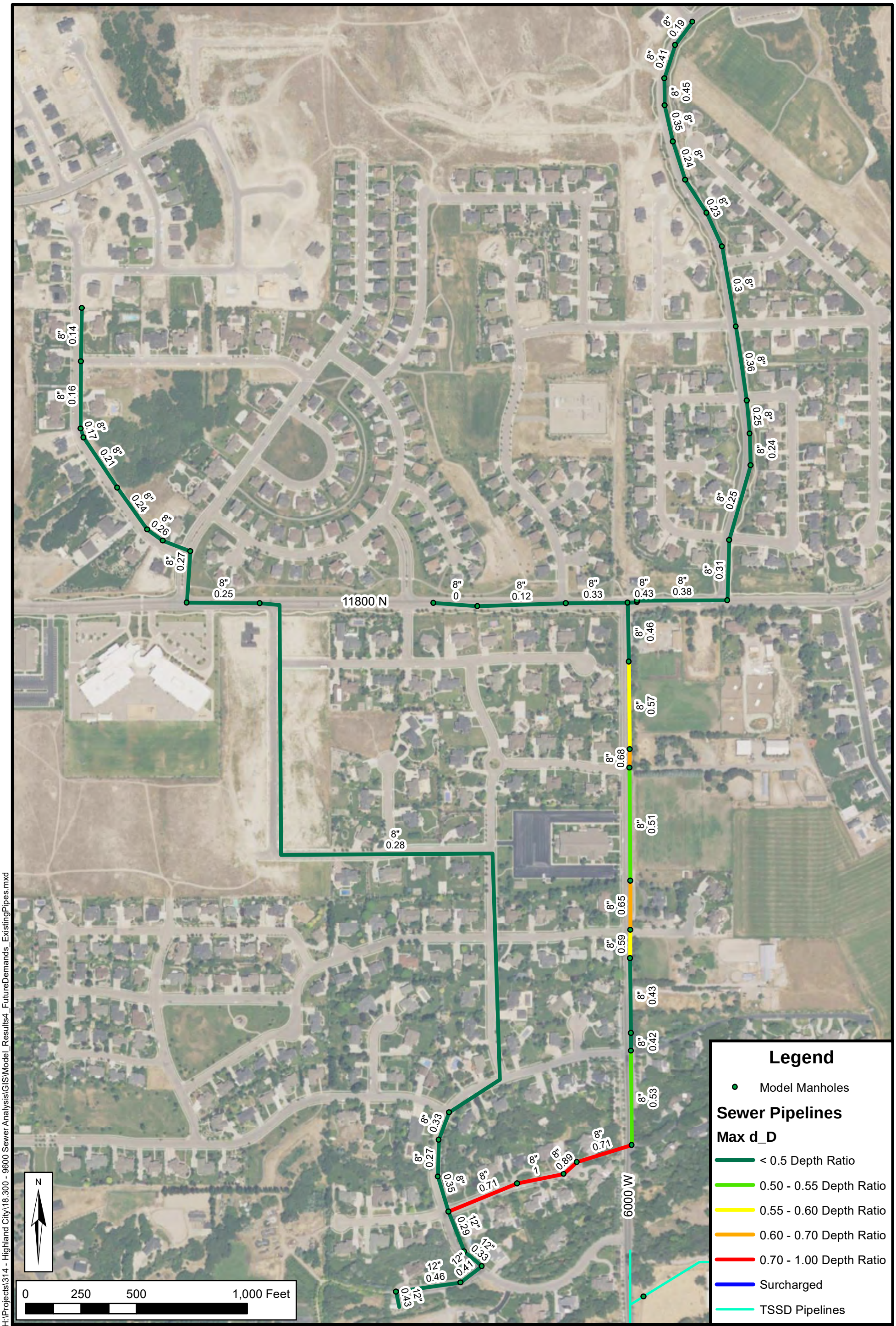
Future Demands Existing Pipes
6800 West Sewer Line Analysis

FIGURE
7



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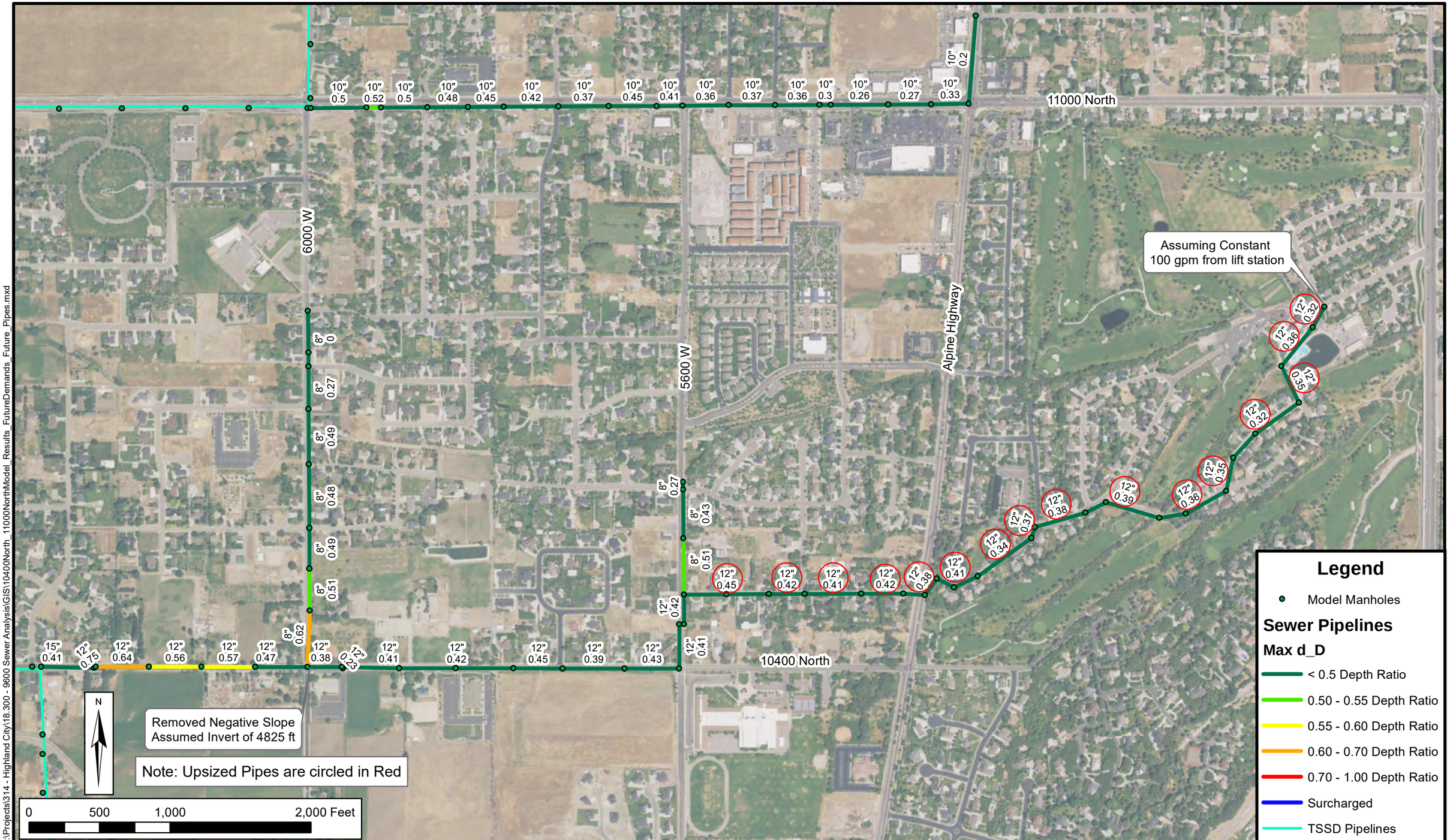
Future Demands Existing Pipes
6000 West Sewer Line Analysis

FIGURE 8



Date: 10/28/2020
Document Path: H:\Projects\314 - Highland City\18.300 - 9600 Sewer Analysis\GIS\10400North_11000North_Model_Results_FutureDemands_Future_Pipes.mxd

HANSEN ALLEN & LUCE INC ENGINEERS

Highland City

Future Demands Future Pipes
10400 North and 11000 North Sewer Lines

FIGURE
9

10100 North

6000 W

Alpine Highway

9600 North

Assuming Constant
500 gpm from lift station

Note: No Pipes Required Upsizing in this area

N

0 500 1,000 2,000 Feet

Legend

- Model Manholes

Sewer Pipelines

Max d/D

- < 0.5 Depth Ratio
- 0.50 - 0.55 Depth Ratio
- 0.55 - 0.60 Depth Ratio
- 0.60 - 0.70 Depth Ratio
- 0.70 - 1.00 Depth Ratio
- Surcharged
- TSSD Pipelines

Date: 10/29/2020
Document Path: H:\Projects\314 - Highland City\18.300 - 9600 Sewer Analysis\GIS\Model_Results2_FutureDemands_Future_Pipes.mxd

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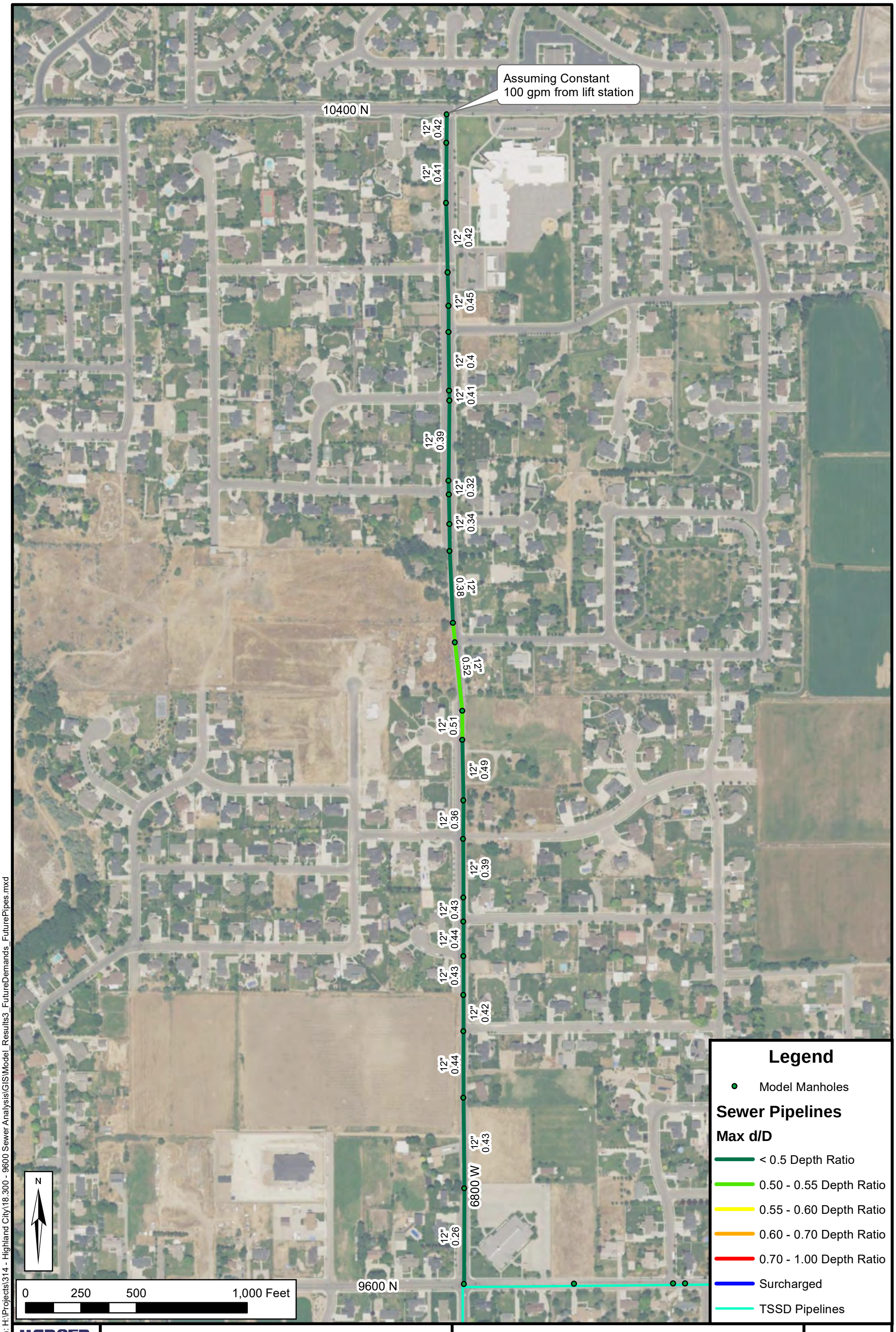
Highland City

Future Demands Future Pipes
10000 North and 9600 North Sewer Lines

FIGURE 10



Date: 10/28/2020
Document Path: H:\Projects\314 - Highland City\18.300 - 9600 Sewer Analysis\GIS\Model_Results3_FutureDemands_FuturePipes.mxd

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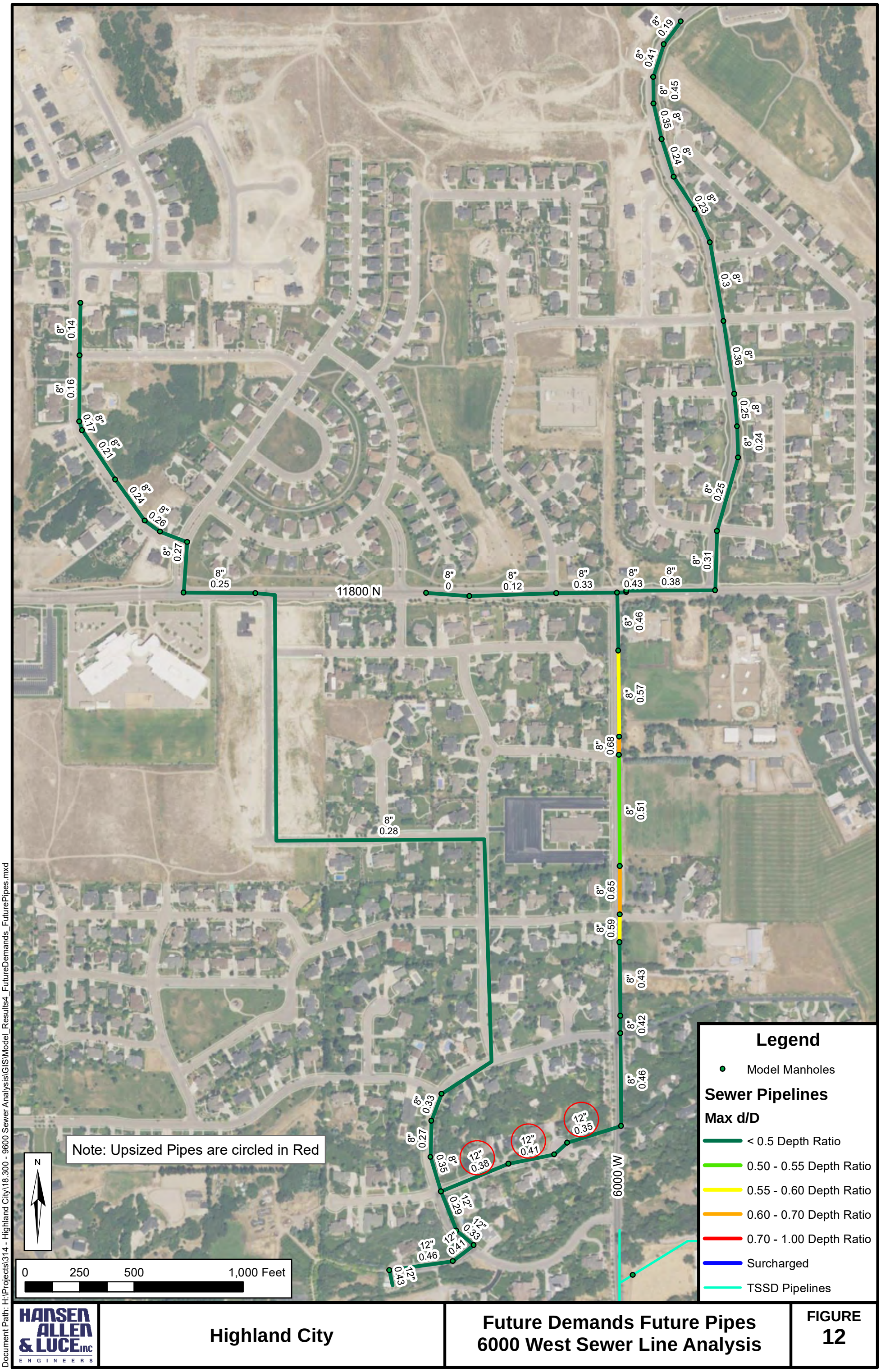
Highland City

Future Demands Future Pipes
6800 West Sewer Line Analysis

FIGURE 11



Date: 10/28/2020
Document Path: H:\Projects\314 - Highland City\18.300 - 9600 Sewer Analysis\GIS\Model_Results4_FutureDemands_FuturePipes.mxd

HANSEN ALLEN & LUCE INC ENGINEERS

Highland City

Future Demands Future Pipes
6000 West Sewer Line Analysis

FIGURE
12

APPENDIX C

COST ESTIMATES

HIGHLAND CITY WASTEWATER COLLECTION MASTER PLAN
PRELIMINARY ENGINEERING ESTIMATE OF COSTS - 2020 DOLLARS

Item	Unit	Unit Price	Quantity	Total Price
1 10480 N. from 5600 W. to Alpine Hwy				
Replace Existing 10" with New 12" PVC Sewer	LF	$ 150	1710	$ 256,500
New Manholes	EA	$ 5,000	7	$ 35,000
Mobilization (10%)	LS	$ 29,150	1	$ 29,150
Testing (5%)	LS	$ 14,575	1	$ 14,575
			Engineering & Admin. (15%)	$ 50,284
			Contingency (10%)	$ 33,523
			Total for 10480 N. from 5600 W. to Alpine Hwy	**$ 419,000**
2 Starting at Alpine Hwy and 10480, Along Country Club Dr and Alpine Cir				
Replace Existing 8" with New 12" PVC Sewer	LF	$ 160	4065	$ 650,400
New Manholes	EA	$ 5,000	16	$ 80,000
Mobilization (10%)	LS	$ 73,040	1	$ 73,040
Testing (5%)	LS	$ 36,520	1	$ 36,520
			Engineering & Admin. (15%)	$ 125,994
			Contingency (10%)	$ 83,996
			Total for Starting at Alpine Hwy and 10480, Along Country Club Dr and Alpine Cir	**$ 1,050,000**
3 Dry Creek Circle to 6000 W				
Replace Existing with New 12" PVC Sewer	LF	$ 250	885	$ 221,250
New Manholes	EA	$ 7,000	5	$ 35,000
Mobilization (10%)	LS	$ 25,625	1	$ 25,625
Testing (5%)	LS	$ 12,813	1	$ 12,813
			Engineering & Admin. (15%)	$ 44,203
			Contingency (20%)	$ 58,938
			Total for Dry Creek Circle to 6000 W	**$ 398,000**
4 Pheasant Hollow Sewer Lift Station				
Masonry & Concrete Building	LS	$ 250,000	1	$ 240,000
Site Piping & Site Improvements	LS	$ 50,000	1	$ 50,000
Mechanical	LS	$ 150,000	1	$ 150,000
Backup Generator	LS	$ 75,000	1	$ 75,000
Electrical/HVAC/SCADA	LS	$ 100,000	1	$ 150,000
Mobilization (10%)	LS	$ 44,000	1	$ 44,000
Testing (5%)	LS	$ 22,000	1	$ 22,000
			Engineering & Admin. (15%)	$ 109,650
			Contingency (20%)	$ 146,200
			Total for Pheasant Hollow Sewer Lift Station	**$ 987,000**
5 Victor View Gravity Line (Replacement of LS)				
8" Dia. PVC Sewer	L.F.	$ 150	500	$ 75,000
12" Dia. Steel Casing	L.F.	$ 100	180	$ 18,000
Utility Crossing Bridge	L.S.	$ 200,000	1	$ 200,000
5' Dia. Sewer Manhole	Each	$ 5,000	4	$ 20,000
Connect to Existing Manhole	Each	$ 2,000	1	$ 150,000
Remove/Abandon Existing Lift Station/Piping	L.S.	$ 20,000	1	$ 20,000
Mobilization (10%)	LS	$ 48,300	1	$ 48,300
Testing (5%)	LS	$ 14,650	1	$ 14,650
			Engineering & Admin. (15%)	$ 81,893
			Contingency (20%)	$ 109,190
			Total for Victor View Gravity Line (Replacement of LS)	**$ 737,000**
6 6800 W. from 10050 N to 9600 N				
Replace Existing 10" with New 12" PVC Sewer	LF	$ 150	2915	$ 437,250
New Manholes	EA	$ 5,000	11	$ 55,000
Mobilization (10%)	LS	$ 49,225	1	$ 49,225
Testing (5%)	LS	$ 24,613	1	$ 24,613
			Engineering & Admin. (15%)	$ 84,913
			Contingency (10%)	$ 56,609
			Total for 6800 W. from 10050 N to 9600 N	**$ 708,000**

APPENDIX D

DESIGN CRITERIA

DESIGN CRITERIA

CRITERIA	VALUE OR ASSUMPTION
Residential Annual Average	• 80 gpcd annual average residential wastewater flow (including infiltration, inflow and extraordinary flows)
Non-residential Annual Average	• Non-residential includes commercial, industrial and institutional. • Non-residential flows determined from average indoor water use
Design Peak Flow	• 4 times annual average or use Highland City Peaking Factor Curve (Figure 4-1)
Planning Period	• Build-out
Land Use & Population Projections	• Zoning – provided by Highland City • Population projections – provided by Highland City
Manhole Locations	• At all changes of grade, pipe size, alignments, and at intersections • 400 feet maximum spacing
Minimum Pipe Size	• 8-inch
Roughness Coefficient	• Gravity Sewers - N = 0.013 • Force Mains – C = 120
Minimum Velocity	• 2 feet per second at design peak flow
Minimum Slope	• 8-inch – 0.004 ft/ft • 10-inch – 0.0025 ft/ft • 12-inch – 0.002 ft/ft • 15-inch – 0.0015 ft/ft
Maximum Design d/D	• 0.70 for pipe diameters 15 inches and greater. • 0.50 for pipe diameters less than 15 inches.
Pump Stations	• At least two pumps are required • Each pump shall have a capacity exceeding the design peak flow