City of Twin Falls

Wastewater Collection System Master Plan

Volume 1
Background Plan Information, Model Development & Analysis

April 2015

Prepared by

J-U-B ENGINEERS, Inc.
115 Northstar Avenue
Twin Falls, Idaho 83301
208-733-2414
Project No. 60-13-103

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EXECUTIVE SUMMARY

ES.1 REPORT OVERVIEW

The last comprehensive sewer Collection System Master Plan for the City of Twin Falls (City) was completed in 2009[1]. The City has experienced significant growth and infrastructure improvements since completion of the 2009 report. The City authorized J-U-B ENGINEERS, Inc. (JUB) to develop a new Collection System Master Plan, with major goals as follows:

GOAL 1: Update the hydraulic collection system model to assess capacity conditions for three growth and flow scenarios during a 10-Year design storm event:

Scenario	Purpose	Scope and Loads
Existing	Provide a snapshot of existing (March 2014) sewer flows Evaluate capacity of all pipes 10 inches and above	Includes loading for all areas that have an existing connection to the sewer collection system Includes loads for existing permitted industries at their permit value.
Committed	Identify remaining uncommitted capacity in the system Identify potential capacity issues as land develops within or near City limits.	In addition to existing loads, includes loading for vacant areas within city limits and commitments to developments that have started the will-serve process Includes capacity for existing and anticipated permitted industrial loads
Master Plan	Maximize capacity of existing pipes Upsize existing or provide new pipes for capacity restricted areas Provide conceptual alignment of new services areas and pipes following natural topography and drainages	In addition to committed loads, includes loading for areas beyond the City limits extending to the study area boundary. Includes capacity for master plan permitted industrial loads

GOAL 2: Establish a comprehensive Capital Improvement Plan (CIP) for the next five to ten years.

This report is organized into eight chapters and two volumes. The following sections provide a brief summary of each chapter of the 2015 Collection System Master Plan (2015 Plan). Volume 1 details the existing system, planning data and growth projections, and Existing and Committed Model development and analyses. It includes the Executive Summary, Chapters 1-5 and the corresponding appendices. Volume 2 details the Master Plan model development and analysis and the CIP. It contains the Executive Summary, Chapters 6-8, and the corresponding appendices.

[1] MSA, (2009) City of Twin Falls Collection System Report.

The study area for the 2015 Plan corresponds to the boundary identified in the 2009 Twin Falls Comprehensive Plan[2] for water and sewer infrastructure and is shown in **Figure 1-1**. The Comprehensive Plan Boundary also shows the areas beyond the sewer service boundary.

ES.2 EXISTING COLLECTION SYSTEM SUMMARY

The City's collection system data was compiled from multiple sources, including City GIS data, record drawings, hardcopy City maps, field verification, operations staff, and the 2009 sewer model. In summary, the City of Twin Falls has approximately 245 miles of sewer pipe ranging in size from 4- to 42-inch and 6 lift stations as shown in **Table 2-4** and **Table 2-5**. **Figure 2-2** shows the existing collection system. While a condition assessment was not completed, the City is aware of several condition problems, such as the droplines into the Rock Creek and Snake River Canyons, manholes along the Grandview pipeline, the Independent Meat Lift Station and many of the pipes in the downtown area.

ES.3 PLANNING DATA AND GROWTH PROJECTIONS

Recent and historical growth rates provide context that can help the City plan the timing of sewer improvements needed to serve future growth. Based on historical growth rates, the City elected to use a 2.0 percent annual growth rate for population growth projections. Typical industrial growth has a relatively small impact on the collection system due to low unit flows. However, permitted industrial flows can significantly affect the system. There has been a recent trend in similar industries developing in the City, which is anticipated to continue. **Figure 3-3** and **Figure 3-4** show the general areas and peak day flows used for future permitted industrial users in the Committed and Master Plan Models, respectively.

The 2009 Comprehensive Plan is the guiding document for land use in the 2015 Plan. Within the Comprehensive Plan, areas designated as residential land use do not have a specific future density assigned. Therefore, a land use density analysis performed throughout the City for all residential land use types resulted in a value of 4 dwelling units per gross acre and was assigned for future residential areas.

ES.4 EXISTING SYSTEM SUMMARY

The Existing Model in the 2015 Plan was built using GIS base layers for system components and InfoSWMM modeling software. The Existing Model used water meter data provided by the City to establish unit flows for each land use type. Each parcel was assigned a land use type and connected to the system. **Figure A-1** in **Appendix A** shows the land use used in the Existing Model. Diurnal curves (the typical 24-hour shape of the flow) were also developed for each land use type. Dry weather flows, consisting of the unit flows and diurnal curves, were calibrated to flow monitoring performed in several locations throughout the City in March of 2014.

A 10-year Type II SCS design storm was aligned with the sanitary peak flow to evaluate the capacity of the existing collection system. Based on these inputs and the level of service criteria established with the City (see **Appendix C**), no immediate capacity problems were identified in the Existing Model. Results for the existing system are summarized in **Figure 4-1** through **Figure 4-3.** **Appendix F** contains the Existing Model results.

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[2] Landmark Design (2009) City of Twin Falls Comprehensive Plan.

ES.5 COMMITTED SYSTEM SUMMARY

The Committed Model includes everything that the City has committed to serve, or is considering to serve, based on known developments. This does not guarantee or imply a will-serve will be granted. It includes estimated loads for developments that have begun the subdividing process, and assumes infill of vacant areas in the existing City limits. The Committed Model also includes anticipated industrial flows over the next 20 years. The Committed Model is used to evaluate whether the existing system has capacity to accommodate flows in the immediate future and to help prioritize needed improvements.

Figure A-2 in **Appendix A** depicts flow inputs in the Committed Model, and **Figure 5-1** and **Figure 5-2** summarize the available capacity of the existing collection system during a design storm event under the Committed flows. **Appendix G** contains model results for the Committed Model. Two capacity issues were identified during the Committed Model associated with residential, commercial, industrial growth, with another three issues based on anticipated industrial growth:

Capacity Issues from Residential, Commercial, and Light Industrial Growth

- Along Park View Dr. , north of Federation Rd., Manhole B1-41 & B1-33 – Surcharge (sewer depth over pipe) of 1.07 to 1.87 feet above the top of the pipe.
- Intersection of Candlewood Ave. and Mountain View Dr., Manhole E2-5 – Surcharge of 1.13 to 1.83 feet above the top of the pipe.

Capacity Issue Triggered by Permitted Industrial Growth

- South of Filer Avenue W., between the Wendell St. and Beta St. alignments, Manhole B3-14 – Surcharge of 1.3 to 1.6 feet above the top of the pipe in this area (See Item 3 in **Figure 7-1**)
- North of Kimberly Rd, between the Trade St. and Freightway St. alignments, Manhole E5-19 – Surcharge of 1.3 feet above the top of the pipe (See Item 9 in **Figure 7-1**)
- Along Addison Avenue between 3rd and 4th Avenue N., Manhole C4-163 – Peak surcharge of 0.6 to 2.67 feet above the top of the pipe (See Item 11 in **Figure 7-1**)

Table 5-3 illustrates the capacity of the lift stations and force mains under the Committed flows. In summary:

A. The Hankins (Jayco) Lift Station needs to be replaced with the Clif Bar development.
B. The Independent Meat Lift Station is nearing capacity at the Committed flows.
C. The Rock Creek Trails Lift Station is beyond capacity for the Committed flows if Grandview Farms subdivision to the north is added to it.

ES.6 MASTER PLAN SYSTEM SUMMARY

The Master Plan Model represents the ultimate build-out of the study area. The Master Plan Model is a tool to guide growth and expansion of the collection system and also identify potential future deficiencies in the current collection system. The Master Plan Model's primary purposes are to:

- Provide the size, approximate location and depth for master planned sewer lines 10 inches and larger in size.
- Identify potential capacity issues that may arise in the existing collection system as the City develops new areas and builds out the study area.
- Develop a base model to use in evaluating future wastewater service scenarios.

Figure 6-1 shows the future pipe sizes needed to provide sewer service for build-out of the entire planning area. **Figure 6-2** shows the approximate depth for all the new master plan pipes. **Figure 6-3** shows the pipe capacity in the existing sewer system compared to the Master Plan flows, which helps illustrate which pipes may cause surcharging. All Master Plan results include the design storm event. **Figure ES-1** summarizes the pipe improvements needed based on the Master Plan Model. Additional information can be found in **Table 6-4**.

Table 6-6 summarizes the capacity of the lift stations and force mains with the following lift stations and force mains expected to be beyond capacity based on the Master Plan Model.

- The Hankins (Jayco) Lift Station and Force Main
- The Independent Meat Lift Station and Force Main
- The Rock Creek Trails Lift Station and Force Main
- The Rock Creek Lift Station and Force Main

Rehabilitation expectations for lift stations are shown in **Table 6-7**.

ES.7 CAPITAL IMPROVEMENT PLAN SUMMARY

The CIP identifies and describes the improvements necessary to provide service to the future wastewater service area, while meeting the necessary level of service criteria (see **Appendix C**) over the next 20 years. The Committed Model generally corresponds to anticipated flows that will occur over this timeframe. The schedule for implementing CIP projects not related to rehabilitation/replacement will ultimately depend on realized growth and non-residential development. **Table ES-1** shows the model flows for the Existing, Committed, and Master Plan Models and the estimated year and population to reach that flow.

Table ES-1 – Flow and Population Summary for Each Model Scenario

Model Scenario	Peak Day Dry Weather Loading		Peak Dry Weather Flow at the WWTP[1] (MGD)	Peak Wet Weather Flow at the WWTP[1] (MGD)	City Population	Approximate Year (2% growth)
	Permitted Industrial Flow (MGD)	Domestic Flow (MGD)				
Existing	5.9	4.5	12.5	22.6	46,900	2014
Committed	11.7	5.7	20.3	31.5	78,000	2040
Master Plan	22.4	14.0	47.5	65.8	159,000	2075

(1) Flow values result from peak flow in all collection pipes. Actual influent values observed at the WWTP will differ from the reported peak flows for various reasons as discussed in **Table 7-1.**

(2) This flow value is within 12% of the 20-year peak hour flow (35.6 MGD) in the 2013 Wastewater Treatment Plant Facility Plan by CH2MHill. The higher values in the 2013 WWTP plan are expected due to higher unit flows used in that plan as compared to this plan.

Due to the age and expected life cycle of the existing collection system infrastructure, the City may want to consider adjusting their annual maintenance budget for replacement/rehabilitation. **Table ES-2** summarizes baseline values and several options for budgeting replacement/rehabilitation of the existing collection system (including inflation, engineering, and contingency). Additional cost savings may be possible in some locations by utilizing trenchless rehabilitation, such as cured-in-place pipe (CIPP), slip-lining or pipe bursting. As additional information is acquired, such as a condition assessment, future fiscal year budgets can be adjusted accordingly.

Table ES-2 – Annual Replacement Budget Options

Option	Total Value	Portion of Existing Pipes and Replacement Method(1), (2)		Replacement Life Cycle (3)	Annual Replacement Budget (in 2014 $)
		Existing Plastic (PVC/HDPE)	Existing Non-Plastic		
1	$332M	100% OT	100 % OT	100	$3.3M
2	$200M	0%	100 % OT	100	$2.0M
3	$282M	50 % OT 50% CIPP	50 % OT 50% CIPP	100	$2.8M
4	$170M	0%	50 % OT 50% CIPP	100	$1.7M

(1) *Replacement methods are for open trench (OT) and cured-in-place pipe (CIPP)*
(2) *Additional costs will be necessary in areas that require new larger pipe.*
(3) *Actual useful life could be longer for plastic pipe and shorter for non-plastic pipe, and will be determined based on age, as well as condition, and acceptable risk to the City.*

Because few capacity issues were identified in the Committed and Existing Models, additional criteria were developed and evaluated with the City to prioritize the improvements in the CIP. The results of the system CIP prioritization and assessment are summarized in **Figure ES-2** and **Table ES-3**.

An on-going annual budget of approximately $1.7 to $3.3 million should be established for replacement or rehabilitation of the existing collection system. The City should budget this amount so that a systematic approach can be used to replace the older deteriorated sewer pipes on a 100 year life cycle. The additional CIP costs identified in the 2015 Plan for lift station replacement/rehabilitation should be reviewed and integrated as budget permits.

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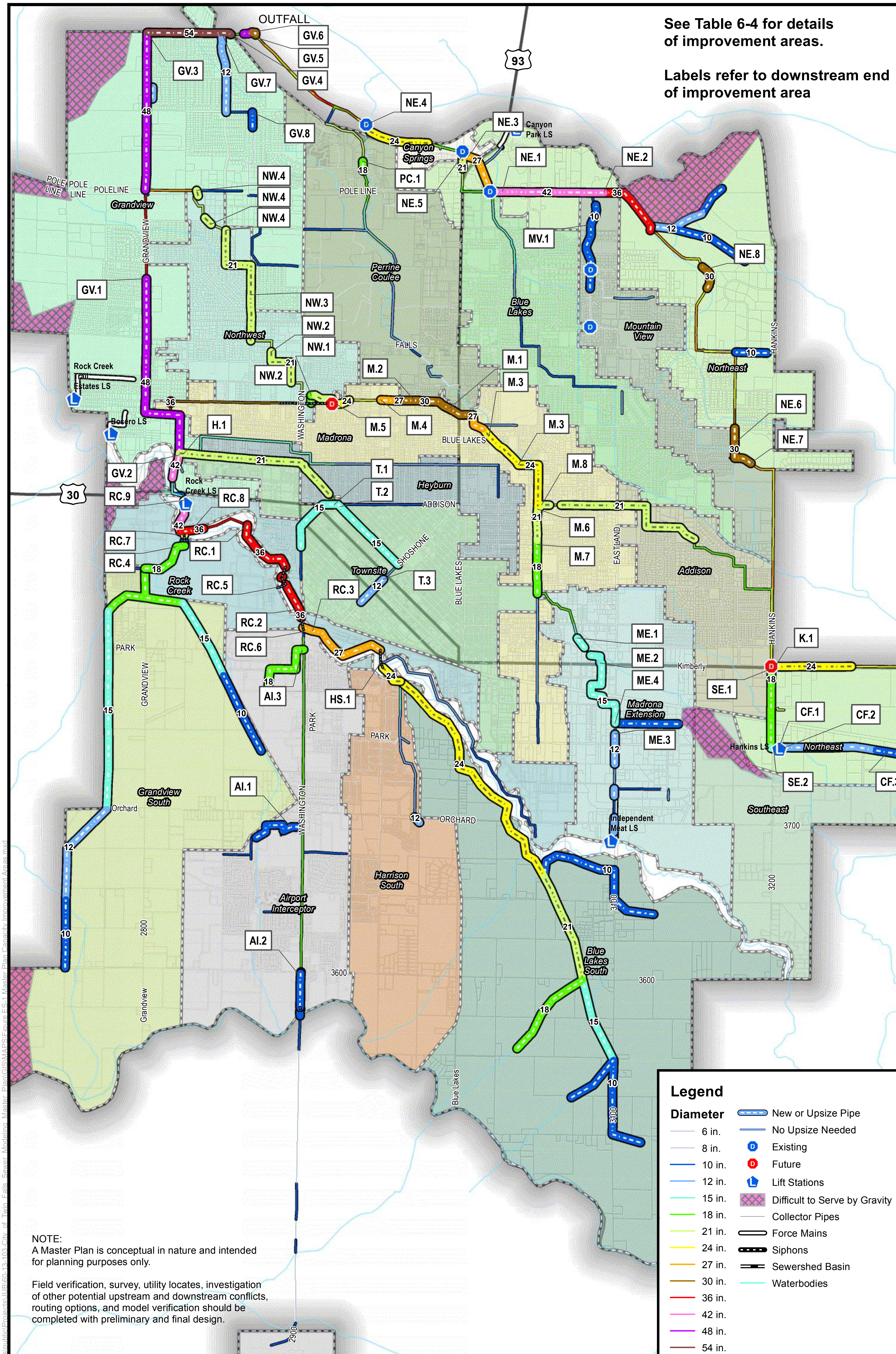

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE ES-1
MASTER PLAN CAPACITY IMPROVEMENTS

J-U-B ENGINEERS, INC.

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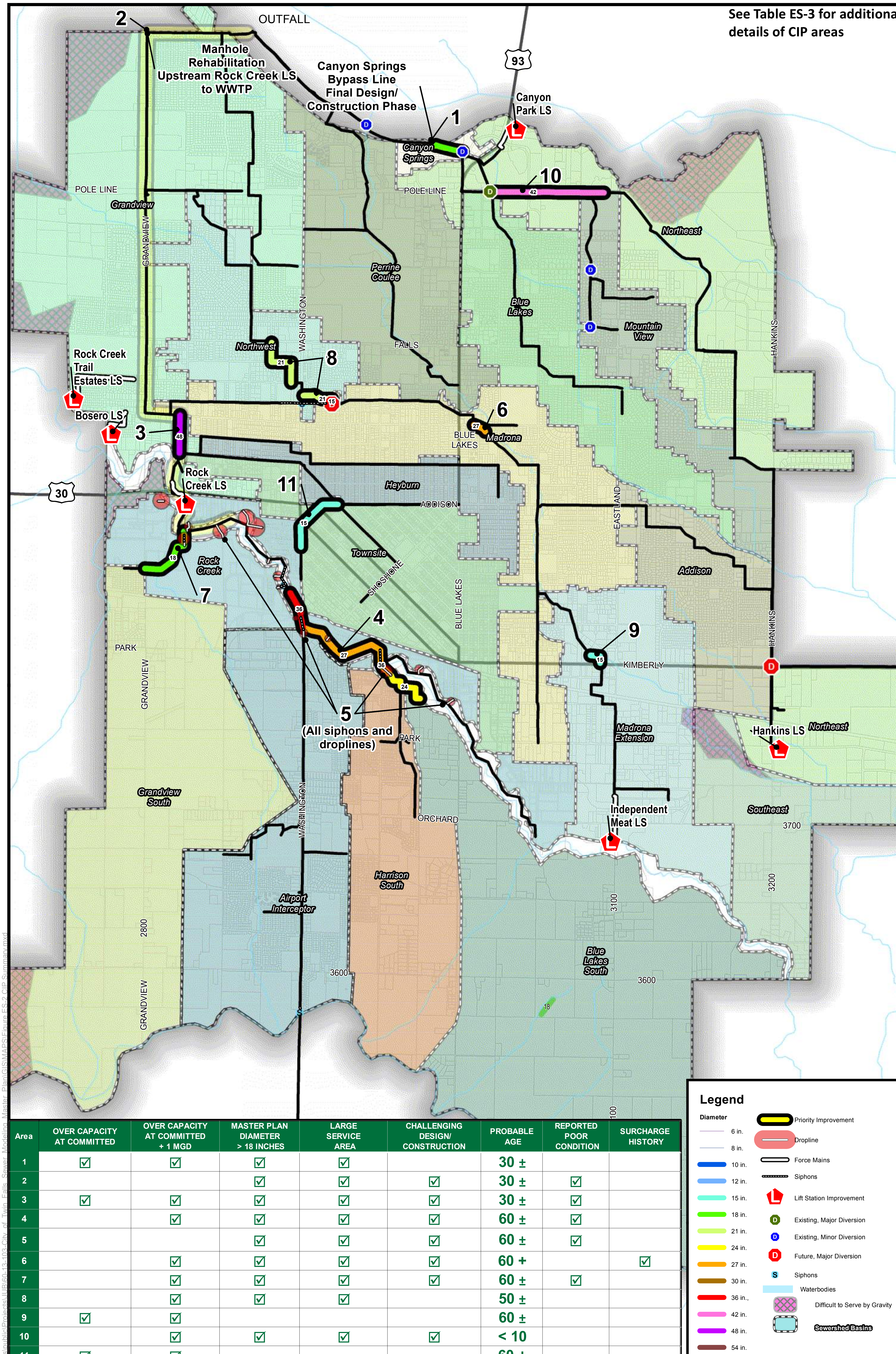
See Table ES-3 for additional details of CIP areas



Area	OVER CAPACITY AT COMMITTED	OVER CAPACITY AT COMMITTED + 1 MGD	MASTER PLAN DIAMETER > 18 INCHES	LARGE SERVICE AREA	CHALLENGING DESIGN/ CONSTRUCTION	PROBABLE AGE	REPORTED POOR CONDITION	SURCHARGE HISTORY
1	☑	☑	☑	☑		30 ±		
2			☑	☑	☑	30 ±	☑	
3	☑	☑	☑	☑	☑	30 ±	☑	
4		☑	☑	☑	☑	60 ±	☑	
5			☑	☑	☑	60 ±	☑	
6		☑	☑	☑	☑	60 +		☑
7		☑	☑	☑	☑	60 ±	☑	
8		☑	☑	☑		50 ±		
9	☑	☑				60 ±		
10		☑	☑	☑	☑	< 10		
11	☑	☑				60 +		

CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE ES-2
CIP SUMMARY

J-U-B ENGINEERS, INC.

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Table ES-3 – CIP Project Summary

CIP Item #	Project *(See Figure 7-1)*	MH Identifier	Length (ft)	New Size (in)	Recommended Action	0 – 5 Years	5 – 10 Years	10 – 20 Years	As Needed with Growth[A]
1	Canyon Springs Rd	CSR2 to D2-202	956	18	In Progress	$ 262,000			
2	Odor Control[E] & Manhole Rehabilitation	Various, See Figure ES-2 or 7-1	-	-	Begin Now	$ 1,930,000			
3	Grandview Trunkline	B3-14 to B4-1	1,275	48	Begin preliminary design[B]			$ 792,000	
4	Rock Creek Trunkline	C4-7 to End of Benno's Ph 2	7,045	24, 27, 36	Begin preliminary design[C]				$ 3,082,000
5	13 Droplines/Siphons, excluding DL.1,14,16	See Table 6-7			Begin preliminary design				$ 4,165,000
6	Madrona Trunkline	Reroute pipe D3-110 to D3-150 & D3-149 to D3-155	2,150	8, 27, 30	Begin preliminary design[D]				$ 881,000
7	Golf Crse Trunkline	B4-120 to B4-137	3,385	18	Complete with development				$ 570,000
8	Northwest Trunkline	C3-235 to C3-193 & C3-236 to C3-79	3,375	15, 21	Complete with development				$ 1,304,000
9	Madrona Ex.Trunkline	E5-19 to E5-31	603	15	Complete with development				$ 201,000
10	Northeast Trunkline	D2-74 to E2-129	3,810	42	Complete with RAA 4-3				$ 2,182,000
11	Albion Trunkline	C4-163 to C4-299	2,235	15	Complete with development				$ 634,000
	Kimberly Diversion	F5-115 to F5-5 or F4-16 to F4-89	N/A	N/A	Complete after CIP 6 & 8				$ 20,000
Lift Stations	**Name**	**Recommended Action**							
Lift Stations	Bosero	Mechanical / Electrical Rehabilitation						$ 58,000	
Lift Stations	Canyon Park	Mechanical / Electrical Rehabilitation						$ 58,000	
Lift Stations	Hankins (Jayco)	Assume that a New Station is Completed 2015; Electrical Rehabilitation in 15-20 yrs						$ 26,000	
Lift Stations	Independent Meat	Cost reflective of rebuild. Mechanical/electrical rehabilitation could be done earlier.[D]					$ 535,000		
Lift Stations	Rock Creek Trails	Cost for Mechanical / Electrical Rehabilitation. Upgrade for capacity may also be needed.						$ 58,000	
Lift Stations	Rock Creek	Electrical Rehabilitation 15-20 years						$ 52,000	
Ongoing Pipe Rehabilitation and Replacement		Select annual budget plan based on system value and begin budgeting for next fiscal year.				Choose Plan 1, 2, 3, or 4 ($3.3M, 2.8M, 2.0M or $1.7M).			
TOTAL (EXCLUDING ONGOING ANNUAL CIP BUDGET)						**$ 2,192,000**	**$535,000**	**$1,044,000**	**$ 13,039,000**

A. Costs generally assume 30% rock removal, 3% inflation, 25% contingency, 18% engineering/construction admin, 5% legal and bonding, a public works contractor bidded project, no costs for easements or right-of-way, no Davis-Bacon wages, and no buy American Iron or Steel provisions. All costs are an AACE Class 4 projection (-30% to +50%).
B. Consider also 3a, which completes Grandview to Manhole B3-3. The project will require completion to either B3-14 or B3-3 due to crown matching. An intermediate point is likely not acceptable. Therefore, survey will likely be needed up to B3-3 to verify crowns and inverts even if improvements are only planned for CIP improvement 1 to manhole B3-14.
C. Potentially consider the affects of abandoning the Independent Meat Lift Station and routing to the Rock Creek Trunkline
D. Survey may be needed beyond the project limits shown for CIP improvement 6 from the Madrona siphon all the way to Locust to verify actual slopes and inverts.
E. Odor control not evaluated by J-U-B; $500,000 included at the request of the City for odor control.

ES.8 SUMMARY

Overall, the existing collection system has adequate capacity to convey the Existing Model and Committed Model flows with a few improvements. Upgrades to convey Master Plan flows, as indicated in the CIP priority list and the future Master Plan pipe sizes, will be needed to handle build-out growth. The following recommendations will help ensure that the City is able to provide service to the entire future wastewater service area and that the Master Plan is implemented as intended.

A. **CIP Implementation** — Follow and implement the recommendations in the CIP.
B. **On-Call Modeling** — Provide modeling for new developments to ensure the Master Plan assumptions are adequate.
C. **Existing System Replacement** — Establish an adequate annual budget for on-going maintenance based on a realistic expected life cycle for the pipe.
D. **Condition Assessment** — Assess and record the condition of the collection system piping and other infrastructure based on standardized formats.
E. **Risk Assessment** — To stretch the City's limited annual maintenance budget, the City could implement a risk-based analysis to evaluate when and where system failures are most likely to occur ("likelihood of failure") and what the consequence of failure would be if it occurred.
F. **Odor** — Identify locations where odor control needs to be implemented.
G. **Survey Rim/Invert Elevations**— If insufficient data exists, the City infrastructure should be surveyed and mapped with horizontal and vertical locations and/or field verified by the operations staff. Data could be collected systematically by public works zone to make it manageable for the City staff.
H. **Annual Record Drawing Updates** — Record drawings provided by developers to the City should be used to update the model and GIS on an annual basis.
I. **Trenchless Technology** — The City should consider the continued use of CIPP and other trenchless technology as a means to cost effectively rehabilitate the existing infrastructure, if applicable.
J. **GIS or On-line Mapping** — The City may want to consider more advanced GIS and/or on-line mapping of their wastewater system. This will likely require additional resources and staffing. Additional considerations regarding on-line mapping:
    a. Grid maps should be updated or scanned to a location in an online map where the grid map applies
    b. Record drawings should be linked in an online map to where the drawing applies.
    c. On-line mapping can be used to show where ongoing improvement projects are occurring across the city.
    d. On-line mapping can make existing infrastructure information available to the City staff and other authorized users
    e. On-line mapping can keep track of existing maintenance activities across the City.
    f. On-line mapping can be used to document the sources for information that are used to update the system information, such as survey, record drawing, field check, etc.
    g. Several fields should be added to the GIS to document the year of construction, elevations based on drawings, separate sources of information for pipeline and manholes, datum of the elevation, and entry date of the information.

K. **Flow Monitoring** — The City should consider flow monitoring with major infrastructure changes, if significant dischargers are added to the system, or if previous assumptions are found to have changed or be wrong, and as a general modeling update approximately every 5 years.

L. **Update the Master Plan** — Changes to the existing wastewater collection system are expected to occur as the City continues to grow over the next decade. Updates to the Master Plan and model should be considered if major assumptions change, comprehensive plans or service boundaries change, additional system data has been acquired, and improvement projects are implemented. Master Plans should generally be updated approximately every five to ten years.

ES.9 ACKNOWLEDGEMENTS

Many people were extremely helpful in providing documentation, information, and input throughout the course of this project. The City council and administrators should be commended for making it possible for this work to be completed. During the preparation and completion of the work, JUB was assisted with support and collaboration by City staff in many departments including administration, IT, utility services, community development, planning and zoning, and the building department. Additionally, JUB worked particularly closely with the engineering and public works staff who provided great support and collaboration. In particular, we wanted to acknowledge the nighttime support of the City sewer staff during flow monitoring. We also appreciate the input and data from CH2MHill and others on the lift stations, the WWTP, and permitted users. Assistance from all is gratefully acknowledged.

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Chapter 1

Introduction

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1.0 INTRODUCTION

1.1 BACKGROUND & PURPOSE

The last comprehensive Wastewater Collection System Master Plan for the City of Twin Falls (City) was completed by Murray, Smith & Associates in 2009[1] (2009 Plan). The 2009 Plan included a computerized hydraulic sewer model that was calibrated in 2006[2].

Since completion of the 2009 Plan, several driving factors have led the City to consider an update to the plan and hydraulic model, including:

- Major industrial growth has occurred on the east side of the City.
- A new trunk line was installed to serve the industrial growth which altered flow routing in other existing basins.
- Record drawings were completed on almost all major developments and are available for use in updating the system layer for many manholes and pipes greater than 10 inches in diameter.
- Several proposed developments included in the previous model have expired and needed to be removed.
- Some of the assumptions of the hydraulic model were modified or updated including future industrial growth.
- Recent water meter records provide updated values for unit flows, which, in the case of residential flows, are different from values used previously.
- The City wants a model that matches their existing GIS data so that model output could be easily linked.
- The City desires to identify, verify, and prioritize capital improvements to the system for the short-term and to consider what other trunk lines may be needed for future growth.
- The City desires to monitor flows and recalibrate the model to know how the existing system is performing with the recent changes.
- A major pump station was upgraded and others were removed since the last update.
- The City expects growth to continue and wants to be prepared to accommodate it.
- The City wants to be prepared for potential service boundary adjustments in the future.

As a result of these issues, in December 2013 the City authorized J-U-B ENGINEERS, Inc. (J-U-B) to begin development on a new Wastewater Collection System Master Plan. The major goals of the 2015 Wastewater Collection System Master Plan (2015 Plan) are as follows:

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[1] MSA, (2009) City of Twin Falls Collection System Report.
[2] CH2MHill (2010) City of Twin Falls Sewer Model Development Report

- Update the hydraulic collection system model to assess conditions for three scenarios: **Existing** (current sewer flows), **Committed** (infill of areas the City has already committed to serve) and **Master Plan** (long-term conditions in areas beyond the current City limits to the study area boundary).
- Establish a comprehensive Capital Improvement Plan (CIP) for the next five to ten years.

1.2 SCOPE

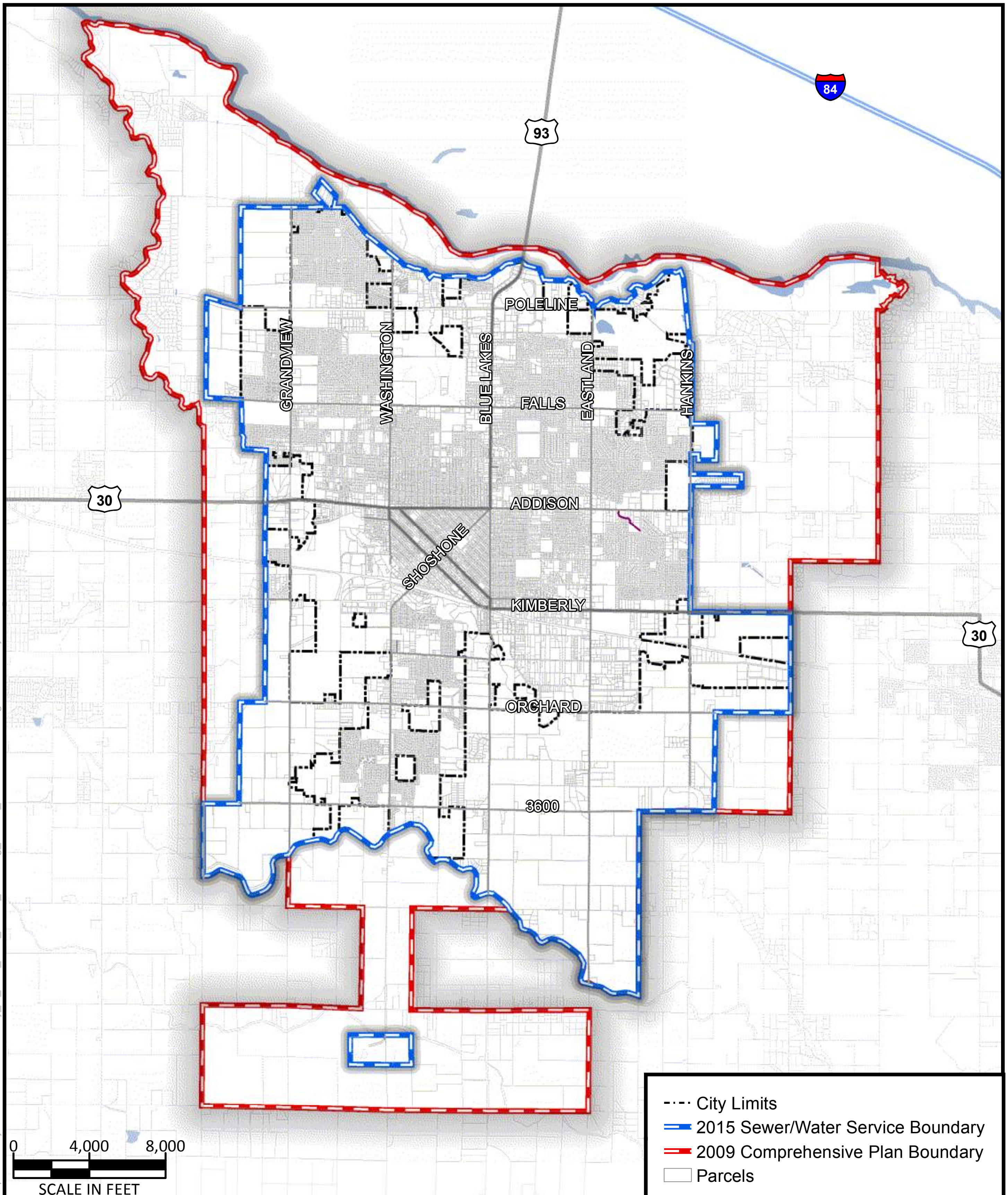
J-U-B worked closely with City staff to update the hydraulic model and develop the 2015 Plan. The new 2015 Plan is a standalone document that is independent of and supersedes all previous updates. The scope for developing the 2015 Plan included the following components:

- Review previous modeling assumptions and update in coordination with the City.
- Collect and compile rim and invert data from the previous hydraulic model, City GIS data, record drawings, and field verification to update the system layer.
- Utilize water meter usage data for existing flow generation and unit flow development.
- Conduct flow monitoring to gather actual flow data for calibration of the hydraulic model.
- Calibrate the hydraulic model to the flow monitoring and wastewater treatment plant (WWTP) data.
- Develop and analyze three scenarios in the hydraulic model to assess the remaining capacity of the existing system, including existing, committed, and master plan conditions.
- Estimate conceptual routing for future trunk lines 10-inch and larger to serve to the extents of the study area boundary.
- Review existing lift stations for capacity when adding in future land area. Evaluate if future trunk lines can be built to eliminate lift stations.
- Develop a comprehensive CIP for the next 20 years, with emphasis on the next 5 to 10 years.
- Assist the City in incorporating the model results into the City GIS.

1.3 STUDY AREA

The study area for the 2015 Plan defines the geographical area for which the City intends to provide sewer service at ultimate build-out. It consists of approximately 18,660 acres or 29 square miles. This study area corresponds to the boundary identified in the 2009 Twin Falls Comprehensive Plan[1] for water and sewer infrastructure and is shown in **Figure 1-1**. The Comprehensive Plan Boundary (synonymous with Area of Impact) also shows the areas beyond the sewer service boundary that would likely develop next if changes were made to the sewer service boundary.

[1] Landmark Design (2009) City of Twin Falls Comprehensive Plan.



06/09/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure 1-1 Study Area.mxd

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

WATER SYSTEM FACILITIES PLAN

FIGURE 1-1 STUDY AREA

J-U-B ENGINEERS, INC.

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Chapter 2

Existing Collection System

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2.0 EXISTING COLLECTION SYSTEM

2.1 DATA SOURCES

The City's collection system data was compiled from multiple sources, including City GIS data, record drawings, hard copy City maps, field verification, operations staff, and the 2009 sewer model. A summary of these data sources is provided in the following sections with additional details summarized in **Appendix B**.

2.1.1 GIS Data

2.1.1.1 Collection System Data

Based on discussions with the City, the existing GIS data layers were used as the base map for updating the sewer lines and manholes. The City originally created these GIS layers by converting their CAD maps to GIS and periodically updating them with new record drawing information. As this GIS update process was ongoing during the start of the master plan, data for some categories continues to be revised. The following collection system data is currently included in the City GIS:

- Sewer Manholes
  - Manhole Identifier (incomplete)
  - Location (approximate northing and easting, not survey quality)
  - Rim Elevation (incomplete)
  - Depth to Invert and corresponding invert elevation (incomplete)
- Sewer Gravity Mainlines
  - Pipe Size (incomplete)
  - Length
  - Material (incomplete)
  - Connectivity - Upstream and downstream manhole identifier
  - CCTV inspection history and video link (incomplete)
  - Private or Public
- Sewer Pressurized Lines (Force Mains and Siphons)
  - Pipe Size
  - Length
  - Material
  - Connectivity - Upstream and downstream manhole identifier
  - Private or Public
- Clean Outs
- Abandoned manholes and pipes

2.1.1.2 Land Use & Zoning Data

Existing land use was based mainly on parcel data retrieved from Twin Falls County in 2014. Additional sources included observation from aerial imagery, verification from previous planning efforts, and online map searches. Future land use was assigned based on designations in the 2009 Comprehensive Plan. City zoning and county assessor property codes were used to determine the existing land use type. Land use was divided into three main categories as shown in **Table 2-1**: Residential, Commercial, and

Industrial. Commercial zoning was then further refined using characteristics such as the assessor "Improvement Type" designation showing the type of business.

Table 2-1 – Land Use Types

Residential	Commercial		Industrial
Residential - Low	Airport	Office	Ameripride
Residential - Medium	Assisted Living	Open Space	Chobani
Residential - High	Car Wash	Park/Golf	Clif Bar
City of Kimberly	Church	Public	Con-Agra
	Commercial	Restaurant	Cummins
	Hospital	RV Park	Glanbia
	Hotel	School	Independent Meat
	Laundromat		Kapstone
			Light Industrial

The Residential-Low (the qualifier "Low" corresponds to density) land use type comprises all of the single-family dwelling units. Residential-Medium consists of multi-family dwelling units with between two and four dwelling units, as well as condos and mobile home parks. Residential-High includes all apartments and multi-family dwelling units with over four dwelling units.

2.1.2 Water Meters

Water meter usage data, specifically during the wintertime months, provides a good approximation of sanitary sewer flows generated by an individual parcel. During the winter, the vast majority of metered water used by customers is discharged to the collection system and is, therefore, a good indicator of base sanitary flow. Monthly water meter usage was averaged over the winter months from 2010 to 2012 to provide an average daily flow for each water meter.

These data could be incorporated directly into the model or used to develop unit flows. To use water meter data directly, a land use type has to be assigned to each meter so that the appropriate diurnal curve can be applied to the flow. Although the City has water meter usage data stored in their billing database, they have yet to create a spatially accurate GIS dataset of these meters. Additionally, several errors exist within the current water meter billing dataset, such as missing meters and incomplete or incorrect addresses. These issues make it impossible to link all the water meters to the correct parcel so that the correct land use type can be associated. It was determined impractical to manually correct these issues and create an accurate GIS dataset of the water meters specifically for the 2015 Plan. Instead, unit flows were developed based on existing land use and aggregate water meter data.

2.1.3 Record Drawings, GRID Map, and CAD Map

Most record drawing pipe sizes and alignments are included in the City GIS, but very few rim and invert elevations have been entered. For pipes generally 10 inch or greater and built after 2008, J-U-B obtained record drawings from the City to supplement rim and invert elevations and verify pipe sizes and alignments. In the case of discrepancies, the City's GRID (historic collection system records) maps, CAD maps, and wastewater staff were consulted for clarification and/or field verification.

2.1.4 Operations Staff & Field Verification

The City operations staff and contractors were vital in obtaining records and verifying information for many collection system components. In particular, City staff and contractors were consulted for the verification of the following components:

- Lift station: active status, flows, dimensions, and capacities.
- Diversions: locations, construction type, operational conditions
- Permitted Users: historic flow data, permit limits, peaking conditions

2.1.5 Previous Modeling Files

The primary source for rim and invert elevation data came from the 2009 sewer model, which consisted of the major trunk lines (generally 10 inch or larger). Rim and invert elevations in the 2009 model were based on record drawings up to 2008, interpolation and survey. A majority of this data was used without additional verification. The 2009 model also provided a check on City GIS pipe sizes and alignments.

The 2009 model contained several manholes that did not correspond with manhole locations within the City GIS. In comparing the model with City GIS, it was found that many of these manholes were used to model intermediate transitions in pipes where the slope changes (i.e., siphons, canyon drop lines). Some particular examples include sections of the Washington Street South sewer and pressurized sewer pipes routed down the Rock Creek or Snake River Canyons. In other cases, a close match with an existing City manhole was identified and the attributes of the model manhole (i.e., rim/invert elevation) were transferred. A complete list of this manhole comparison, evaluation, and assignment is located in **Appendix B**. In all cases when a conflict between 2009 Model/City GIS ID's occurred, a new label with prefix "JUB" was assigned so that these conflicts and assumptions may be tracked as the City updates their GIS system.

2.1.6 Updated System Layer & Source Documentation

Updated GIS base layers were created for the sewer lines and manholes using the data described in the previous sections. Care was taken to preserve the naming conventions in the City GIS and assign the most current and correct information to each manhole and pipe. An effort was made to obtain accurate data for trunk lines 10-inches and larger although, the accuracy of this data is limited by the available sources as described previously. Minimal effort was made to improve the accuracy of the data for the 8-inch collector lines because modeling results were not included for the collectors in this update.

Several of the manholes lacking good spatial accuracy from survey were moved slightly within their immediate vicinity to better match expected location based on aerials or recent record drawing information. Lift station information was obtained from the best available information from design memos and record drawings.

Fields were created in the updated GIS base layers to document the manhole location and the rim and invert elevation sources. **Table 2-2, Table 2-3**, and **Figure 2-1** provide a summary of data sources used for the collection system. A figure showing manhole rim elevation source is similar to invert source elevation for the majority of cases.

Table 2-2 – Data Source Summary for Manhole Location, Pipe Size and Lift Stations

Source	Pipe Size		Manhole Location		Lift Stations
	Number	Percent	Number	Percent	Number
Survey	2	0.0%	139	2.8%	
Field/Staff Verify	51	1.0%	-	-	
Record Drawings	167	3.3%	185	3.7%	6
2009 Model [(1)]	621	12.3%	646	12.9%	
CAD / GRID Map	77	1.5%	-	-	
City GIS	4,022	79.4%	3,898	77.7%	
Design Memo	-	-	-	-	2
Other	124	2.4%	151	3.0%	
Total	5,064	100%	5,019	100%	6

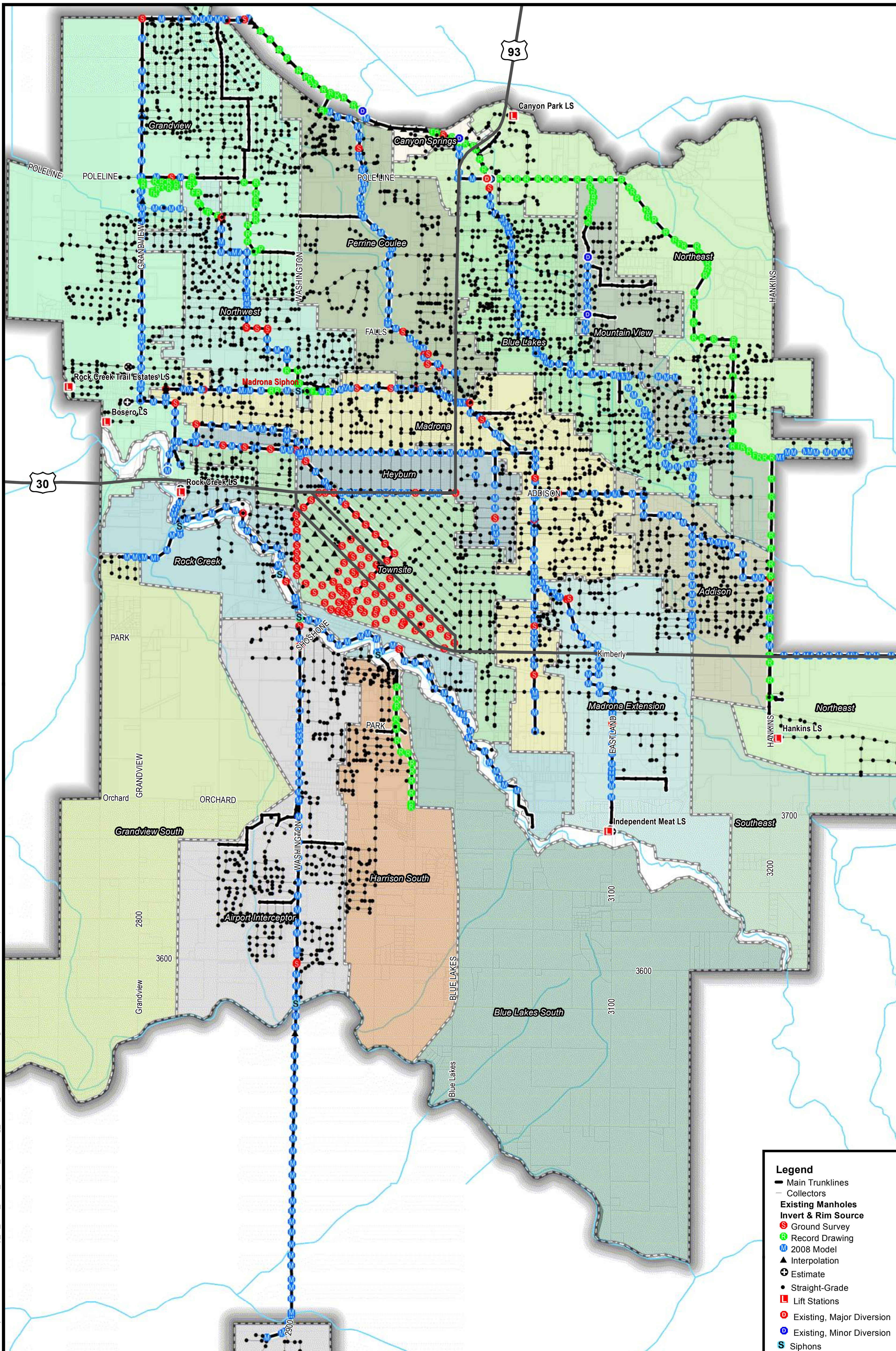
(1) 2009 model data sources included survey, record drawings and interpolation. Survey from the 2009 model is included under the survey source.

Table 2-3 – Data Source Summary for Manhole Rim and Invert Elevations

Source	Inverts		Rims	
	Number	Percent	Number	Percent
Survey	114	2.3%	143	2.8%
2008- 2014 Record Drawings	215	4.2%	177	3.5%
2009 Model [(1)]	617	12.2%	624	12.4%
City GIS	-	-	-	-
Interpolation / Straight Graded / Contours[(2)]	4,118	81.3%	4,075	81.2%
Total	5,064	100%	5,019	100%

(1) 2009 model data sources included survey, record drawings and interpolation. Survey from the 2009 model is included under the survey source.

(2) Of these 4,118 pipes, 90.8 % are collector pipes < 10 inch diameter



SEWER COLLECTION MASTER PLAN

FIGURE 2-1
DATA SOURCE SUMMARY

J-U-B ENGINEERS, INC.

0 1,500 3,000
SCALE IN FEET

03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure 2-1 Data Source Summary.mxd

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2.2 COLLECTION SYSTEM OVERVIEW

The original sewer lines for the City's collection system were constructed in the early 20th century. In summary, the collection system consists of 245 miles of gravity mains, force mains, and siphons with several diversions as shown in **Figure 2-2**. **Table 2-4** summarizes the system by pipe size and material. The City also maintains six sewer lift stations, which are shown in **Figure 2-2**. A summary of each lift station is included in **Table 2-5**. The collection system can be divided into several sewer basins, which are shown in **Figure 2-3**. In addition, the location and a description of existing diversions are shown in **Table 2-6**. The current sewer infrastructure served approximately 46,000 people in the City of Twin Falls at the end of 2013 and 3,300 people in the City of Kimberly.

Table 2-4 – Existing Pipe Size & Material Summary

Pipe Size (in)	Length by Material Type and Pipe Size (ft)								Total Length by Pipe Size		
	PVC	Clay	Concrete	HDPE	Steel	Transite	Unknown(1)	Force Main(2)	Feet	Miles	Percent
4	0	0	133	0	0	0	256	5,048	5,437	1.0	0.4
6	3,677	24,911	31,085	0	0	1,498	44,903	1,157	107,232	20.3	8.3
8	429,713	70,479	94,698	1,489	602	105,423	179,211	0	881,614	167.0	67.9
10	21,607	3,495	18,677	363	0	2,515	18,672	942	65,330	12.4	5.0
12	32,777	7,325	13,146	0	0	1,225	19,999	232	74,703	14.1	5.8
14	0	0	0	0	0	0	2,088	897	2,985	0.6	0.2
15	2,094	5,326	3,966	0	351	0	9,275	0	21,012	4.0	1.6
16	178	0	0	0	0	0	0	0	178	0.03	0.01
18	1,532	4,378	18,198	0	0	0	24,810	0	48,918	9.3	3.8
21	4,848	0	1,116	0	0	0	4,771	0	10,735	2.0	0.8
24	14,907	624	3,383	0	0	0	10,906	835	30,655	5.8	2.4
27	7,649	0	383	0	0	0	2,011	0	10,042	1.9	0.8
30	5,867	0	0	0	0	0	12,723	0	18,590	3.5	1.4
36	1,052	0	715	0	0	0	16,447	0	18,214	3.4	1.4
42	0	0	0	0	0	0	2,844	0	2,844	0.5	0.2
Total Length by Material Type									Grand Total		
Feet	524,959	116,539	185,500	1,851	953	110,661	348,916	9,110	1,298,490		
Miles	99.4	22.1	35.1	0.4	0.2	21.0	66.1	1.7		245.9	
Percent	40.4	9.0	14.3	0.1	0.1	8.5	26.9	0.7			100

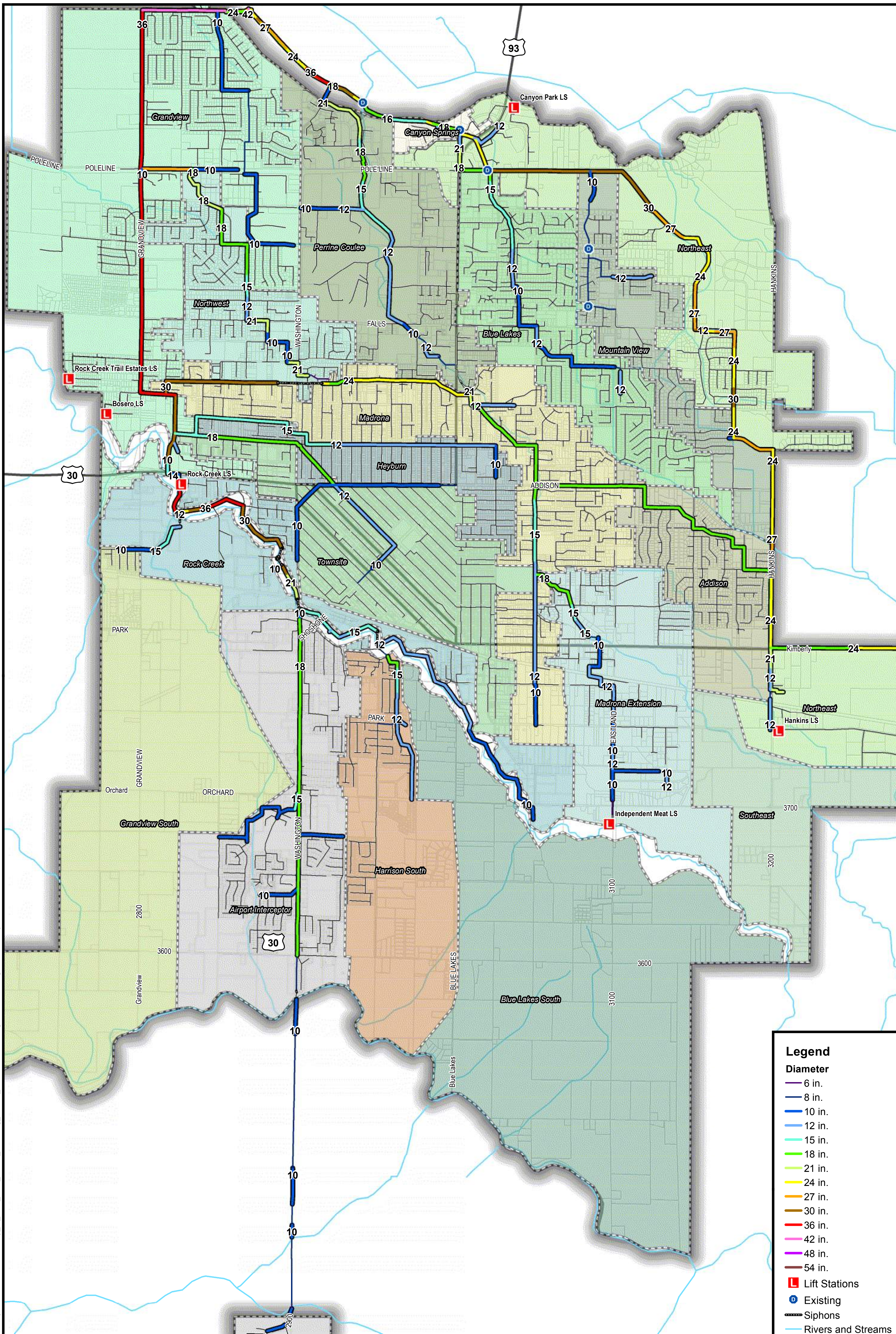
(1) Material not yet identified in the City GIS
(2) Material type is believed to be primarily PVC

Table 2-5 – Existing Lift Station Summary

Parameter	Units	Rock Creek Trails LS	Bosero LS	Rock Creek LS RCLS #1	Rock Creek LS RCLS#2	Independent Meat LS	Hankins (Jayco) LS	Canyon Park LS
Pumps	-	2	2	4	3	2	2	2
Pump Model	-	Pioneer Model P4	Pioneer Model P4	Cornell 6NHTB-VC18 Cycloseal	Cornell 6NHTB-VC18 Cycloseal	Peabody Barnes 4SCUS	Hydromatic S4NX	Hydromatic 40MP
Pump Type	-	Self-Priming, V-Belt	Self-Priming, V-Belt	Vertical Coupled	Vertical Coupled	Self-Priming	Submersible	Self-Priming, V-Belt
Horsepower	hp	15	10	50	50	20	5	10
Max Speed (1)	rpm	1800	1800	1200	1200	1750	1750	1750
VFD	-	No	No	Yes	Yes	No	No	No
Design Flow per Pump	gpm	160	200	2,073	2,073	300	460	250
PS Firm Flow	gpm	160	200	12,438		300	460	250
PS Rated Flow	gpm	320	400	14,511		600	920	500
Design TDH	feet	76.3	50	62	62	85	21	59
Design Speed	rpm	1,600	1,360	1,180	1,180	1,650	1,750	1,530
Wet Well Depth(2)	feet	14.00	9.42	18.00	15.00	12.08	24.17	7.54
Wet Well Diameter	inches	4.92	5.88	-	-	4.00	5.96	6.04
Wet Well Length	feet	-	-	16.00	13.50	-	-	-
Wet Well Width	feet	-	-	10.83	5.00	-	-	-
Set Point & Level Controller	-	Hydro-Ranger	Hydro-Ranger	Pressure Transducer	Pressure Transducer	Floats	Hydro-Ranger	Floats
Pump 1 On (1)	feet	4.50	3.00	5.42	6.33	4.63	4.00	2.29
Pump 1 Off	feet	3.00	2.60	4.00	6.33	2.17	1.50	0.92
Pump 2 On	feet	4.75	3.40	5.67	6.42	5.75	5.00	2.88
Pump 2 Off	feet	3.00	2.70	5.67	6.42	5.25	1.50	1.79
Pump 3 On	feet	-	-	5.88	6.50	-	-	-
Pump 3 Off	feet	-	-	5.88	6.50	-	-	-
Pump 4 On	feet	-	-	6.08	-	-	-	-
Pump 4 Off	feet	-	-	6.08	-	-	-	-
High Level Alarm	feet	7.50	4.00	Not Avail.	Not Avail.	6.42	7.00	3.67
High Level Off	feet	6.50	3.50	Not Avail.	Not Avail.	6.17	6.00	3.42

(1) Referenced from the bottom of the wet well.

(2) Rock Creek wet well dimensions are for one (1) wet well, the station contains two (2) identical wet wells



SEWER COLLECTION MASTER PLAN

FIGURE 2-2 EXISTING COLLECTION SYSTEM

J-U-B ENGINEERS, INC.

03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure 2-2 Existing Collection System.mxd

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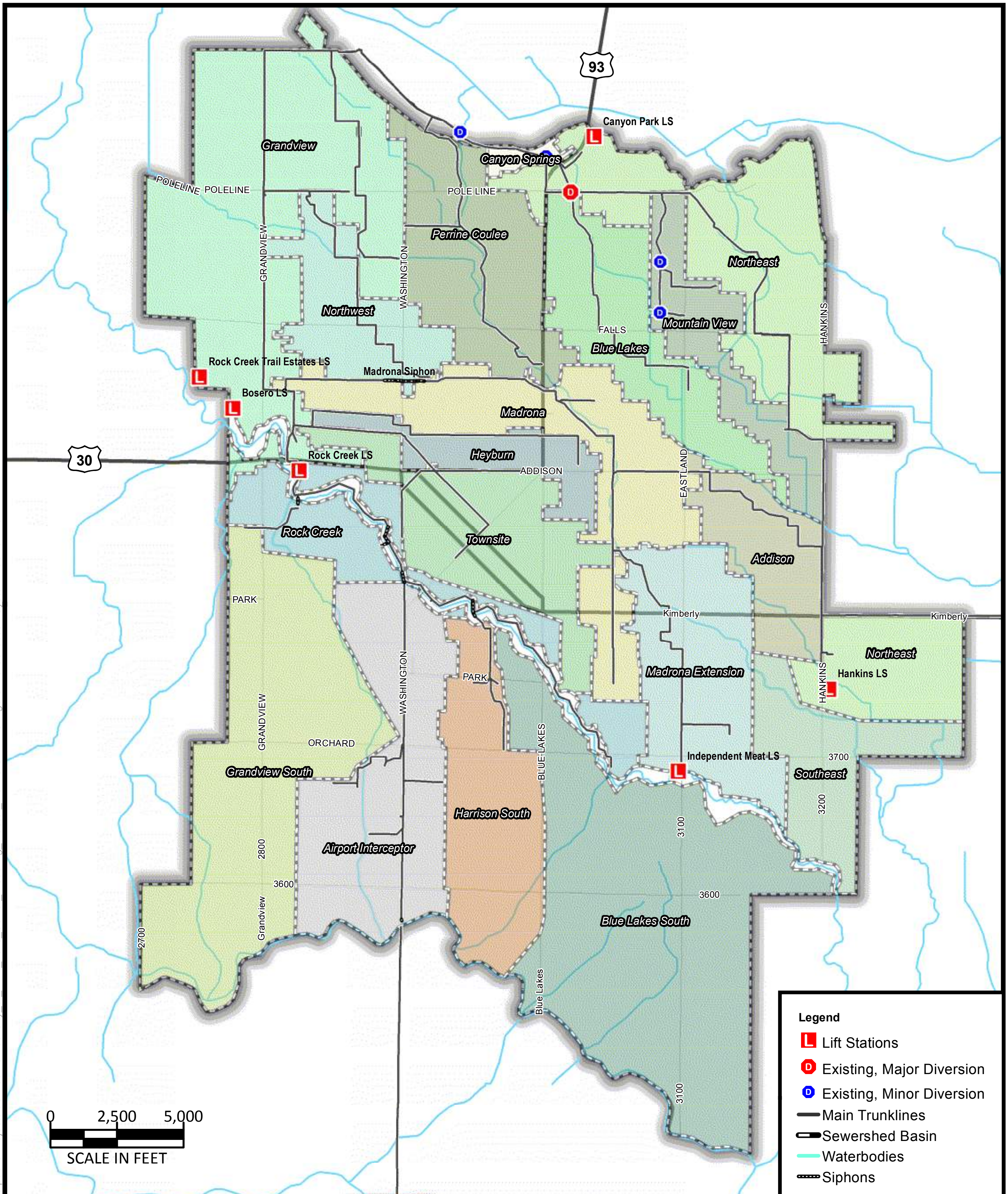

CITY OF TWIN FALLS PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE 2-3 COLLECTION SYSTEM BASINS

J-U-B ENGINEERS, INC.

Table 2-6 –Existing Diversions

Location	Description of Diversion
Mountain View Drive/Bitteroot Drive	Concrete diversion built to send water north, flow depths >10 inches can divert west
Mountain View Drive/Candlewood Ave.	Concrete diversion built to send water north, flow depths >10 inches can divert west
Blue Lakes Blvd Diversion on Polel Line Road E.	Concrete diversion built to send water north, flow depths >24 inches can divert west
Canyon Springs Road (Currently planned)	Raised pipe invert diversion sends water levels > 1.4 feet to 18 inch parallel pipe, provides full pipe flow in 24 inch trunkline and ¾ pipe flow in 18 inch trunkline (has service lines)
Canyon Springs Road	Dissipation box diversion sends water to 24 inch trunkline (normal operation) or gate valve can open to older 15 inch parallel trunkline
Kimberly/Hankins	Manhole drop diversion built to send water from Kimberly to Northeast Trunkline, no bypass currently available

2.3 SYSTEM CONDITION

The 2015 Plan does not include a comprehensive condition assessment. However, in the process of collecting information for the hydraulic model, specific lines with condition or maintenance concerns were discussed by City staff, including:

- Manhole C3-145 on the Madrona Siphon was covered with concrete when Washington Street was widened in 2010. This particular manhole has a sump that the video camera falls into, making it difficult to regularly clean and videotape this siphon. During the 2010 construction, the Madrona Siphon was inspected and reported as good condition.
- Significant levels of sediment six inches and greater were discovered in the Madrona Trunk at the corner of Wirsching Ave. W. and Beta St., Manhole B3-289, during flow monitoring. Increased sediment likely occurs in the line upstream to Hankins Road due to reduced flow now that the City of Kimberly flow has been rerouted to the Northeast trunkline. This trunk line may require a more frequent flushing schedule due to increased sediment levels.
- Nuisance odors are occasionally present in the Northeast Trunkline and near the Rock Creek Lift Station.
- Several of the siphons and drop lines into Rock Creek and into the Snake River Canyon are reportedly in need of repair or replacement.
- The manholes along the Grandview Trunkline in general from the Rock Creek lift station to the wastewater treatment facility are deteriorated and in need of rehabilitation or replacement.
- The Independent Meat Lift Station has exceeded its service life and is in need of replacement.
- Many of the pipes in the collection system are reportedly greater than 60 years old. Depending on the material, pipe generally has a service life of 50 to 100 years. For plastic PVC/HDPE, this service life is typically 75 to 100 years or longer. For all other non-plastic pipe, the service life is

generally 50 years. As a result, it appears that many of the pipes may be approaching the end of their useful service life.

The City has recently divided the community into sections so that systematic infrastructure maintenance can be completed in coordination with water, sewer, stormwater, and/or roadway improvements. A system-wide collection system condition assessment would allow the City to prioritize which sewer lines in each section are in need of replacement or rehabilitation. It would also identify the appropriate method for replacing and/or rehabilitating the pipes (e.g., open trench, cured-in-place-pipe [CIPP], pipe bursting, etc.). Incorporating a condition and risk based prioritization would further optimize the overall maintenance approach and costs to the City.

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Chapter 3

Planning Data and Growth Projections

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3.0 PLANNING DATA AND GROWTH PROJECTIONS

3.1 HISTORICAL POPULATION DATA

Recent and historical growth rates provide context that can help the City plan the timing of sewer improvements needed to serve future growth. Growth rates can be used in conjunction with unit flows to estimate the time it will take to reach a specific flow that corresponds to a model run or scenario. Historical US Census population data[1] for the City is included in **Table 3-1**. The City of Kimberly population data is also included since the City of Twin Falls collects and treats wastewater from Kimberly.

Table 3-1 – US Census Population Data

Year	Twin Falls		Kimberly		Combined	
	Population	Annual Growth Rate	Population	Annual Growth Rate	Population	Annual Growth Rate
1940	11,851	-	963	-	12,814	-
1950	17,600	4.0%	1,347	3.4%	18,947	4.0%
1960	20,126	1.4%	1,298	-0.4%	21,424	1.2%
1970	21,914	0.9%	1,558	1.8%	23,472	0.9%
1980	26,209	1.8%	2,307	4.0%	28,516	2.0%
1990	27,591	0.5%	2,367	0.3%	29,958	0.5%
2000	34,469	2.3%	2,614	1.0%	37,083	2.2%
2010	44,125	2.5%	3,264	2.2%	47,389	2.5%
2013(1)	45,981	1.4%	3,350	0.9%	49,331	1.3%

(1) Census Estimate

3.2 POPULATION GROWTH PROJECTIONS

To prioritize and program needed improvements, municipalities often consider what growth may occur over the next 20 to 30 years assuming a fixed annual growth rate. Overall, the City has experienced an average annual growth rate of approximately 1.9 percent since 1940. Based on this information, the City elected to use a 2.0 percent annual growth rate for population growth projections. This is the same growth rate used in the 2015 Water Mater Plan[2]. **Figure 3-1** shows population growth projections from 2013 to 2040. Actual growth rates will vary and should be periodically reviewed and compared to the recommendations in this study.

[1] U.S. Census Bureau
[2] J-U-B (2015) City of Twin Falls Water Master Plan.

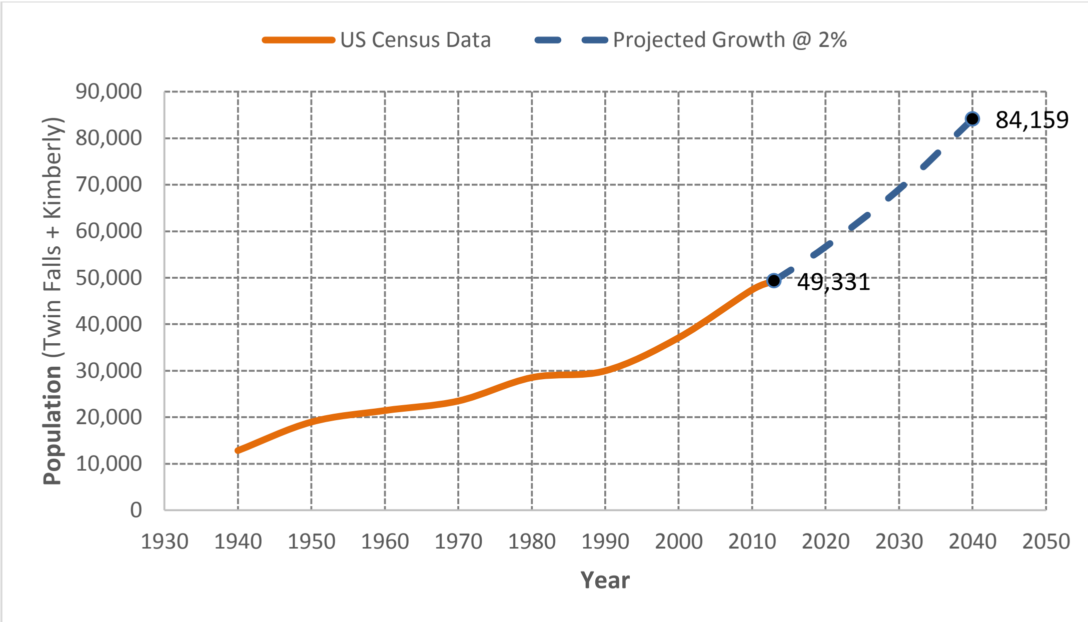


Figure 3-1 – Population Projections to 2040

3.2.1 Growth Projections for Permitted Users

Typical industrial growth has a relatively small impact on the collection system due to low unit flows. A flow and density analysis on existing water meters for industrial users, excluding the highest users, resulted in a values below 200 GPAD. However, the highest industrial users' flow was significantly greater than this and can dramatically affect the system capacity. Flow projections for the existing permitted industrial users were derived from a survey conducted in 2013 which estimated their growth projections over a 20-year planning period. Based on the survey and extrapolation of the results to sewer load, a maximum day load of 1.48 MGD is anticipated to be discharged beyond existing permitted limits. **Figure 3-2** shows the location and flows for the existing permitted users. A flow for each permitted user's anticipated growth is also included.

Table 3-2 –Peak Day Flows of Existing Permitted Users

Industry	MH	Peak Day Flows (MGD)	
		Permit	Committed[1]
Ameri Pride	C4-200	0.15	0.50
Chobani	JUB098	1.0	2.50
Clif Bar[2]	G5-20	0.16	0.16
Con Agra/ UASB	C4-324	2.8	3.42
Cummins Family Produce	E5-69	0.03	0.07
Glanbia Foods	C5-160	0.7	0.77
Independent Meat	E6-18	0.25	0.55
Kapstone (formerly Longview Fibre)	C5-26	0.13	0.13
Kimberly	G5-3	0.75	1.15

[1]Committed flows are anticipated and will require new permit agreements with City. Committed flows do not guarantee or imply a will-serve will be granted.
[2]Clif Bar is modeled at 1.12 MGD peak hour flow

Additionally, there have been a few new industries developing in the City. The City requested that the 2015 Plan account for future permitted industrial users. Based on discussions with the City, **Figure 3-3** and **Figure 3-4** show the general areas and peak day flows used for future industrial users in the Committed and Master Plan Models, respectively. The flows shown in **Figure 3-4** for the Master Plan Model are in addition to the flows in **Figure 3-3** for the Committed Model. **Table 3-3** summarizes the current and future permitted users in the City.

Table 3-3 – Peak Day Flows of Future Industrial Users by Basin

Sewer Basin	Peak Day Flows (MGD)	
	Committed	Master Plan
Airport Interceptor	0.9	2.9
Blue Lakes South	-	1.0
Grandview	0.5	3.0
Grandview South	0.5	1.0
Madrona	-	2.0
Madrona Extension	0.4	0.8
Northeast	4.5	5.6
Rock Creek	3.4	3.4
Southeast	-	1.2
Townsite(1)	1.2	1.5
Totals	11.4	22.4

(1) Includes growth and/or redevelopment of industrial/commercial users

3.3 LAND USE DENSITY

3.3.1 Existing Density

A land use density analysis was performed throughout the City for all residential land use types. Residential densities are listed on both a net and gross area basis (**Table 3-4**). The gross area includes residential dwelling units, schools, parks and public right-of-way. For every acre of residential land use, there are approximately 0.5 acres of land for commercial and light industrial use in the City. The conversion between net and gross area is estimated to be approximately 75 percent for residential areas, based on an analysis of several City neighborhoods. A conversion factor of 85 percent was estimated for non-residential areas.

Further, the 2010 census[1] indicates that the per capita density is 2.58 persons per household. Other sources range from 2.66[2] and 2.64[3]. The 2015 Plan will use 2.66 persons per household.

[1] U.S. Census (2010) http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.
[2] U.S. Census (2014) http://quickfacts.census.gov/qfd/states/16/1682810.html; Last Revised July 8, 2014.
[3] MSA, (2009) City of Twin Falls Collection System Report.

Table 3-4 – Existing Residential Density

Land Use Type	Net Area (AC)	Net Density(1) (EDU(3)/AC)	Gross Density(2) (EDU(3)/AC)
Residential - Low	3,142	4.2	3.35
Residential - Medium	347	7.1	5.3
Residential - High	153	15.9	11.9

(1) Net Density– The net area includes only the area of the parcel and excludes any right-of-way, open space, roads, parks or landscape buffers. Therefore, net area based parameters are higher than those based on gross area.
(2) Gross Density – The gross area includes the parcel area, as well as, any internal or adjacent right-of-way, open space, roads, parks and landscape buffers. Consequently gross area based parameters are lower than those based on net area.
(3) Equivalent Dwelling Unit (EDU) corresponds to a population density of 2.66 people/EDU

3.3.2 Future Density

The 2009 Comprehensive Plan is the guiding document for land use in the 2015 Plan. Within the Comprehensive Plan, areas designated as residential land use do not have a specific future density assigned. Residential growth represents single-family homes and/or higher density housing. Infill tends to be higher density and does not necessarily correspond to existing zoning or future Comprehensive Plan designations. This higher density residential development can represent a significant amount (up to 1/3) of the total residential flow. Therefore, a conservative value of 4 dwelling units per gross acre is assumed for future residential areas. Apart from developing vacant land, redevelopment of existing land is anticipated in a portion of downtown as described in the URA's Downtown Assessment Study[1].

3.4 SUMMARY OF PLANNING DATA

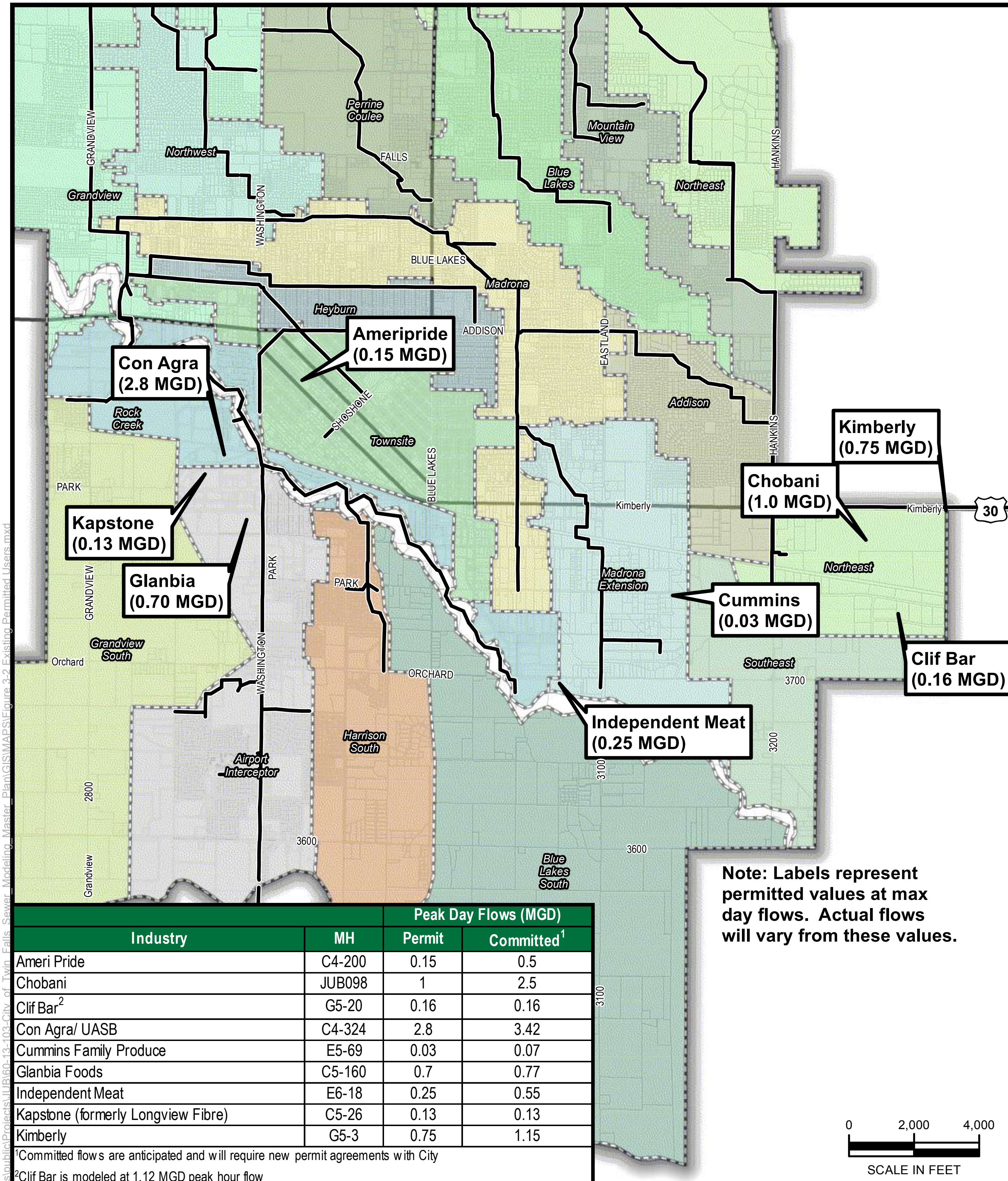
This sewer master plan relies on multiple sources of information when developing these preceding planning rates and values. This process was guided by comprehensive planning documents, published sources, analysis of existing city rates, and input from City staff. A summary of these rates and values are provided in **Table 3-5**. Additional information about the development of this information can be obtained in **Section 4.3** and **Appendices B** and **D**.

Table 3-5 – Summary of Residential Planning Information

Parameter	Unit	Value	Sources Consulted
Population Density	People/EDU[1]	2.66	2010 Census, Census estimate for 2014, 2009 Sewer Master Plan
Residential Loading Rate	GPD/EDU[1]	170	Evaluation of existing wintertime water meter records, density analysis, published values, comparison to similar Idaho communities, and model calibration to flow monitoring. See discussion in **Section 4.3.1**
	GPD/Person	63.9	Calculation
Residential Gross Density	EDU[1]/Acre	4	City-wide residential parcel density analysis

[1]EDU = Residential Dwelling Unit

[1] Twin Falls URA (2013) Facilities Assessment for Downtown and Old Towne



Note: Labels represent permitted values at max day flows. Actual flows will vary from these values.

		Peak Day Flows (MGD)	
Industry	MH	Permit	Committed[1]
Ameri Pride	C4-200	0.15	0.5
Chobani	JUB098	1	2.5
Clif Bar[2]	G5-20	0.16	0.16
Con Agra/ UASB	C4-324	2.8	3.42
Cummins Family Produce	E5-69	0.03	0.07
Glanbia Foods	C5-160	0.7	0.77
Independent Meat	E6-18	0.25	0.55
Kapstone (formerly Longview Fibre)	C5-26	0.13	0.13
Kimberly	G5-3	0.75	1.15

[1]Committed flows are anticipated and will require new permit agreements with City

[2]Clif Bar is modeled at 1.12 MGD peak hour flow

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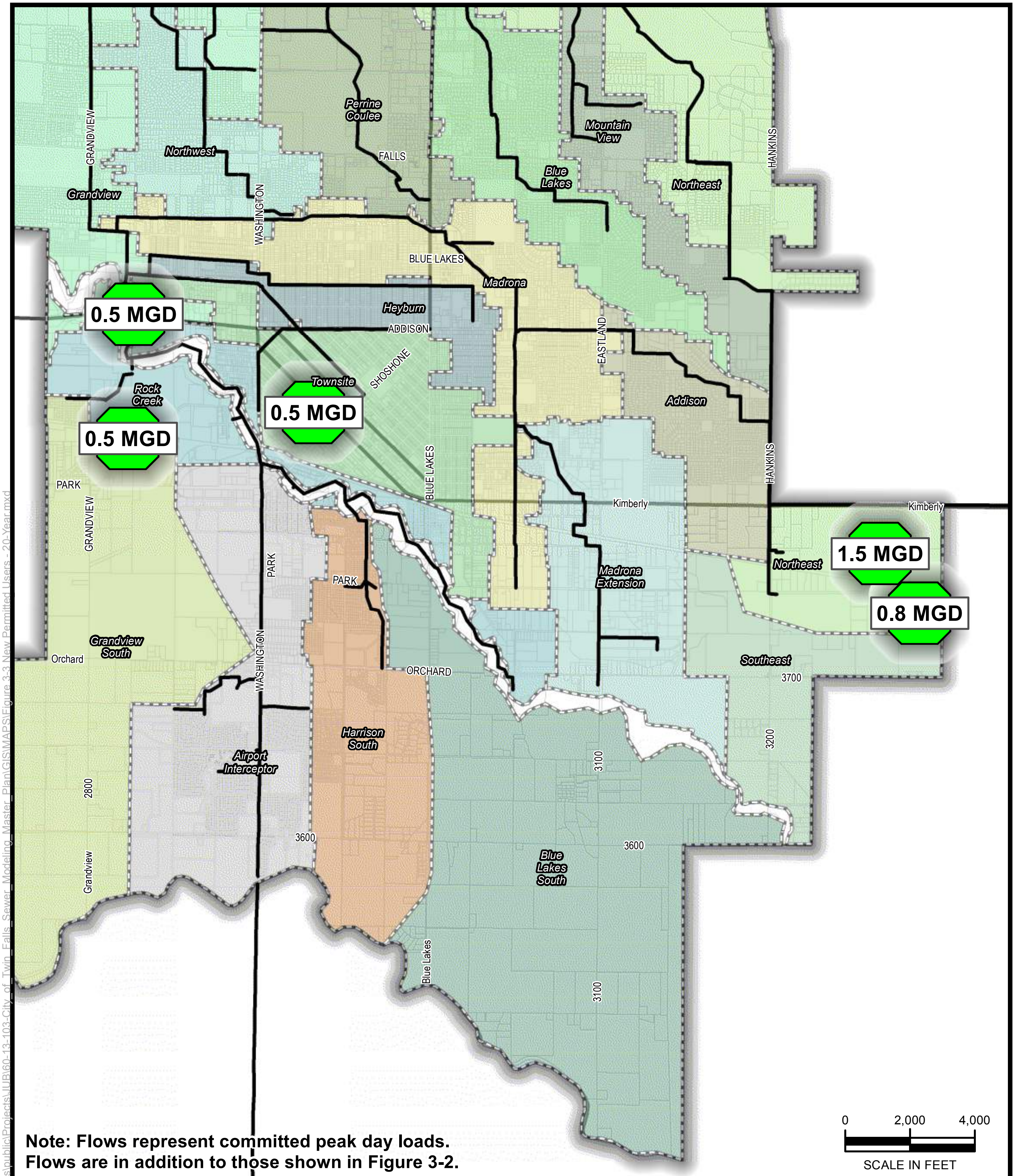
SEWER COLLECTION MASTER PLAN

FIGURE 3-2 EXISTING PERMITTED USERS

J-U-B ENGINEERS, INC.

3/31/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103 City of Twin Falls Sewer Modeling Master Plan\GIS\MAPS\Figure 3-2 Existing Permitted Users.mxd



CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE 3-3 COMMITTED SYSTEM PERMITTED USERS

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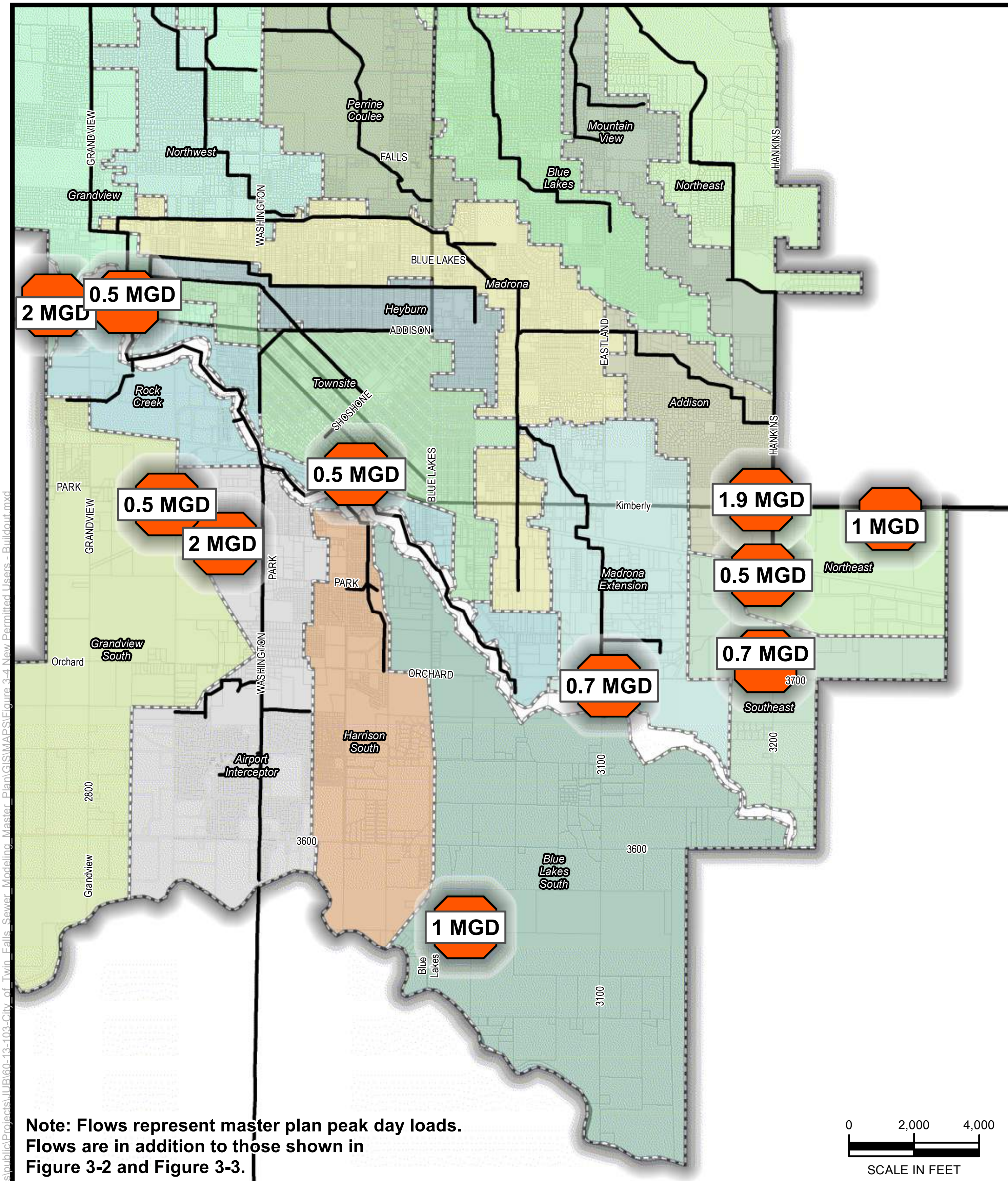

Note: Flows represent master plan peak day loads. Flows are in addition to those shown in Figure 3-2 and Figure 3-3.

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION
MASTER PLAN

FIGURE 3-4
MASTER PLAN PERMITTED USERS

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Chapter 4

Existing Model Development and Analysis

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4.0 EXISTING MODEL DEVELOPMENT AND ANALYSIS

4.1 GENERAL

The Existing Model in the 2015 Plan was built using the City's updated GIS data and InfoSWMM modeling software. The Existing Model's primary purposes are to:

- Provide a snapshot of current system flows
- Identify potential existing capacity issues
- Calibrate unit flows and other model parameters for use in the Committed Model (Chapter 5) and Master Plan Model (Chapter 6)

The Existing Model consists of two layers: the System Layer and the Flow Generation Layer. Each layer includes multiple parameters and corresponding assumptions that characterize the area and system being modeled. The assumptions are based on the City's GIS data, pipe inverts, record drawing data, flow monitoring, characteristics of the physical system, similar studies done in the region, and general and historical knowledge gained through work with the City. Key assumptions establishing the level of service were reviewed with the City and are documented in **Appendix C**. These assumptions were used in preparing the Existing Model in the InfoSWMM modeling software to analyze the City sewer collection system. The Existing Model is representative of the City's sewer system and flows as of March 9, 2014.

4.2 EXISTING SYSTEM LAYER

The Existing Model System Layer consists of the manholes, gravity sewer pipes, force mains, diversions, siphons, and lift stations in the collection system. A map of the Existing Model System Layer is found on **Figure 2-2**.

4.2.1 Existing Pipes and Manholes

As discussed in **Section 2.1**, the updated GIS base layers for the sewer lines and manholes were used as the source for the Existing Model system layer. This system layer contains the best information available for pipe and manhole locations, rim elevations, invert elevations, pipe sizes and pipe lengths. This information was imported into the InfoSWMM model.

The 2015 Plan focuses on trunk lines 10-inches and larger. Modeling results are not included for collector lines (8-inch and less). Collector lines were added to the model to improve flow routing due to the flow generation method used in the Existing Model. The majority of the rim and invert elevations of the collector lines were approximated for modeling purposes, as discussed in **Section 2.1**. Since the collector's main purpose is to route the flow to the trunk lines so that peak attenuation through the trunk lines is represented correctly, this approach was deemed sufficient and appropriate.

4.2.2 Lift Stations

Lift station and force main data were added to the Existing Model based on the updated City GIS, previous modeling records and information provided by the City, as summarized in. The Rock Creek Lift Station was modeled as an "ideal pump" because variable frequency drives operate at this station. An ideal pump in InfoSWMM matches the flow rate at the discharge manhole to the flow rate at the influent to the pump station, resulting in no storage in the pump station wet well. All other lift stations were modeled as constant speed pumps.

4.3 EXISTING FLOW GENERATION LAYER

The Existing Model is a parcel based model where each parcel is assigned a specific land use type, an average daily flow and a diurnal curve that corresponds to the land use type.

Different land use types generate peak sewer flows on different days of the week and it is important to model the variation throughout the week correctly. For instance, residential areas often have higher average and peak flows on the weekend. Conversely, schools generate the majority of their wastewater during the week. As a result, a school's daily average is adjusted so that the majority of the flow is distributed throughout the week and very little flow is distributed over the weekend. The Existing Model was built using weekday and weekend factors to adjust the average flows to capture maximum peak possibilities. Land use types used in the Existing Model are listed in **Table 2-1** and shown in **Figure A-1** in **Appendix A**.

Diurnal curves (the typical 24-hour shape of the flow) were also developed for each land use type. The diurnal curves were initially based on previous modeling experience and flow monitoring data and later adjusted during calibration efforts to align with flow monitoring results. They are described in more detail in **Appendix C**.

Average daily flows were estimated from unit flows assigned to existing parcels based on land use type. Unit flows derived during this process were used as an initial estimate because land use variability can occur in a given zoning type. For example, a general commercial zoning may contain some residential development, such as apartments. Some residential zoning allows for commercial uses. This type of variability is usually a small percentage of total parcels. Initial estimates of unit flows were compared to values from other modeling efforts throughout Idaho and adjusted during calibration to represent existing City flows.

4.3.1 Residential Unit Flows

Residential unit flows are measured in gallons per day per dwelling unit (gpdu) or gallons per capita per day (gpcd). Ten States Standards[1] recommends a planning rate of 100 gpcd excluding major commercial, institutional or industrial flows for new sewer design unless water usage data is available. CH2MHill[2] reported that from 2003 to 2009 the City had an average day flow of 101 gpcd for residential, typical commercial, and light industrial, but excluding major or permitted industrial flow users.

ASCE[3] published a review of many cities across the country with data primarily collected prior to 2000. Residential unit flows generally ranged from 43 to 90 gpcd for a household size of 2.6 people per dwelling unit (ppdu). Metcalf and Eddy[4] published typical flows for 2.0 ppdu ranging from 63 to 81

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[1] GLUMRB. (2004). Recommended Standards for Wastewater Facilities.
[2] CH2MHill. (2010). Facilities Plan Update for the Twin Falls Wastewater Treatment Plant.
[3] Bizier, P. (Ed.). (2007). Gravity Sanitary Sewer Design and Construction. 2nd ed. *Manuals and Reports on Engineering Practice No. 60; WEF Manual of Practice No. FD-5*. Virginia: ASCE
[4] Tchobanoglous, G., Burton, F. L., Stensel, H. D. (2003). Wastewater Engineering *Metcalf and Eddy, Inc*. New York: McGraw-Hill.

gpcd, and for 3 PPDU as 54 to 70 gpcd. In general, many cities are seeing a decline in residential unit flows. One reason for this may be low flow appliances and fixtures.

As part of the water meter usage analysis, key representative locations throughout the City were used to identify aggregate residential unit flows based on land use. The locations consisted of fully developed areas with the vast majority being single-family homes. The resulting residential unit flows in the City ranged from 127 to 178 gpdu, or 48 to 67 gpcd assuming 2.66 ppdu. These values don't include potential flows from open areas, parks, or schools. Therefore, the likely residential unit flows are near the higher end of the calculated values. **Table 4-1** summarizes the residential unit flows used in the Existing Model and verified during calibration.

Table 4-1 – Existing Residential Unit Flows

Land Use Type	Unit Flow per Dwelling Unit (GPDU)	Unit Flow per Person (1) (GPCD)
Residential - Low	175	65.8
Residential - Medium	165	62.0
Residential - High	165	62.0

(1) Assumes 2.66 people per dwelling unit.

4.3.2 Non-Residential Unit Flows

Non-residential unit flows, other than permitted industrial users, are measured in gallons per acre per day (gpad) on a parcel land area basis. Unit flows per land use type were developed based on monthly water meter and land use data for the City and on typical values from similar cities in Idaho.
Table 4-2 shows the calibrated non-residential unit flows used in the Existing Model.

Table 4-2 – Existing Non-Residential Unit Flows

Land Use Type	Net Area (AC)	Net Unit Flow (GPAD)	Gross Unit Flow (GPAD)	Land Use Type	Net Area (AC)	Net Unit Flow (GPAD)	Gross Unit Flow (GPAD)
Airport	328	10	8	Laundromat	1.8	6,000	5,100
Assisted Living	33	1,700	1,450	Office	147	600	510
Car Wash	3.5	4,000	3,400	Park/Golf	485	30	35
Church	155	150	130	Public	63	600	510
Commercial	735	400	340	Restaurant	48	2,500	2,130
Hospital	39	800	680	RV Park	8.0	1,000	850
Hotel	39	3,000	2,550	School	269	200	170
Light Industrial	707	200	170				

4.3.3 Permitted Users

Permitted users have maximum flows approved by the City and are typically measured in million gallons per day for a maximum daily flow. Refer to **Section 3.2.1** for a summary of the permitted users. Based on input from the City, the permitted peak day flows were used in the Existing Model rather than the actual measured existing flows. Existing permitted peak day flows total 5.81 MGD. Based on discussions with the City regarding adjustments with some industries, 5.9 MGD was applied for the Existing Model.

4.3.4 Infiltration and Inflow

Infiltration is groundwater entering the sewer through cracked pipes or joints, service or manhole connections, or other deficiencies in the system. This can be groundwater from a high water table or rainfall induced groundwater. Based on historical flow monitoring and WWTP records, infiltration from groundwater does not appear to be significant. Rainfall dependent infiltration is accounted for with inflow. Therefore, the Existing Model does not include an infiltration component in the flows.

Inflow is the flow of water directly into the sewer during and after a precipitation event due to direct connection to the sewer from storm drains, roof drains, parking lots, manholes, etc. Inflow also occurs from snow melt and can be significantly greater during rain on snow events. Inflow can be characterized by the contributing area to the sewer, the percentage of precipitation that enters the sewer and the rate at which this happens. The 2009 Plan calibrated these parameters assuming the contributing area to be a 200 foot buffer around each pipe in the system (100 feet on each side). Due to a lack of significant rainstorms during flow monitoring, no additional data was gathered to refine historical inflow modeling parameters. These parameters are documented and discussed in **Appendix B** and **Appendix C**.

The Existing Model includes a simulated rainfall event from a design storm. The design storm used was a 10-Year 24-hour Type II SCS design storm with a total rainfall amount of 1.4 inches. To simulate a peak flow condition in the model, the peak inflow from the storm event was aligned with the diurnal peak in the sanitary flow. This results in a larger net return period for the storm event. While peaks occur at different times for each individual pipe and basin, all dry weather flows were found to generally peak in the morning, midday, or evening on both the weekday and weekend. The model was used to calculate the peak at each of these time periods on both the weekday and weekend. The maximum peak flow from all of these events was determined for each individual pipe and then used during the wet weather capacity criteria evaluation.

4.3.5 Flow Allocation

Flow from each parcel was allocated to the upstream manhole of the nearest pipe. Total parcel flow was calculated based on unit flows, acreage, number of residential dwelling units and land use type.

4.4 EXISTING MODEL CALIBRATION

Calibration is the process of modifying various parameters and their assumed values in the model to match real world conditions. For this study, sewer flows were monitored at the WWTP and twelve other locations in the system between March 3 and March 19, 2014. Flow was also recorded at the Rock Creek Lift Station during this time period; however, an error with the recording device resulted in data that were not readable. As a result, flows were subsequently recorded again from April 14 to May 7, 2014. All these monitored flows are assumed to be representative for the City since the period was relatively dry and historical flow data shows no substantial seasonal change in the flows at the WWTP. A summary of the 2014 flow monitoring is contained in **Appendix B** and flow monitoring locations are shown on **Figure B-1**.

While perfect agreement between data collected and model output is impossible, some factors can cause this gap to widen. Some of these factors include an expected level of uncertainty in the flow monitoring data, unit flows, and unknown diurnal patterns for some of the large users. Considering these limitations, the model calibrated well, without significant changes to base assumptions or parameters, providing a high level of confidence in the Existing Model results. A successful model calibration also contributes to increased confidence in projections derived from the Committed and Master Plan Models. A complete listing of model assumptions and parameters are included in **Appendix C**.

4.4.1 Dry Weather Calibration

The model was calibrated to both weekend and weekday dry weather flows. The average flow for each monitoring site was plotted with individual days to show the uncertainty and variability of flow at any given point in the system. Large service areas showed less variability in flow than smaller service areas due to the number of customers upstream. An average weekend diurnal and average weekday diurnal were estimated for each site from the flow monitoring data. Days with rain events were removed and the model was calibrated to these average curves. Final calibration graphs for dry weather flows are included in **Appendix D**.

4.4.2 Wet Weather Calibration

No rainfall events of significance occurred during the flow monitoring period in which wet weather flows could be conclusively separated from dry weather flows. Therefore, wet weather model calibration was not possible. Rather, the wet weather rainfall parameters developed in the 2009 Plan were applied to the updated dry weather calibration for the existing system. Wet weather results from the Existing Model were corroborated by flow conditions observed during significant precipitation events which occurred outside of the flow monitoring period but within the development time-period of the Master Plan.

The first event occurred from February 7 to 8, 2014, just prior to the flow monitoring period. On February 7, several inches of snow fell on the entire community. The following day, temperatures increased and rain fell on top of the snow resulting in near-complete snowmelt across the City and significant inflow into the sewer collection system. An estimated 0.73 inches of precipitation fell over a 24-hour period as measured near Blue Lakes Boulevard and Falls Avenue.

Inputting this storm into the model along with the dry weather calibrated flows resulted in a modeled peak day flow of 14.0 MGD at the WWTP. The actual measured peak flow at the WWTP was approximately 14.0 to 14.5 MGD. This close resemblance between the measured and modeled wet weather flow provided confirmation for the dry weather calibration along with the continued use of the wet weather parameters from the 2009 Plan. Graphs of WWTP data and model output for this storm event are included in **Appendix D**.

Later, an even larger rain event occurred from August 5 to 6, 2014. The rain gauge at the airport recorded a rainfall total over 2.2 inches in a 24–hour period, which is considered a 100-year event. In contrast, the average rainfall between a gauge near the Canyon Ridge High School and a gauge near Blue Lakes Boulevard and Falls Avenue was approximately 2.045 inches over the highest 24-hour period.

With this value applied to the model, a peak flow of 24.8 MGD was estimated at the WWTP. The WWTP operators reported a peak flow of approximately 25 MGD; however, there is some uncertainty associated with this value because water levels in the influent flume exceeded the range of the ultrasonic level sensor and flow data was not recorded. Regardless, the approximate correlation in total flows further corroborates model calibration results.

Apart from high flows at the WWTP, a number of locations in the sewer collection system backed up during the storm. Sewer lines that are located in drainages tend to receive higher volumes of storm water due to inflow. While model calibration is intended to account for a 10-year event, the August event was closer to a 100-year event, which may require different calibration parameters for individual basin analysis.

4.5 EXISTING MODEL ANALYSIS

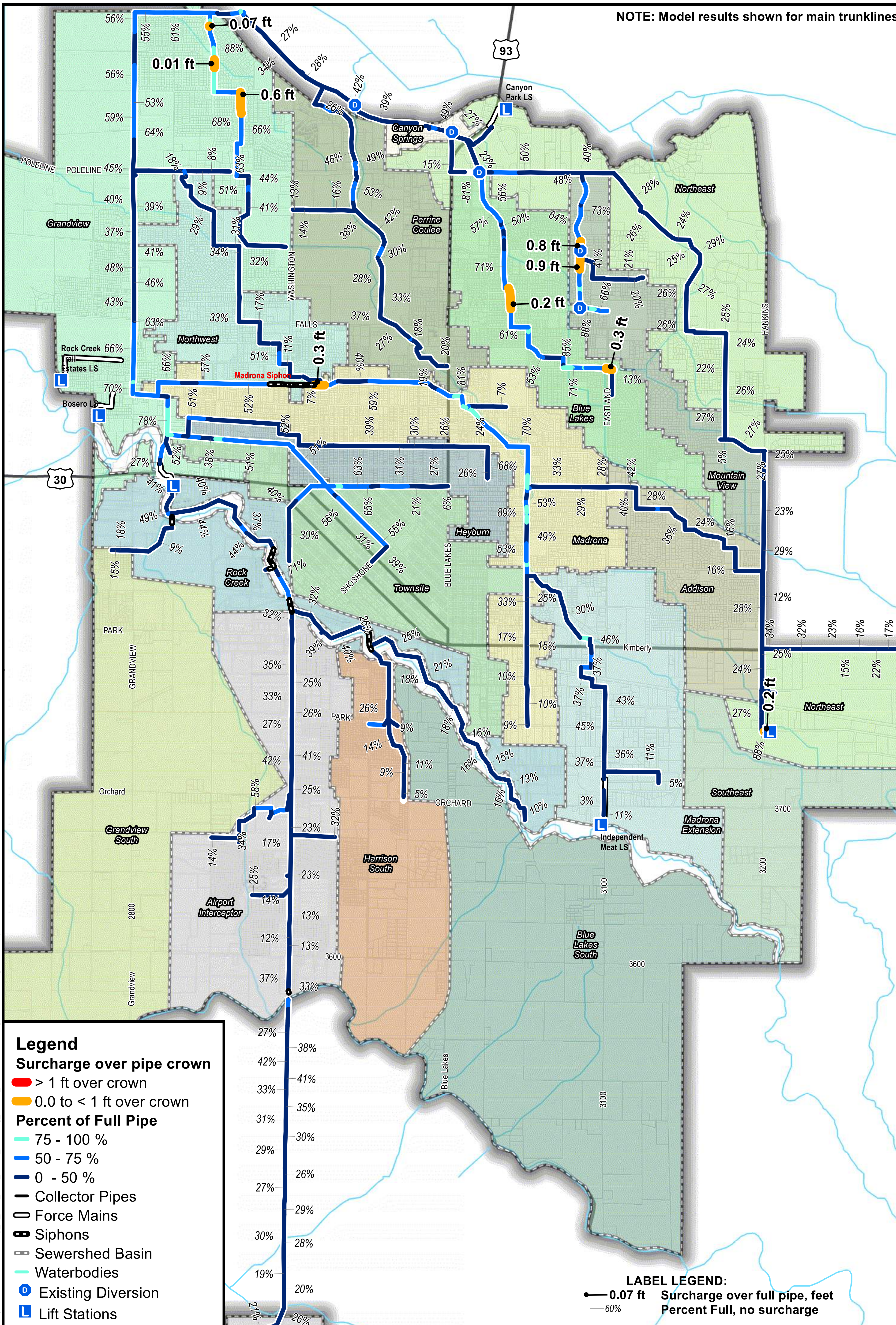
The 10-year design storm discussed in **Section 4.3.4** was added to the calibrated model for analysis of the existing system capacity. Additionally, the City requested that all permitted users be loaded with their permitted flows during evaluation. **Appendix F** contains tabular model output results from the Existing Model Analysis. **Figure 4-1**, **Figure 4-2**, and **Figure 4-3** show Percent Full Pipe, Remaining Pipe Capacity, and Depth-from-Rim during peak flow for the Existing Model. The Percent Full Pipe plot can be used to identify the extents of surcharging, if present, and are shown in feet over the crown of pipe. It includes any backwater effects from downstream pipe segments which restrict flow. Areas where surcharging occurs also represent sections of pipe with a greater possibility of basement flooding, depending on the elevation of collector lines that tie into the main trunklines. A capacity criteria allowing a surcharge of 1-foot above the crown of the pipe was compared against the maximum modeled percent of full pipe.

The Remaining Pipe Capacity at Existing Flows figure can be used to identify individual pipes that could be the root cause of the surcharging seen in the Percent Full Pipe figure. The figure compares the capacity of a sewer line flowing full to the existing modeled peak flow in the pipe. Pipe surcharging generally, but not always, occurs in areas where existing pipe capacity is less than peak flow. A pipe may flow slightly more than full pipe capacity without a depth over crown violation if some surcharging occurs or at slightly less than full pipe capacity if the depth has not increased to match a “normal” flow depth based on the manning equation.

The Depth-from-Rim figure illustrates the distance between the maximum water surface at each upstream manhole and the rim elevation. This figure helps to identify where shallow pipelines may make it difficult to install service connections. These shallow manholes also represent areas with greater possibilities of sanitary sewer overflows and/or basement flooding when large precipitation events occur.

The Existing Model analysis showed that all pipes have sufficient hydraulic capacity using the criteria outlined in **Appendix C.** For wet weather flows, maximum flow depths are less than 1-foot above the crown of the pipe. All dry weather flows also meet the capacity criteria of no surcharging (< 100% full pipe). While some sewer lines may have condition problems, no hydraulic capacity concerns appear to exist.

All lift stations have sufficient capacity for existing flows and for the immediate future.



SEWER COLLECTION MASTER PLAN

FIGURE 4-1 EXISTING MODEL PERCENT FULL PIPE

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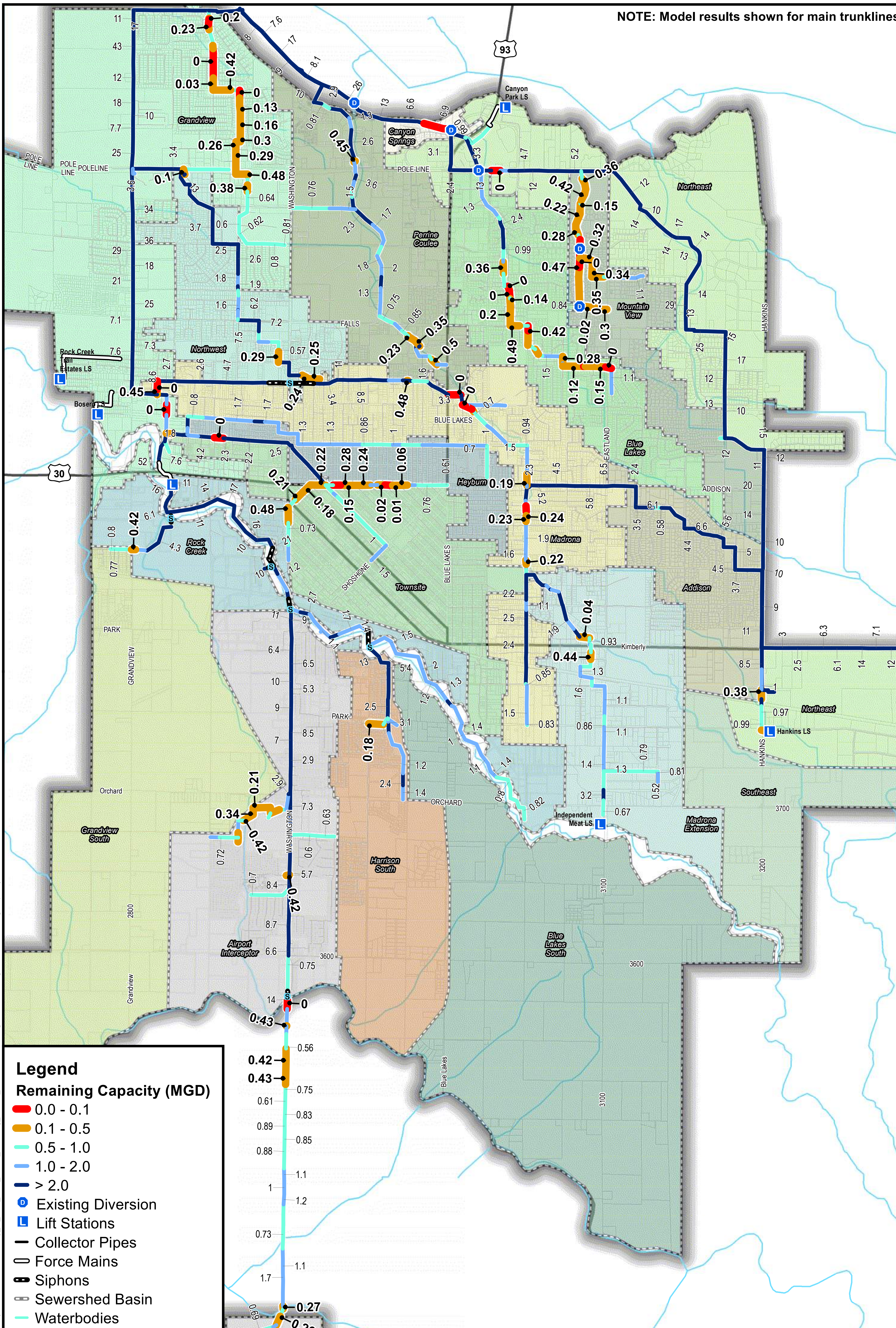

SEWER COLLECTION MASTER PLAN

FIGURE 4-2
REMAINING PIPE CAPACITY AT EXISTING FLOWS

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03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure 4-2 Existing Model Remaining Capacity.mxd

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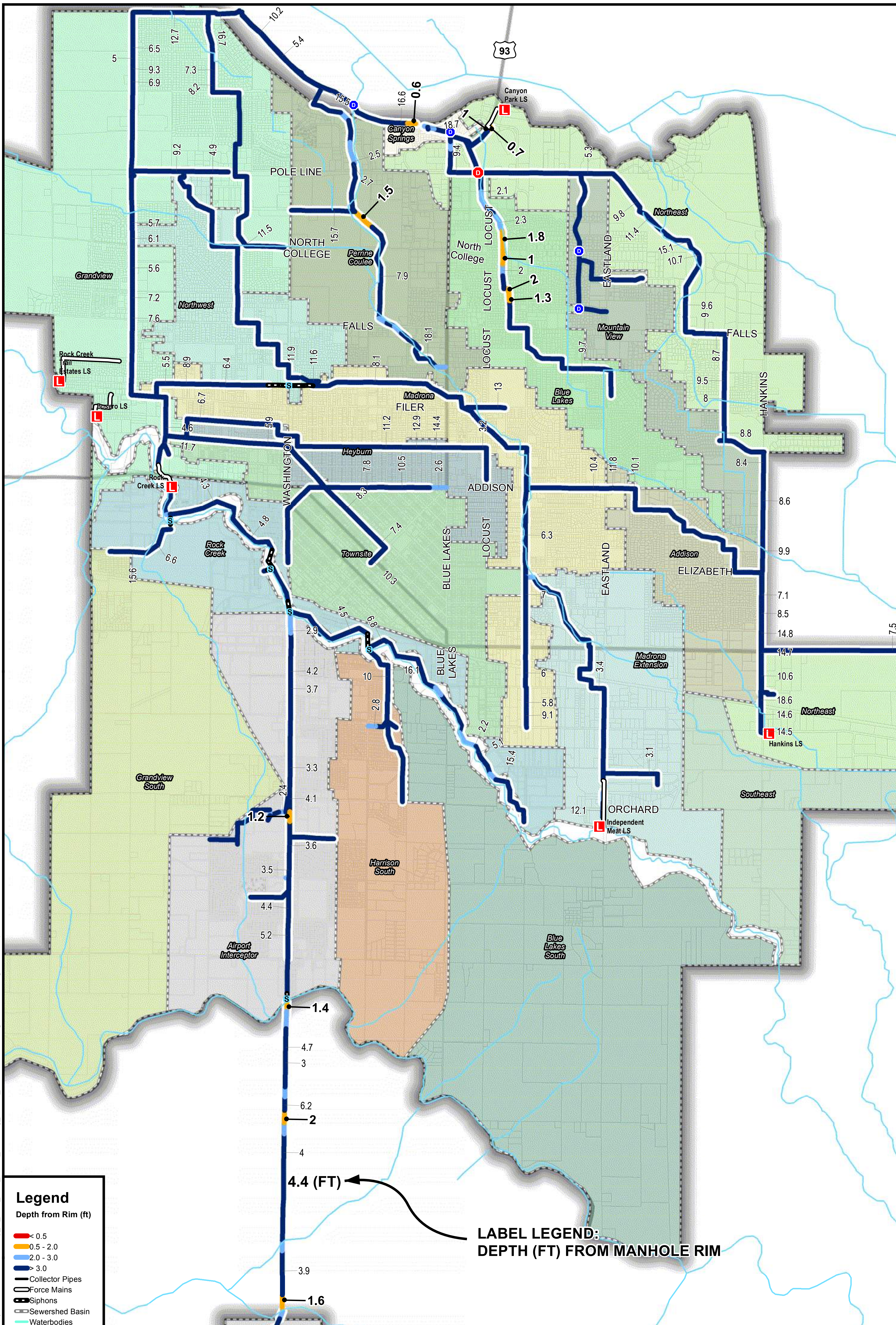

SEWER COLLECTION MASTER PLAN

FIGURE 4-3 EXISTING MODEL DEPTH FROM RIM

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03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure 4-3 Existing Model Depth from Rim.mxd

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Chapter 5

Committed Model Development and Analysis

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5.0 COMMITTED MODEL DEVELOPMENT AND ANALYSIS

5.1 GENERAL

The Committed Model includes everything that the City has committed to serve, or is considering to serve, based on known developments. This does not guarantee or imply a will-serve will be granted. It includes estimated loads for all existing customers, developments that have begun the subdividing process, and assumes infill of remaining vacant areas in the existing City limits. The Committed Model also includes anticipated industrial flows over the next 20 years, as described in **Chapter 3.0**. The Committed Model is a tool to estimate the available capacity in the existing collection system, taking into account developments proposed in or near the City. The Committed Model's primary purposes are to:

- Show the remaining, uncommitted capacity in the system.
- Identify potential hydraulic capacity issues that may arise as the City develops area already within or nearby the City limits.

If a new development seeks approval, the associated flows are typically added to the Committed Model to check for capacity. The model results will indicate if there is sufficient capacity remaining in the downstream lines. Due to the additive nature of the flows associated with new developments, the Committed Model always represents what the City has committed to or plans to serve based on the date of the last development request.

5.2 COMMITTED MODEL SYSTEM LAYER

The Committed Model uses the same system layer as the Existing Model (see **Section 4.2**), plus a few of the proposed Master Plan lines for anticipated developments to help route flows to the Existing Model sewer lines. The proposed lines were added during the Master Plan system layer development and subsequently turned on in the Committed Model. See **Section 6.2** for details on the Master Plan system layer.

5.3 COMMITTED MODEL FLOW GENERATION LAYER

To form the Committed Model Flow Generation Layer, flows were added to the Existing Model Flow Generation Layer from three areas:

1. Infill or undeveloped areas already within the City limits were assigned flows according to the current land use and zoning and associated unit flows.
2. Flows from known developments outside the City were added based on current land use and unit flows. The known developments were reviewed and provided by the City for inclusion in the model.
3. The 20-year permitted industrial flows plus anticipated permitted industrial growth were added based on City input.

5.3.1 Committed Land Use

Land use designations for the Committed Model were determined from parcel data in a similar manner as the Existing Model (see **Section 4.3**). **Figure A-2** in **Appendix A** shows the land use for the Committed Model.

5.3.2 Committed Residential Unit Flows

Committed residential unit flows were assigned at 170 gpdu (see **Table 3-5** for additional planning rates and sources). For the 2015 Plan, 170 gpdu is defined as one equivalent dwelling unit (EDU) and is used for all future residential flows.

Future residential developments may have flows that are greater from the assigned unit flows (i.e., changes in density). In such cases, the City should consider using the development-requested flow value on a case-by-case basis with service to the development contingent on model verification.

The City of Kimberly is a permitted user that currently has a predominantly residential land use. Kimberly is also projected to fill in their service area[1], and while the model includes their flow projections, this does not imply a commitment to serve.

5.3.3 Committed Non-Residential Unit Flows

Since specific commercial land use types are unknown, a composite unit flow for future commercial development was used based on the unit flows used in the Existing Model, those used in the 2009 Plan, and input from the City (**Table 5-1**).

Unit flows for the majority of industrial users are typically very low, while the remaining few permitted industries can be very high and variable, depending on the industry type. A typical unit flow value was assigned for industrial land uses based on unit flows for light industrial from the Existing Model (**Table** 4-2). Committed flows for the permitted industries include the permitted industrial flows plus anticipated permitted industrial growth as shown in **Table 3-2**.

Table 5-1 summarizes the non-residential unit flows used in the Committed Model.

Table 5-1 – Committed Non-Residential Unit Flows

Land Use Type	Net Unit Flow (GPAD)	Gross Unit Flow (GPAD)
Composite Commercial	1,150	980
Light Industrial	200	170

5.3.4 Flow Allocation

Each parcel the City has committed, or proposes, to serve is modeled by injecting flow into the nearest upstream manhole in the system layer. Some large committed parcels were divided and injected into multiple locations according to the Master Plan layout. The dry weather loading used for the Committed Model is shown on **Figure A-2** in **Appendix A**.

[1] J-U-B (2014) City of Kimberly Wastewater Facilities Plan Agency Review Copy

5.3.5 Infiltration and Inflow

As discussed in **Section 4.3.4**, infiltration is not included in the 2015 Plan model.

Inflow, which is assumed to capture any rain-dependent infiltration, was assigned in the Existing Model for areas already served and was used as the base for inflow in the Committed Model. Inflow from the new committed areas was added to this base flow. Inflow is distributed in the model by assigning sewershed area to the manholes. New sewershed areas were allocated at 60 percent of the land area for new committed residential and commercial parcels and 30 percent of industrial parcel area similar to the previous Master Plan. The design storm discussed in **Section 4.3.4** was also used in the Committed Model.

5.4 COMMITTED MODEL ANALYSIS

The Committed Model analysis shows the results if all of the committed flows are developed without any changes to the existing infrastructure. This helps identify priorities for capital improvement projects in subsequent chapters. **Appendix G** contains results from the Committed Model Analysis. **Figure 5-1** and **Figure 5-2** summarize the Percent Full Pipe, and Remaining Capacity, respectively, for the Committed Model peak flows.

Table 5-2 contains a list of the areas where hydraulic capacity issues were identified in the system for the Committed Model. Each problem reach is discussed in detail in **Appendix E,** as well as what actions,

Table 5-2 – Committed Model Issues

Location	MH Identifier	Description	Issue	Recommended Action
Along Parkview Dr., north of Federation Rd.	B2-142 to B1-33 B1-38 to B1-41	8-10 inch pipe located at the northern end of Grandview Basin	Sewer depth > 1 foot over top of pipe ~2.3 ft over the crown at worst	Do nothing but prevent basements in Canyon Trails #6 through #8, require in-house pumps (sump pump), or replace the pipe. No existing basements appear to be here, building department should verify.
South of Filer Ave., between Wendel St. and Beta St.	B4-2 to B3-14	30 inch pipe located downstream of Rock Creek Lift Station	Sewer depth > 1 foot over top of pipe	Recommended replacement during the next couple of decades. The issue is caused by growth from existing permitted users, new industrial growth, and development south of Rock Creek.
Intersection of Candlewood Ave. and Mountain View Dr.	E3-139 to E2-5	8 inch pipe located near the center of Mountain View Basin	Sewer depth > 1 foot over top of pipe	Do nothing. The violating pipe is over 10 feet in the ground and surcharge is minimal. Recheck after basin is approaching build-out conditions.
North of Kimberly Rd, between Trade St. and Freightway St.	E5-31 to E5-19	8-10 inch pipe located near the center of Madrona Extension Basin	Sewer depth > 1 foot over top of pipe	This only becomes an issue with additional industrial or committed flow. Consider upgrading when development-requested flow triggers improvement.
Along Addison Ave., between 3rd and 4th Avenue N.	C4-299 to C4-163	10 inch pipe located at the downstream end of Townsite Basin	Sewer depth > 1 foot over top of pipe	Triggered by large industrial flow downtown. Replace as needed with growth.

if any, are recommended to address the issue. The extent of each problem is identified using the upstream and downstream manhole as an ID. The issues are also shown in the CIP as presented in **Chapter 7**.

Table 5-3 contains a summary of each lift station and the remaining capacity. A 10 percent factor is added to the model flows as a factor of safety.

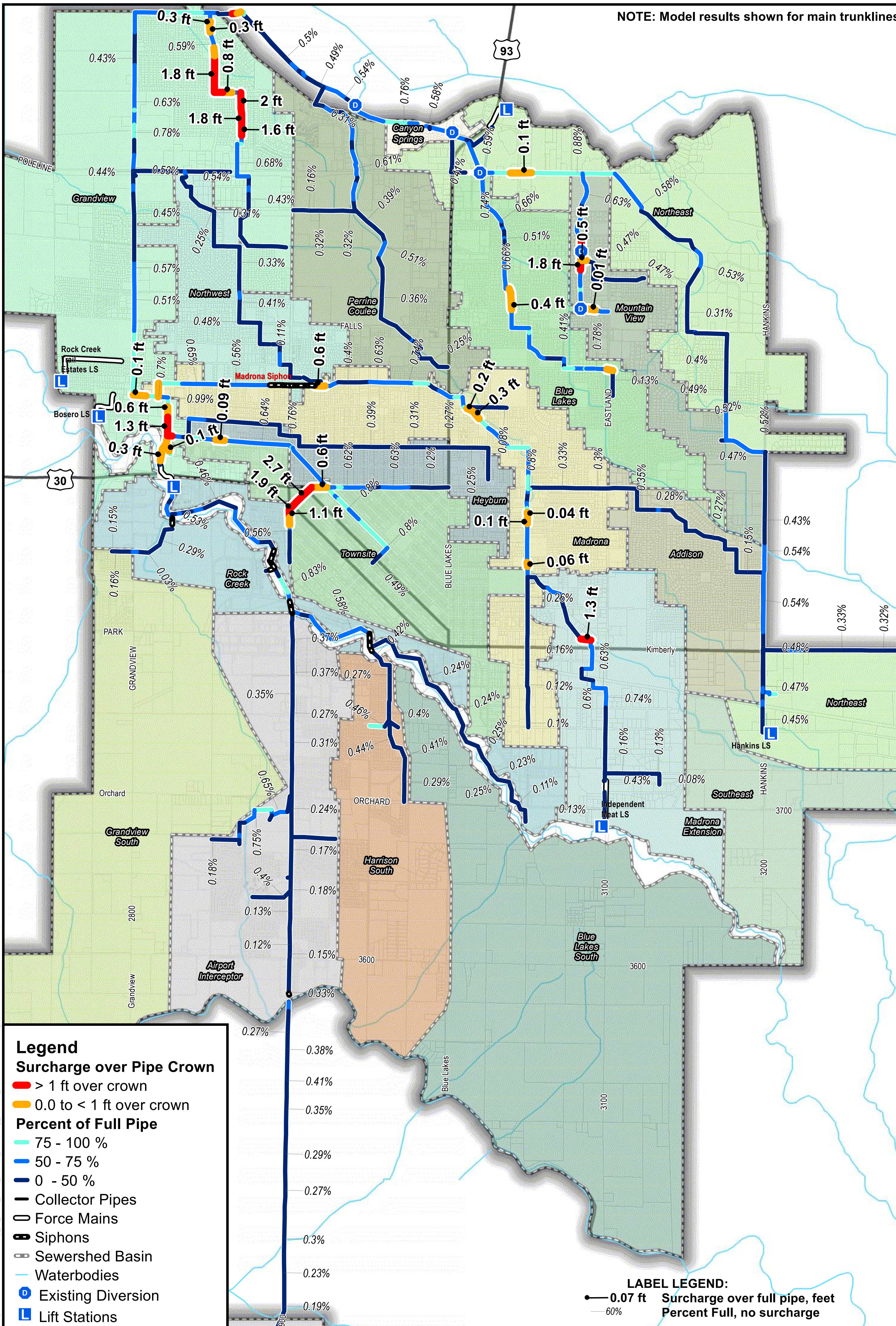
Table 5-3 – Committed Model Lift Station Summary

Lift Station Name	Design Lift Station Firm Capacity (GPM)	Committed Peak Flow (1) (GPM)	Remaining Lift Station Capacity (GPM)	Force Main Design Capacity(2) (GPM)	Force-Main Remaining Capacity (GPM
Bosero	200	65	135	235	170
Canyon Park	250	131	119	235	104
Hankins (Jayco) (3)	460	916	(456)	2,115	1,199
Independent Meat	300	304	(4)	940	636
Rock Creek Trails (4)	160	283	(123)	235	(48)
Rock Creek(5)	12,438	6,912	5,526	8,461	1,549

(1) *Peak flow listed is 10% higher than model flows to provide a safety factor for lift station capacity.*
(2) *Force main capacity limited to 6 fps as discussed in **Appendix C.***
(3) *Committed flow does not reflect flow that is needed for Clif Bar.*
(4) *Rock Creek Trails Lift Station limited as discussed below. Preliminary design needed as growth requires.*
(5) *The design flow reflects firm capacity which is six out of seven pumps operating. Currently seven of eight pumps are installed.*

The Independent Meat Lift Station is nearing capacity for the committed flows. During preliminary design, anticipated industrial flows in this area should be verified, and other design assumptions should be reviewed. The CIP includes costs to upsize the Independent Meat Lift Station. Rather than improving the lift station, the City could investigate the possibility of abandoning the lift station and sending the flow via gravity to the Rock Creek trunkline. A cost benefit analysis would be helpful to evaluate which alternative is in the best interest of the City.

The Rock Creek Trails Lift Station is beyond capacity for the committed flows. This is primarily caused by flow generated from the 80 acre parcel immediately north of Rock Creek Trail Estates. Both the lift station pumps and four inch force main do not have sufficient capacity to handle all of the flow from this area. The four inch force main will violate the 6 ft/s maximum design velocity if this flow is all allocated to the Rock Creek Trails Lift Station. However, some of this northern property may be able to flow by gravity to the Grandview trunkline. After survey is complete, preliminary design will help verify what amount of flow may actually need to be lifted. An upgraded lift station could be designed to a maximum of 235 gpm and still meet force main velocity requirements, otherwise the forcemain should be upsized. The CIP assumes the force main will not be upsized.



CITY OF TWIN FALLS

SEWER COLLECTION MASTER PLAN

FIGURE 5-1
COMMITTED MODEL PERCENT FULL PIPE

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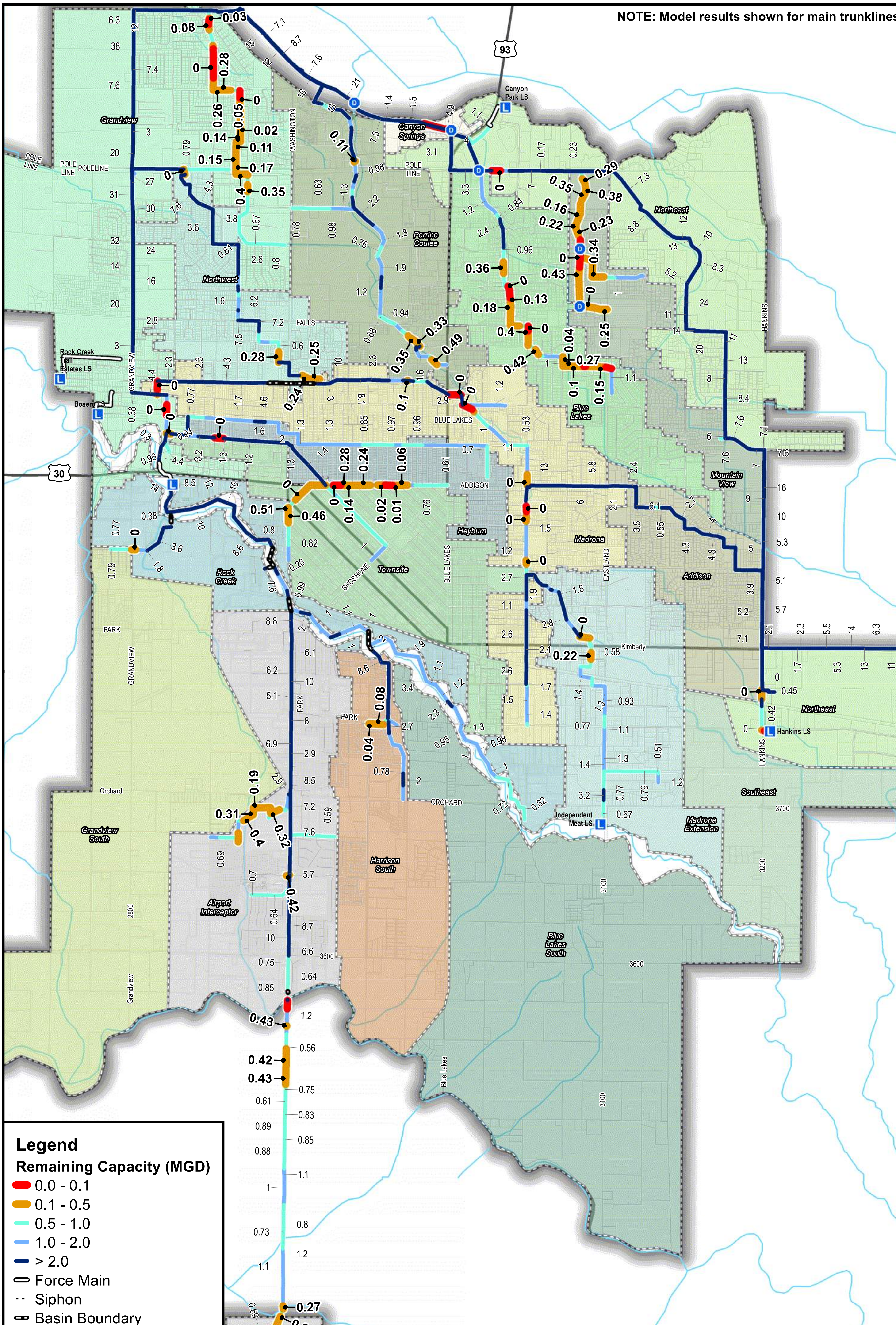

CITY OF TWIN FALLS
SEWER COLLECTION MASTER PLAN

FIGURE 5-2
COMMITTED MODEL REMAINING PIPE CAPACITY

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Appendix A

Large Figures

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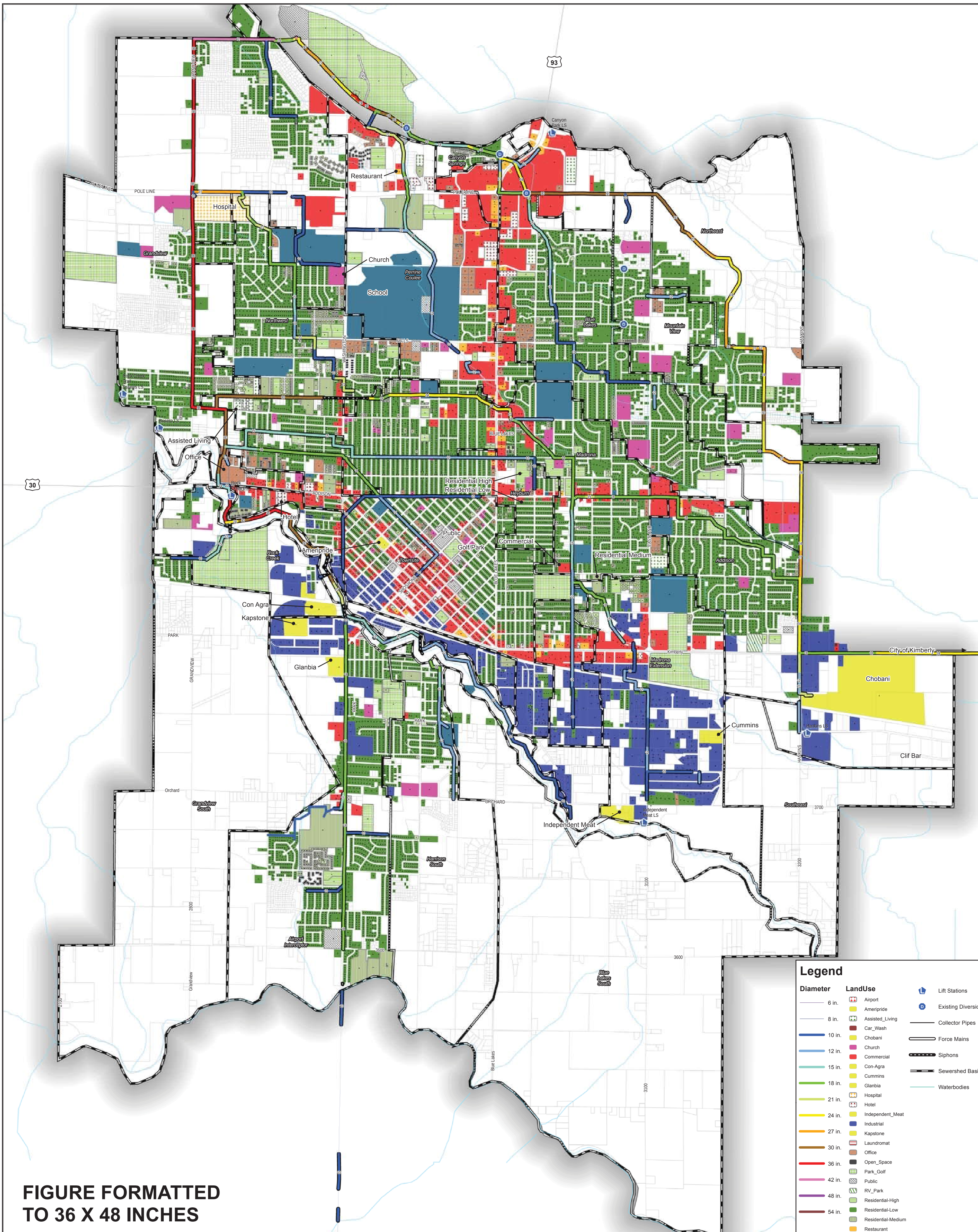

J·U·B ENGINEERS, INC.

FIGURE A-1
EXISTING LAND USE & LOAD ALLOCATION

CITY OF TWIN FALLS
SEWER COLLECTION MASTER PLAN

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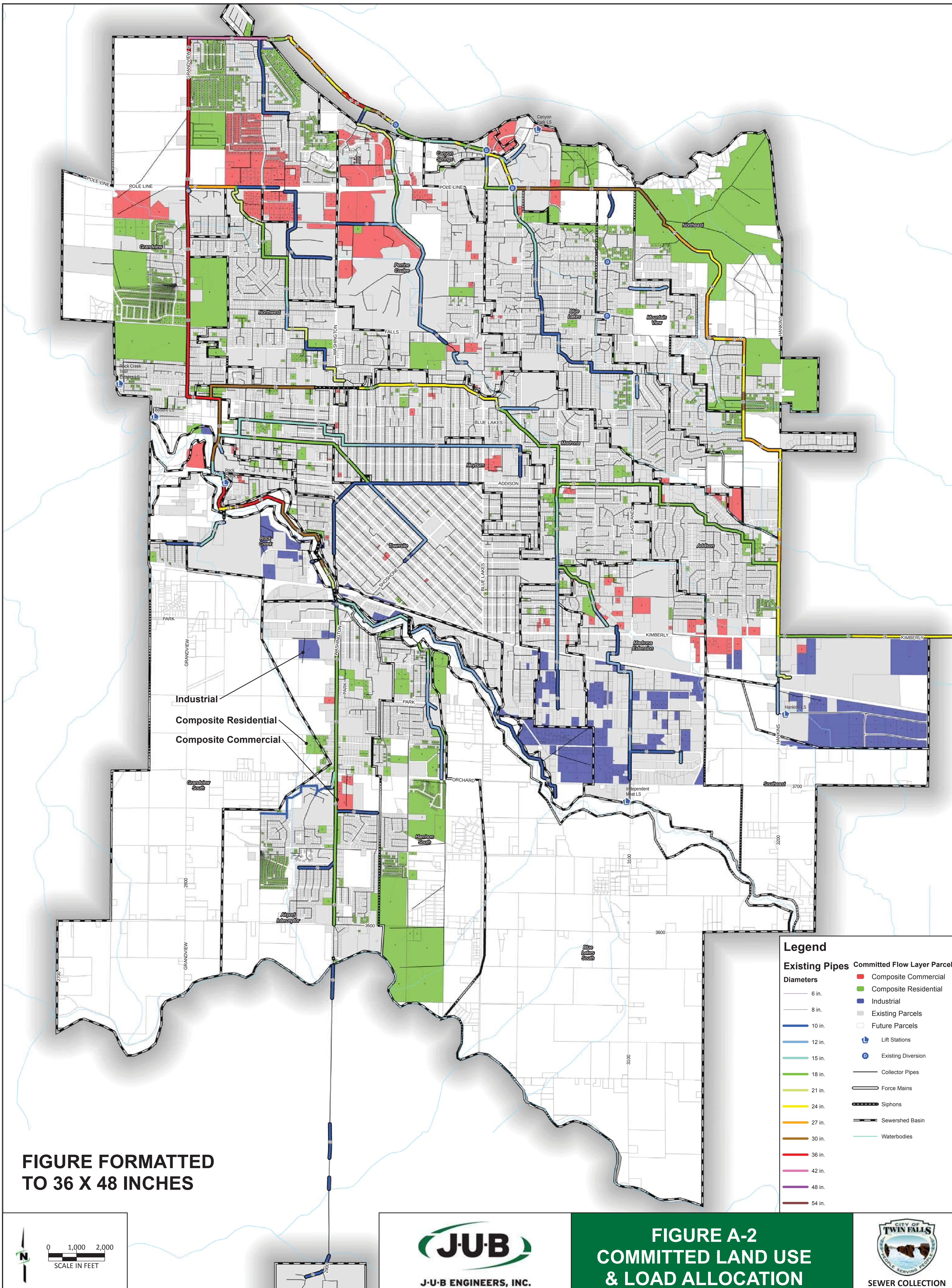

J-U-B ENGINEERS, INC.

FIGURE A-2
COMMITTED LAND USE & LOAD ALLOCATION

SEWER COLLECTION MASTER PLAN

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Appendix B

Data Compiled for Use in Model Development

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Contents

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Tables

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Appendix - B Data Compiled for Use in Model Development

B.1 Background Data

Data that was compiled and used in this study is summarized in **Volume 1**.

B.2 Collection System Flow Monitoring

B.2.1 General

Flow monitoring completed in March 2014 was used for this Master Plan. The 2006 flow monitoring was used for reference. It was completed during the course of the previous Master Plan[1]. Additionally, wet weather parameters from the previous 2009 Plan were used to model effects of precipitation.

Figure B-11 shows flow monitoring locations for the City of Twin Falls. Flow monitoring data from each location is summarized in subsequent sections. Use of the data is documented in the main report.

[1] MSA, (2009) City of Twin Falls Collection System Report.

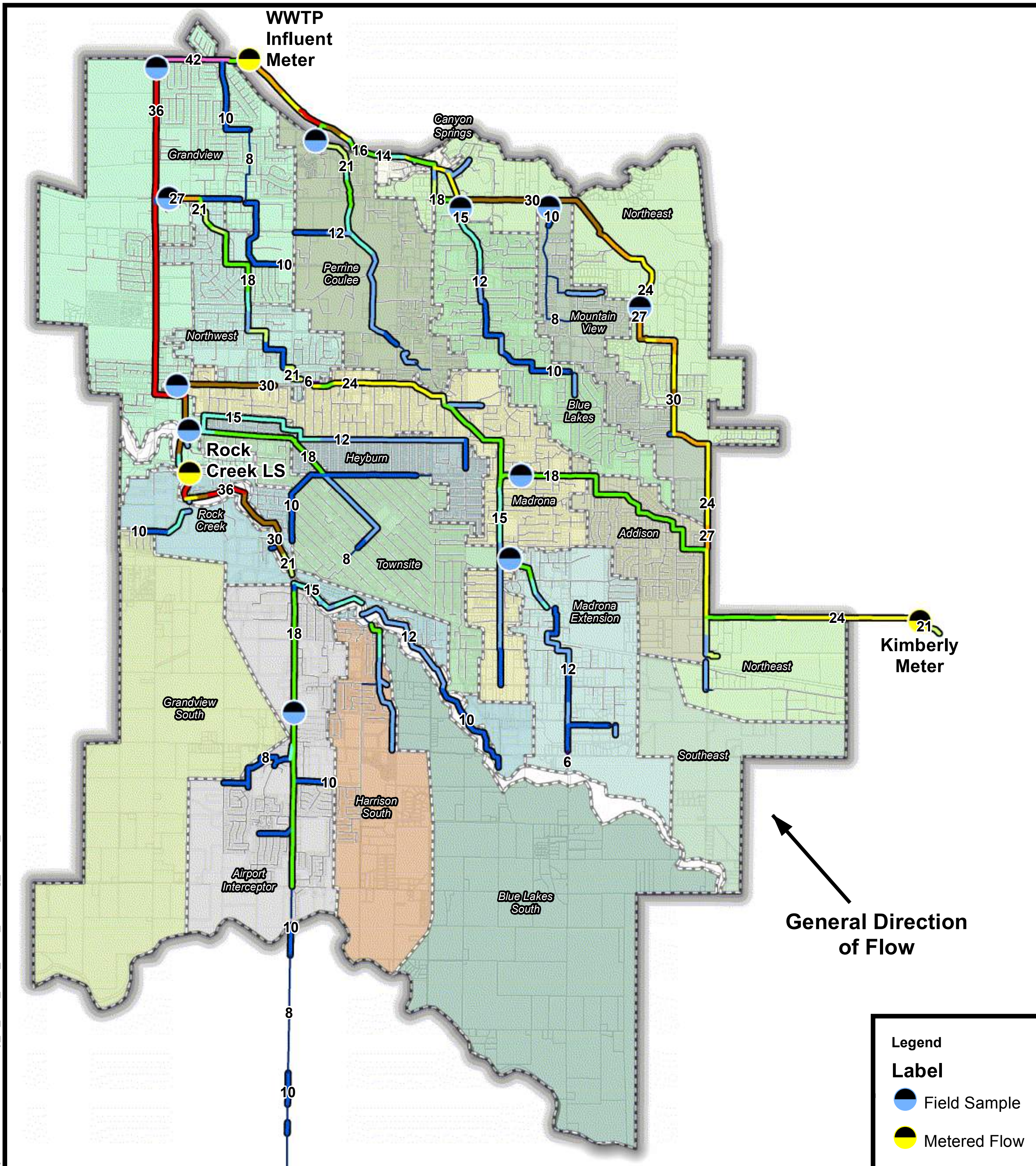
Table B-1 – Background Data Sources

Item Requested	City Contact Person	Date Received	Comments
GIS Basemap Data			
Sewer Collection System	Robin Wilson	1/28/2014	Shape files for manholes, pipes, lift stations, etc. Other resources and discrepancies described under Sewer Collection System Resources.
Parcels	Robin Wilson	2/12/2014	Shapefile Received from TF County
Roads	Robin Wilson	preproject	Shapefile already provided from previous work
City Limits	Robin Wilson	2/12/2014	Shapefile
Building Footprint	Robin Wilson	…	Not available.
Zoning	Robin Wilson	2/12/2014	Shapefile
Assessor Data & Codes	Robin Wilson	2/12/2014 4/21/2014	Shapefile and excel file received from TF County for type of dwellings and land use.
Impact Area / Urban Growth Area	Robin Wilson	2/12/2014	Use water/sewer service boundary in Comprehensive Plan, Shapefile not available but was created for this project.
Comprehensive Plan	Robin Wilson	1/23/2014	Shapefile
Subdivisions	Robin Wilson	…	Not provided or used
Contours	Robin Wilson	1/29/2014	CAD and GIS contours from 2008 and 2012 aerial mapping provided; Additional contours built from hydrant data
Contours	Robin Wilson	preproject	Additional contours built from hydrant data
Contours	USGS	4/2/2014	NAVD 88 contours tif format
Aerial Imagery	Robin Wilson	preproject	2012 high resolution imagery in sid and tif format

Item Requested	City Contact Person	Date Received	Comments
Sewer Collection System Resources Besides GIS			
Sewer Discrepancies	Robin Wilson Jerry Auten	2/20/2014 2/13/2014 April 2014 May 2014	Initial Manhole discrepancies Initial Pipe discrepancies Other major discrepancies resolved with City staff Minor discrepancies to be resolved by City Staff after/during Plan Update
Record Drawings Since 2008 for 10 inch or >	Lee Glaesemann	Feb. 2014	Record drawings since 2008 for 10 inch or >. Previous modeling files used for pipes prior to 2008. What is available in GIS for all other pipes.
Sewer Manhole Book	Jerry Auten	4/21/2014	Book showing manhole connections and sizes based on CCTV inspection
M-Sewer map	Kristi Fehrigner	preproject	Autocad map used to track pipe location and size
Grid Maps	Jerry Auten	4/17/2014	Grid maps showing annotated comments for many of the older pipe. Used to resolve discrepancies on a few of the other GIS/record drawings. This was not exhaustively reviewed.
ID Designator Map	Robin Wilson	2/25/2014	Map showing grids for Manhole designation
Lift Station Flows (Each Lift Station)			
Record Drawings / Design Information	Jon Caton Harry Stites	2/23/2014 Feb. 2014	Rock Creek record drawings, and design info. Other LS design memos, pump curves, pump information and wet well information were provided.
Daily Flows	Jon Caton Harry Stites	2/6/2014 4/23/2014	No historical flow data is available because there are no flow meters at any site except Rock Creek. At Rock Creek, flows have not historically been logged. For flow monitoring at Rock Creek, 2 minute flows were logged April 14-22, 2014 for each pump and total pump station flows.
Peak Hour Flows	Jon Caton Harry Stites	2/6/2014 4/23/2014	See above under daily flows.
SCADA Flows	Jon Caton Harry Stites	4/23/2014	Not possible in SCADA anywhere except Rock Creek. Rock Creek is not automatically set up to log this data, but was recorded to a USB during the flow monitoring period March 3-20. This failed, but was redone at 2 minute intervals April 14-22, 2014 for each pump and total pump station flows.
Treatment Plant Flows			
Daily Flows	Jon Caton	2/6/2014	Daily influent and effluent flow data from 2009 through 2013

Item Requested	City Contact Person	Date Received	Comments
	Jack Bennion		
Peak Hour Flows	Jon Caton Jack Bennion B. VanWagoner	…	Flow charts showing peak influent and effluent flows may be available from 2009 through 2013. This data is not readily available in a database format, so was not thought to be used unless necessary for calibration.
WWTP Hourly Flows	Jon Caton; Brett VanWagoner	3/27/2014	March 1-25, 2014--1 minute influent flows for flow monitoring
Permitted / Industrial Flows (if applicable)			
Daily Flows	Jon Caton Cindy Pettigrew	2/6/2014 2/20/14	Daily data from October 2011 through December 2013
Peak Hour Flows	Jon Caton Cindy Pettigrew	2/6/2014 3/21/2014	No peak hour flow data is available for permitted users.
Hourly Flows	Jon Caton Cindy Pettigrew	2/6/2014 3/21/2014	No hourly flow data is available for most permitted users. 15 minute data from City of Kimberly March 1-20,2014 for flow monitoring
Permitted Flows	'Jon Caton Cindy Pettigrew Lee Glaesemann	2/6/2014 2/20/14 3/5/2014	Maximum day permit limits and annual reports have been provided for October 2011-October 2013; Clif Bar Agreement provided
Utility Water/Sewer Meters			
GIS shape file	Robin Wilson	preproject	Location with address and Water Meter ID (ID corresponding to billing). Include parcel number and any other data associated with each water meter
Water Usage Data	Bill Baxter	preproject	Utility water meters Jan. 2008 through April 2013 provided. Winter use data anticipated for sewer flow development. Winter 2014 data wouldn't have been available until April 2014, so we decided to use previous data.
Sewer Usage Data	Bill Baxter	3/18/2014	Sewer utility meters where water is not also provided to supplement water utility meters
Previously Completed Sewer Reports and Files			
Previous Modeling Files	Lee Glaesemann	1/7/2014	Historical modeling files and explanation current as of December 2013.

Item Requested	City Contact Person	Date Received	Comments
2008 Model Sources	Lee Glaesemann	2/28/2014 4/22/2014 4/23/2014	GIS shapefile with source of elevation in 2009 Collection System Plan Excel file showing pipe age for many of the Trunklines Email with application of elevation source received 2/28/2014
2009 Collection Plan	Lee Glaesemann	preproject	Twin Falls 2009 Collection System Master Plan
2010 Model Report	Lee Glaesemann	2/10/2014	Original model development report and flow monitoring
2013 URA Assessment	Melinda Anderson	preproject	URA Assessment recorded material, provided survey for the downtown area, and looked at a higher downtown flow loading.
2006 Survey Data	Lee Glaesemann	2/24/2014	Survey prepared by John Root on several locations across the City
Flow Monitoring			
Rainfall Hourly Data	Lee Glaesemann	1/21/2014	Use Weather Underground data from Canyon Ridge High School (KIDTWINF9), Wilmore Subdivision (KIDTWINF12), Twin Falls (KIDTWINF10), and Twin Falls (KTWF).
Rainfall Daily Data	Lee Glaesemann	1/21/2014	Rainfall collected near Falls Avenue West & 2700 E. March 6-18, 2014
11 Pipes for Flow Monitoring	Lee Glaesemann	3/3-19/2014	Flow monitoring Sites Verified 1/29/2014 and Monitored March 3-19, 2014
Other Data			
Developments in the Study Area	Troy Vitek	4/10/2014	Verification of committed and proposed developments
Population Forecast	Jackie Fields	preproject	Consistent with Water Master Plan
Datum Conversion Report	Lee Glaesemann	preproject	Draft Datum Conversion Report indicating differences in Datums.



J-U-B ENGINEERS, INC.

FIGURE B-1

FLOW MONITORING LOCATIONS

0 2,500 5,000
SCALE IN FEET
N

Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure B-1 Flow Sampling Locations.mxd

3/31/2015

B.2.3 2014 Flow Monitoring

B.2.3.1 General

The fourteen sites that were selected to conduct flow monitoring in 2014 are listed in **Table B-2** and are shown in **Figure B-1**. The purpose for flow monitoring was to collect data to be used for model calibration purposes and to potentially supplement inflow information depending on weather conditions. All of these same sites are recommended as sites for future monitoring. Monitoring at site 7 should not be completed until after the

Table B-2 – Summary of 2014 Flow Monitoring Sites

Site	Manhole Name	Location	Basin / Interceptor	Data of Monitoring	Nominal Pipe Diameter	Future Site?
1	E2-126	On Mountain View Drive 250 feet south of Pole Line Road	Mountain View	03/03/14-03/19/14	10”	X
2	E3-314	On Carriage Lane 1,200 feet North of Falls Avenue	Northeast	03/03/14-03/19/14	27”	X
3	D2-11	Corner of Pole Line Road and Locust at the SW corner of Harbor Freight store	Blue Lakes	03/03/14-03/19/14	15”	X
4	C1-15	North of Pinnacle Court, West of Elevation 486 Restaurant along Canyon Rim	Perrine Coulee	03/03/14-03/19/14	21”	X
5	B1-10	Corner of Grandview Drive North and Hometowne Road	Grandview	03/03/14-03/19/14	35”	X
6	B3-289	Corner of Wirsching Avenue and Beta Street	Madrona	03/03/14-03/19/14	30”	X
7	B2-11	On Pole Line Road 500 feet east of Grandview Drive North	Northwest	03/03/14-03/19/14	27”	X
8	D4-78	On Addison Avenue 100 feet east of Morningside Drive	Addison	03/03/14-03/19/14	18”	X
9	C6-95	Washington St. South and Osterloh, South of Ridley’s	Airport Interceptor	03/03/14-03/19/14	18”	X
10	B4-20	In field 575 feet west of Martin Avenue along Heyburn Avenue alignment	Heyburn/ Downtown	03/03/14-03/19/14	15”	X
11	D4-186	SE of Madrona St and Elizabeth Street, 375 feet east of Harmon Park at the north corner of the CSI complex Trans IV	Madrona Extension	03/03/14-03/19/14	18”	X
12	N/A	City of Kimberly Meter	Kimberly	03/03/14-03/19/14	24”	X
13	Rock Creek Lift Station	SCADA reading at Rock Creek Lift Station	Rock Creek	04/14/14-04/22/14	24” PS	X
14	WWTP	SCADA reading on influent at the WWTP	N/A	03/03/14-03/19/14	N/A	X

Northwest Diversion is constructed. Flow monitoring should also be considered at the top of the Canyon Springs Road. Other additional locations for flow monitoring should be based on future flow changes to the system.

B.2.3.2 Flow Monitoring Equipment and Process

ADS Flow Shark flow monitors were used for this study for flow monitoring sites 1 through 11. Data was collected from SCADA for sites 12 through 14, which are metered. Flow monitoring sites were selected based on location, access, and uniformity of flow through the manhole. Flow monitor installation required measurement of horizontal and vertical pipe diameters and then use of size-specific steel bands for the sewer pipe to be monitored.

The steel bands support several sensors. A velocity sensor is mounted in the band at the pipe invert to measure velocity. The band supports an ultrasonic level sensor mounted at the crown of the pipe to measure depth, and a pressure sensor is mounted toward the lower portion of the band to measure pressure to help validate depth from the ultrasonic and to account for any surcharging in the manhole. Bands are placed in the manhole's upstream pipe far enough to be in the near-uniform flow condition before flow enters the manhole.

After installation, flow depth was manually checked and the flow monitor was calibrated to this depth. Flow monitors were set to automatically record pressure, level, and velocity at five minute intervals. Flow is calculated by the monitor based on the level and velocity measurements in conjunction with user programmed pipe geometry information. Data was periodically downloaded from the monitors and processed in the office. Prior to removing the monitors and sensors, flow depth was again manually measured to provide additional calibration. This manual measurement was compared to the monitor reading and a shift was applied if the values differed significantly. This shift is referred to as a "calibration correction" value. Flow monitoring went very well, and all sites matched sufficiently between the monitor and manual measurements such that no adjustment was needed except for the Madrona Basin where an adjustment was made for 4-5 inches of silt.

Data for all sites also was subject to a quality control process. During this process, depth and velocity data were flagged for any anomalies or unrealistic recordings. Adjustment or substitution was made of individual recordings in some cases if possible and individual point data was removed from the final analysis if no other reconciliation could be made. In general, each location appeared to have acceptable velocity and depth measurements for the bulk of the flow monitoring period.

Precipitation data was collected from four locations[2] throughout the City on 15 minute intervals: the Airport, south of Rock Creek along Washington Street, at Canyon Ridge High School, and near the intersection of Blue Lakes Boulevard and Falls Avenue. Additionally, rain buckets were placed at two other locations to identify spatial variation based on recording at 12 hour intervals: the intersection of Falls Avenue West and Sunway Drive North, and the intersection of Addison Avenue

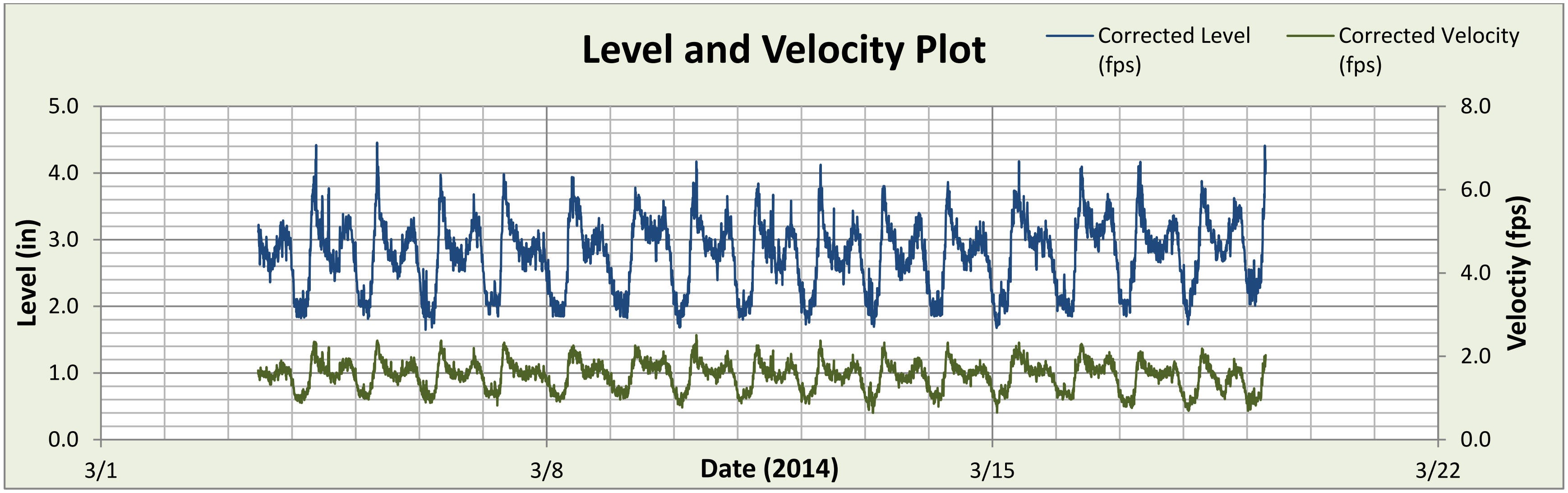
[2]Retreived from Weatherlink.com sites:KTFW, KIDTWINF10, KIDTWINF9, and KIDTWINF12

and Sunrise Boulevard. Results from this last location were discarded due to malfunctioning equipment.

B.2.3.3 Flow Monitoring Results

The level, velocity, and flow results from the monitoring sites are shown below in **Figure B-2** through **Figure B-13**

Figure B-2 – Site 1: Mountain View Basin Raw Data at MH E2-126



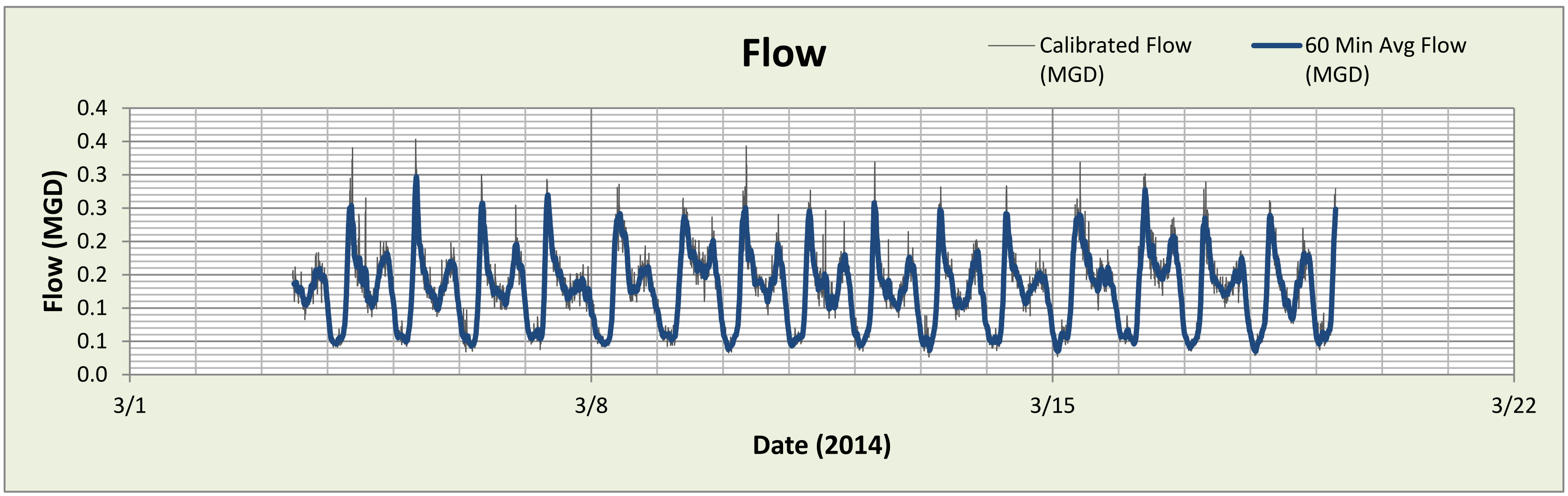
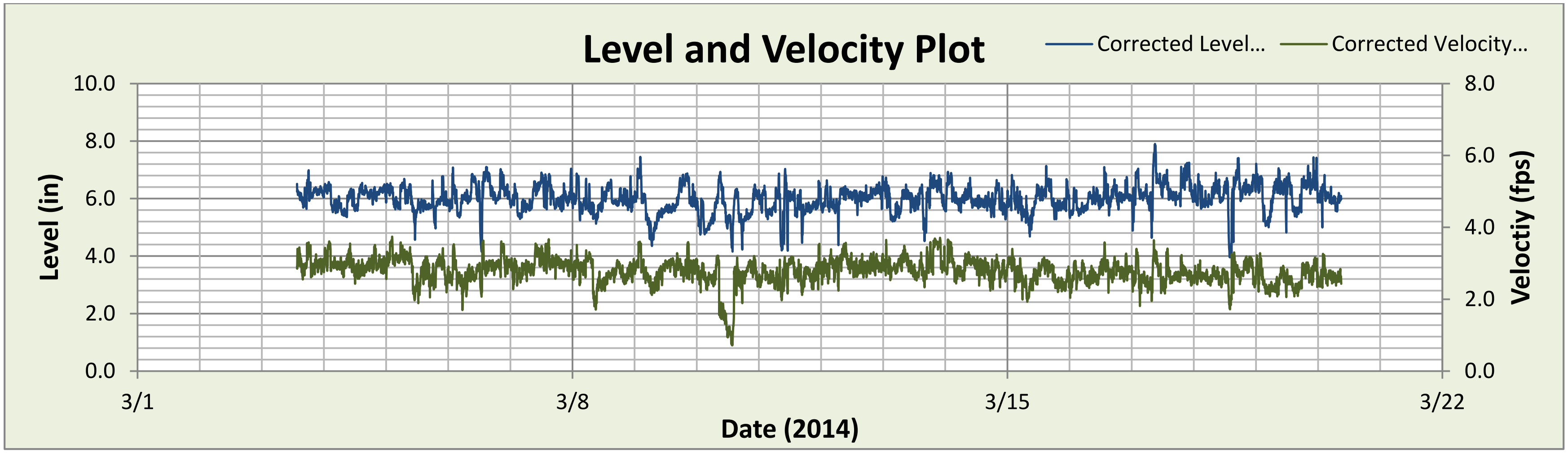


Figure B-3 – Site 2: Northeast Basin Raw Data at MH E3-134



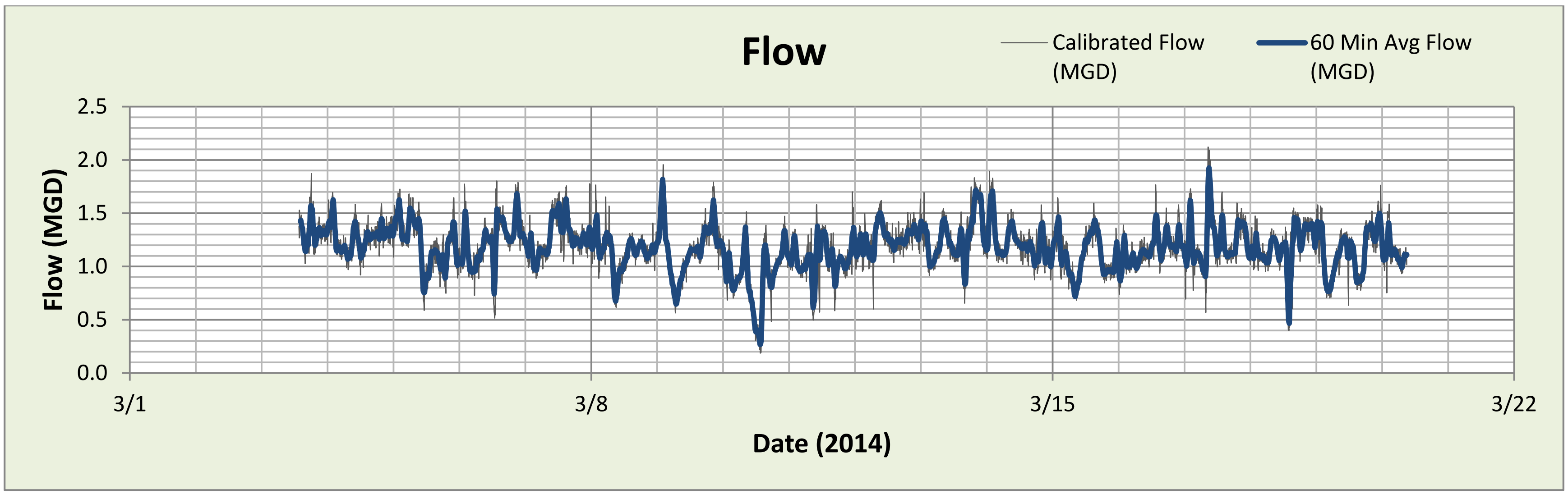
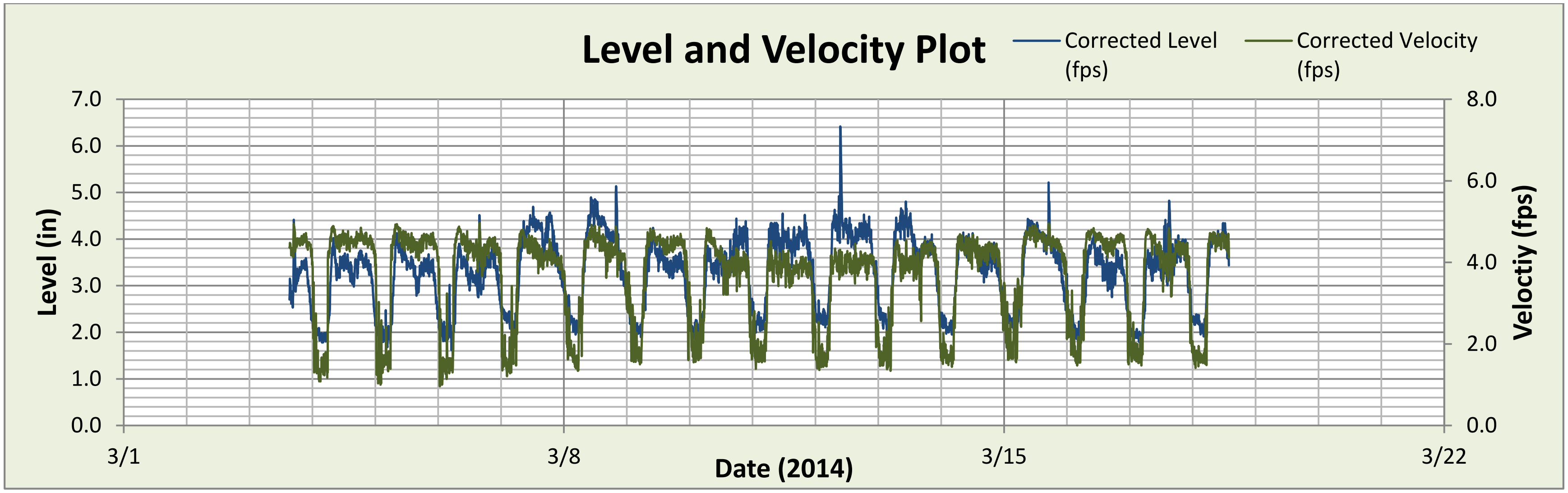


Figure B-4 – Site 3: Blue Lake Basin Raw Data at MH D2-11



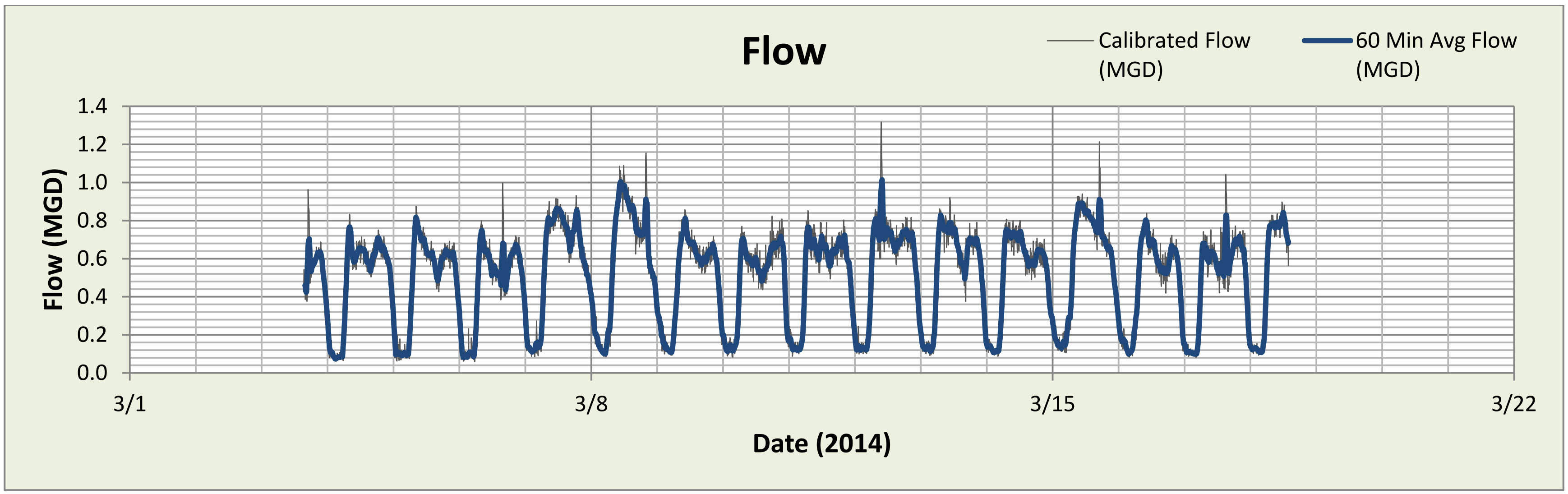
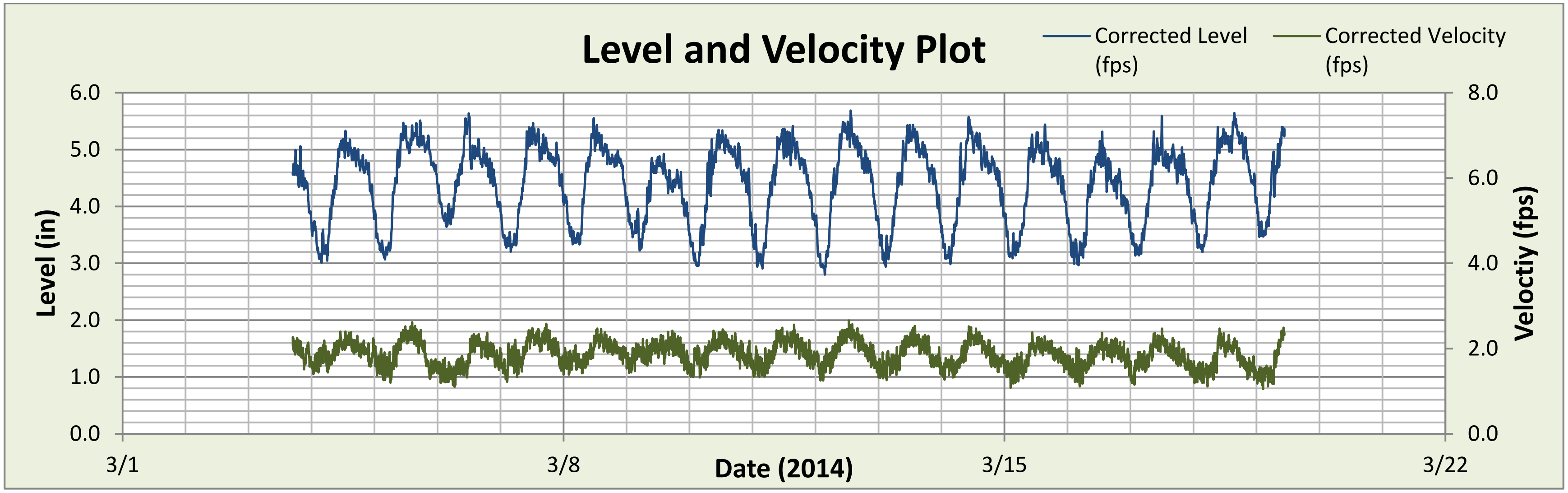


Figure B-5 – Site 4: Perrine Coulee Basin Raw Data at MH C1-15



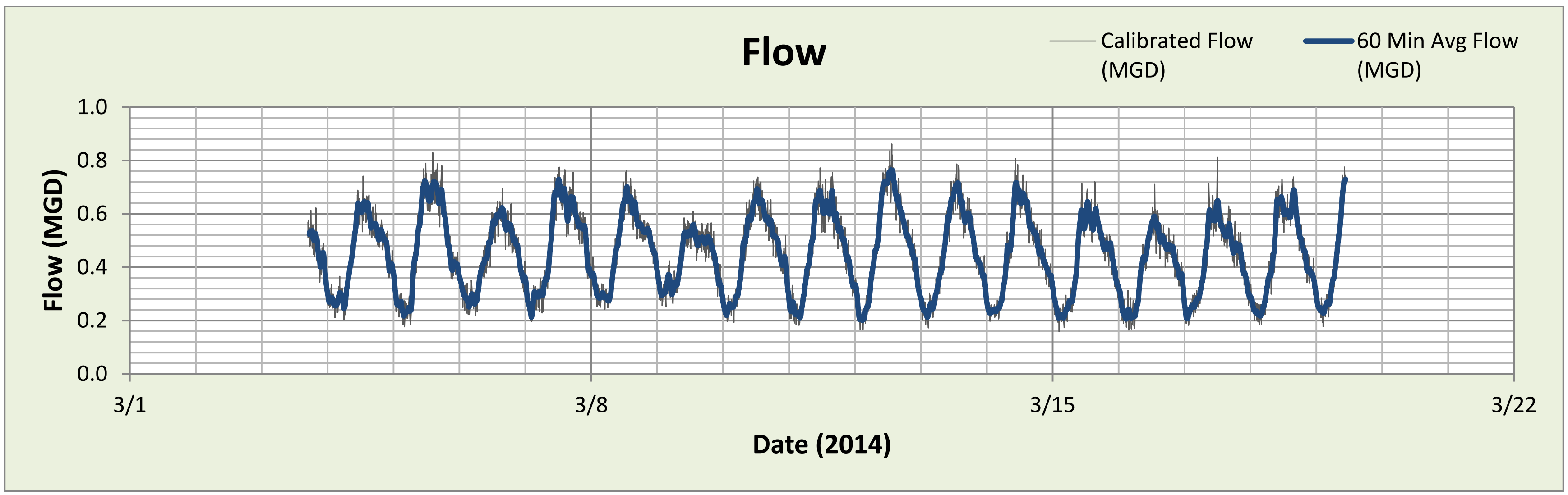
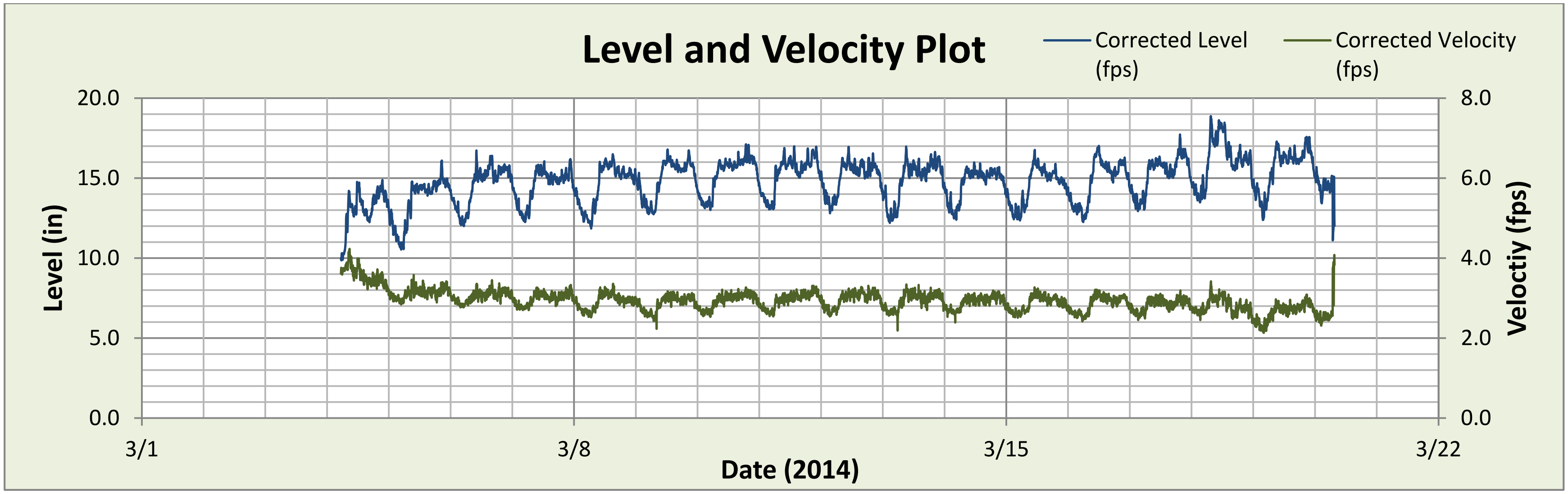


Figure B-6 – Site 5: Grandview Basin Raw Data at MH B1-10



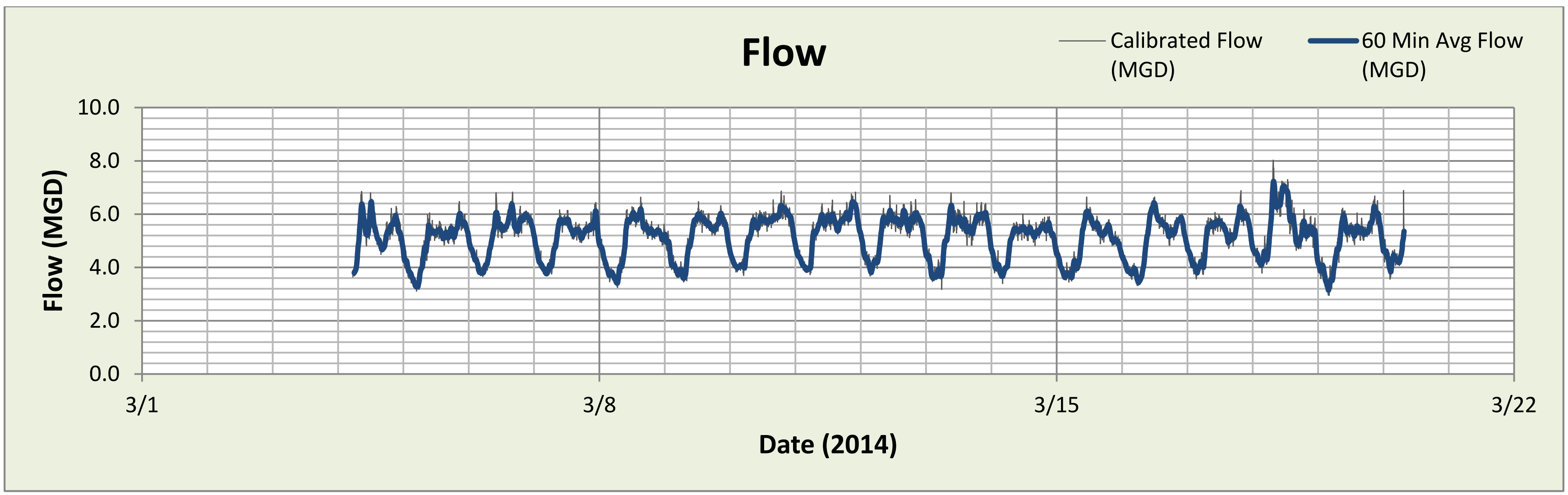
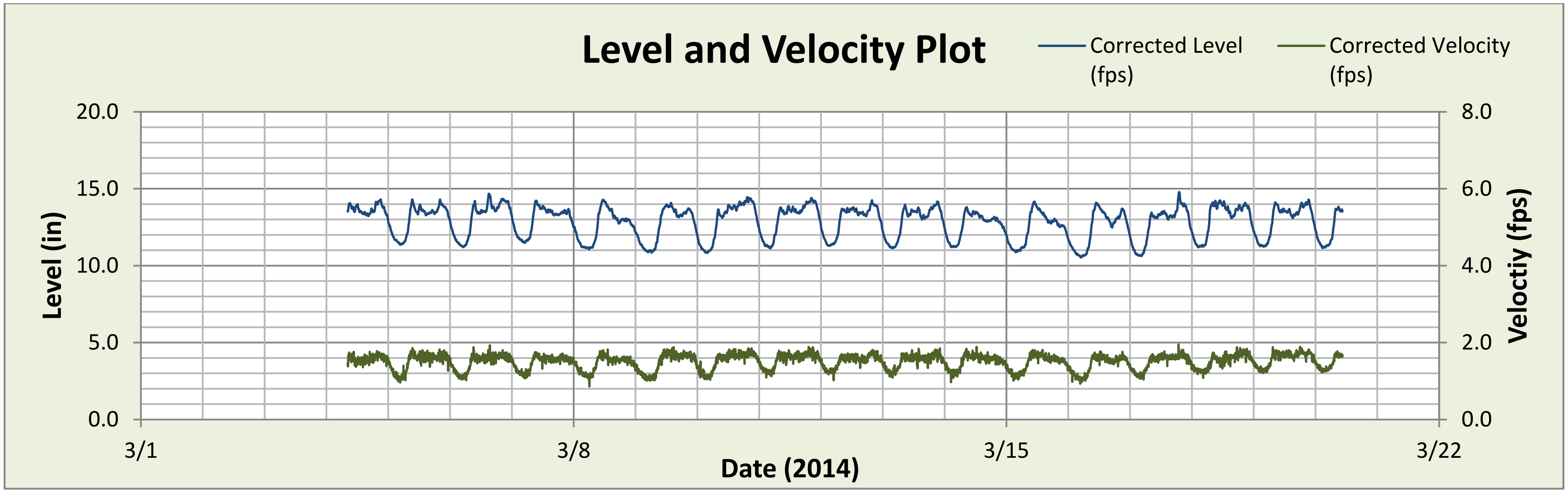


Figure B-7 – Site 6: Madrona Basin Raw Data at MH B3-289



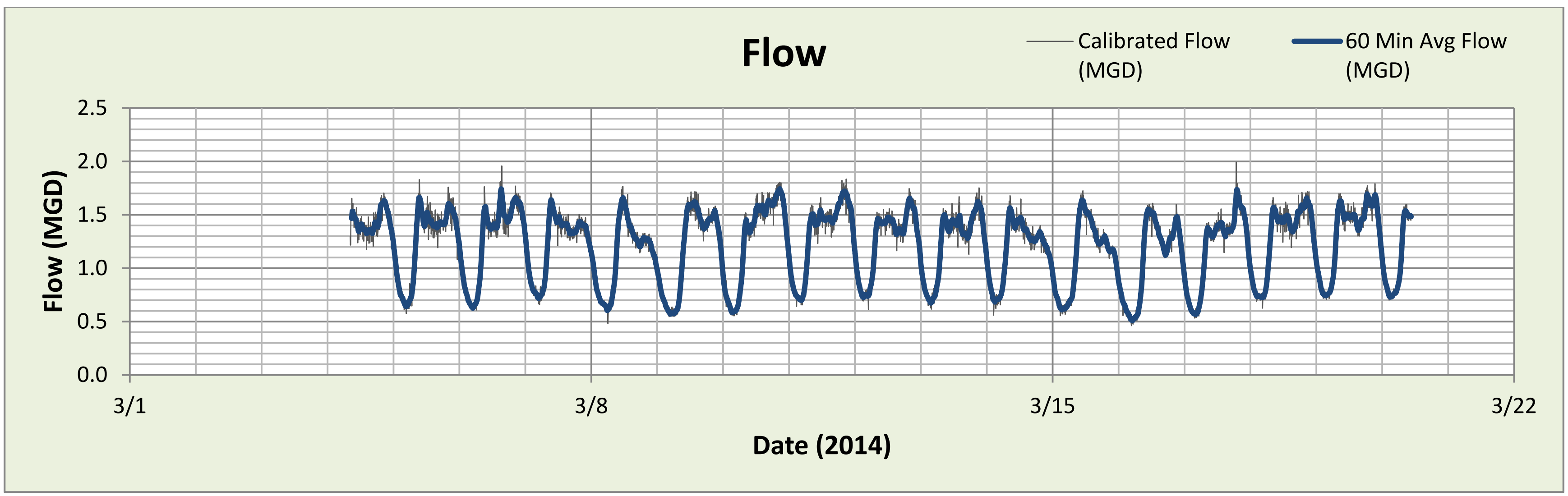
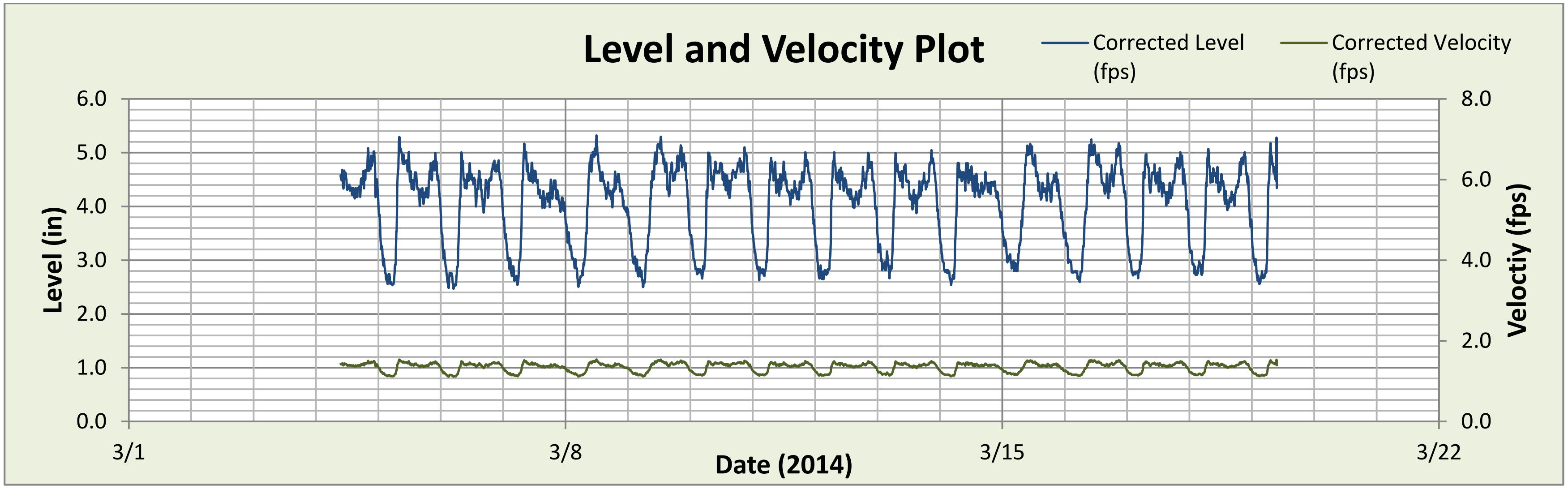


Figure B-8 – Site 7: Pole Line Basin Raw Data at MH B2-11



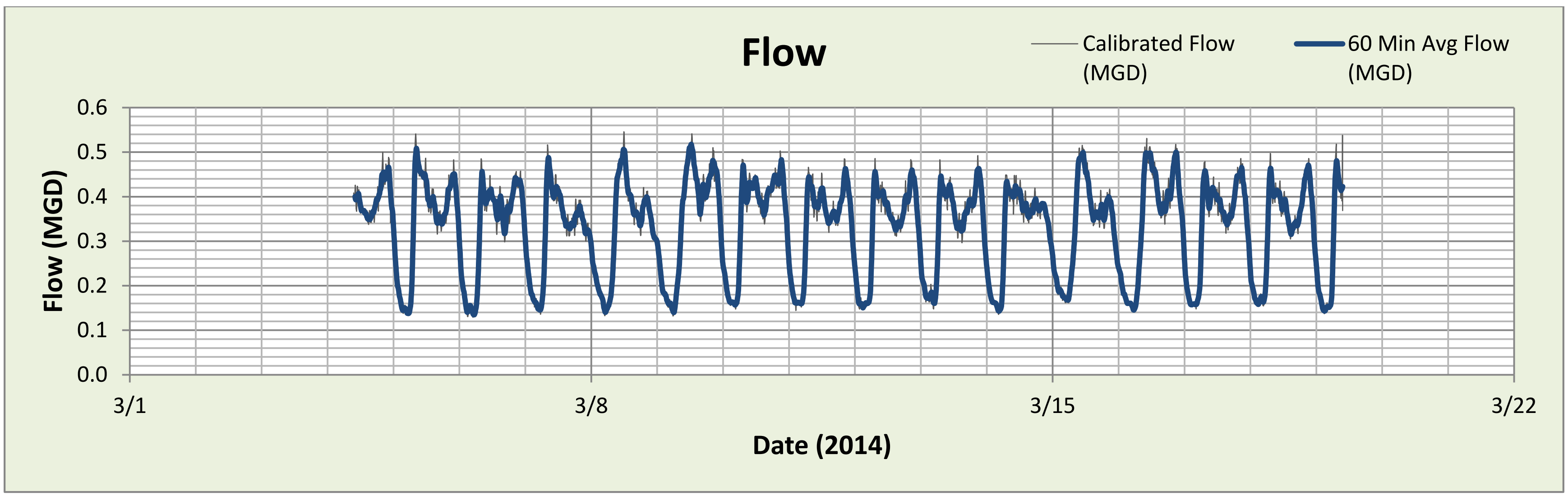
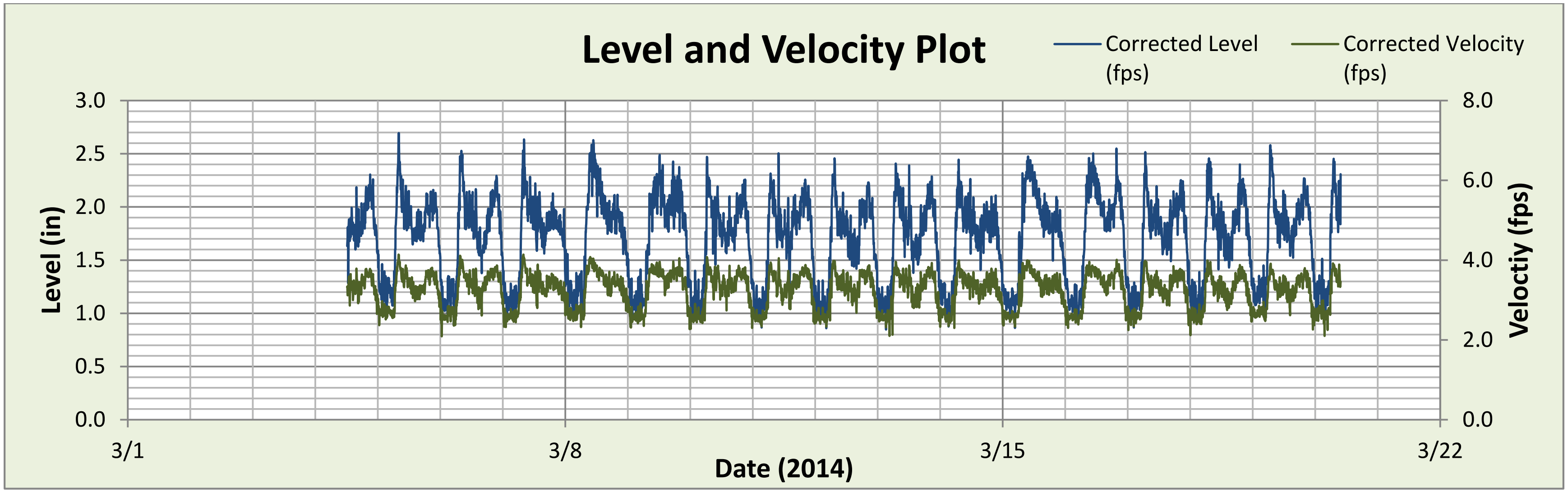


Figure B-9 – Site 8: Addison Basin Raw Data at MH D4-78



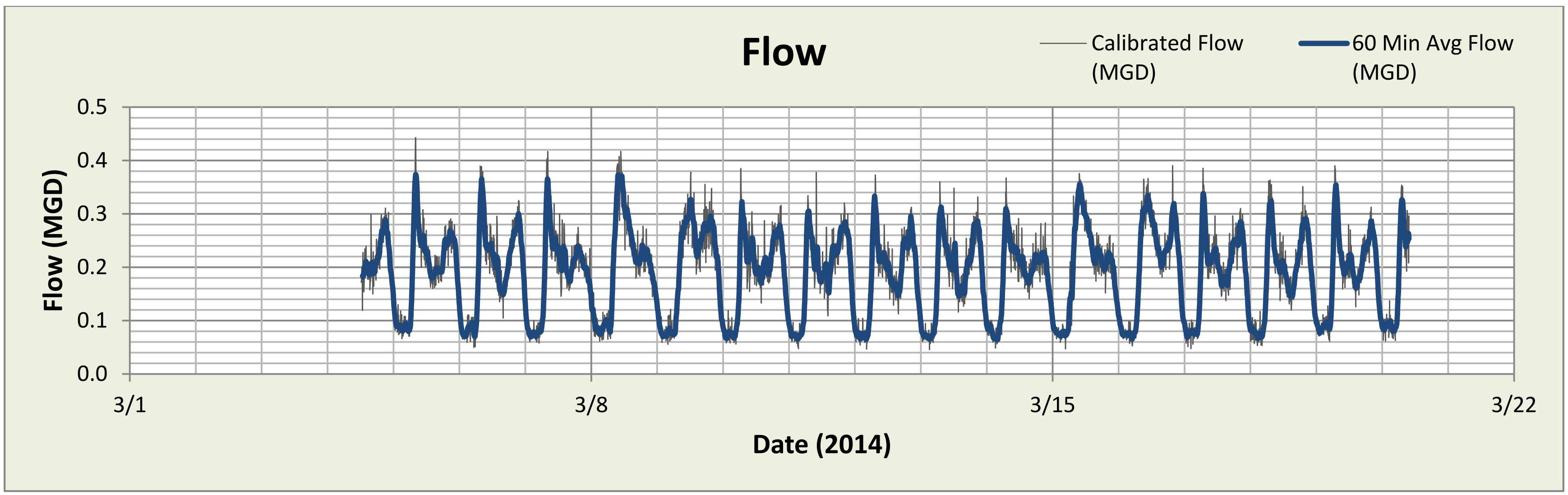
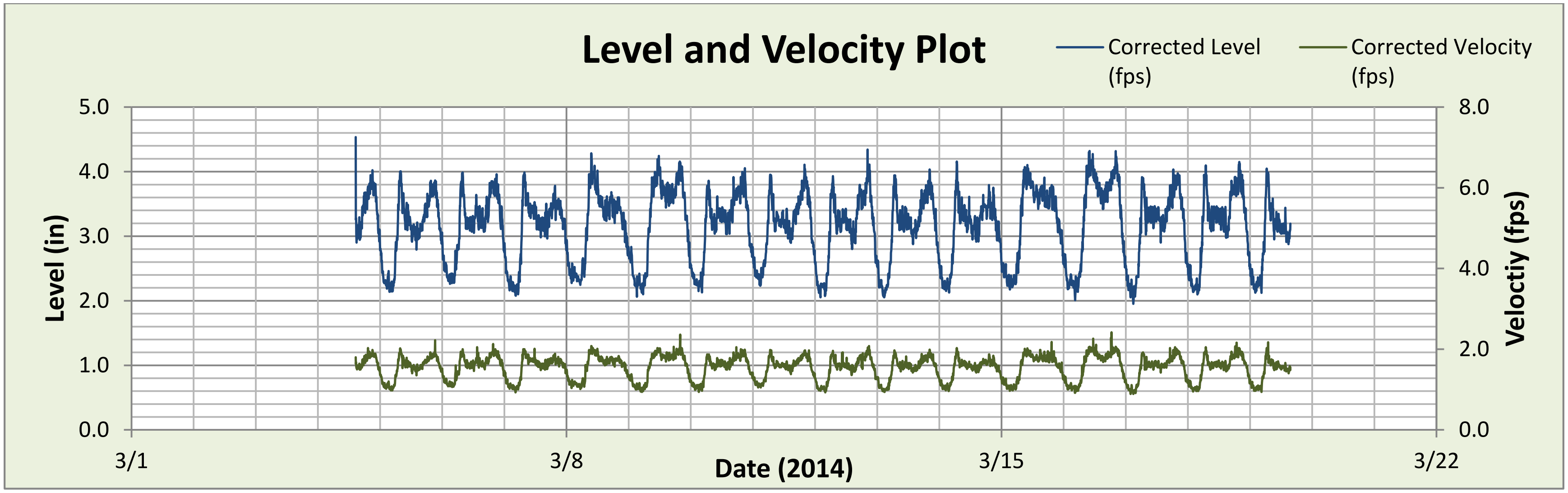


Figure B-10 – Site 9: Washington Basin Raw Data at MH C6-95



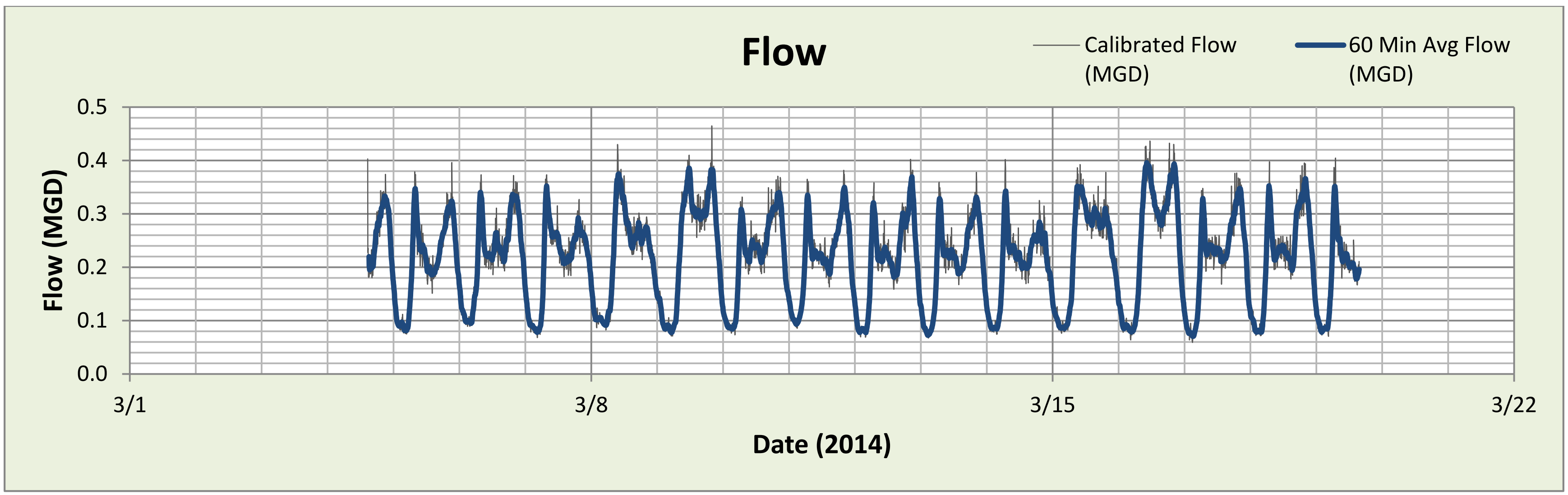
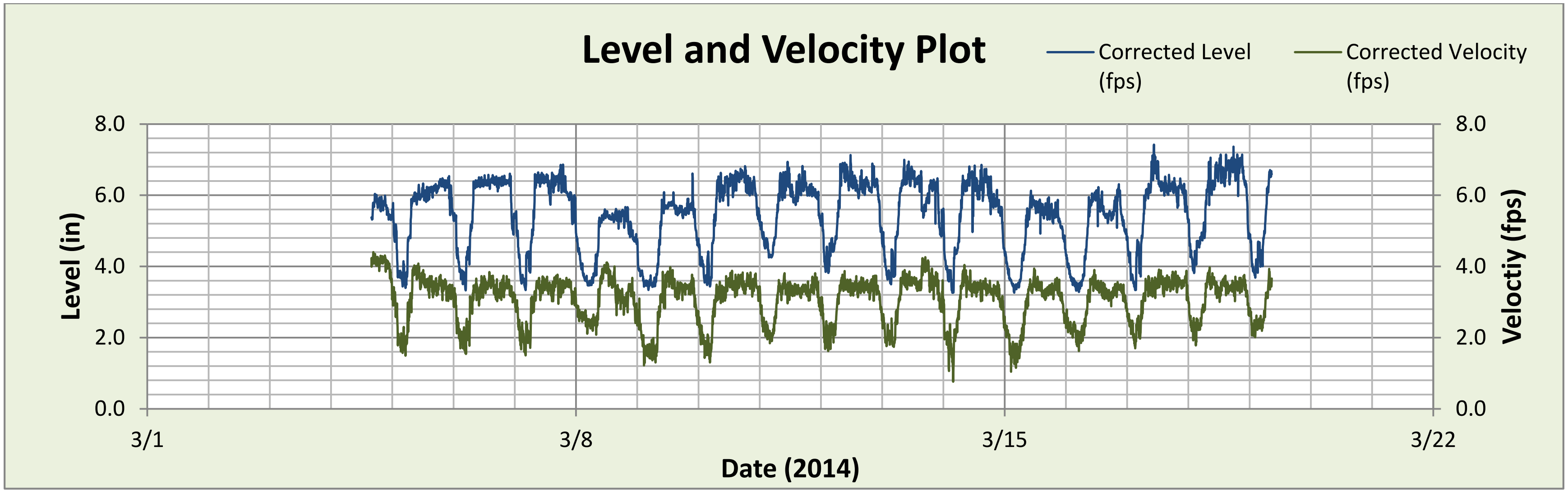


Figure B-11 – Site 10: Heyburn-Downtown Basin Raw Data at MH B4-20



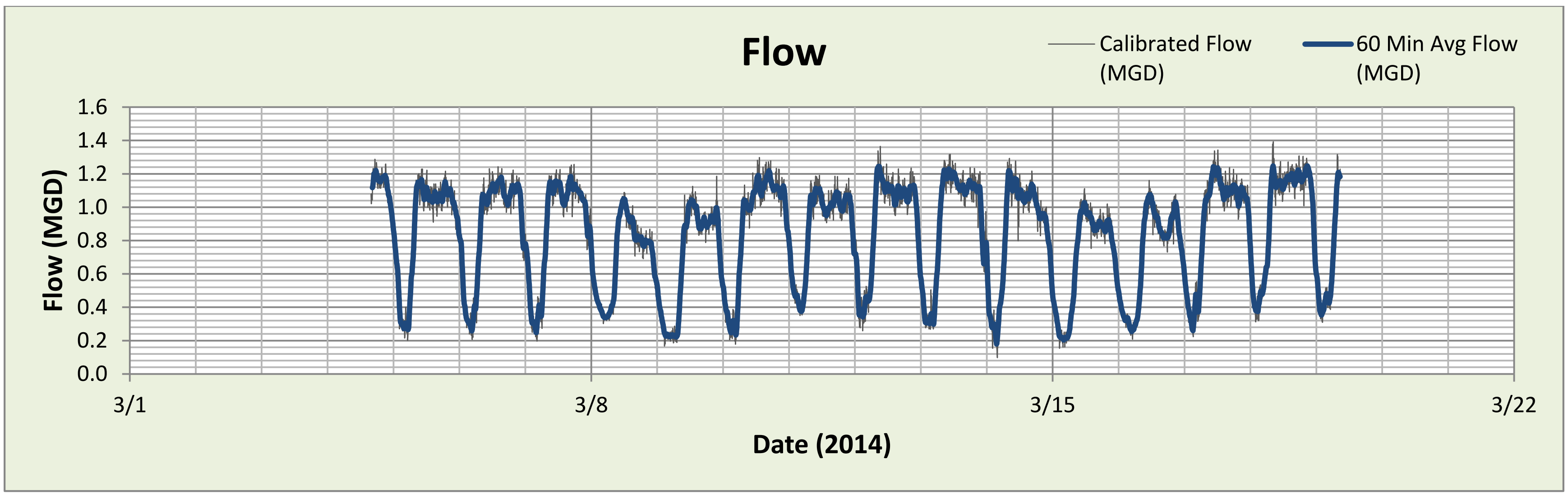
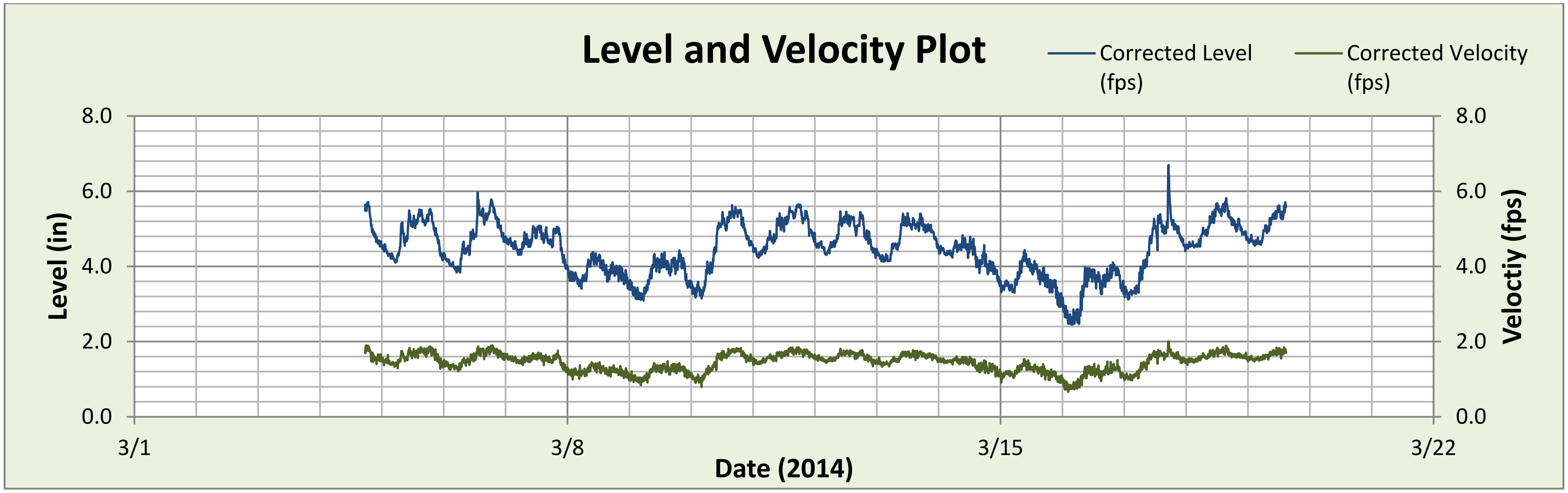


Figure B-12 – Site 11: Madrona Extension Basin Raw Data at MH D4-186



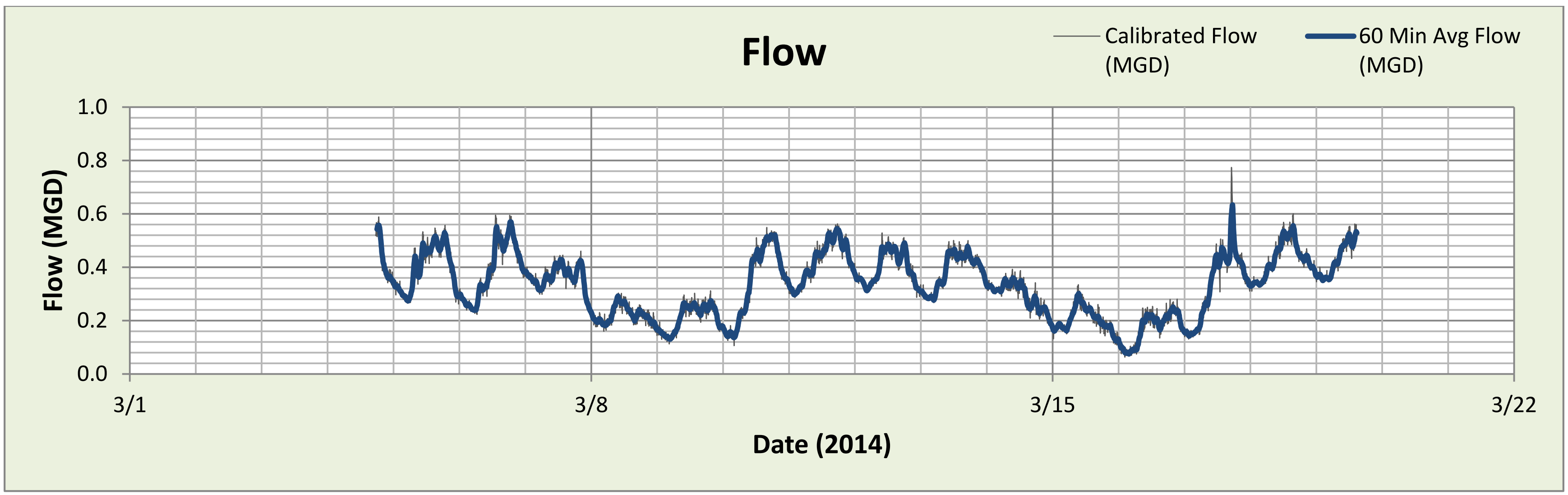


Figure B-13– Site 12: Kimberly Basin Raw Data from City of Kimberly Flow Meter SCADA

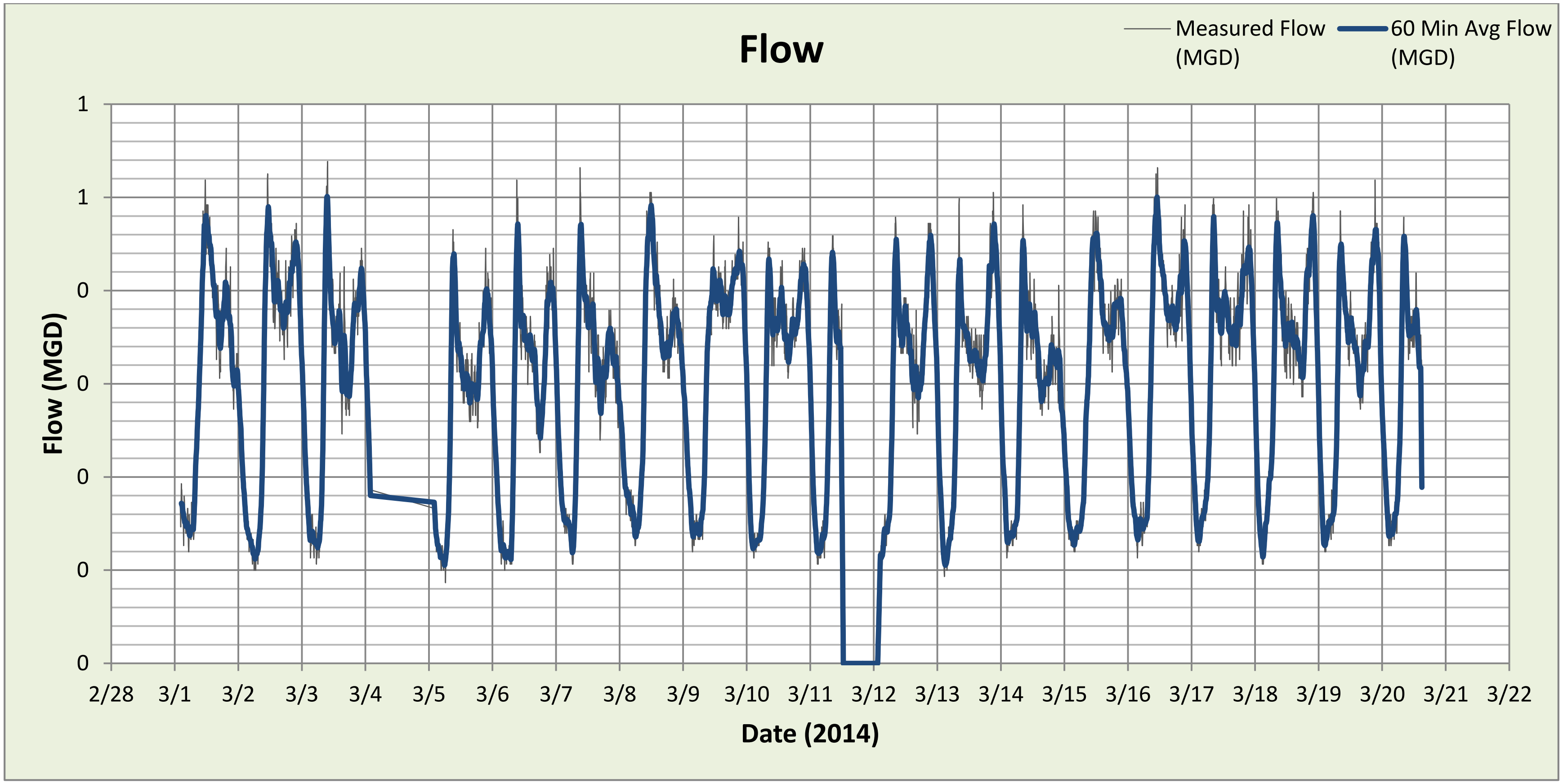


Figure B-14 – Site 13: Rock Creek Basin Raw Data from Rock Creek Lift Station SCADA

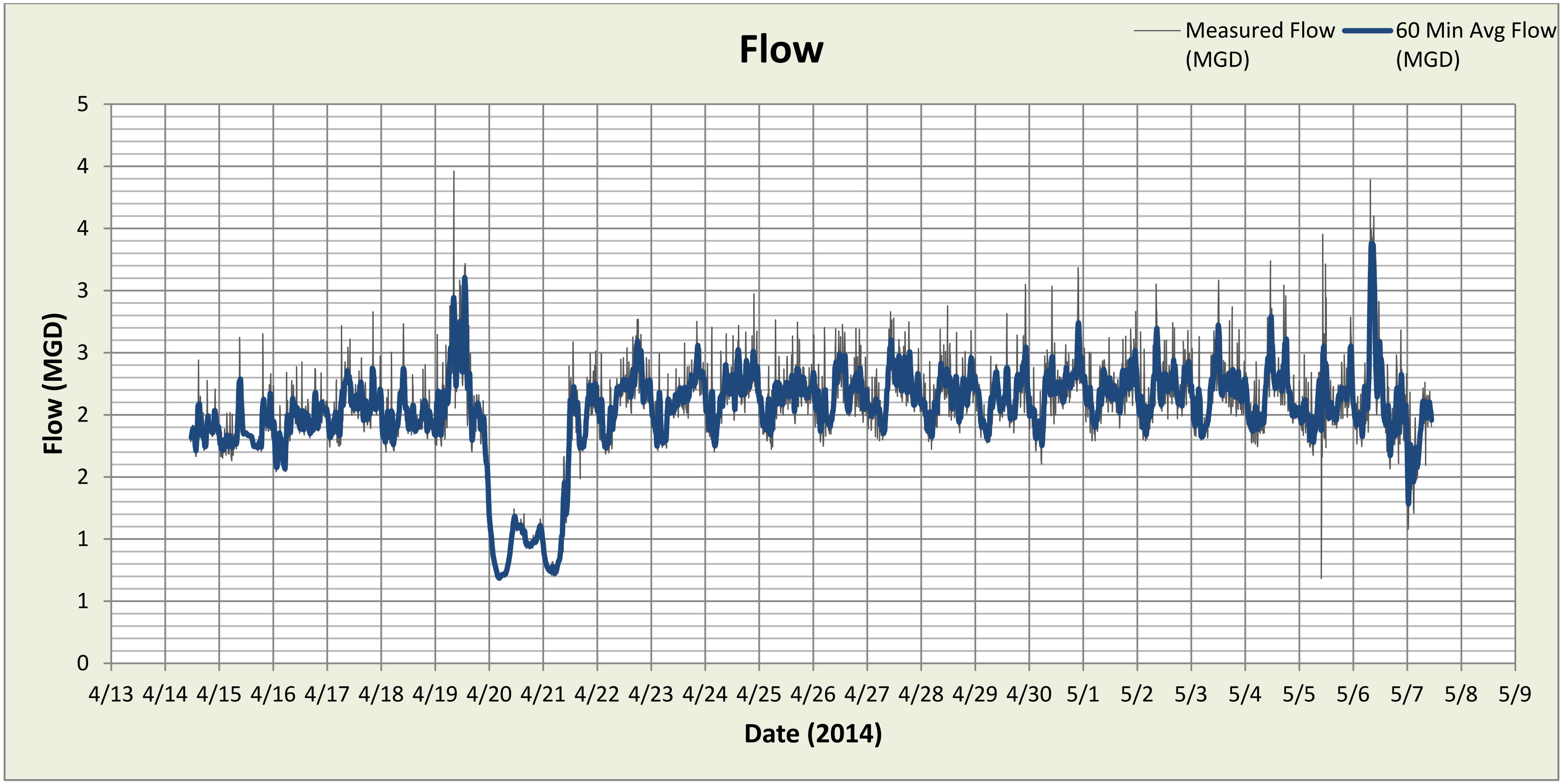
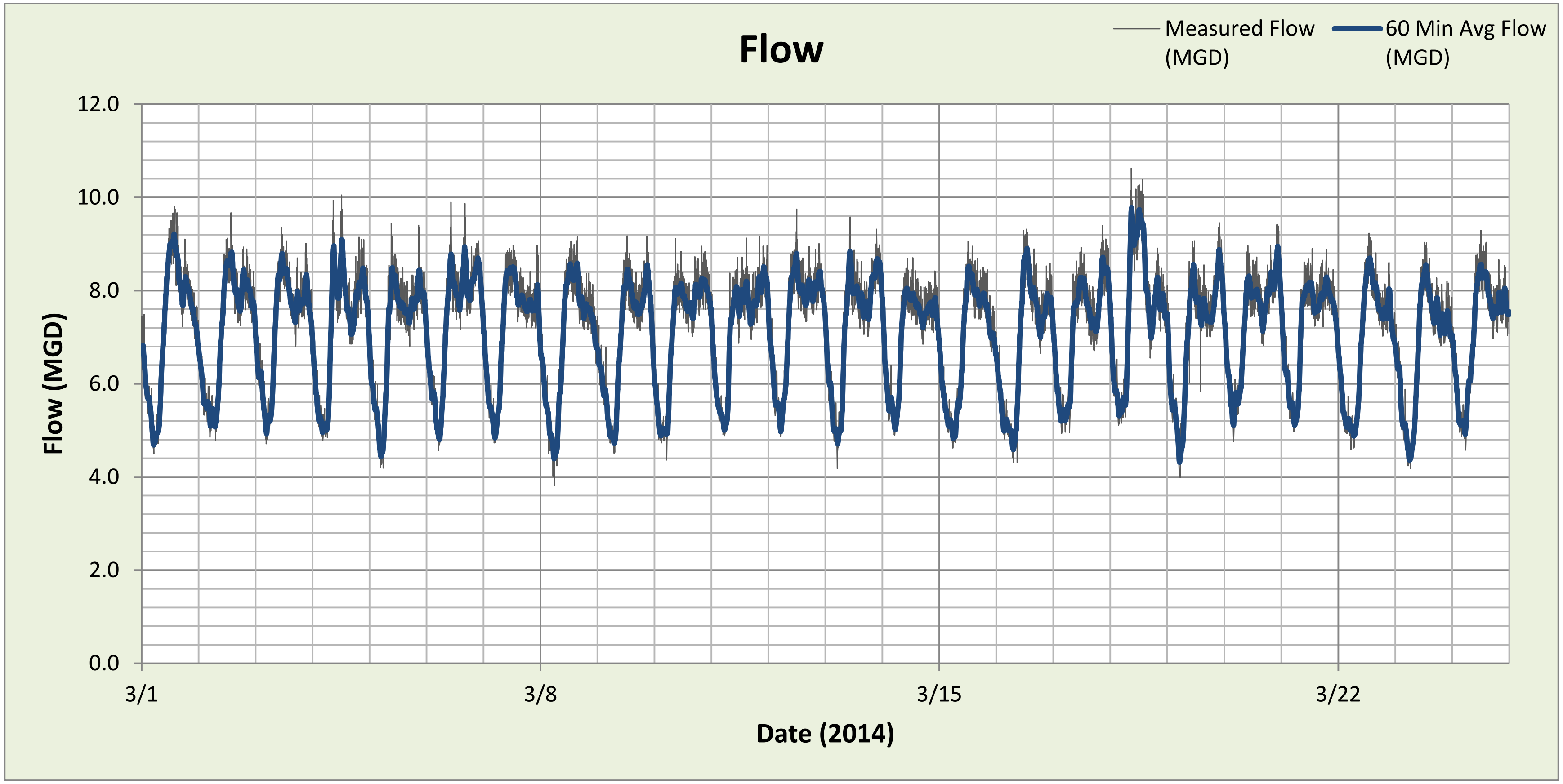


Figure B-15 – Site 14: WWTP Influent Raw Data from SCADA



B.2.3 Historical Flow and Rain Monitoring

Previous flow and rain monitoring occurred in 2006 for Twin Falls and were used in developing the 2009 Plan[3]. These data are compiled in a report on the development of the sewer model[4]. The data were not explicitly used for calibration, but a visual comparison was made to understand trends and identify changes that should be expected. However, due to the lack of significant storms during the March 2014 flow monitoring period, wet weather unit hydrograph parameters were used from the 2009 Plan as shown in **Table B-3** below. Differing from the 2009 plan, the Kimberly Basin was split into the Kimberly and Addison Basins due to the new northeast trunkline.

Table B-3 – Wet Weather Unit Hydrograph Parameters

Flow Monitoring Basin	R1	T1 (hrs)	K1	R2	T2 (hrs)	K2	R3	T2 (hrs)	K3
Blue Lakes	0.009	0.5	2	0.004	2	2	0.001	6	2
Perrine Coulee	0.007	1.0	2	0.002	2	2	0.001	6	2
Northwest	0.004	0.5	2	0.002	2	2	0.001	6	2
Townsite	0.009	0.5	2	0.004	2	2	0.001	6	2
Heyburn	0.002	1.0	2	0.002	2	2	0.001	6	2
Madrona	0.006	0.5	2	0.006	2	2	0.001	6	2
Kimberly/Addison	0.009	0.5	2	0.006	2	2	0.002	6	2
Rock Creek Lift Station	0.009	0.5	2	0.004	2	2	0.001	6	2
Grandview (WWTP)	0.009	0.5	2	0.004	2	2	0.001	6	2

[3] MSA, (2009) City of Twin Falls Collection System Report.
[4] CH2MHill (2010), Development of a Computerized Collection System Hydraulic Model.

B.3 Manhole Comparison – City GIS to 2009 Model

The 2009 model contained several manholes that did not correspond with manhole locations within the City GIS. In comparing the model with City GIS, it was found that many of these manholes were used to model intermediate transitions in pipes where the slope changes (i.e., siphons, canyon drop lines). Some particular examples include sections of the Washington Street South sewer and pressurized sewer pipes routed down the Rock Creek or Snake River Canyons. In other cases, a close match with an existing City manhole was identified and the attributes of the model manhole (i.e., rim/invert elevation) were transferred. In all, four cases were identified when comparing the City GIS to the 2009 manhole:

1. Manholes that are likely redundant to city manholes or there is a better match to a city manhole
2. Manholes that do not correspond to City manholes, but are necessary for model flow routing
3. Manholes that likely correspond to City manholes but are not needed for model flow routing
4. Manholes that likely correspond to City manholes and are likely needed for model flow routing.

A list of the manholes that fall into these four categories, along with comments from City GIS staff and J-U-B staff are listed below.

B.3.1 Case 1 – Likely redundant or not needed

ID	JUB Comment	COTF Comments
AI-1000	**Redundant, no Tees**	No city match needs verifying
AI-1001	**Redundant, no Tees**	No city match needs verifying
AI-1002	**Redundant, no Tees**	No city match needs verifying
AI-1003	**Redundant, no Tees**	No city match needs verifying
AI-1004	**Redundant, no Tees**	No city match needs verifying
AI-1005	**Redundant, no Tees**	No city match needs verifying
AI-1006	**Redundant, no Tees**	No city match needs verifying
AI-1007	**Redundant, no Tees**	No city match needs verifying
AI-1008	**Redundant, no Tees**	No city match needs verifying
AI-1009	**Redundant, no Tees**	No city match needs verifying
AI-1010	**Redundant, no Tees**	No city match needs verifying
AI-1011	**Redundant, no Tees**	
AI-1012	**Redundant, no Tees**	No city match needs verifying
AI-1013	**Redundant, no Tees**	No city match needs verifying
AI-1014	**Redundant, no Tees**	No city match needs verifying
AI-1015	**Redundant, no Tees**	No city match needs verifying
AI-1016	**Redundant, no Tees**	No city match needs verifying
AI-1017	**Redundant, no Tees**	No city match needs verifying
AI-1018	**Redundant, no Tees**	No city match needs verifying
AI-1019	**Redundant, no Tees**	No city match needs verifying
AI-1020	**Redundant, no Tees**	No city match needs verifying
AI-1021	**Redundant, no Tees**	No city match needs verifying
AI-1022	**Redundant, no Tees**	No city match needs verifiying
AI-1023	**Redundant, no Tees**	No city match needs verifiying

AI-1024	**Redundant, no Tees**	No city match needs verifiying
AI-1025	**Redundant, no Tees**	No city match needs verifiying
AI-1026	**Redundant, no Tees**	No city match needs verifiying
AI-1027	**Redundant, no Tees**	No city match needs verifiying
AI-1028	**Redundant, no Tees**	
AI-1029	**Redundant, no Tees**	No city match needs verifying
AI-1030	**Redundant, no Tees**	No city match needs verifying
AI-1031	**Redundant**	No city match needs verifiying
C7-32	**Redundant Junction**	
JCT-396	**ID = JCT-396, stub off of NE trunkline**	No Manhole
JCT-446	**ID = JCT-446, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-448	**ID = JCT-448, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-450	**ID = JCT-450, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-460	**ID = JCT-460, nearest C5-143, stub to conagra**	
JCT-462	**ID = JCT-462, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-464	**ID = JCT-464, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-466	**ID = JCT-466, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-468	**ID = JCT-468, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-470	**ID = JCT-470, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-474	**ID = JCT-474, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-476	**ID = JCT-476, nearest C5-143, stub to conagra**	No city match needs verifying
JCT-628	**ID = JCT-628, nearest C4-9**	
JCT-630	**ID = JCT-630, nearest C4-8**	
JCT-632	**ID = JCT-632, nearest C4-8**	
JCT-868	**ID = JCT-868, nearest C5-21, redundant**	No city match needs verifying
JCT-870	**ID = JCT-870, nearest C5-4, redundant**	No city match needs verifying
LC-2	**Redundant Junction**	No city match needs verifiying
LC-3	**Redundant Junction**	No city match needs verifiying
LC-4	**Redundant Junction**	No city match needs verifiying
LC-5	**Redundant Junction**	No city match needs verifiying
SWS-1	**ID = SWS-1, nearest B4-122, redundant, no tee**	No Manhole
SWS-10	**ID = SWS-10, nearest B4-122, redundant, no tee**	No Manhole
SWS-2	**ID = SWS-2, nearest B4-122, redundant, no tee**	No Manhole
SWS-3	**ID = SWS-3, nearest B4-122, redundant, no tee**	No Manhole
SWS-4	**ID = SWS-4, nearest B4-122, redundant, no tee**	No Manhole
SWS-5	**ID = SWS-5, nearest B4-122, redundant, no tee**	No Manhole
SWS-6	**ID = SWS-6, nearest B4-122, redundant, no tee**	No Manhole
SWS-7	**ID = SWS-7, nearest B4-123, redundant, no tee**	No Manhole
SWS-8	**ID = SWS-8, nearest B4-122, redundant, no tee**	No Manhole
SWS-9	**ID = SWS-9, nearest B4-122, redundant, no tee**	No Manhole

B.3.2 Case 2 – No match to City, needed for flow routing

ID	JUB Comment	COTF Comment
B1-1	**WWTP connection of East/West Trunklines**	
JCT-802	**ID = JCT-802, near D3-108 and D3-143**	No sewer line here
JCT-830	**ID = JCT-830, Perrine C. drop to Canyon Sprgs**	
JCT-832	**ID = JCT-832, Perrine C. drop to Canyon Sprgs**	Grade Change/Restr Block
JCT-838	**ID = JCT-838, Perrine C. drop to Canyon Sprgs**	Grade Change Restr Block
JCT-840	**ID = JCT-840, Perrine C. drop to Canyon Sprgs**	Grade Change Restr Block
JCT-842	**ID = JCT-842, Perrine C. drop to Canyon Sprgs**	Grade Change Restr Block
JCT-846	**ID = JCT-846, Perrine C. drop to Canyon Sprgs**	Grade Change/Restr Block
MV-14	**MV trunkline, no likely junction, need record dwg**	No city match needs verifying
MV-4	**MV trunkline, no likely junction, need record dwg**	
MV-5	**MV trunkline, no likely junction, need record dwg**	

B.3.3 Case 3 – Likely City GIS match, likely not needed for flow routing

ID	JUB Comment	COTF Comment
B2-128B	No Tee but nearest to B2-127, need to verify	
CONN-5	ID = CONN-5, no tee, nothing nearby, verify	No city match needs verifiying
F5-67	Redundant Junction	No city match needs verifiying
F5-68	Redundant Junction	No city match needs verifiying
FIELDSTONE-2	No Tee on 8" line, likely B2-145	
HC-C1-2	ID = HC-C1-2, between C5-78 AND C5-73	No city match needs verifying
HC-C1-3	ID = HC-C1-3, between C5-73 and C5-16	No city match needs verifying
HC-C1-4	ID = HC-C1-4, between C5-73 and C5-16	No city match needs verifying
ST_LUKES	No Tee, likely B2-69	

B.3.4 Case 4 – Likely City GIS match, likely needed for flow routing

ID	JUB Comment	COTF Comment
B4-121	Near B4-120, likely trunkline tee	
CL26	ID = CL26, nearest E2-132, NE trunk	
CSR-101	ID = CSR-101, no tee, likely D2-264	
CSR-102	ID = CSR-102, no tee, likely C2-164	
CSR-103	ID = CSR-103 no tee, likely C2-165	
CSR-104	ID = CSR-104, no tee, likely C2-166	
D2-5	Possibly redundant or secondary line	No city match needs verifiying
D2-75	Needs to be verified, might be a trunkline	No city match needs verifiying
D4-8	Id's appear to match	
F4-35	ID = F4-35, Trunkline tee, likely F4-35	
F4-42	ID = F4-42, likely F4-74	
F4-43	ID = F4-43, Trunkline, no tee, likely F4-75	
F4-44	ID = F4-44, Trunkline, no tee, likely F4-76	
F4-45	ID = F4-45, Trunkline, no tee, likely F4-77	
F4-46	Trunkline, no tee, likely F4-78	
F4-47	Trunkline, no tee, likely F4-79	
F4-48	Trunkline, no tee, likely F4-80	
F4-50	Possible Tee, nearest F4-81	
GW-1	ID = GW-1, likely C5-79, no tees	
GW-10	ID = GW-10, likely C5-226, tee	
GW-2	ID = GW-2, nearest C5-231, tee	
GW-3	ID = GW-3, nearest C5-230	
GW-4	ID = GW-4, likely C5-229	
GW-5	ID = GW-5, likely C5-228	
GW-6	ID = GW-6, likely C5-172	
GW-7	ID = GW-7, nearest C5-227	
GW-8	ID = GW-8, nearest C5-173	
GW-9	ID = GW-9, likely C5-174	
HC-C1-1	ID = HC-C1-1, nearest C5-173	
HC-C1-5	ID = HC-C1-5, between C5-73 and C5-16	No city match needs verifying
HC-C1-6	ID = HC-C1-6, between C5-73 and C5-16	No city match needs verifying
HC-C6-152	ID = HC-C6-152, nearest C6-152	
HC-C6-153	ID = HC-C6-153, nearest C6-153, tee	
HC-C6-180	ID = HC-C6-180, between C6-153 and C6-180, tee	
JCT-442	ID = JCT-442, likely C5-148, stub to conagra	No city match needs verifying
JCT-444	ID = JCT-444, nearest C5-143, stub to conagra	
JCT-472	ID = JCT-472, likely C4-322, tee to conagra	No city match needs verifying
JCT-626	ID = JCT-626, nearest C4-9	
JCT-834	ID = JCT-834, Perrine drop, likely C1-14, tee	
JCT-848	ID = JCT-848, Perrine drop, likely C1-50	
JCT-850	ID = JCT-850, Perrine tee, likely C1-18	
MV-10	MV trunkline, no tees, likely E2-123	
MV-11	MV trunkline, no tees, likely E2-124	
MV-12	MV trunkline, no tees, likely E2-125	
MV-13	MV trunkline, no tees, likely E2-126	
MV-6	MV trunkline, no tees, likely E2-102	
MV-7	MV to 8" collector, likely E2-120	
MV-8	MV trunkline, no tees, likely E2-121	
MV-9	MV trunkline, no tees, likely E2-122	
P-1	ID = P-1, likely D2-10, trunkline tee	
P-10	NE trunkline, no tees, likely D2-268	
P-11	NE trunkline, no tees, likely D2-269	
P-12	Connection MV to NE trunkline, likely E2-128	

ID	JUB Comment	COTF Comment
P-13	NE trunkline, no tees, likely E2-129	
P-14	On NE Trunkline, no tee, likely E2-131	
P-15	Stub to NE Trunkline, nearest E2-132	No Manhole
P-5	Likely D2-186, no tee but on 30" line	
P-8	Likely D2-266, no tee but on 30" line	
P-9	Likely D2-267, No tees but on 30" line	
PBL-8	Unfinished stub, nearest junction D2-68	
PBL-9	No junction nearby, perhaps D2-68	
RC_DS_FM1	Rock Creek LS	No city match needs verifying
RC_DS_FM2	Rock Creek LS	Manhole not labeled in records
RC_DS_FM3	Rock Creek LS	
RC_DS_FM4	Rock Creek LS	valve manhole
RC_DS_FM5	Rock Creek LS	Not here, flanged joint
RC_DS_FM6	Rock Creek LS	Line abandoned

Appendix C

Modeling Assumptions and Improvement Criteria

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Contents

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Model Assumptions

C.1 Introduction

A hydraulic model of a sewer system is based on assumptions that characterize the area and system under study. The assumptions used in a model are typically based on flow monitoring, learned characteristics of the system, discussions with City staff, and a general knowledge of sewer flow characteristics gained through past experience with monitoring flows and modeling other sewer systems.

C.2 Model Assumptions

This section summarizes the assumptions used for the updated model analysis and criteria for deficiencies. It is assumed that any violation of the criteria is reviewed with the City to determine on a case-by-case basis if something should be changed and what improvements will be recommended.

C.2.1 System Layer

Parameter: Manning's "n"

Discussion: The roughness factor used in the Manning's formula $Q = (1.49/n)AR^{2/3}S_o^{1/2}$. The Manning's formula relates flow in a pipe with the depth of flow, diameter of the pipe and the slope of the pipe. Typical "n" values range from 0.009 for very smooth glass or plastic to greater than 0.016 for unfinished concrete. For sewer pipes, however, a slime layer develops on any sewer material in contact with sewage and provides relatively consistent roughness regardless of material.

ASCE provides ranges of recommended Manning's "n" values based on size and condition. For pipes installed and maintained with 'extra care' they suggest a Manning's "n" range from 0.0092 to 0.0107 for sizes 6" to 60" respectively. For 'typical' installations Manning's "n" range from 0.0106 to 0.0123 for sizes 6" to 60" respectively. For 'substandard' installations Manning's "n" range from 0.0120 to 0.0139 for sizes 6" to 60" respectively.

Applies to: Existing and future master planned pipes.

2009 TF Model: *Manning's "n" values varied between 0.014, 0.013, and 0.01.*

Updated Parameter: Use a Manning's "n" of 0.012 regardless of pipe material, size and age.

Parameter: Pipe Sizing Methodology

Discussion: The maximum depth of flow/diameter of pipe (d/D) is an indicator of how much of the pipe capacity is being used. When the flow in a pipe reaches the point where the d/D ratio is greater than the maximum d/D ratio, the pipe diameter will increase to the next size. Flows from the Master Plan will be used to size future sewer lines.

A graduated scale for maximum d/D dependent on the size of the pipe is recommended as shown below. The scale is based on ASCE recommendations for master planning sewer systems at a d/D of less than 0.5 for sewers less than 18 inches in diameter and 0.75 for larger sewers. This allows for a safety factor for smaller sewers where variations in land use and extensions of the service area can have large impacts on the available capacity of the sewer. The larger sewer lines have a smaller safety factor because variations in land use tend to balance out over the larger area served by the large sewer.

During the design storm, the City would like to prevent sewer backup into homes. Assuming a standard plumbing slope of 0.25in/ft and a 50 foot offset, this is approximately 1-foot of surcharge over the top of the pipe that could occur before sewer would begin surcharging into a home.

Applies to: Future master planned pipes.

2009 TF Model: *Used a d/D of 0.8 or 80% full regardless of pipe size.*

Updated Parameter: **Use a graduated scale for the maximum d/D as listed in Table C-1 for dry weather flows. Allow surcharge of 1.0 foot above the crown of the pipe for wet weather flows.**

Table C-1 – Depth Over Diameter Ratios for Pipes

Size	d/D	Resultant Safety Factor
8"	0.50	2.00
10"	0.55	1.71
12"	0.60	1.49
15"	0.65	1.32
≥18"	0.75	1.10

Parameter: Capacity Criteria

Discussion: Many communities don't allow surcharging to occur above the top of the pipe to minimize the possibility of a sewer service backup. The City has historically decided to address this on a risk based policy of allowing no surcharge for dry weather flows, but allowing some amount of surcharge for wet weather flows.

Applies to: Existing pipes.

2009 TF Model: *Dry weather flows have d/D < 0.8. Allow surcharge to within 2.0 feet of the rim for wet weather flows.*

Updated Parameter: **Dry weather flows have a max d/D = 1.0. Allow surcharge of 1.0 foot above the crown of the pipe for wet weather flows.**

Parameter: Surcharge Depth in Shallow Manholes

Discussion: Construction of several manholes has historically been difficult without a large capital expense to comply with the typical surcharge depth. In these cases, an exception has been made for a shallow manhole during wet weather flows.

Applies to: Historical evaluation of existing manholes.

2009 TF Model: *0.5 feet from the rim*

Updated Parameter: **No exception standard will be provided for shallow manholes.**

Parameter: Pipe Slopes

Discussion: The State of Idaho DEQ has adopted the minimum pipe slopes outlined in "Ten State Standards". The use of a minimum velocity to determine slope may result in Master Plan slopes that differ from the slopes used in final design and construction of the Master Plan line which would typically be designed to the "Ten State Standards". Minimum slopes for pipes larger than 21-inch are recommended to be 0.10%. For slopes less than 0.10%, constructability becomes difficult.

Applies to: Future master planned pipes.

2009 TF Model: Gravity Pipes: Maintain a 2 ft/sec minimum velocity with a minimum 8 inch diameter pipe.
Siphons: Maintain a 3 ft/sec minimum velocity with a minimum of 2 barrels.

Updated Parameter: **Gravity Pipes: Use Ten State Standards minimum slopes as modified and shown below in Table C-2.**
Siphons: No change to previous modeling parameters.

Table C-2 – Minimum Slopes for Design Pipes

Size	Slope
8"	0.40%
10"	0.28%
12"	0.22%
15"	0.15%
18"	0.12%
≥21"	0.10%

Parameter: Sewer Pipe Connection Point

Discussion: When two sewer lines of different sizes meet, the connection point can affect pipe hydraulics. Convention and some sewer standards require the design to match the pipe crowns or to match the design depths of the sewers to keep from surcharging the smaller line. The City standards require the minimum invert elevation of laterals be at the centerline elevation of the main line or at an elevation which matches the crown of the lateral with the crown of the main line, whichever is higher.

Applies to: Future master planned pipes.

2009 TF Model: *Not addressed*

Updated Parameter: **Match the crowns of the two pipes for simplicity during modeling.**

Parameter: Maximum Velocities

Discussion: Typically the surcharge depth will control velocity through a pipe, but in a few cases where this does not occur, velocity should still be limited through the system to help preserve the longevity of the pipe system.

Applies to: Existing and future master planned pipes.

2009 TF Model: *Gravity Pipes: 10 ft/second maximum velocity*
Force Mains: 6 ft/second maximum velocity

Updated Parameter: **No change to previous modeling parameters. Drop lines may have a higher velocity with specific design to handle higher velocities.**

Parameter: Allowable Downstream Pipe Diameters

Discussion: Smaller diameter pipes can be constructed downstream of larger diameter pipes and provide adequate hydraulic capacity if there is sufficient slope in the smaller diameter pipe, and surcharging is not expected. However, decreases are not recommended due to the possibility of obstructions lodging at locations where trunk lines decrease in size, and because of the decreased hydraulic capacity in a surcharged condition if allowed. Decreases may be necessary when tying a master planned line into an existing trunk line, but should be avoided for future lines. For master planning, pipes generally smaller than 24 inch will be noted as needing a larger size when they are replaced.

Applies to: Future master planned pipes.

2009 TF Model: *Not addressed*

Updated Parameter: **Downstream pipe diameters shall be equal to or greater than the immediate upstream pipe diameter for future pipes. Existing downstream pipes that decrease in diameter from upstream pipes will be discussed for replacement consideration, and if the downstream pipe is smaller than 24 inches will generally be flagged to be replaced with a larger pipe if upstream pipes are already larger. This replacement does not need to be completed unless the pipe condition is poor.**

Parameter: Distance Between Manholes

Discussion: The distances between manholes may vary, but according to the 10 State Standards, should be limited to a maximum of 400 feet for lines less than 18 inches in diameter and 500 feet for lines 18 inches and larger. The average modeled distance between manholes in an existing system tends to be around 300 feet.

Applies to: Future master planned pipes.

2009 TF Model: *Not addressed*

Updated Parameter: **Use 300 feet as the distance between manholes. Provide 0.1 feet of drop across each master planned manhole.**

Parameter: Pipe Depths

Discussion: While the minimum depth of the trunk line may be set in the model, care must be taken to check that the trunk line has sufficient depth to serve to the boundary of its service area. This can be accomplished by using “check lines” in the model. “Check lines” are 8-inch model lines extended at a slope of 0.45% (0.05% greater than minimum slope to account for manhole drops) to locations within a service area that may be difficult to reach. “Check lines” force the trunk line down if necessary to serve a service area.

Applies to: Future master planned pipes.

2009 TF Model: *Not addressed.*

Updated Parameter: **Set the typical cover at 7 feet. A standard minimum cover of 5 feet will be used to verify check lines as needed to ensure sufficient depth. Check results for excessive depth (>15 feet). Before a lift station is considered, an *exception, not the standard,* would be to decrease the required cover to a minimum of 3 feet.**

Parameter: Manhole Drop and Meander Factor

Discussion: The invert drop through manholes allows for head loss in manholes. Standard drop in a manhole is 0.10 feet. To account for meander in design pipes, additional drop is added to the manholes to account for lengthened pipe and construction on curved roads that differ slightly from the master planned alignments. Additional drop is considered so that minimum slope criteria are also not violated. However, even though minimum slopes can be kept, if overall pipe length varies from the master planned pipe lengths, the hydraulic grade line (HGL) will increase at the upstream end which may be a violation greater than 1 foot over the crown. The master plan accounts for at least a 20% meander factor. If actual designs vary more than this, pipe sizes and slopes may be affected.

Applies to: Future master planned pipes.

2009 TF Model: *Not addressed*

Updated Parameter: **Total drop included in the master planned manholes consists of two parts: 1) 0.10 feet for every 300 feet of pipe. 2) Drop for an additional 20% of length of the upstream pipe to ensure minimum slopes are still possible on meandering routes. Total meander factor also consists of validating that the hydraulic grade line meets d/D criteria after increasing length by 20% on new pipes to account for up to 20% meander. This validation is also made possible by manhole losses discussed below.**

Parameter: Manhole losses

Discussion: Headloss occurs in most manholes unless the manhole is built over an existing pipe with the top of the pipe cut out. The loss comes from the change in geometry as flow enters the manhole and exits to the next pipe. This headloss is approximated by using a loss coefficient multiplied by the velocity head in the upstream pipe. The Federal Highway Administration published a methodology in Hydraulic Engineering Circular 22 based on research on these loss coefficients which includes initial estimates and a more elaborate and iterative process to determine loss. As a first initial estimate for outlet control conditions 0.2 is recommended for a pipe entrance loss, and 0.4 for pipe exit loss under inlet or outlet conditions. On new pipelines, due to the potential for meander during actual design, an adjustment also needs to be made to increase these values to account for additional manholes that could occur with the meander. A higher loss coefficient in master planning also provides sufficient provision for up to an additional 20 percent meander length in design in conjunction with the lengthening described above. This additional length will cause additional friction loss and a subsequent hydraulic grade line increase.

Applies to: Existing and Future master planned pipes.

2009 TF Model: *Not addressed.*

Updated Parameter: ***Existing*** **pipe manhole loss coefficients: 0.4 exit, and 0.2 entrance**

Future **pipe manhole headloss will be approximated by using an exit loss coefficient of 1.0 on each pipe and 0 for the entrance loss coefficient**.

Parameter: Constant Speed Pump Cycle Volume

Discussion: The cycle volume of a pump station is the volume of the wet well between the pump off and pump on settings for a constant speed pump.

The model performs its calculations in discrete time increments. The results can be provided in time increments down to 1 second or less. A lift station with a cycle time less than the analysis time increment will result in a peak flow that has been reduced.

The Rock Creek Lift Station, different than the others, has variable frequency drives and will be modeled such that the flow coming into the pump station will approximate the flow leaving.

Applies to: Existing lift stations.

2009 TF Model: *Smaller lift stations were not modeled previously. Rock Creek Lift Station modeled as inflow equals outflow.*

Updated Parameter: **Smaller Lift Stations: Model cycle volume according to the current set points. Set calculation time increment to 1 minute or less.**
Rock Creek Lift Station: Model with inflow hydrograph matching outflow hydrograph (ideal pump in InfoSWMM).

Parameter: Future Pump Station Capacity

Discussion: The capacity of each lift station in the model is set individually. Lift stations tend to be designed based on assumptions that are more conservative and yield peak flows higher than a system wide model. A safety factor for the lift station is desirable to reduce the chance of overloading the lift station and to account for infiltration or inflow if needed.

Applies to: Future master planned lift stations.

2009 TF Model: *Set the firm (largest pump considered out of service) lift station peak hour capacity equal to dry weather flow plus a 20% allowance for infiltration and inflow. Set the rated capacity (all pumps are on) to handle dry weather plus 10-year 24-hour storm event.*

Updated Parameter: **Set the lift station firm capacity need at least 10% higher than the incoming total wet weather peak flow.**

C.2.2 Flow Generation

Future Flows

Parameter: Residential Unit Flows

Discussion: A selected unit flow on the high end of flows observed in Twin Falls is expected to capture expected flows for future planning. Using a higher value also helps account for some higher density housing that may occur.

Kimberly is also projected to fill in their service area, and modeled values assume Twin Falls will serve Kimberly based on their projected growth. Kimberly is a permitted user.

Applies to: Future areas currently planned with a residential land use and other areas not zoned commercial or industrial. This loading applies to areas not currently being serviced by the City.

2009 TF Model: *Ten States Standard of 100 gpcpd (1 EDU)*[1] *= 264 gpdu (2.64 people per dwelling unit)*

Updated Parameter: **170 gpd per dwelling unit (1 EDU) = 64 gpcd (2.66 people per dwelling unit)**

Parameter: Non-Residential Unit Flows (Excluding Permitted Users)

Discussion: The loading (gpad) for each non-residential land use type was estimated from the winter water meter data, zoning data, acreage, and discussions with the City.

Non-residential unit flows for Twin Falls are as follows:

- Aggregated commercial areas typically range from 328 to 1075 gpad on a gross area basis
- Aggregated industrial areas typically range from 38 to 309 gpad on a gross area basis. (typically <100 gpad)

As noted above, commercial flows as an aggregate are generally not as high as some particular individual business flows; however, to accommodate the possibility of some higher use a commercial value is selected.

Industrial flows are typically very low except for water use businesses or permitted industries. Rather than assign all industrial users the same unit flow, high or low water users, unit flows were assigned to low water-use industries, while permitted industries were assigned their permit value. Based on results from the City water meter density analysis, general industrial users were assigned a value of 200 gpad which corresponds to roughly double the average light industrial flow values. Large permitted industries are assigned higher loadings as discussed in the section *Permitted Industrial Users* below.

Applies to: Future areas zoned commercial or industrial.

2009 TF Model: *Commercial Area 1,150 gpad (0.8 gpm/acre)*
Industrial Areas 1,440 gpad (1 gpm/acre)

Updated Parameter: **Commercial: 1,150 gpad (0.8 gpm/acre)**
Industrial: 200 gpad (0.14 gpm/acre)

Parameter: Permitted Industrial Users

Discussion: Typical industrial growth is anticipated in areas zoned as such. However, large point flows can change the pipe sizes significantly.

[1] GLUMRB. (2004) Recommended Standards for Wastewater Facilities.

The City conducted a survey of existing permitted customers to anticipate their future water needs. Based on this survey, the City may need to prepare for requests of an additional 1.48 MGD of sewer flows over the next 20 years.

Additionally, in the past few years, the City has experienced a surge in interest from industries to develop in the area.

Applies to: Locations and anticipated flows of new permitted users are illustrated in **Figure 3-2** through **3-4** in the report. Flows represent average day loading and received a peaking factor of 1.4 to account for peak hour flows beyond permit levels.

2009 TF Model: *No point loads, but a higher industrial unit flow was used.*

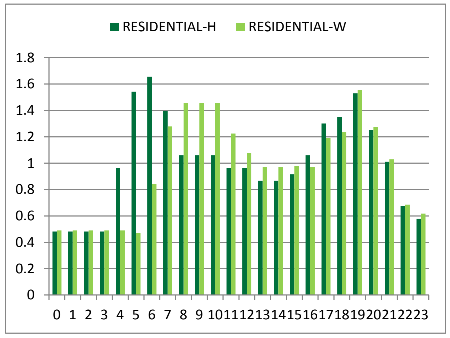
Updated Parameter: **Anticipated Growth of Existing Permitted Users, 20-Year Industrial growth and Build-Out Industrial Growth shown in section 3.2 of the report**.

Parameter: Diurnal Curves

Discussion: A diurnal curve describes the shape of sanitary flow contribution to the collection system over a 24-hour period. Diurnal curves differ for each type of land use. Diurnal curves are modified and refined during the calibration process by comparison to flow monitoring data. For calibration, permitted industry diurnal curves were developed to best reflect the flow monitoring data collected. For analysis, permitted industrial diurnal curves were set to a value of 1 for all time periods and applied to the permitted flow for the industry.

Model Assumption: Hourly diurnal curves for the major land use types are listed below and are described in terms of weekday hourly (H) or weekend hourly multipliers (W) on the average unit flows. It should be noted that these are not the peak flows applied, however, because during calibration, additional *daily* multiplication factors for land type are also used to adjust average flow based on the day of the week. Daily multipliers do not vary much from 1 for most land use types, with a couple of exceptions. For instance, a Saturday/Sunday multiplier for schools reduces the flow to 0.175 times the average flow, and a church weekend multiplier increases the average flow by 2.75 times on the weekend (a combined daily weekend/hourly diurnal peak of 6.81). *These combined hourly with daily patterns are not reflected below*, and some businesses have a different daily land use pattern than the land use type for hourly diurnal curves.

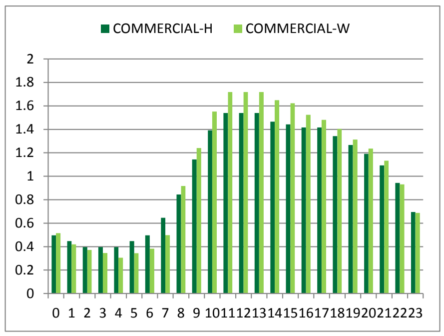
Residential



*Does not reflect flow change based on the day of the week

- Low Density Residential
- Medium Density Residential
- High Density Residential
- Assisted Living
- RV-Park

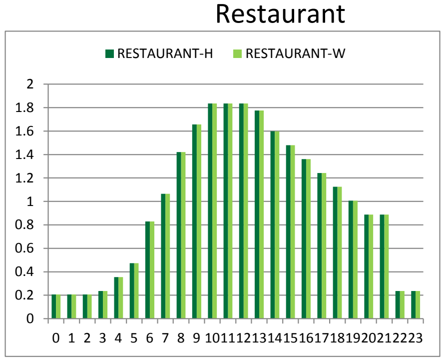
Commercial



*Does not reflect flow change based on the day of the week

- Commercial
- Car Wash
- Laundromat

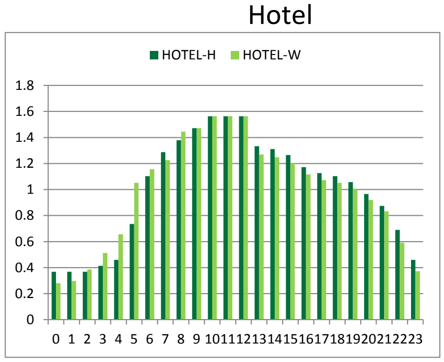
Restaurant



*Does not reflect flow change based on the day of the week

- Restaurant

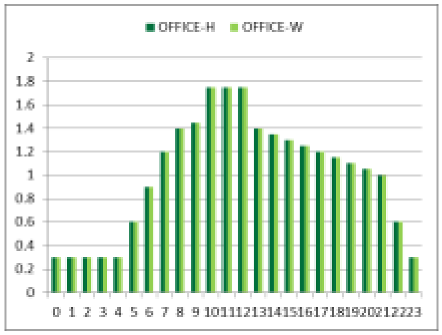
Hotel



*Does not reflect flow change based on the day of the week

- Hotel

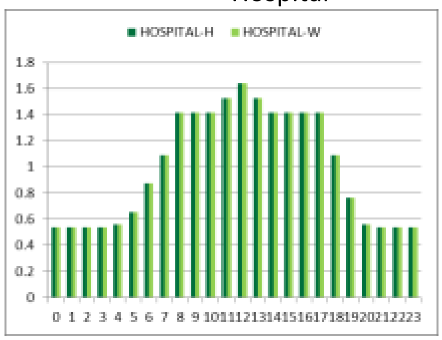
Office



*Does not reflect flow change based on the day of the week

- Office
- Public
- Airport

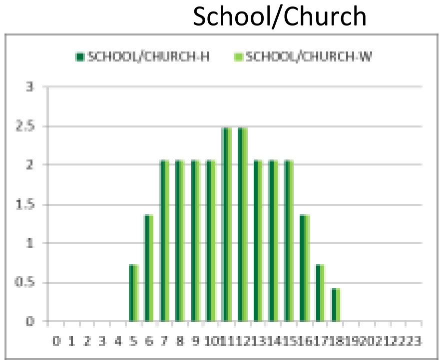
Hospital



*Does not reflect flow change based on the day of the week

- Hospital

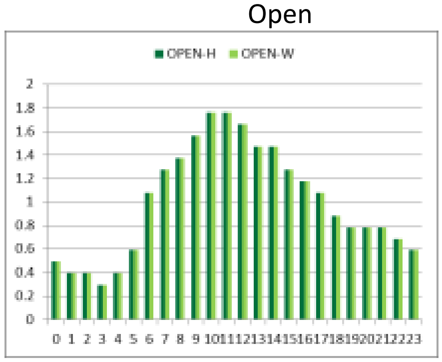
School/Church



*Does not reflect flow change based on the day of the week

- School
- Church

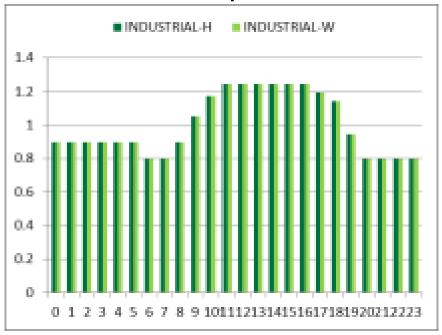
Open



*Does not reflect flow change based on the day of the week

- Park
- Golf Course

Industry Not Permitted



*Does not reflect flow change based on the day of the week

- Industry Not Permitted

Constant

1.0 Constant all times/all days

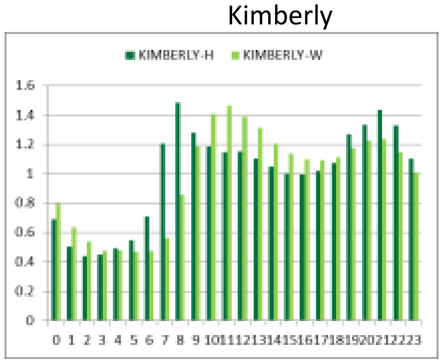
- Existing Permitted Industry (Clif Bar is still developing)
- Swimming Pool

Future Industry

1.4 Constant all times/all days

- Future Industrial Flows
- Anticipated Flow for Existing Permitted Industry

Kimberly



- City of Kimberly

C.2.4 Infiltration and Inflow

Parameter: Design Storm for Inflow

Discussion: A design storm will be used to simulate a rainfall event. The 2009 Master Plan documented that the typical storm pattern for south central Idaho is a Type II SCS design storm. The storm peak will be aligned with the sanitary peak to evaluate the worst case scenario. Aligning these peaks significantly increases the return period for the storm.

Applies to: Existing Pipes: 200 foot buffer area around pipes (100 feet on each pipe side)
Future Areas: 60% of the area for residential/commercial and 30% for industrial

2009 TF Model: *24-hr Type II SCS 10-year design storm with 1.4 inches of precipitation*

Updated Parameter: **No changes to previous modeling parameter.**

Parameter: Infiltration

Discussion:	Infiltration describes the groundwater or rainfall that enters the sewer system through imperfections in the pipes and manholes. Current and past flow monitoring has shown that infiltration from groundwater is not significant. Infiltration values from rainfall are estimated for large basins from flow monitoring data. It is described in terms of the wet weather Unit Hydrograph to account for infiltration associated with the rainfall events if applicable.
2009 TF Model	*Infiltration from rain associated with a wet weather unit hydrograph. No additional infiltration from groundwater was assigned to the model.*
Updated Parameter	**Infiltration from rain associated with a wet weather unit hydrograph. This is assumed to be a part of inflow discussed above.** **No additional infiltration will be assigned in the model for groundwater**.

C.2.5 Elevation and Datum Assumptions

Parameter: Vertical Datum

Discussion:	There have been multiple vertical datums used in the City of Twin Falls vicinity. A different vertical datum can cause differences in elevations at the same point by many feet. The City has been migrating toward the National American Vertical Datum of 1988 (NGVD 88), but has historically used the National Geodetic Vertical Datum of 1929 (prior to 1960), the Power Pole Datum (1960's – 1980's), and a local Fire Hydrant Datum (1980 to current). The 2009 Sewer Master plan was created on the Fire Hydrant Datum, but many engineers have started to use the NAVD 88 over the last several years when creating drawings. The NAVD 88 datum is approximately 3.648 feet higher than the Fire Hydrant Datum.
2009 TF Model:	*Twin Falls Fire Hydrant Datum*
Updated Parameter:	**NAVD 88 Vertical Datum**

Parameter: Coordinate System

Discussion:	A coordinate system defines where a point in space is located. The same X, Y coordinates in different coordinate systems can be in different locations. The North American Datum of 1983 (NAD 83) is the base for many coordinate systems. The NAD 83 State Plane system consists of several coordinate systems for each state. The City uses the NAD 1983 Idaho Central State Plane US Feet coordinate system in their GIS system, and a local coordinate system for the CAD and grid maps.

The existing GIS pipe and manhole locations have been updated with recent record drawings, alignment to aerial photos, field verifications, and discussion with operations staff. Previous model manhole ID values have been correlated to the recent GIS data with visual and tabular corrections to best align the data. There are still some questions as to validity of location for all manholes and pipes. To get the most accurate location possible in the city GIS and model, the City's manholes should be entered with survey data.

2009 TF Model: *NAD 1983 Idaho Central State Plane US Feet coordinate system georeferenced from the original CAD/grid maps.*

Updated Parameter: **NAD 1983 Idaho Central State Plane US Feet coordinate system.**

Parameter: Elevation Data for Master Planned Area

Discussion: The City of Twin Falls has collected elevation points from flights of the area in 2008 and 2012 at the NAVD 88 vertical datum. This data does not cover the entire future wastewater service area, but the data is generally accepted as fairly accurate where it is available. The City also has not purchased all of the data available from the flights.

10-meter USGS contours are available for the entire study area. The USGS contours are available with the NAVD 88 vertical datum.

2009 TF Model: *Not addressed*

Updated Parameter: **Use topographic values from the 2008 or 2012 aerial flyover, or, where these are not available, use USGS elevation values shifted to the NAVD 88 datum. Supplemental survey to be used for any critical locations.**

C.3 Model Assumptions Summary

Table C-3. Model Assumptions Summary

Parameter	2009 Plan	2015 Plan	Brief Discussion
Manning's "n"	Varies: 0.01 - 0.014	0.012	ASCE: low range of substandard installations of pipe sizes 6 to 60 inches
Wet Weather Capacity Criteria	< 2 ft from MH rim	< 1 foot over crown	Sewer backups more likely to occur at depths over crown > 1 ft.; Depth from rim criteria ignores service line elevations. Criteria applies to majority of pipes
Dry Weather Pipe Sizing	0.8 d/D	Graduated, from 0.5 to 0.75 d/D	Graduated scale provides more realistic design which accounts for highest variability of flow in smallest pipes
Dry Weather Capacity Criteria	0.8 d/D	1.0 d/D	Risk-based policy restricts surcharge during dry weather flows
Surcharge Depth in Shallow Manholes	0.5 feet from Rim	No exception for shallow manholes	
Pipe Slopes	Varies: Velocity-based criteria	Varies: Slope-based criteria, no slopes smaller than 0.10%	Velocity-based standards cannot account for constructability constraints. Modified Ten State Standards.
Sewer Connection Points	Not addressed	Match crowns of all connecting pipes	New criteria consistent with city design standards.
Maximum velocity of gravity pipes	10 fps	No change	Drop lines allowed with higher velocity if designed with adequate dissipation
Maximum velocity of forcemains	6 fps	No change	
Allowable downstream diameter (future pipes)	Not addressed	New downstream pipe diameter to be equal or greater than upstream pipe diameter for pipes > 24 in.	Discussion for replacement of existing pipes.
Pipe Depths	Not addressed	Typical = 7 ft., minimum = 5 ft., maximum = 15 ft.	Excessive depth or minimal depth preferred before lift station considered.
Manhole Drop	Not addressed	0.1 feet every 300 feet of pipe	
Meander Factor	Not addressed	20% additional length from current alignment	Master plan alignments are conceptual, actual alignments anticipated to vary up to 20%
Manhole Losses	Not addressed	0.4 exit, 0.2 entrance	Based on FHA research on intial estimates for manhole losses.

Parameter	2009 Plan	2015 Plan	Brief Discussion
Constant Speed Pump Cycle Volume	Small Lift Stations not modeled, Rock Creek LS = Constant Flow	Small Lift Stations = Current set points, Rock Creek LS = Constant Flow	Lift stations modeled according to pump configuration
Future Pump Station Capacity	Firm Capacity = dry weather peak hour + 20%	Firm Capacity = Wet weather peak flow + 10%	Conservative design criteria prevents overloading lift station and accounts for inflow/infiltration
Future Flows - Residential Unit Flows	264 gpdu or 100 gpcd	170 gpdu or 64 gpcd	Selected high range (conservative) of observed Twin Falls residential flows
Future Flows - Commercial Unit Flows	1,150 gpad	No change	
Future Flows - General Industrial Unit Flows	1,440 gpad	200 gpad	Selected high range (conservative) of observed Twin Falls general industrial flows
Future Flows -Permitted Industrial Unit Flows	No Point Loads, used higher industrial unit flow	Assigned according to permitted and future anticipated industries	
Diurnal Curves	Aligned to sewer basins	Aligned to land use types and adjusted during calibration	Calibrating to land use types ensures future growth areas can be loaded according to land use
Inflow - Design Storm	Selected according to local storm profile	No change	
Inflow - Infiltration	Infiltration assigned design storm	No change	
Vertical Datum	Twin Falls Fire Hydrant Datum	NAVD 88	Updated to a more globally compatible datum
Horizontal Datum	NAD 1983 Idaho Central State Plane US Feet	No change	
Elevation Data	Not addressed	2008/2012 contours, fire hydrant datum, USGS contours	Used best elevation source available, all aligned to NAVD 88

Appendix D

Model Calibration

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Figures

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Appendix - D Model Calibration

D.1 Introduction

Calibration of a hydraulic model is necessary to provide confidence in the results of the model. This model was calibrated to eleven locations in the system where flow monitoring was performed between March 3 and March 19, 2014 (**Appendix B, Figure B-1**). SCADA data were also obtained from the City for the WWTP influent data, from the City of Kimberly for influent data,, and from Rock Creek Lift Station.. Influent data were used to calibrate dry weather flows at the WWTP. The Rock Creek Lift Station flows were taken both during the March flow monitoring period and during April/May. The March data were corrupted and unavailable, so the April data at this site may not necessarily correspond as well as to the other flow monitoring data. This appendix provides graphs comparing the monitored flow data with the model output for dry weather situations. Hourly influent data were also obtained to validate the wet weather peak at the WWTP. During flow monitoring, no significant wet weather storms occurred, so previous calibration values from the 2009 Plan were used and validated with a large wet-weather event from February 7-8, 2014.

D.2 Dry Weather Calibration

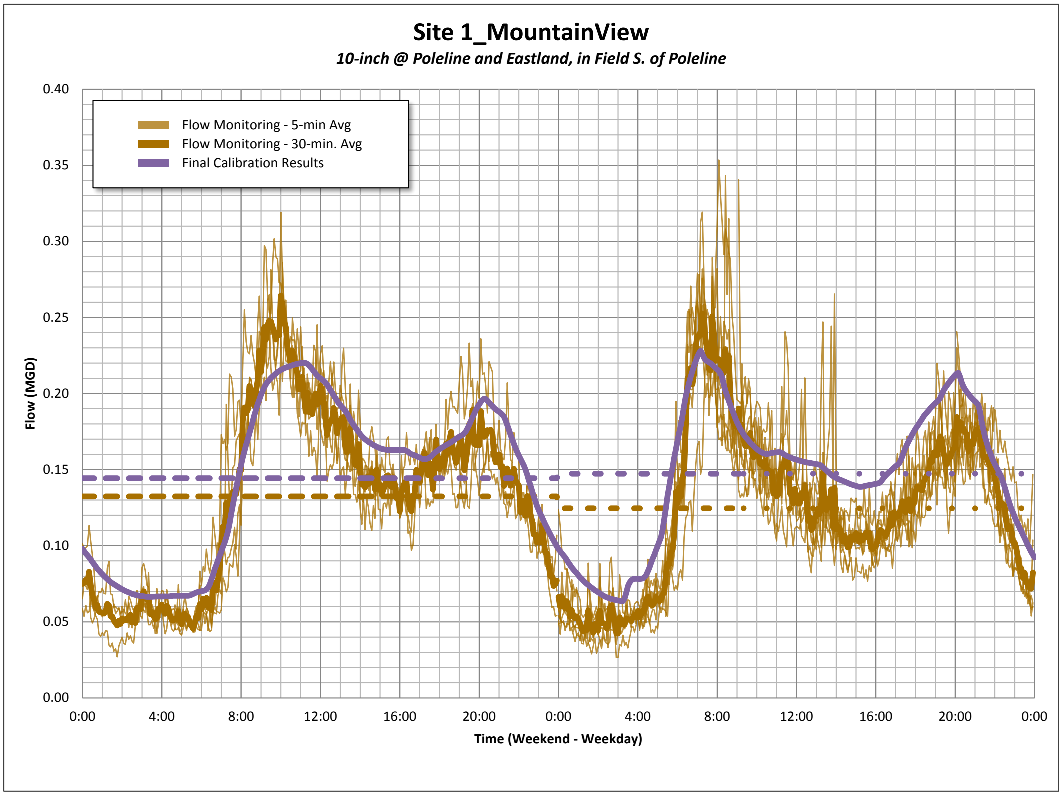

Figure D-1. Site 1: Mountain View Basin Raw Data at MH E2-126

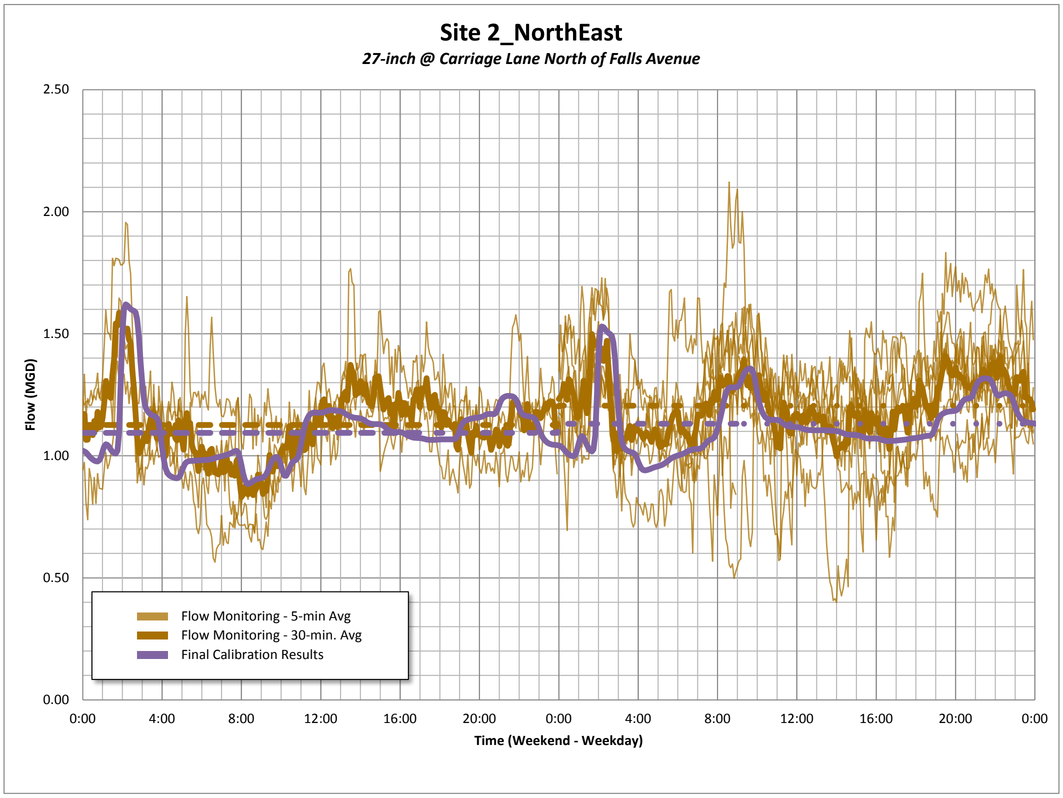

Figure D-2. Site 2: Northeast Basin Raw Data at MH E3-134

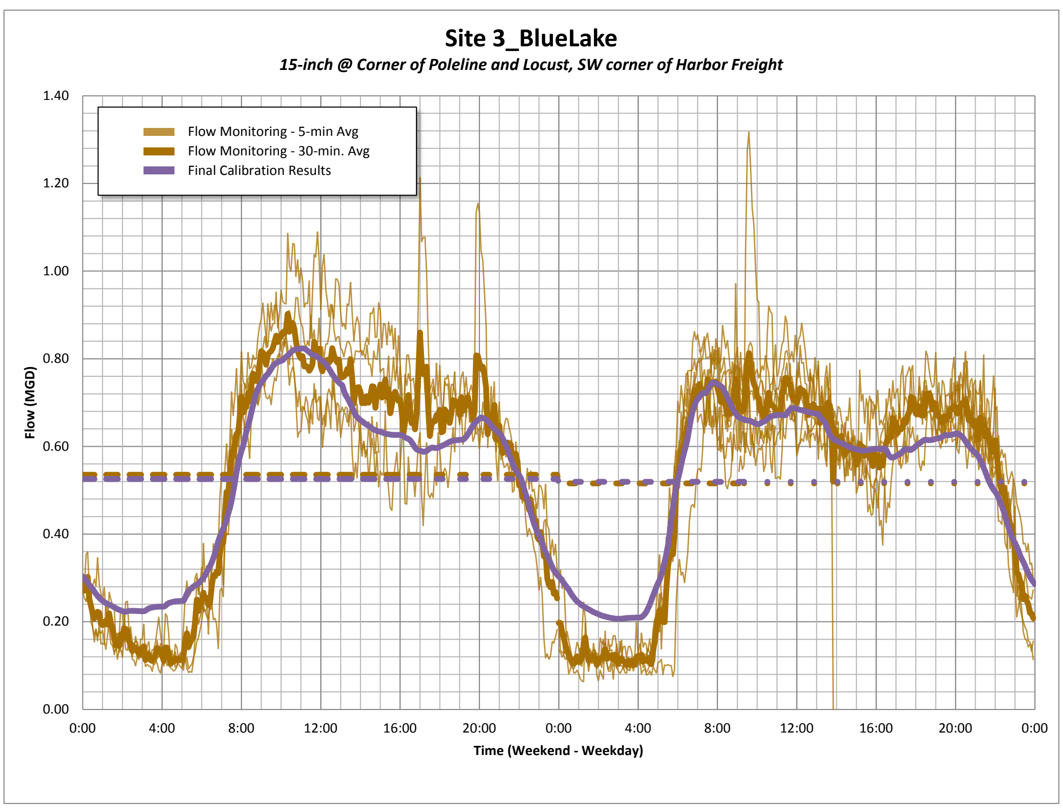

Figure D-3. Site 3: Blue Lake Basin Raw Data at MH D2-11

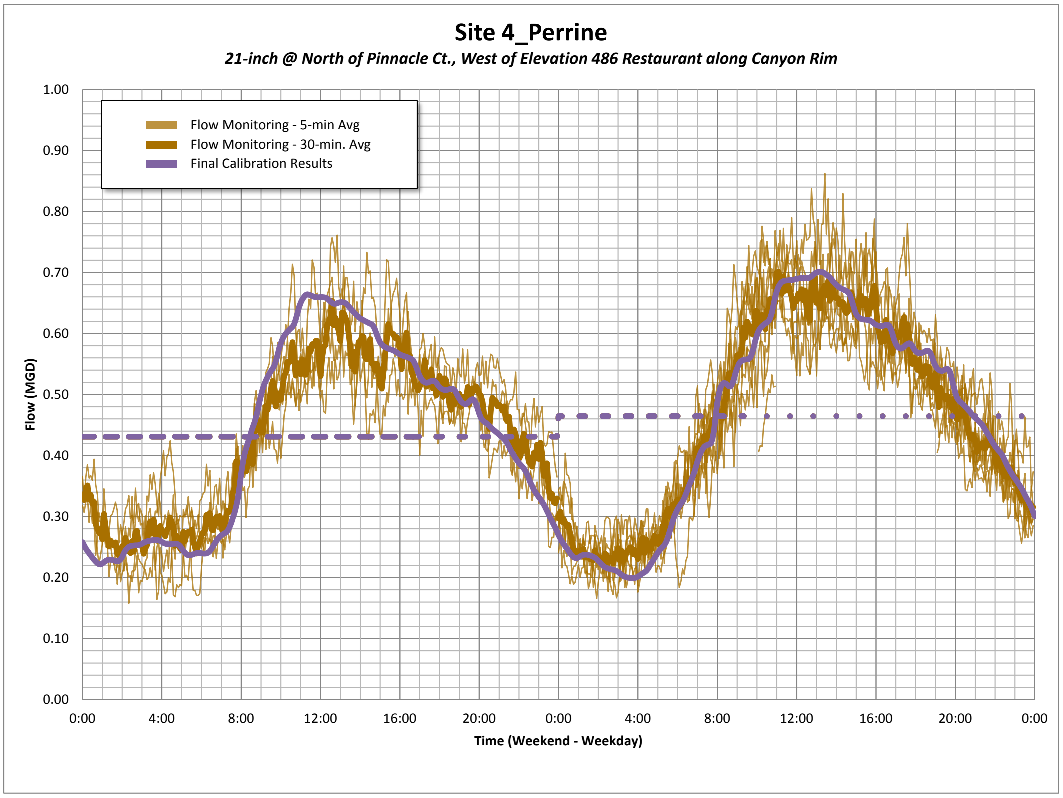

Figure D-4. Site 4: Perrine Coulee Basin Raw Data at MH C1-15

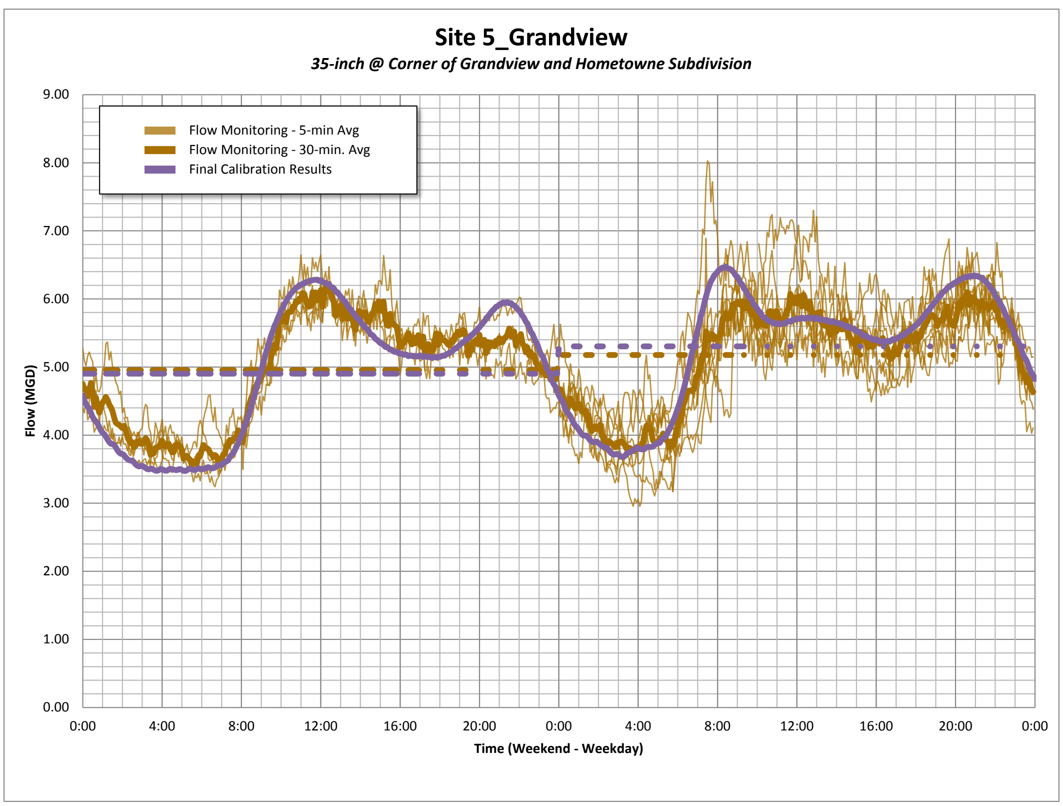

Figure D-5. Site 5: Grandview Basin Raw Data at MH B1-10

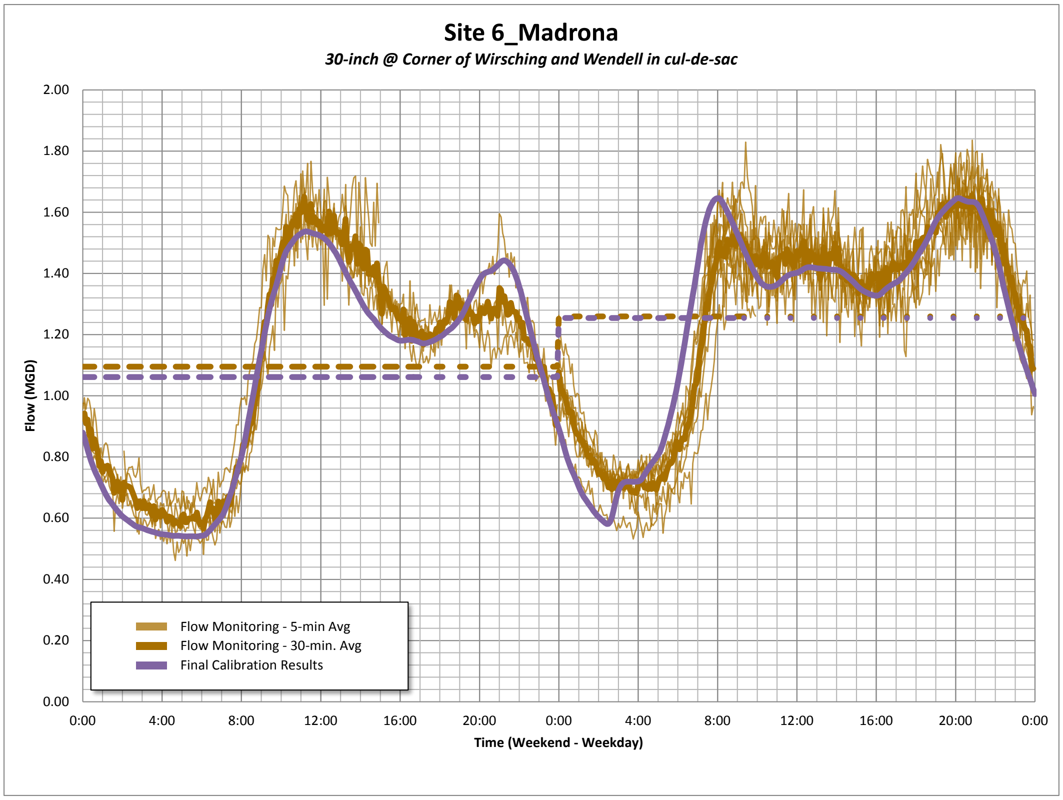

Figure D-6. Site 6: Madrona Basin Raw Data at MH B3-289

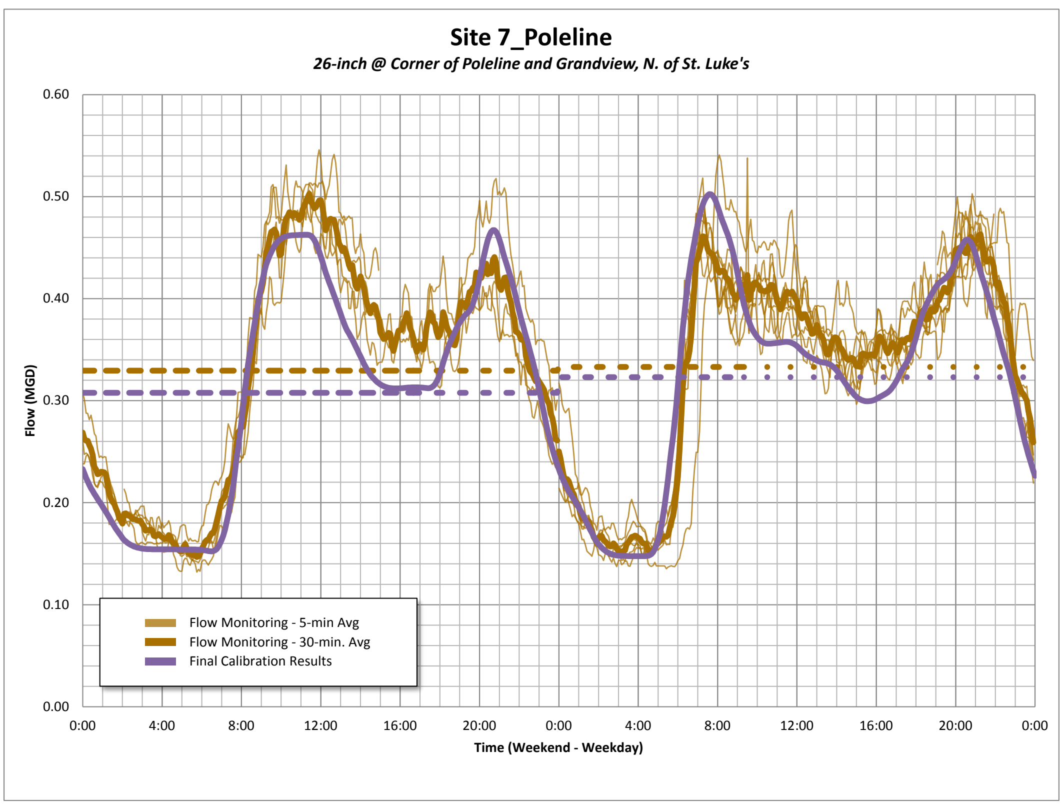

Figure D-7. Site 7: Pole Line Basin Raw Data at MH B2-11

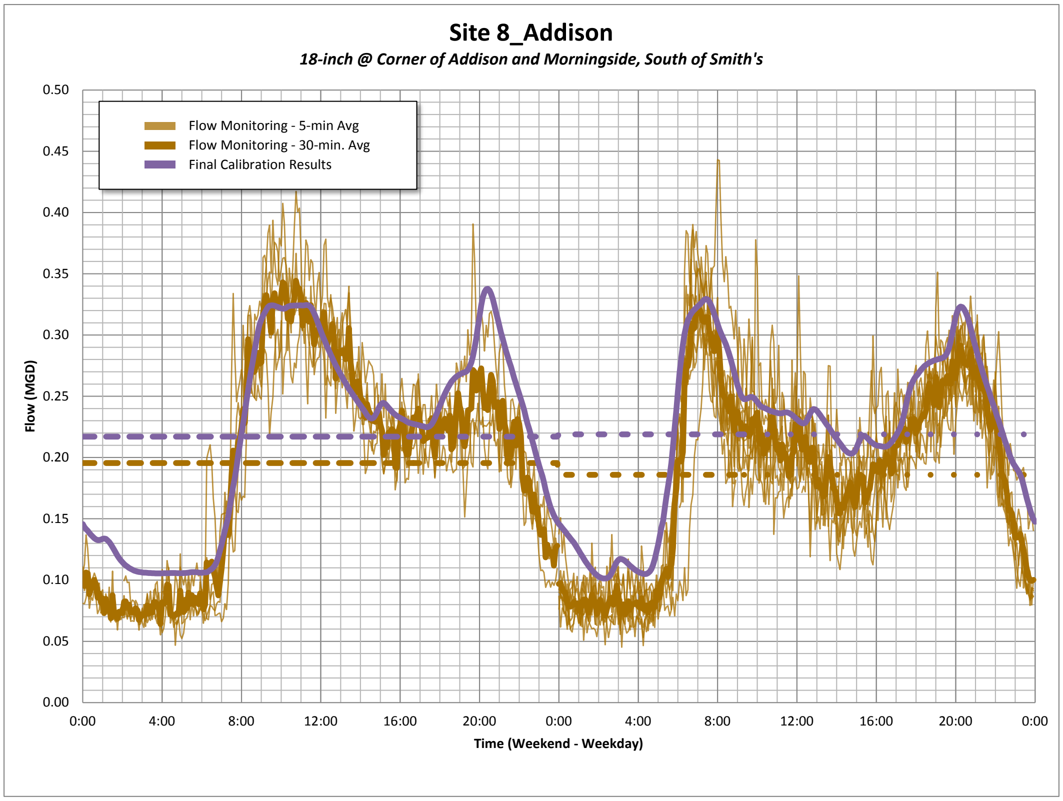

Figure D-8. Site 8: Addison Basin Raw Data at MH D4-78

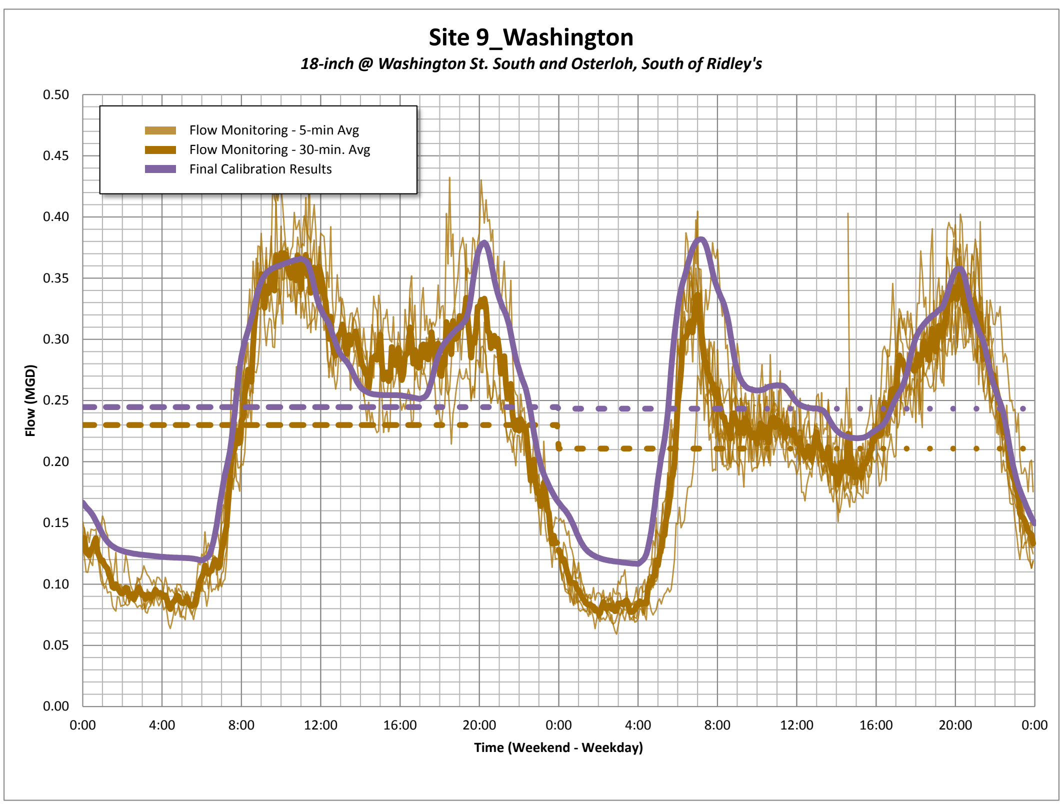

Figure D-9. Site 9: Washington Basin Raw Data at MH C6-95

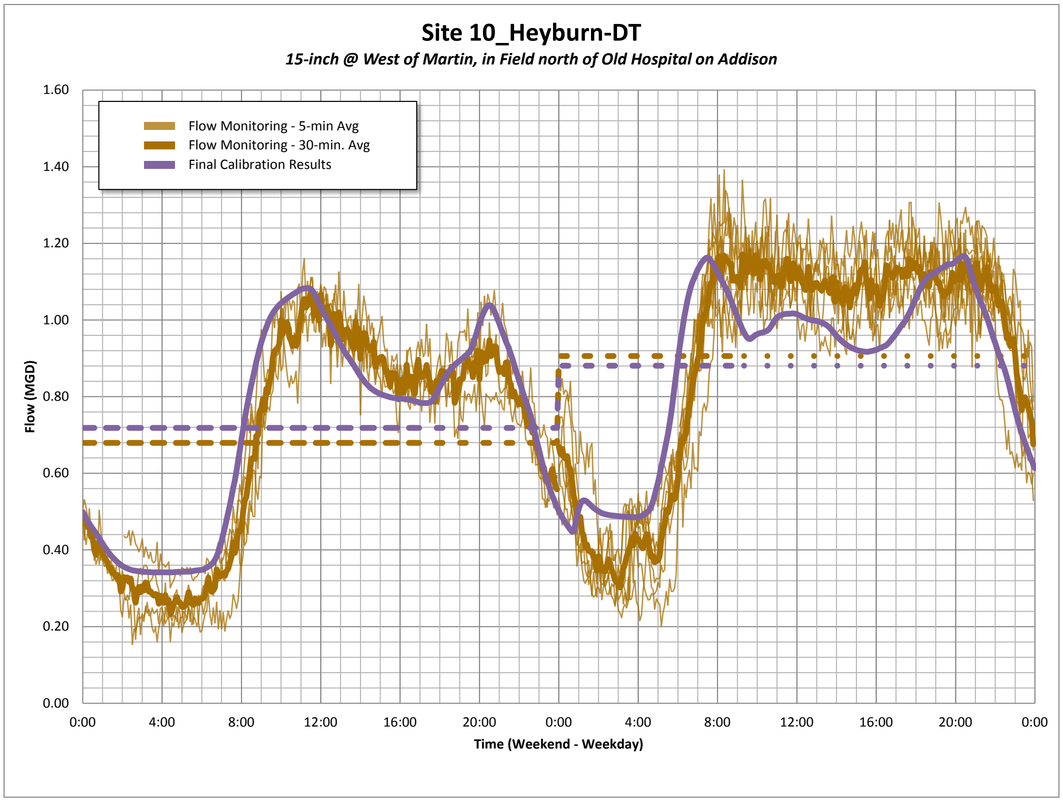

Figure D-10. Site 10: Heyburn-Downtown Basin Raw Data at MH B4-20

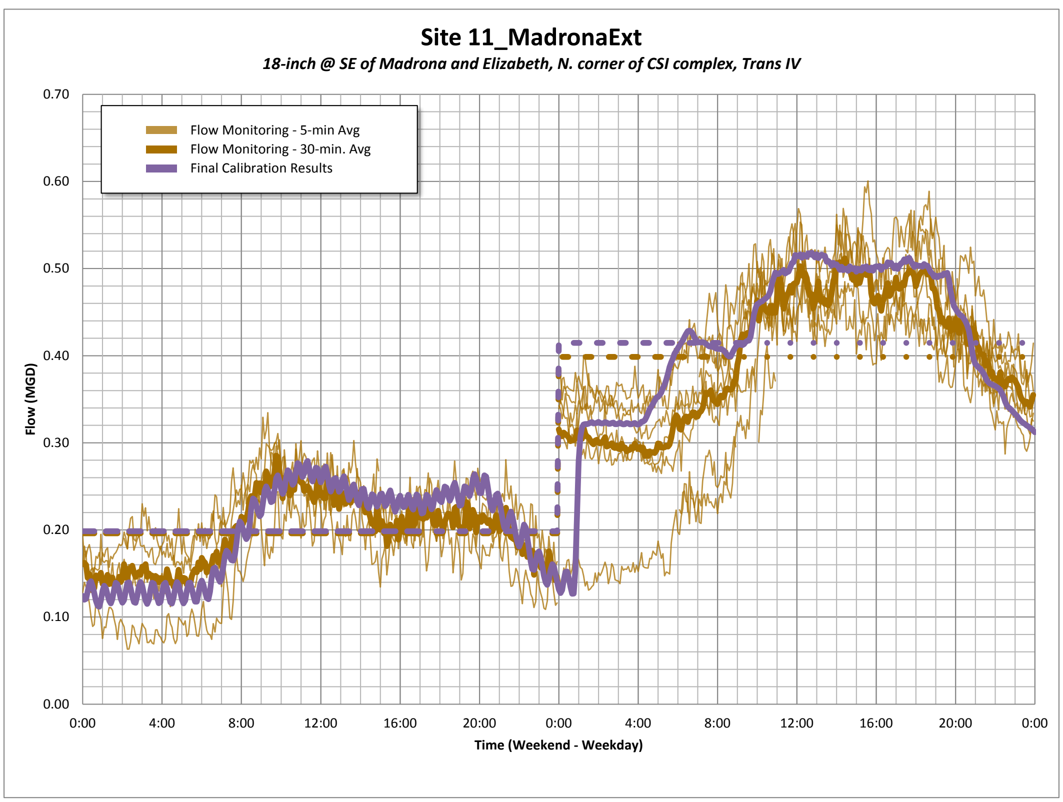

Figure D-11. Site 11: Madrona Extension Basin Raw Data at MH D4-186

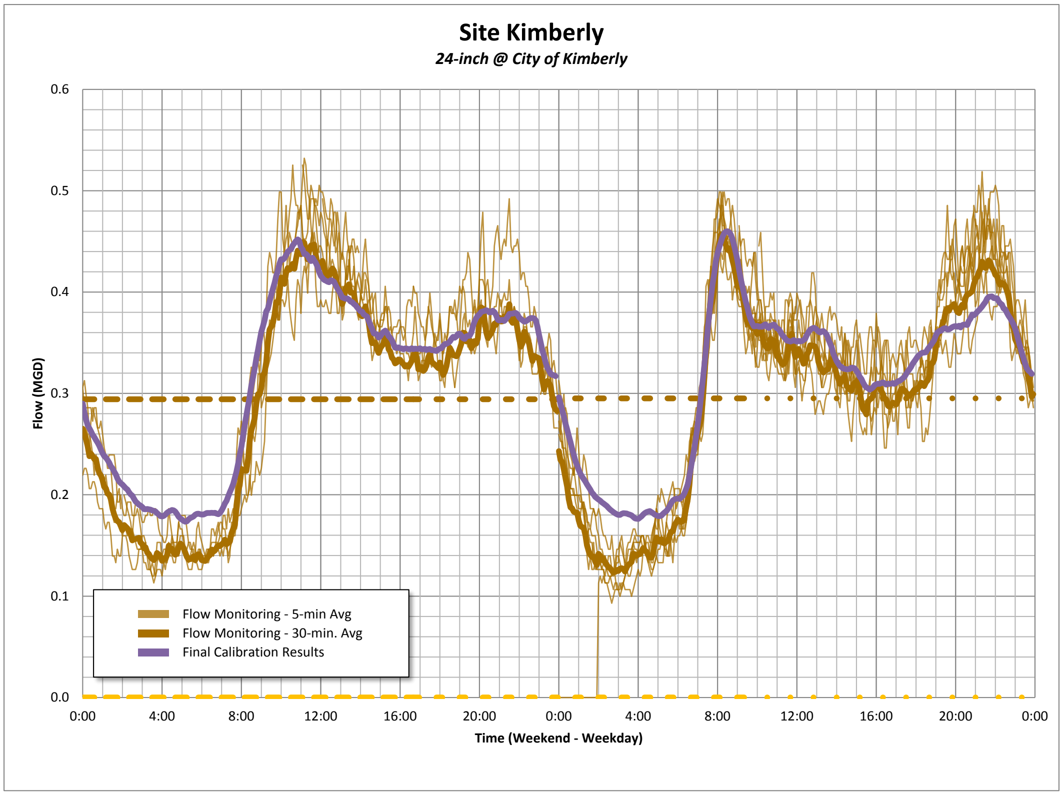

Figure D-12. Site 12: Kimberly Basin Raw Data from City of Kimberly Flow Meter SCADA

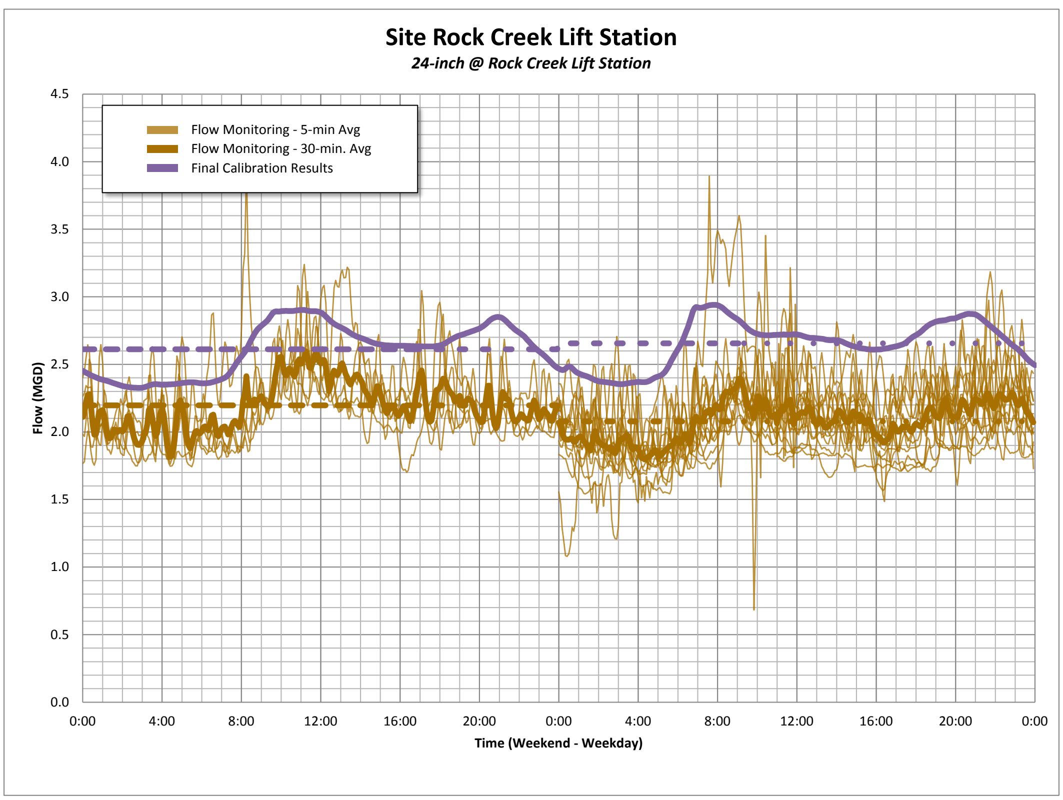

Figure D-13. Site 13: Rock Creek Basin Raw Data from Rock Creek Lift Station SCADA

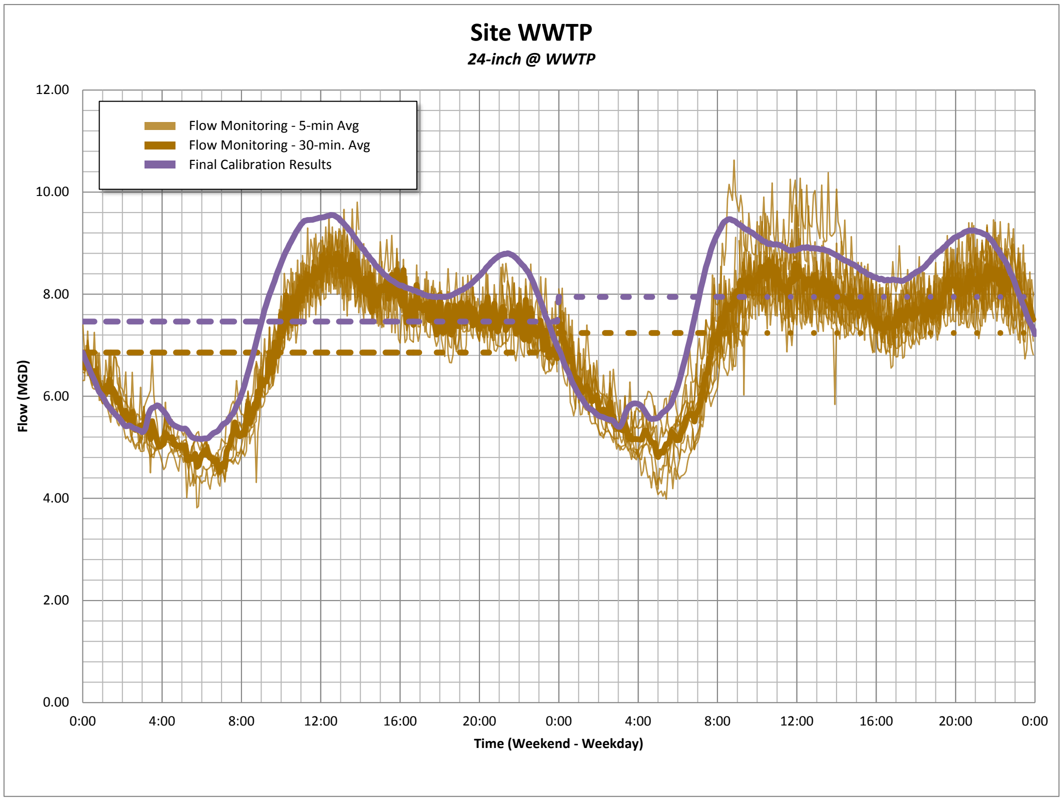

Figure D-14. Site 14: WWTP Influent Raw Data from SCADA

D.3 Wet Weather Calibration

No signifant increase in flows were detected at flow monitoring stations during the few storms that occurred within the March 2014 study period. In some instances, daily variations in flows during dry weather periods were larger than those seen during wet weather flow monitoring. Essentially, the rain fall was not large enough to overcome the variations in the dry weather flow signal. Conversely, the city was fortunate to get a large wet-weather event on February 8, 2014 with influent and effluent flow values shown below at the WWTP. Unfortunately, flow monitoring did not occur during this event. Instead, recently calibrated dry weather flows were combined with the wet weather parameters from the 2009 Plan and the storm volume from the February 8 storm to produce flow modeled at a peak of 14.0 MGD at the WWTP. This aligned well to the observed WWTP peak flows of 14-14.5 MGD (**Figure D-15**).

Similar results were seen when modeling the August 2014 storm. Peak model flows were 24.8 MGD with observed flows approximately 25 MGD.

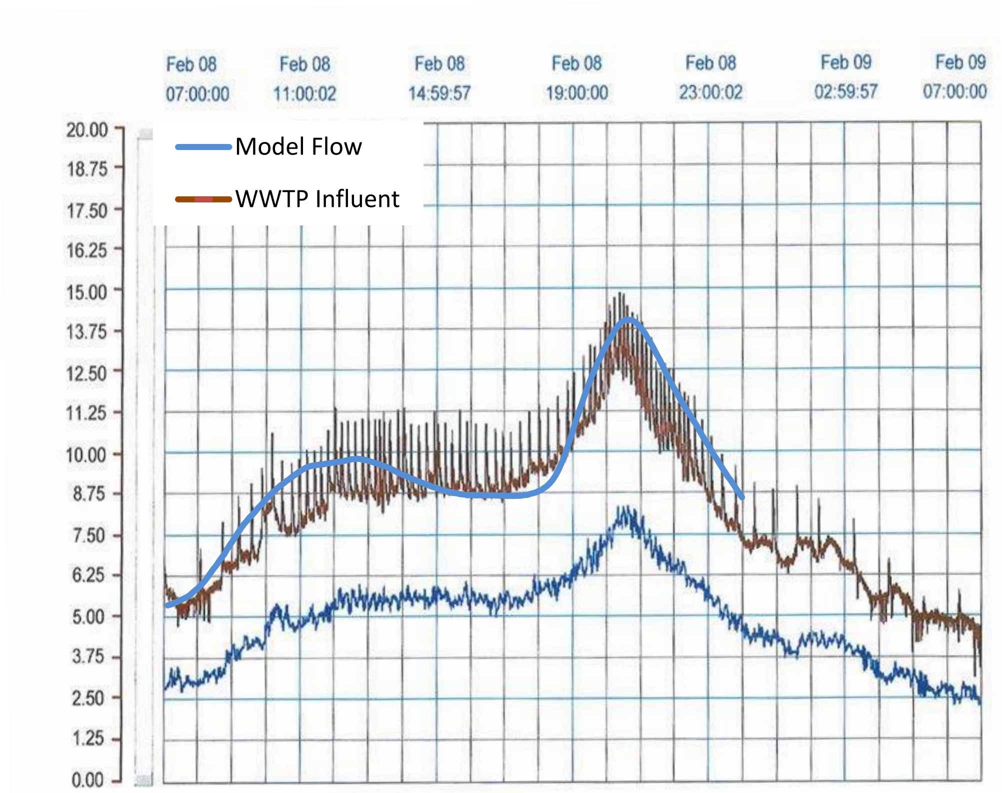

Figure D-15. WWTP influent flows (brown line) during February 8, 2014 storm event.

Appendix E

System Issues

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Contents

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Appendix E System Issues

This appendix provides more details for each of the hydraulic capacity issues identified throughout the 2015 Wastewater Collection System Master Plan. The focus of this Appendix is to highlight the locations and extent of impact when surcharging occurs over one foot above the crown. Each issue is discussed with key background information listing the main causes for capacity restrictions. The end of each main section contains hydraulic grade line (HGL) plots showing the maximum water surface profile during a morning peak storm.

This Appendix is divided into 3 main sections:

E.1 - Existing Model
E.2 - Committed Model
E.3 - Master Plan Model

Each section contains an entry for each issue identified by the downstream manhole of the reach.

E.1 - Existing Model - System Issues

The Existing Model did not have any capacity issues in violation of the criteria.

E.2 - Committed Model - System Issues

E.2.1 - B1-33

<u>Background</u>
Basin Location and Connectivity: Located in the northern end of the Grandview basin, receives flow from Canyon Ridge High School, Walmart, etc.
Pipe Geometry: This section has existing diameters of 8 inches from B2-89 to B1-33 and 10 inches downstream of B1-33.
Unique Section Characteristics: Relatively new pipe that should be in good condition.
Data Quality: Inverts were set based on record drawings (Canyon Trails Subdivision)

<u>Issues</u>
Minimum Slope: No pipes are below minimum slopes
Surcharging: B2-90 to B1-35 all experience surcharging > 1 foot above the crown during a midday peak storm.
Reserve Capacity: The following pipes are over capacity and contribute to the surcharges: B2-89 to B1-33.

E.2.2 - B1-41

<u>Background</u>
Basin Location and Connectivity: Located in the northern end of the Grandview basin, receives flow from Canyon Ridge High School, Walmart, etc.
Pipe Geometry: This section has a diameter of 10 inches from B1-39 to B1-41 in the problem area and continues downstream with a 10 inch diameter to the Grandview Trunkline.
Unique Section Characteristics: Relatively new pipe that should be in good condition.
Data Quality: Inverts were set based on record drawings (Settler's Ridge Subdivision)

<u>Issues</u>
Minimum Slope: No pipes are below minimum slopes
Surcharging: Pipes from B1-39 to B1-41 all experience surcharging > 1 foot above the crown during a midday peak storm.
Reserve Capacity: The following pipes are over capacity and contribute to the surcharges: B1-39 to B1-43.

E.2.3 - B1-14

<u>Background</u>

Basin Location and Connectivity: Located downstream of the Rock Creek Lift Station, this section receives flow from the majority of the service area south of Rock Creek including many large industries (Ameripride, Glanbia, Con Agra). It also receives 1 MGD of future industrial loading.
Pipe Geometry: This section has a diameter of 30 inches from B4-2 to B3-14 with 36 inch pipe downstream of B3-14.
Unique Section Characteristics: The lower slopes of this section cause it to be a locally-limited section although additional flow downstream from the Madrona basin cause many downstream pipes to be capacity limited shortly beyond the committed model flows.
Data Quality: Most inverts along this section were based on the 2009 model.

Issues
Minimum Slope: No pipes are below minimum slopes (smallest is 0.16 %)
Surcharging: Pipes from B4-2 to B3-16 all experience surcharging at > 1 foot above the crown during a midday peak storm.
Reserve Capacity: The following pipes are over capacity and contribute to the surcharges: B4-1 to B3-14.

E.2.4 - C4-163

Background
Basin Location and Connectivity: Located within the Townsite Basin, this section receives flow from Ameripride, Glanbia Downtown and a future industrial loading of 0.5 MGD
Pipe Geometry: This section has a diameter of 10 inches from C4-237 to C4-163
Unique Section Characteristics:
Data Quality: Most inverts along this section were based on a J-U-B survey for the URA sewer model.

Issues
Minimum Slope: No pipes are below minimum slopes
Surcharging: No pipes surcharge over the rim during a midday peak storm; although, many have water depths that are greater than 1 foot over the pipe crown.
Reserve Capacity: The following pipes are over capacity and contribute to the surcharges: C4-196 to C4-163

E.2.5 - E2-5

Background
Basin Location and Connectivity: Located near the center of the Mountain View Basin.
Pipe Geometry: This section has a diameter of 8 inches from E2-9 to E2-5.
Unique Section Characteristics: E2-2 has a 10 inch overflow to Blue Lakes Basin
Data Quality: Inverts were set based on 2009 sewer model, record drawings, and field verification

Issues
Minimum Slope: Pipe E2-9 to E2-5 is below minimum slope: 0.28%

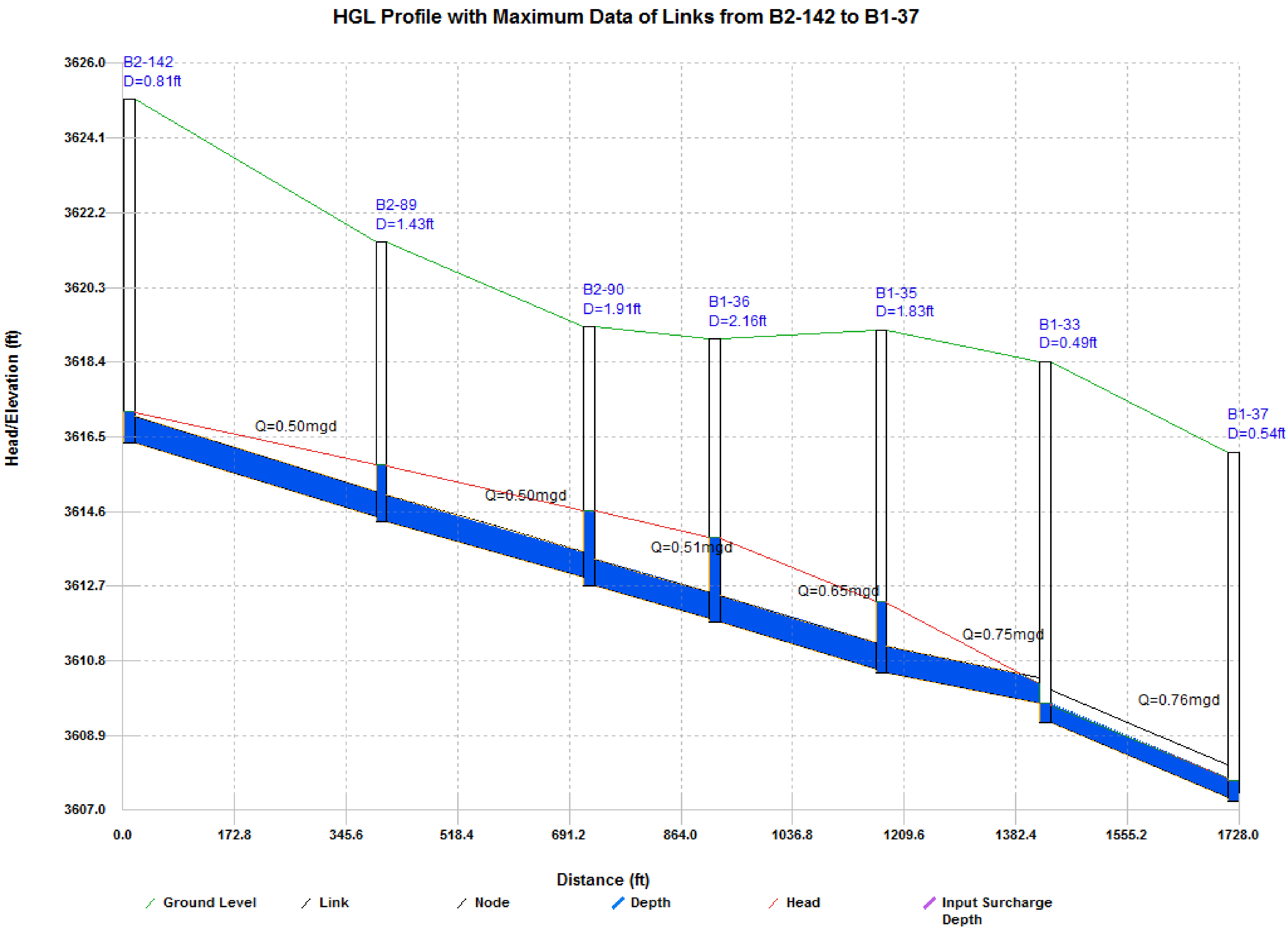
Surcharging: No pipes surcharge over the rim during a morning peak storm. Surcharges at 1 foot over the crown occur from E2-9 to E2-5.
Reserve Capacity: The following pipes are over capacity and contribute to the surcharges: E2-5 to E2-97

E.2.6 - E5-19

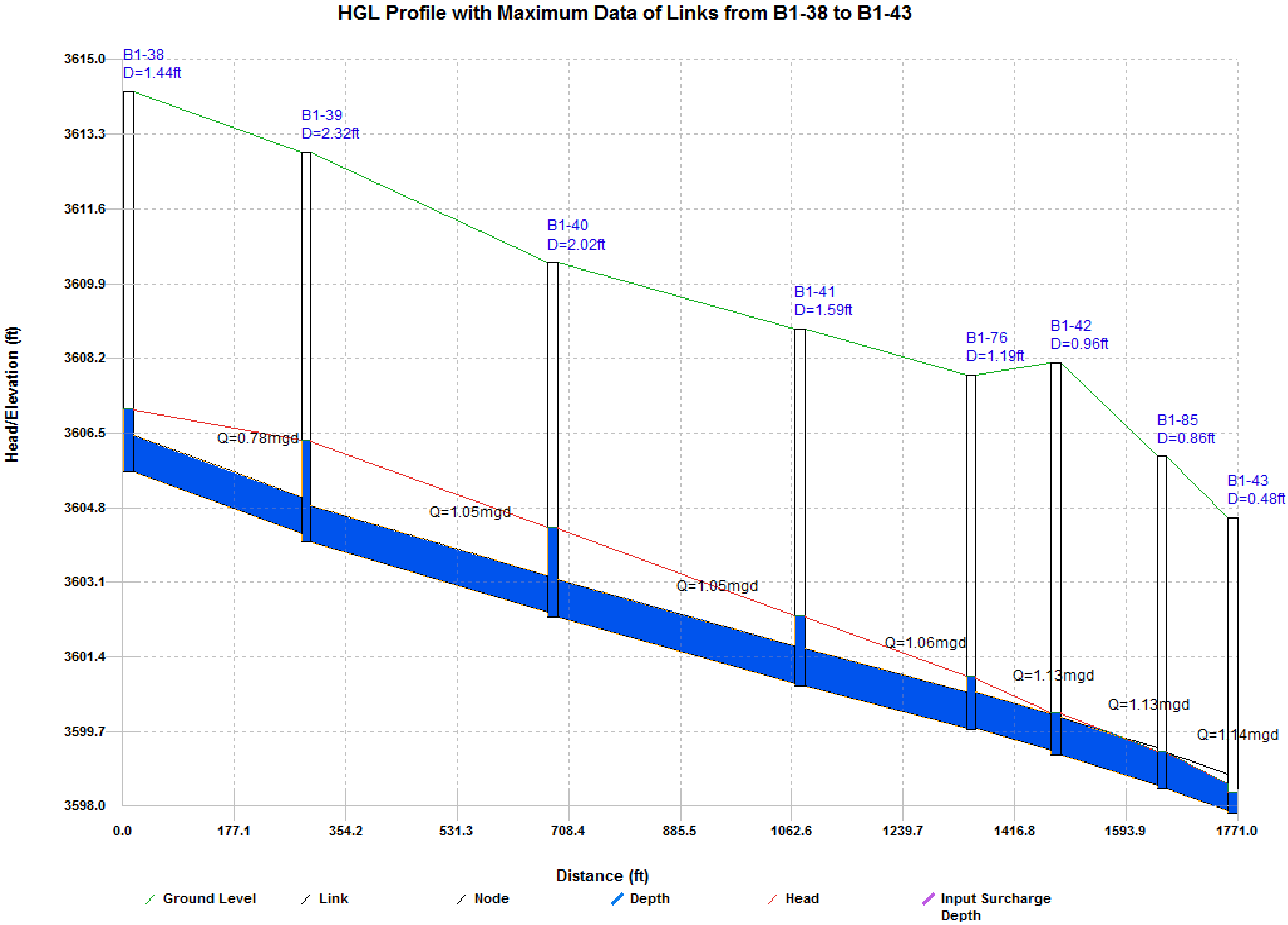
Background
Basin Location and Connectivity: Located within the Madrona Extension Basin, north of Kimberly Road and east of Eastland Avenue, receives flow from Independent Meat and Cummins Family Produce.
Pipe Geometry: This section has a diameter of 10 inches from E5-30 to E5-29, 8 inches from E5-29 to E5-19, and 15 inches from E5-19 to E5-18
Unique Section Characteristics: Modeled as a drop manhole at E5-19
Data Quality: Inverts were set based on 2009 sewer model

Issues
Minimum Slope: No pipes are below minimum slopes
Surcharging: E5-29 has a depth above crown of > 1 foot, during midday peak storm.
Reserve Capacity: The following pipes are over capacity and contribute to the surcharges: E5-29 to E5-19 (8 inches)

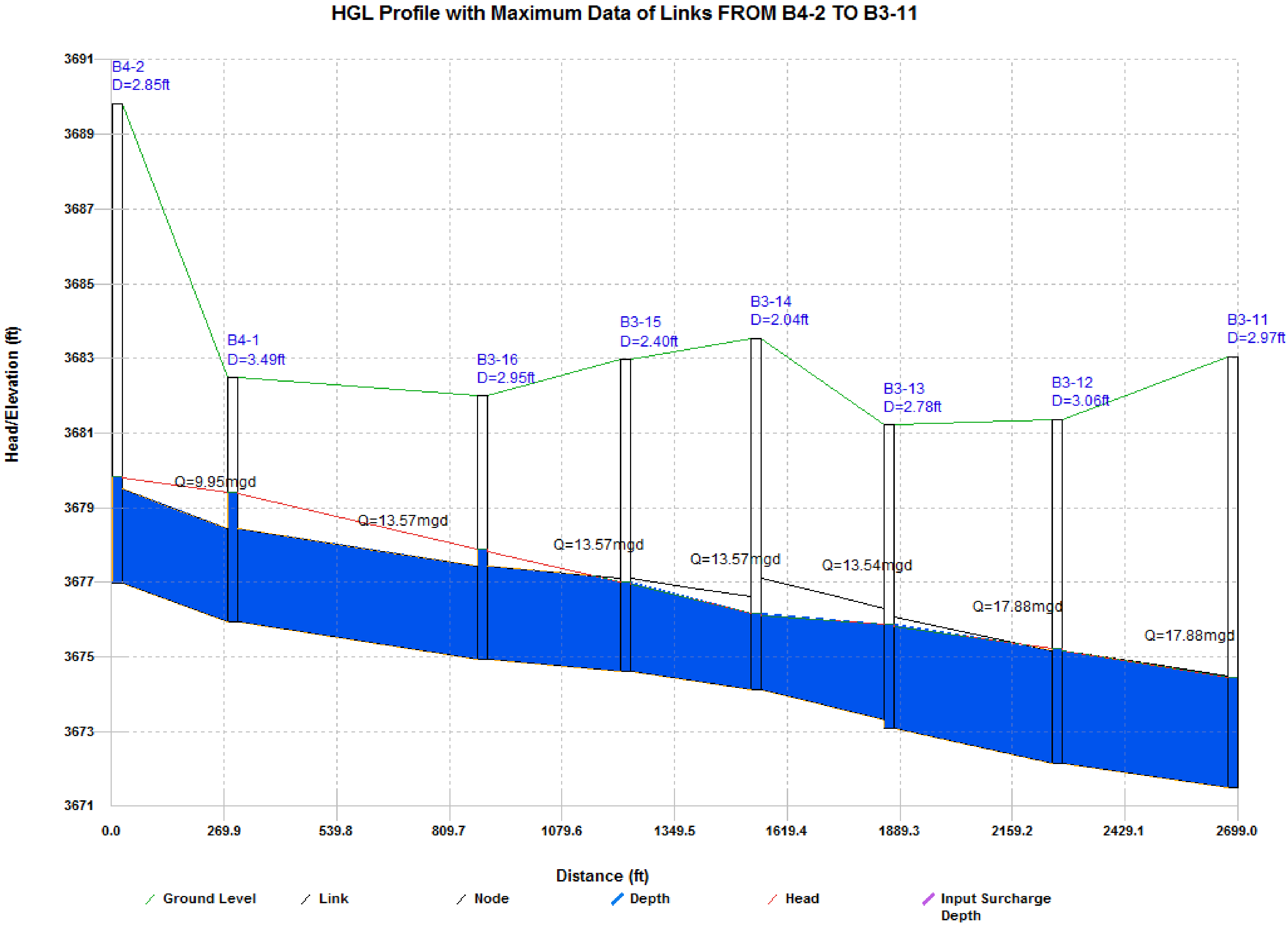
COMMITTED SYSTEM ISSUES – MANHOLE B1-33



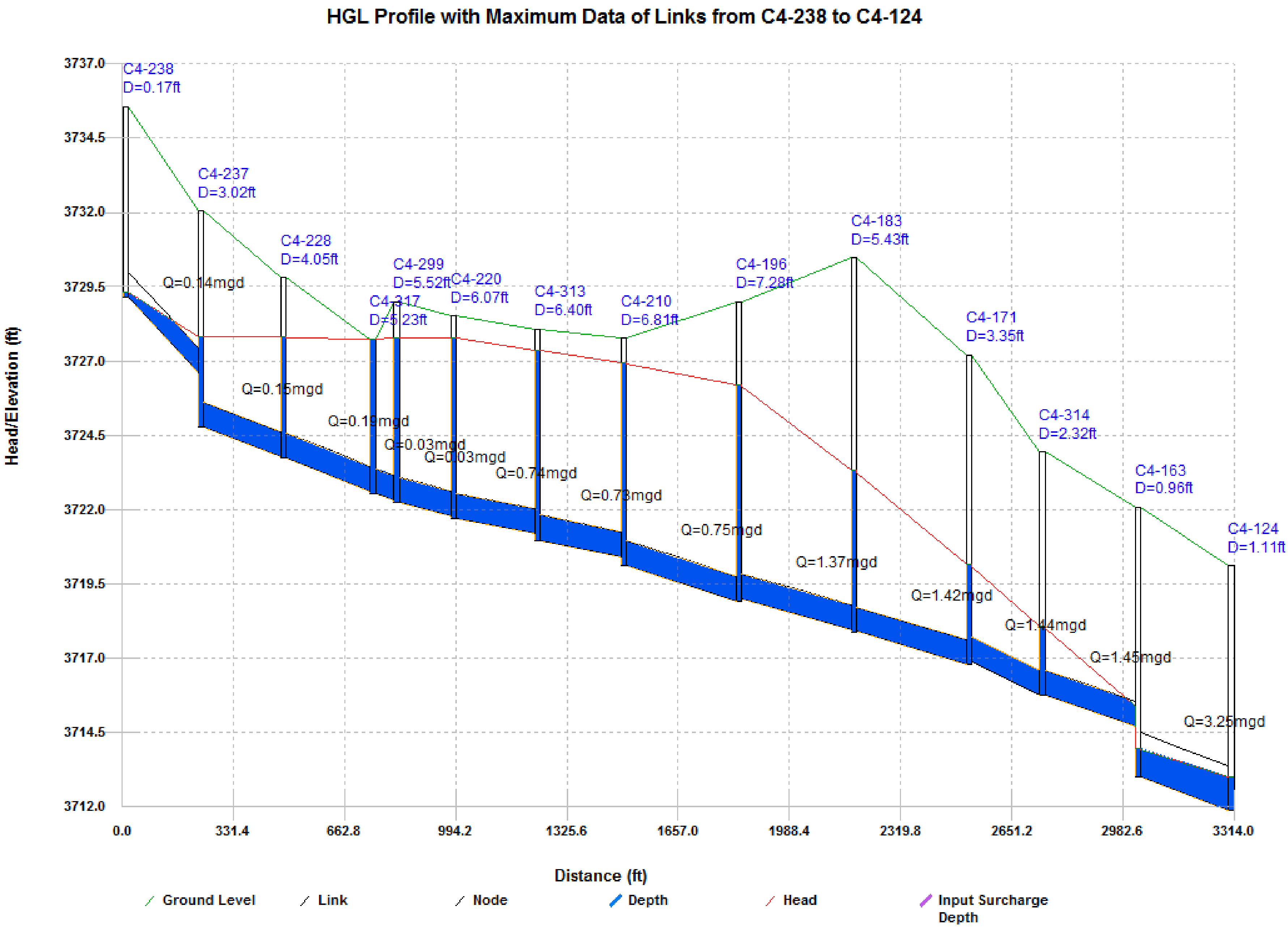
COMMITTED SYSTEM ISSUES – MANHOLE B1-41



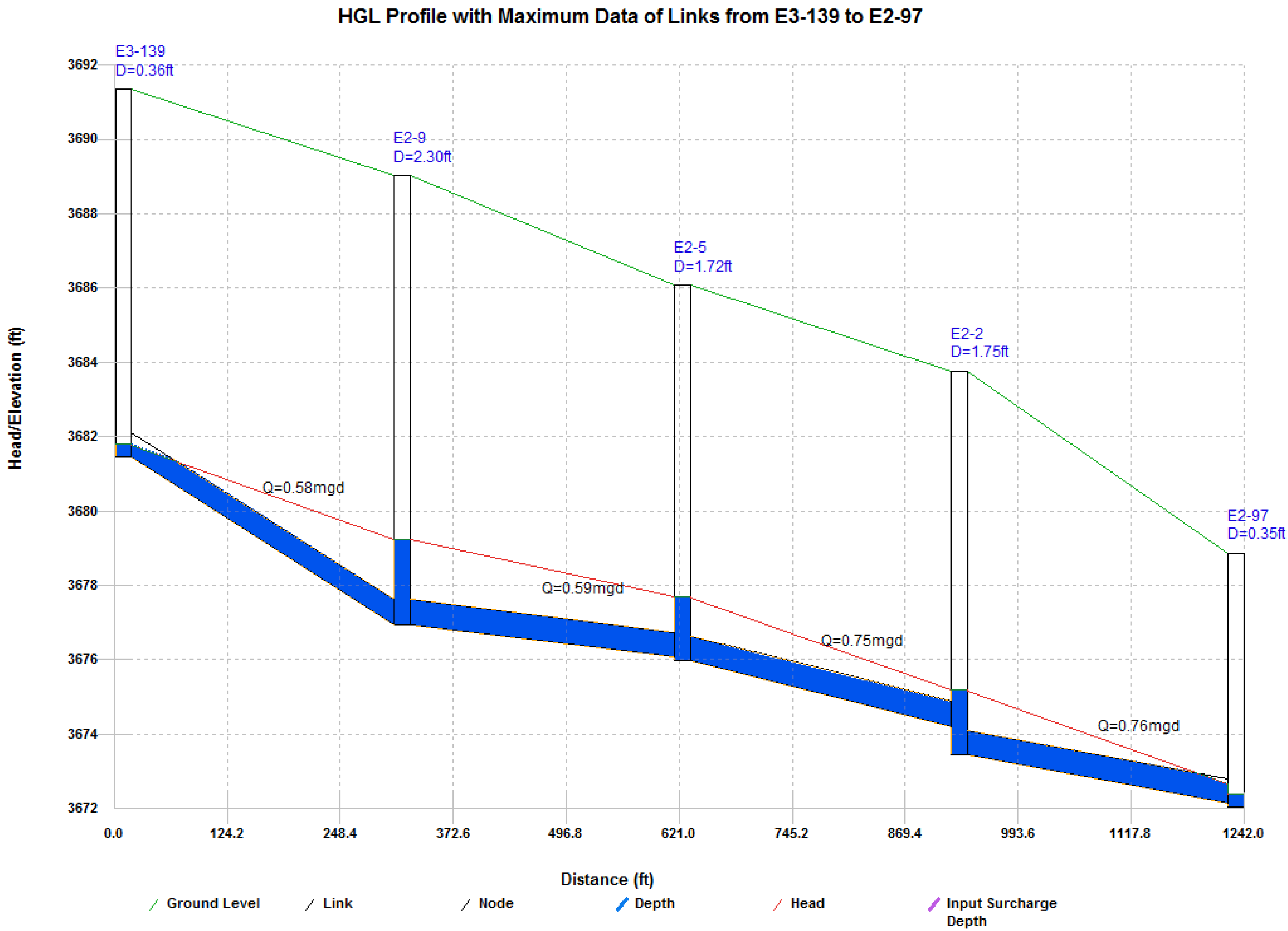
COMMITTED SYSTEM ISSUES – MANHOLE B1-14



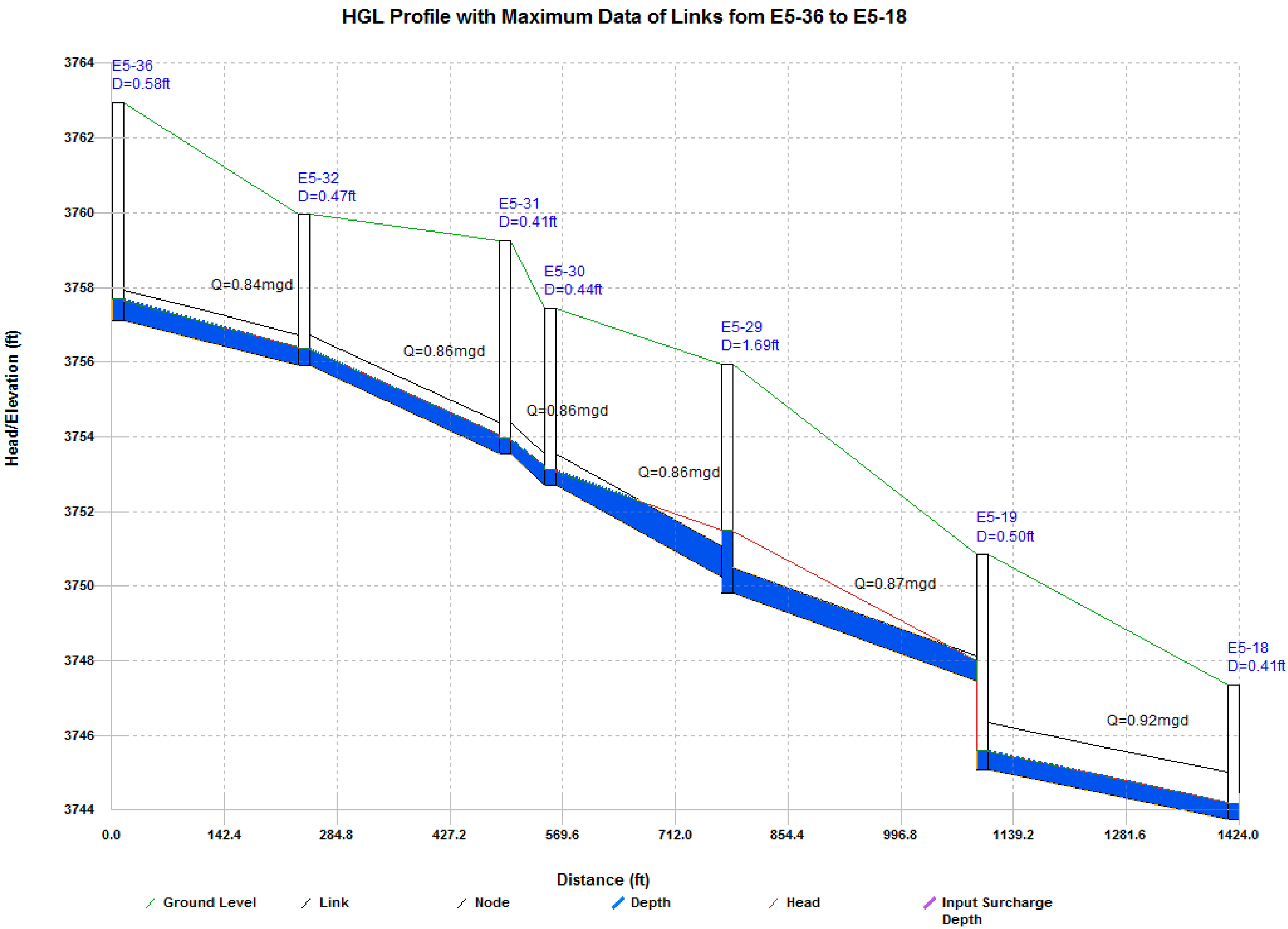
COMMITTED SYSTEM ISSUES – MANHOLE C4-163



COMMITTED SYSTEM ISSUES – MANHOLE E2-5



COMMITTED SYSTEM ISSUES – MANHOLE E5-19



E.3 -Master Plan Model - System Issues

HGL plots for existing pipes are not shown for the Master Plan Model as the existing system capacity restrictions cause extensive overflow in the system. Thus, HGL plots would be inaccurate based on the existing system due to overflows caused by Master Plan loading. However, existing capacity was compared with master plan flows conveyed through master planned pipe sizes in the 2014 Plan. This comparison helped guide selection of locations for system improvements.

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Appendix F

Existing Model Results

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Appendix F - Existing Model Results

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B1-10	B1-9	659.1	36	3594	3585.9	3584	0.31%	3587.6	0.57	-	5.34	15.15	26.17
B1-108	B1-48	40	10	3596.3	3587.5	3587	0.75%	3588.2	0.84	-	3.91	1.13	1.33
B1-12	B1-17	448.1	36	3609	3602.9	3596	1.55%	3604	0.37	-	10.37	15.15	58.23
B1-13	B1-12	510.1	36	3615.6	3604.6	3603	0.34%	3606.3	0.57	-	5.99	15.15	27.28
B1-14	B1-13	489.7	36	3614.9	3606.3	3605	0.35%	3608	0.57	-	5.7	15.15	27.44
B1-15	B1-16	25.6	36	3620	3608.9	3609	0.51%	3610.8	0.63	-	5.55	15.12	33.26
B1-16	B1-194	226.1	36	3617.6	3608.8	3608	0.50%	3610.4	0.53	-	6.18	15.12	33.01
B1-163	B1-7	286.6	42	3597.7	3581.9	3581	0.15%	3584	0.6	-	3.86	15.19	27.32
B1-17	B1-10	645.7	36	3603.4	3595.9	3586	1.55%	3597	0.37	-	7.47	15.15	58.22
B1-179	B1-8	330.2	42	3591.6	3583.2	3582	0.21%	3585.1	0.54	-	4.16	15.18	31.97
B1-19	B1-5	227.5	42	3594.9	3580.5	3580	0.11%	3582.7	0.63	-	3.77	15.31	23.81
B1-194	B1-14	264.9	36	3615.6	3607.6	3606	0.50%	3609.2	0.53	-	5.95	15.15	32.98
B1-2	JUB153	41.3	42	3182.6	3174.5	3174	6.03%	3177.2	0.77	-	15.08	22.63	173.04
B1-28	B1-29	42.6	42	3595.1	3578.4	3577	4.16%	3579.5	0.31	-	12.36	15.94	143.72
B1-29	B1-30	430.4	24	3593.7	3576.7	3182	229.19%	3577	0.15	-	21.54	15.94	239.8
B1-30	B1-32	162.4	24	3191.2	3182	3179	1.93%	3183.4	0.7	-	10.06	15.94	22.03
B1-32	B1-2	142.4	24	3184.7	3178.8	3176	1.97%	3180.3	0.75	-	10.82	15.94	22.21
B1-33	B1-37	296.4	10	3618.4	3609.2	3607	0.64%	3609.7	0.6	-	3.5	0.66	1.23
B1-35	B1-33	253.6	8	3619.2	3610.5	3610	0.31%	3611.8	1.95	0.63	3.14	0.65	0.47
B1-36	B1-35	259.8	8	3619	3611.8	3611	0.46%	3613	1.8	0.53	2.55	0.57	0.57
B1-37	B1-38	298.9	10	3616.1	3607.2	3606	0.50%	3607.7	0.6	-	3.25	0.66	1.09
B1-38	B1-39	286.4	10	3614.3	3605.6	3604	0.50%	3606.1	0.6	-	3.17	0.66	1.08
B1-39	B1-40	405.5	10	3612.9	3604	3602	0.39%	3604.7	0.84	-	3.17	0.93	0.96
B1-4	B1-28	49.1	42	3593.5	3579.6	3578	2.30%	3580.7	0.31	-	9.47	15.94	106.77
B1-40	B1-41	406.3	10	3610.4	3602.3	3601	0.37%	3603	0.84	-	3.03	0.94	0.94
B1-41	B1-76	275.4	10	3608.9	3600.8	3600	0.36%	3601.6	0.96	-	2.74	0.93	0.92
B1-42	B1-85	163.9	10	3608.1	3599.2	3598	0.42%	3600	0.96	-	3.29	1.02	0.99
B1-43	B1-86	142	10	3604.6	3597.8	3596	1.57%	3598.3	0.6	-	5.15	1.03	1.92
B1-46	B1-108	137.1	10	3596.2	3588.1	3588	0.46%	3588.9	0.96	-	3.29	1.09	1.04
B1-47	B1-4	248.5	42	3593.9	3579.9	3580	0.12%	3581.9	0.57	-	5.06	15.94	24.88
B1-48	B1-47	253.9	10	3595.9	3587.1	3584	1.34%	3587.6	0.6	-	5.24	1.13	1.78
B1-5	B1-47	261.8	42	3594.3	3580.2	3580	0.14%	3582.4	0.63	-	4.02	15.31	26.12
B1-6	B1-19	273.9	42	3595.6	3580.9	3581	0.13%	3583.1	0.63	-	3.65	15.29	25.54
B1-68	B1-46	27.9	10	3597.8	3588.3	3588	0.43%	3589.2	1.08	0.07	3.11	1.09	1.01
B1-7	B1-6	439.5	42	3596.3	3581.5	3581	0.14%	3583.6	0.6	-	3.76	15.29	26.67
B1-76	B1-42	129.2	10	3607.8	3599.8	3599	0.37%	3600.6	0.96	-	3.13	1.02	0.93
B1-8	B1-163	368.4	42	3590	3582.5	3582	0.15%	3584.6	0.6	-	3.92	15.18	27.44
B1-85	B1-43	104.6	10	3606	3598.4	3598	0.47%	3599.1	0.84	-	3.5	1.03	1.05
B1-86	B1-87	399.6	10	3601.7	3595.6	3590	1.48%	3596.1	0.6	-	5.21	1.03	1.86
B1-87	B1-68	182.3	10	3597.8	3589.6	3588	0.69%	3590.2	0.72	-	3.42	1.04	1.27

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B1-9	B1-179	315.8	42	3592.1	3583.8	3583	0.21%	3585.7	0.54	-	4.41	15.15	31.96
B2-1	B1-15	469.3	36	3623	3614.8	3613	0.29%	3616.5	0.57	-	5.79	15.12	25.32
B2-10	B2-9	501.3	36	3662.1	3654.1	3650	0.84%	3655.4	0.43	-	8.11	14.01	42.7
B2-103	B2-19	108.6	21	3638.7	3631.8	3631	0.64%	3632.2	0.23	-	3.18	0.98	8.91
B2-11	B2-59	499.7	27	3629.9	3624.9	3625	0.08%	3625.6	0.31	-	1.7	1	6.29
B2-12	B2-11	497.3	27	3633.5	3625.4	3625	0.09%	3626	0.27	-	1.78	1	6.45
B2-13	B2-12	305.2	27	3631.3	3625.5	3625	0.04%	3626.2	0.31	-	1.6	1	4.33
B2-14	B2-13	382.9	27	3635.6	3625.7	3626	0.04%	3626.4	0.31	-	1.41	1	4.43
B2-142	B2-89	400.9	8	3625.1	3616.3	3614	0.47%	3616.8	0.75	-	2.89	0.42	0.58
B2-143	B2-142	281.9	8	3626	3619.2	3617	0.72%	3619.6	0.6	-	3.25	0.41	0.72
B2-144	B2-143	143.1	8	3625.6	3620.2	3620	0.51%	3620.7	0.75	-	2.91	0.41	0.61
B2-15	B2-14	399	10	3633.6	3628.2	3627	0.28%	3628.3	0.12	-	0.94	0.01	0.81
B2-16	B2-15	397.6	10	3635	3629.4	3628	0.28%	3629.4	0	-	0.81	0.01	0.81
B2-17	B2-16	401.7	10	3635.5	3630.5	3629	0.28%	3630.6	0.12	-	0.78	0.01	0.81
B2-18	B2-17	311.3	10	3635.4	3631.4	3631	0.28%	3631.4	0	-	0.49	0	0.81
B2-19	B2-20	324.3	21	3640.9	3631.1	3630	0.31%	3631.6	0.29	-	2.73	0.98	6.13
B2-2	B2-1	508.3	36	3623.8	3616	3615	0.24%	3617.9	0.63	-	5.12	15.12	22.79
B2-20	B2-274	94.3	21	3640.1	3630.2	3630	0.29%	3630.7	0.29	-	2.83	0.99	5.94
B2-209	B2-213	214.4	8	3634.9	3626.1	3625	0.63%	3626.4	0.45	-	3.03	0.39	0.67
B2-21	B2-103	298.2	18	3639.4	3633.7	3632	0.63%	3634.1	0.27	-	3.75	0.97	5.84
B2-213	B2-214	394.9	8	3632.5	3624.6	3622	0.65%	3625	0.6	-	3.1	0.39	0.68
B2-214	B2-144	254.8	8	3628.9	3621.9	3620	0.62%	3622.3	0.6	-	3.08	0.41	0.67
B2-22	B2-78	127.3	21	3642.9	3635.3	3635	0.42%	3635.7	0.23	-	2.68	0.88	7.16
B2-228	B2-209	212.3	8	3635.4	3627.5	3626	0.63%	3627.9	0.6	-	3.02	0.38	0.67
B2-23	B2-22	392.2	18	3643.2	3636.9	3635	0.41%	3637.3	0.27	-	3.13	0.87	4.73
B2-24	B2-23	411.4	18	3645.1	3638.5	3637	0.39%	3638.9	0.27	-	3.05	0.87	4.59
B2-269	B2-14	183.9	18	3636.5	3626.5	3626	0.02%	3627.3	0.53	-	2.18	0.99	1.08
B2-270	B2-269	36.2	21	3637.2	3627.1	3626	1.60%	3627.4	0.17	-	2.34	0.99	14.04
B2-271	B2-270	112.4	21	3637.8	3628	3627	0.81%	3628.4	0.23	-	4.37	0.99	9.98
B2-272	B2-271	79.9	21	3638.5	3628.2	3628	0.25%	3628.7	0.29	-	3.1	0.99	5.55
B2-273	B2-272	274.8	21	3641.5	3629.6	3628	0.51%	3630	0.23	-	2.99	0.99	7.92
B2-274	B2-273	60.7	21	3640.7	3629.9	3630	0.49%	3630.3	0.23	-	3.28	0.99	7.8
B2-3	B2-2	497.9	36	3627.8	3619.8	3616	0.78%	3621.1	0.43	-	6.17	15.12	41.23
B2-31	B2-24	63.7	18	3645.7	3638.8	3638	0.47%	3639.2	0.27	-	2.98	0.87	5.05
B2-4	B2-3	533.8	36	3631.7	3623.8	3620	0.73%	3625.1	0.43	-	7.88	15.12	39.92
B2-45	B2-70	314.2	18	3647.8	3640.7	3640	0.24%	3641.1	0.27	-	2.55	0.78	3.62
B2-47	B2-45	130.2	18	3647.8	3640.9	3641	0.23%	3641.5	0.4	-	2.34	0.78	3.53
B2-48	B2-47	144.3	18	3648.1	3641.3	3641	0.25%	3641.8	0.33	-	2.36	0.77	3.67
B2-5	B2-4	486	36	3634.8	3628.3	3624	0.93%	3629.4	0.37	-	7.69	14.02	45.04
B2-51	B2-48	267.5	18	3648.5	3641.9	3641	0.24%	3642.4	0.33	-	2.35	0.73	3.6
B2-52	B2-51	303.9	18	3649.7	3642.6	3642	0.19%	3643.1	0.33	-	2.33	0.73	3.21
B2-53	B2-52	387.9	18	3648.9	3643.3	3643	0.21%	3643.8	0.33	-	2.22	0.72	3.34
B2-59	B2-4	36.5	27	3631.6	3624.5	3625	0.05%	3625.2	0.31	-	2.76	1.45	5.08
B2-6	B2-61	207.9	36	3638.6	3632.5	3630	1.12%	3633.7	0.4	-	7.67	14.02	49.33

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B2-60	B2-62	257.6	10	3644	3636.5	3636	0.31%	3636.8	0.36	-	2.11	0.21	0.85
B2-61	B2-5	266.2	36	3636.7	3630.2	3628	0.71%	3631.5	0.43	-	7.48	14.02	39.45
B2-62	B2-66	297.5	10	3646.6	3635.6	3635	0.32%	3636	0.48	-	2.26	0.26	0.87
B2-66	C2-199	297.6	10	3643.6	3634.6	3634	0.32%	3634.9	0.36	-	2.27	0.27	0.87
B2-69	B2-59	167	10	3633.2	3627.2	3625	1.57%	3627.4	0.24	-	2.81	0.52	1.92
B2-7	B2-6	512.7	36	3644.9	3638.4	3633	1.05%	3639.6	0.4	-	8.84	14.01	47.93
B2-70	B2-31	287.9	18	3647.7	3639.9	3639	0.39%	3640.3	0.27	-	2.97	0.86	4.59
B2-78	B2-79	334.4	21	3641.9	3634.7	3634	0.22%	3635.2	0.29	-	2.49	0.89	5.25
B2-79	B2-21	69.6	21	3639.9	3634	3634	0.36%	3634.4	0.23	-	3.05	0.97	6.65
B2-8	B2-7	504	36	3651	3644.3	3638	1.16%	3645.4	0.37	-	8.81	14.02	50.36
B2-89	B2-90	328.5	8	3621.4	3614.3	3613	0.44%	3614.8	0.75	-	2.81	0.43	0.56
B2-9	B2-8	489.4	36	3657.2	3649.9	3644	1.16%	3651.1	0.4	-	9	14.02	50.4
B2-90	B1-36	189.2	8	3619.3	3612.7	3612	0.44%	3613.5	1.2	0.13	2.67	0.44	0.56
B3-1	B2-10	530.3	36	3663.7	3656.7	3654	0.48%	3658.2	0.5	-	6.64	14.01	32.51
B3-10	B3-9	13.1	36	3682	3670.7	3671	0.31%	3672.9	0.73	-	3.88	13.8	25.81
B3-11	B3-158	19.3	36	3683	3671.5	3671	0.42%	3673.8	0.77	-	3.72	13.76	30.1
B3-12	B3-11	427.8	36	3681.4	3672.1	3671	0.15%	3674.4	0.77	-	3.74	13.76	18.34
B3-13	B3-12	406.9	36	3681.2	3673.1	3672	0.23%	3675	0.63	-	4.17	13.76	22.33
B3-136	B3-172	74.9	30	3685.3	3674.9	3675	0.15%	3676.1	0.48	-	2.93	4.36	11
B3-14	B3-13	317.9	36	3683.5	3674.1	3673	0.26%	3675.6	0.5	-	4.31	9.86	23.72
B3-15	B3-14	311.9	30	3683	3674.6	3674	0.16%	3676.5	0.76	-	4.43	9.86	11.38
B3-158	B3-164	72.3	36	3683.3	3671.4	3671	0.19%	3673.6	0.73	-	3.9	13.8	20.55
B3-16	B3-15	341.9	30	3682	3674.9	3675	0.09%	3677.1	0.88	-	3.63	9.86	8.65
B3-164	B3-10	312.3	36	3683	3671.3	3671	0.19%	3673.4	0.7	-	3.87	13.8	20.47
B3-17	B3-13	169.6	30	3681.2	3673.3	3673	0.03%	3675.1	0.72	-	2.03	4.48	4.93
B3-170	B3-8	274.1	36	3680.5	3669.8	3669	0.19%	3671.8	0.67	-	4.29	13.83	20.53
B3-171	B3-170	261.6	36	3681.3	3670.3	3670	0.19%	3672.4	0.7	-	4.21	13.81	20.62
B3-172	B3-175	389.5	30	3684.8	3674.8	3674	0.15%	3675.9	0.44	-	2.67	4.37	11.27
B3-175	B3-19	205	30	3682.4	3674.2	3674	0.17%	3675.6	0.56	-	2.16	4.41	11.87
B3-18	B3-289	60.8	30	3681.2	3673.4	3673	0.02%	3675.2	0.72	-	1.87	4.46	3.68
B3-181	B3-7	380.1	36	3679	3668.6	3668	0.21%	3670.6	0.67	-	4.17	14	21.29
B3-19	B3-18	584.7	30	3681	3673.8	3673	0.06%	3675.5	0.68	-	1.92	4.44	7.13
B3-2	B3-1	471.8	36	3666.1	3659.3	3657	0.56%	3660.7	0.47	-	6.59	14.01	34.8
B3-23	B3-136	19.7	30	3685.3	3674.9	3675	0.41%	3676.2	0.52	-	2.8	4.36	18.31
B3-24	B3-23	551.3	30	3683.8	3675.3	3675	0.06%	3676.7	0.56	-	2.52	4.31	6.92
B3-25	B3-24	256.7	30	3683.8	3675.6	3675	0.14%	3676.9	0.52	-	2.48	4.3	10.76
B3-26	B3-25	429.1	30	3683.7	3676	3676	0.10%	3677.3	0.52	-	2.65	4.3	8.99
B3-27	B3-26	124.5	30	3683.7	3676.2	3676	0.11%	3677.5	0.52	-	2.6	4.3	9.63
B3-28	B3-90	15.3	12	3659.8	3649.6	3649	1.38%	3649.9	0.3	-	3.4	0.51	2.93
B3-285	B3-28	282.5	12	3662.5	3651.8	3650	0.80%	3652.2	0.4	-	3.49	0.51	2.23
B3-289	B3-17	218.3	30	3681.7	3673.4	3673	0.02%	3675.2	0.72	-	1.94	4.47	4.39
B3-3	B3-2	498.2	36	3671.2	3662.8	3659	0.69%	3664	0.4	-	7.07	14.01	38.69
B3-36	B4-24	380.4	15	3693.1	3687.4	3685	0.55%	3687.7	0.24	-	2.56	0.52	3.37
B3-37	B3-36	508.4	15	3695.1	3687.8	3687	0.08%	3688.4	0.48	-	1.79	0.51	1.31

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B3-38	B3-37	492.3	15	3696.3	3688.9	3688	0.22%	3689.3	0.32	-	1.6	0.51	2.14
B3-4	B3-3	553.8	36	3675.4	3666.5	3663	0.68%	3667.8	0.43	-	7.39	14.01	38.58
B3-40	B3-38	437.7	15	3696.8	3690.1	3689	0.27%	3690.5	0.32	-	2.28	0.5	2.37
B3-5	B3-4	308.7	36	3676.7	3667.2	3667	0.20%	3669	0.6	-	5.29	14	21.1
B3-6	B3-5	129.1	36	3677.4	3667.5	3667	0.29%	3669.5	0.67	-	4.57	14.01	25
B3-66	B3-67	166	12	3656.9	3647.1	3646	0.67%	3647.5	0.4	-	2.62	0.66	2.04
B3-67	B3-68	173.3	15	3655.5	3646	3646	0.11%	3646.6	0.48	-	2.12	0.66	1.5
B3-68	B3-73	140.7	15	3655.1	3645.8	3645	0.41%	3646.2	0.32	-	2.76	0.71	2.88
B3-7	B3-6	223	36	3678.1	3667.8	3668	0.14%	3670	0.73	-	4.23	14	17.69
B3-73	B3-74	140.9	15	3654.7	3645.2	3645	0.33%	3645.7	0.4	-	2.67	0.71	2.61
B3-74	B3-75	261.5	15	3654.1	3644.8	3644	0.31%	3645.2	0.32	-	2.58	0.71	2.52
B3-75	B2-53	297.9	18	3652.9	3643.9	3643	0.20%	3644.4	0.33	-	2.27	0.72	3.3
B3-8	B3-181	300.2	36	3679.6	3669.3	3669	0.21%	3671.3	0.67	-	4.38	14.01	21.56
B3-9	B3-171	156.4	36	3681.8	3670.6	3670	0.19%	3672.7	0.7	-	4.1	13.8	20.46
B3-90	B3-66	316.5	12	3659.5	3649.4	3647	0.72%	3649.7	0.3	-	3.1	0.51	2.12
B3-91	B3-285	40.8	12	3662.8	3651.9	3652	0.22%	3652.4	0.5	-	2.51	0.51	1.17
B4-1	B3-16	621.2	30	3682.5	3675.9	3675	0.16%	3677.9	0.8	-	3.55	9.86	11.58
B4-10	B4-9	128.9	36	3640.6	3633.9	3634	0.29%	3635.1	0.4	-	3.7	6.72	25.02
B4-102	B4-4	135.2	30	3694.9	3684	3678	4.21%	3684.5	0.2	-	6.5	6.8	58.93
B4-105	B4-29	309.8	18	3704.1	3698	3697	0.43%	3698.8	0.53	-	3.22	2.5	4.8
B4-11	B4-10	197.8	36	3640.4	3634.1	3634	0.08%	3635.5	0.47	-	3.35	6.72	12.86
B4-112	B4-126	453.1	15	3707.4	3698.4	3693	1.25%	3700.7	1.84	1.05	2.07	0.07	5.06
B4-117	B4-68	62	12	3710.3	3704.3	3703	2.80%	3704.4	0.1	-	1.95	0.02	4.17
B4-119	B4-39	181.7	12	3696.9	3679	3679	0.20%	3679.3	0.3	-	1.47	0.15	1.13
B4-12	B4-120	110.4	24	3643.1	3638.2	3636	1.79%	3639.1	0.45	-	7.54	6.64	21.22
B4-120	B4-11	122.2	24	3639.2	3635.7	3635	0.89%	3637.2	0.75	-	6.67	6.72	14.96
B4-122	B4-120	124.4	12	3641.4	3637.5	3637	0.23%	3637.7	0.2	-	1.51	0.09	1.18
B4-125	B4-124	259.5	12	3696.7	3687.7	3684	1.58%	3690.1	2.4	1.4	3.55	0.09	3.13
B4-126	B4-125	527.1	15	3701.7	3692.7	3688	0.95%	3695.1	1.92	1.15	2.05	0.08	4.41
B4-127	B4-112	30.1	15	3706.3	3701.2	3701	0.17%	3701.3	0.08	-	0.34	0	1.84
B4-128	B4-21	40	15	3690	3684.9	3684	2.03%	3685.5	0.48	-	6.18	2.57	6.44
B4-13	B4-12	154.6	24	3645.7	3640.4	3638	1.40%	3641.3	0.45	-	7.85	6.62	18.77
B4-135	B4-112	83	10	3708.8	3699.8	3698	1.74%	3702.2	2.88	1.57	2.66	0.07	2.02
B4-136	B4-135	308.5	10	3713.6	3704.6	3700	0.90%	3704.9	0.36	-	2.26	0.07	1.45
B4-137	B4-136	140.4	10	3720.9	3706.1	3705	0.10%	3705.3	-0.96	-	1.11	0.07	0.49
B4-138	B4-137	168.3	10	3720.7	3713.8	3713	0.28%	3714	0.24	-	1.46	0.06	0.81
B4-14	B4-13	399.3	30	3649.5	3643.8	3641	0.82%	3644.7	0.36	-	6.66	6.62	25.95
B4-141	B4-138	263.4	10	3723	3714.7	3714	0.28%	3714.8	0.12	-	1.35	0.05	0.81
B4-149	B4-157	113.2	10	3724.1	3715.6	3715	0.29%	3715.7	0.12	-	1.21	0.03	0.83
B4-15	B4-14	447.8	36	3650	3644.6	3644	0.15%	3645.9	0.43	-	4.01	6.62	17.93
B4-157	B4-141	147.8	10	3724.5	3715.2	3715	0.28%	3715.3	0.12	-	1.21	0.03	0.81
B4-16	B4-15	520.8	36	3651	3645.6	3645	0.19%	3646.8	0.4	-	3.64	6.59	20.46
B4-17	B4-93	270.9	36	3658.7	3647.2	3646	0.27%	3648.3	0.37	-	4.16	6.59	24.08
B4-18	B4-17	367.5	30	3653.6	3648.4	3647	0.34%	3649.6	0.48	-	4.59	6.43	16.82

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B4-19	B4-18	278.7	30	3655.1	3649.2	3648	0.27%	3650.4	0.48	-	4.4	6.43	15
B4-2	B4-1	271	30	3689.8	3677	3676	0.39%	3678.1	0.44	-	3.65	6.91	17.96
B4-20	B4-1	155.6	15	3684.4	3678.3	3677	0.58%	3679.3	0.8	-	4.74	3.03	3.44
B4-21	B4-20	374.9	15	3689.1	3684.1	3678	1.54%	3684.7	0.48	-	5.45	3.02	5.61
B4-22	B4-21	175.2	15	3690.2	3684.7	3684	0.35%	3685.1	0.32	-	1.99	0.52	2.67
B4-23	B4-128	158.7	15	3693.5	3688.1	3685	2.03%	3688.7	0.48	-	6.74	2.57	6.44
B4-24	B4-22	217.3	15	3691.2	3685.3	3685	0.26%	3685.7	0.32	-	2.39	0.52	2.3
B4-26	B4-23	338.9	15	3697	3690.8	3688	0.80%	3691.6	0.64	-	5.91	2.54	4.04
B4-27	B4-26	365.3	18	3701	3693.9	3691	0.84%	3694.5	0.4	-	4.82	2.53	6.75
B4-28	B4-27	179.3	18	3702.9	3696.4	3694	1.37%	3696.9	0.33	-	5.87	2.53	8.62
B4-29	B4-28	298.1	18	3703.5	3696.7	3696	0.12%	3697.9	0.8	-	3.68	2.52	2.52
B4-3	B4-2	216.6	30	3688.2	3677.3	3677	0.13%	3678.7	0.56	-	4.14	6.81	10.32
B4-30	B4-105	115.8	18	3704	3698.6	3698	0.46%	3699.4	0.53	-	4.06	2.49	4.98
B4-39	B4-2	82.8	12	3695.1	3678.7	3679	0.20%	3678.9	0.2	-	1.72	0.16	1.11
B4-4	B4-3	398	30	3688.3	3678.3	3677	0.25%	3679.5	0.48	-	3.84	6.81	14.4
B4-41	B4-119	117.9	12	3698.1	3679.3	3679	0.20%	3679.5	0.2	-	1.51	0.15	1.11
B4-62	RCK_LS	211.3	12	3641	3634.8	3633	0.85%	3634.9	0.1	-	2.03	0.07	2.3
B4-63	B4-62	476.3	12	3642.4	3636.4	3635	0.29%	3636.5	0.1	-	1.39	0.06	1.34
B4-64	B4-63	130	12	3676.4	3670.4	3636	27.12%	3670.4	0	-	2.09	0.05	12.99
B4-65	B4-64	60	12	3685.5	3679.5	3670	15.30%	3679.5	0	-	5.3	0.05	9.76
B4-66	B4-65	474.9	12	3695.3	3689.3	3679	2.08%	3689.4	0.1	-	2.94	0.04	3.6
B4-67	B4-66	407.9	12	3700.5	3694.5	3689	1.26%	3694.6	0.1	-	1.84	0.04	2.81
B4-68	B4-67	411.9	12	3708.6	3702.6	3694	1.96%	3702.6	0	-	1.68	0.03	3.49
B4-7	RCK_LS	466.7	36	3640.2	3632.7	3632	0.14%	3634.1	0.47	-	4.01	6.72	17.7
B4-8	B4-7	210.7	36	3640.2	3633.3	3633	0.25%	3634.5	0.4	-	3.7	6.72	23.2
B4-9	B4-8	106.8	36	3640.5	3633.5	3633	0.20%	3634.8	0.43	-	3.67	6.72	20.71
B4-93	B4-16	330.2	36	3651.6	3646.5	3646	0.27%	3647.6	0.37	-	4.05	6.59	24.25
B6-1	C6-146	169.1	8	3840	3834.7	3832	1.36%	3834.9	0.3	-	4.24	0.28	1.2
B6-2	B6-1	405.2	8	3848.6	3843	3835	2.05%	3843.2	0.3	-	4.94	0.28	1.47
B6-3	B6-2	169.9	8	3850.9	3844	3843	0.49%	3844.3	0.45	-	2.9	0.27	0.72
B6-4	B6-3	308	8	3853.3	3845.6	3844	0.42%	3845.7	0.15	-	1.9	0.07	0.67
B6-5	B6-4	308.8	8	3853.3	3847.5	3846	0.58%	3847.6	0.15	-	2.07	0.06	0.78
B6-6	B6-5	308.8	8	3860	3853.2	3848	1.84%	3853.3	0.15	-	2.99	0.06	1.39
B6-9	B6-3	139.8	8	3872.8	3844.6	3844	0.40%	3844.9	0.45	-	2.46	0.2	0.65
C1-1	C1-27	247.8	24	3186.7	3180.1	3179	0.40%	3180.7	0.3	-	3.3	1.42	10.01
C1-13	C1-16	306.3	21	3623.5	3618.3	3618	0.04%	3619.2	0.51	-	2.06	1.3	2.1
C1-14	C1-50	547.3	9	3622.9	3613.7	3224	101.32%	3613.8	0.13	-	25.35	1.4	11.66
C1-15	C1-14	65.6	21	3621.5	3617.7	3617	0.26%	3618.3	0.34	-	3.05	1.3	5.65
C1-16	C1-15	197.5	21	3622.7	3618.2	3618	0.26%	3618.8	0.34	-	2.8	1.3	5.69
C1-2	C1-1	437.6	18	3197.9	3187.3	3180	1.63%	3187.7	0.27	-	4.88	1.42	9.4
C1-27	C1-29	189.8	24	3185.8	3179.1	3178	0.35%	3179.7	0.3	-	3.29	1.42	9.41
C1-3	C1-2	452.3	18	3201	3194.1	3187	1.51%	3194.5	0.27	-	5.71	1.41	9.05
C1-4	C1-3	518.2	18	3206.3	3201.9	3194	1.50%	3202.3	0.27	-	5.69	1.41	9
C1-49	C1-8	272	18	3229.5	3221.4	3220	0.39%	3222	0.4	-	3.52	1.41	4.62

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C1-5	C1-4	420.3	18	3215.5	3210.6	3202	2.08%	3211	0.27	-	6.13	1.41	10.6
C1-50	C1-49	99	16	3239.4	3223.5	3222	1.98%	3223.9	0.3	-	5.99	1.41	7.56
C1-51	C1-52	65	24	3240.3	3236.2	3235	1.75%	3237	0.4	-	8.74	5.6	20.98
C1-52	C1-53	261	24	3239.6	3235.1	3225	3.92%	3235.6	0.25	-	8.11	5.6	31.34
C1-53	C1-54	408.9	30	3231.5	3224.9	3223	0.52%	3225.8	0.36	-	5.23	5.6	20.68
C1-54	C1-55	246.2	30	3227.9	3222.7	3221	0.53%	3223.7	0.4	-	5.14	5.6	20.95
C1-55	C1-56	225	30	3228.5	3221.4	3220	0.52%	3222.4	0.4	-	4.9	5.6	20.8
C1-56	C1-57	254.7	36	3227	3220.3	3219	0.31%	3221.3	0.33	-	4.27	5.6	26.17
C1-57	C1-58	352.6	36	3226	3219.4	3218	0.32%	3220.4	0.33	-	4.17	5.61	26.32
C1-58	C1-59	158.9	36	3225.4	3218.3	3218	0.31%	3219.4	0.37	-	3.94	5.61	26.19
C1-59	C1-60	74.7	36	3223.8	3217.8	3218	0.33%	3218.9	0.37	-	4.13	5.61	27.02
C1-6	C1-5	350.1	18	3222.9	3217.9	3211	2.08%	3218.3	0.27	-	6.37	1.41	10.6
C1-60	C1-61	157.4	36	3223.3	3217.6	3217	0.34%	3218.5	0.3	-	5.36	5.61	27.1
C1-61	C1-62	322.6	24	3223.1	3217.1	3211	1.98%	3217.8	0.35	-	8.88	5.62	22.26
C1-62	C1-63	562	24	3216.7	3210.7	3199	2.01%	3211.4	0.35	-	8.75	5.62	22.46
C1-63	C1-64	384.9	27	3203.8	3199.4	3194	1.47%	3200.1	0.31	-	7.81	5.62	26.3
C1-64	C1-65	452	27	3201.3	3193.7	3187	1.45%	3194.5	0.36	-	7.98	5.62	26.14
C1-65	C1-66	430.4	27	3197.6	3187.2	3181	1.50%	3187.9	0.31	-	7.26	5.63	26.55
C1-66	C1-67	460.5	30	3187.4	3180.7	3178	0.67%	3181.5	0.32	-	5.19	5.63	23.56
C1-67	B1-2	181.4	24	3183.3	3177.6	3176	0.86%	3178.7	0.55	-	6.2	6.97	14.69
C1-7	C1-6	347.1	24	3224.9	3218.9	3218	0.30%	3219.5	0.3	-	3.2	1.41	8.67
C1-8	C1-7	368.6	24	3226.2	3220.3	3219	0.36%	3220.8	0.25	-	3.18	1.41	9.51
C2-10	C2-9	219.2	18	3634.1	3628.4	3628	0.40%	3628.9	0.33	-	3.25	1.05	4.66
C2-11	C2-10	290.6	15	3637.3	3629.1	3628	0.22%	3629.7	0.48	-	2.89	1.05	2.14
C2-112	C2-8	21.3	18	3626.6	3623.1	3623	0.19%	3623.9	0.53	-	2.31	1.23	3.19
C2-115	JUB101	268.8	16.3	3397.5	3390.2	3237	69.24%	3390.5	0.22	-	15.33	5.6	46.97
C2-116	C2-6	195.2	15	3623.9	3621.4	3620	0.72%	3621.9	0.4	-	3.16	1.26	3.83
C2-12	C2-11	235	15	3635.7	3629.5	3629	0.17%	3630.2	0.56	-	2.37	1.04	1.89
C2-120	C2-25	269	10	3651.8	3641.4	3641	0.28%	3641.6	0.24	-	1.31	0.05	0.81
C2-13	C2-73	117.4	15	3639.9	3636.5	3635	0.84%	3636.9	0.32	-	4.19	1.02	4.15
C2-14	C2-13	474.4	15	3640.9	3638.9	3636	0.51%	3639.4	0.4	-	3.51	0.95	3.24
C2-145	C2-146	161.3	18	3629.1	3623.5	3623	0.14%	3624.3	0.53	-	1.88	1.05	2.72
C2-146	C2-147	170.5	18	3627.7	3623.3	3623	0.10%	3624.1	0.53	-	1.75	1.06	2.32
C2-147	C2-112	47.8	18	3626.6	3623.2	3623	0.04%	3623.9	0.47	-	1.8	1.06	1.5
C2-15	C2-14	290.2	15	3642	3640.2	3639	0.43%	3640.7	0.4	-	3.3	0.94	2.98
C2-151	C2-200	36.7	10	3635.9	3629	3629	0.30%	3629.4	0.48	-	2.44	0.36	0.84
C2-157	C2-151	321.7	10	3637	3630.1	3629	0.32%	3630.5	0.48	-	2.28	0.33	0.87
C2-158	C2-217	150.1	10	3640.4	3631.4	3631	0.47%	3631.7	0.36	-	2.48	0.31	1.05
C2-159	C2-158	339.3	10	3643.8	3632.8	3632	0.38%	3633.2	0.48	-	2.48	0.31	0.95
C2-16	C2-15	389.6	15	3646	3641.5	3640	0.34%	3642	0.4	-	3.06	0.94	2.64
C2-164	C2-165	439	14	3564.4	3526.5	3480	10.53%	3527	0.43	-	17.02	5.59	12.22
C2-165	C2-166	483.1	16.3	3504.4	3480.5	3430	10.53%	3481	0.37	-	16.89	5.59	18.32
C2-166	C2-115	378.7	16.3	3453.2	3429.9	3390	10.53%	3430.4	0.37	-	16.89	5.59	18.32
C2-17	C2-16	275.4	12	3649.3	3645.2	3642	1.24%	3645.6	0.4	-	4.87	0.94	2.78

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C2-18	C2-17	228.2	12	3652.2	3646.7	3645	0.67%	3647.2	0.5	-	3.87	0.93	2.05
C2-19	C2-18	337	12	3652	3648.3	3647	0.47%	3648.8	0.5	-	3.39	0.87	1.71
C2-199	C2-159	199.6	10	3646.4	3633.6	3633	0.34%	3633.9	0.36	-	2.32	0.28	0.89
C2-2	C1-13	394.1	21	3623.4	3618.9	3618	0.14%	3619.5	0.34	-	1.93	1.29	4.22
C2-20	C2-19	349.3	12	3655.4	3651.2	3648	0.82%	3651.5	0.3	-	2.37	0.44	2.27
C2-200	B2-228	392.7	10	3635.7	3628.8	3628	0.31%	3629.2	0.48	-	2.45	0.36	0.86
C2-217	C2-157	220.3	10	3638.6	3630.6	3630	0.21%	3631	0.48	-	2.1	0.32	0.7
C2-23	C2-13	465.7	12	3654.1	3638.6	3637	0.40%	3638.7	0.1	-	1.66	0.08	1.58
C2-24	C2-23	397.8	12	3655.3	3639.5	3639	0.22%	3639.6	0.1	-	1.24	0.06	1.17
C2-25	C2-24	422.1	10	3653.5	3640.7	3639	0.28%	3640.8	0.12	-	1.3	0.06	0.81
C2-26	C2-120	214.4	10	3650	3642	3641	0.28%	3642.2	0.24	-	0.94	0.03	0.81
C2-27	C2-26	346.2	10	3648.7	3643	3642	0.28%	3643.1	0.12	-	1.09	0.03	0.81
C2-3	C2-2	380.7	21	3622.7	3619.2	3619	0.10%	3620	0.46	-	2.15	1.29	3.51
C2-35	C2-38	246	10	3647.8	3639.2	3639	0.28%	3639.5	0.36	-	1.58	0.13	0.81
C2-38	C2-41	260	10	3647.7	3638.6	3638	0.28%	3638.8	0.24	-	1.7	0.17	0.81
C2-4	C2-3	321.3	21	3623.9	3619.4	3619	0.05%	3620.3	0.51	-	1.81	1.29	2.55
C2-41	B2-60	422.2	10	3649.6	3637.8	3637	0.29%	3638.1	0.36	-	2.06	0.21	0.82
C2-5	C2-4	81.6	21	3624.7	3619.7	3619	0.29%	3620.3	0.34	-	1.93	1.29	6.02
C2-6	C2-5	326.9	21	3625.7	3620	3620	0.09%	3620.7	0.4	-	2.07	1.26	3.42
C2-63	C2-64	267	10	3652.9	3641.4	3641	0.28%	3641.5	0.12	-	0.48	0	0.81
C2-64	C2-65	251.6	10	3650	3640.7	3640	0.28%	3640.7	0	-	0.33	0.01	0.81
C2-65	C2-35	248.3	10	3648.7	3639.9	3639	0.28%	3640.1	0.24	-	1.35	0.09	0.81
C2-7	C2-116	116.6	15	3624.5	3622.3	3621	0.81%	3622.8	0.4	-	4.21	1.24	4.06
C2-72	C2-12	99.5	15	3636.8	3633.3	3632	1.02%	3633.7	0.32	-	4.48	1.02	4.58
C2-73	C2-72	218.2	15	3638.9	3635.5	3633	1.00%	3635.9	0.32	-	4.4	1.02	4.52
C2-8	C2-7	397.7	18	3626.3	3623.1	3622	0.20%	3623.8	0.47	-	2.88	1.23	3.28
C2-9	C2-145	125.8	18	3629.9	3623.7	3624	0.10%	3624.4	0.47	-	1.93	1.05	2.36
C3-1	C2-20	381.4	12	3663	3654.8	3651	0.94%	3655	0.2	-	3.51	0.44	2.42
C3-104	C3-167	139.1	24	3700.6	3692.2	3692	0.12%	3693.5	0.65	-	2.81	3.84	5.54
C3-14	C3-259	373.3	30	3683.3	3676.7	3676	0.10%	3678	0.52	-	2.51	4.25	8.92
C3-147	C3-250	184.6	30	3683.3	3676.8	3677	0.10%	3678.5	0.68	-	2.11	4.23	9.21
C3-157	C3-159	460.1	15	3699.1	3694	3693	0.24%	3694.4	0.32	-	2.3	0.48	2.21
C3-159	C3-170	340.8	15	3702.1	3692.9	3692	0.35%	3693.2	0.24	-	2.15	0.48	2.68
C3-167	C3-97	204.8	24	3700.7	3692	3692	0.15%	3693.3	0.65	-	3	3.84	6.06
C3-170	C3-171	169.5	15	3700.7	3691.7	3691	0.16%	3692.1	0.32	-	1.86	0.49	1.81
C3-171	C3-173	234.7	15	3700.5	3691.4	3691	0.18%	3691.9	0.4	-	2.03	0.5	1.94
C3-173	B3-40	387	15	3700.3	3691	3690	0.23%	3691.4	0.32	-	2.24	0.5	2.18
C3-183	C3-196	345.2	10	3667.1	3660.1	3658	0.71%	3660.4	0.36	-	3.14	0.37	1.29
C3-188	C3-183	329.9	10	3668.9	3662.6	3660	0.75%	3662.8	0.24	-	2.39	0.24	1.33
C3-189	C3-275	258.6	10	3671.1	3664.7	3663	0.63%	3664.9	0.24	-	2.44	0.23	1.21
C3-190	C3-189	215.8	10	3671	3665.3	3665	0.30%	3665.7	0.48	-	2.14	0.23	0.84
C3-192	C3-190	99.6	10	3670.9	3665.6	3665	0.27%	3665.9	0.36	-	1.85	0.23	0.8
C3-193	C3-192	362.5	10	3673.9	3666	3666	0.11%	3666.4	0.48	-	1.48	0.22	0.51
C3-196	C3-235	305.7	21	3664.9	3657.7	3655	0.79%	3657.9	0.11	-	2.66	0.38	9.85

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C3-197	C3-198	349	21	3663.3	3655	3654	0.35%	3655.3	0.17	-	2.39	0.41	6.59
C3-198	B3-91	355.7	21	3661.8	3653.8	3652	0.51%	3654	0.11	-	1.71	0.41	7.91
C3-2	C3-1	364.2	12	3662	3658.4	3655	0.99%	3658.7	0.3	-	3.61	0.43	2.49
C3-235	C3-197	55.8	21	3664.5	3655.2	3655	0.47%	3655.5	0.17	-	2.25	0.38	7.57
C3-236	C3-64	59.4	21	3677.4	3670.1	3670	0.64%	3670.2	0.06	-	1.48	0.06	8.87
C3-250	C3-14	347.5	30	3683.2	3677	3677	0.08%	3678.3	0.52	-	2.52	4.25	8.15
C3-259	B3-27	164.7	30	3683.6	3676.3	3676	0.10%	3677.7	0.56	-	2.53	4.3	8.95
C3-267	C3-3	360.4	12	3666.1	3661.5	3660	0.30%	3661.9	0.4	-	2.31	0.36	1.37
C3-3	C3-2	483	12	3666.6	3660.4	3658	0.42%	3660.7	0.3	-	2.61	0.37	1.62
C3-4	C3-267	94.4	12	3666	3661.8	3662	0.30%	3662.2	0.4	-	2.14	0.36	1.36
C3-5	C3-4	301	12	3667.5	3664.6	3664	0.20%	3665	0.4	-	2.1	0.35	1.1
C3-6	C3-5	267.7	12	3675.3	3665.1	3665	0.19%	3665.5	0.4	-	1.8	0.35	1.08
C3-63	C3-193	359.9	21	3674.7	3668	3666	0.54%	3668.2	0.11	-	1.17	0.22	8.17
C3-64	C3-63	424.9	21	3676.8	3669.7	3668	0.40%	3669.8	0.06	-	1.27	0.06	7
C3-65	C3-236	270.7	21	3682.5	3670.4	3670	0.10%	3670.6	0.11	-	0.93	0.06	3.57
C3-72	C3-71	113	6	3684.2	3674.5	3674	0.40%	3674.5	0	-	0.95	0.01	0.25
C3-73	C3-72	137.4	6	3685.3	3675	3674	0.40%	3675.1	0.2	-	0.68	0	0.25
C3-74	C3-73	354	6	3688.1	3676.4	3675	0.40%	3676.5	0.2	-	0.63	0	0.25
C3-79	C3-78	195.3	24	3686.9	3677.5	3676	0.89%	3679.8	1.15	0.3	2.03	4.11	14.95
C3-80	C3-79	138.1	18	3686.5	3678.6	3677	0.80%	3680.3	1.13	0.2	4.36	4.11	6.59
C3-83	C3-80	309.4	18	3687.7	3681.8	3679	1.04%	3682.6	0.53	-	5.95	4.1	7.51
C3-84	C3-83	160.3	18	3688.2	3683.3	3682	0.92%	3684.2	0.6	-	6.05	3.96	7.04
C3-86	C3-84	194	24	3691.9	3684.9	3683	0.84%	3685.7	0.4	-	5.15	3.95	14.52
C3-88	C3-86	183.5	24	3695.4	3686.4	3685	0.81%	3687.2	0.4	-	5.63	3.94	14.27
C3-95	C3-88	344.3	24	3698.2	3688.8	3686	0.70%	3689.6	0.4	-	5.52	3.92	13.25
C3-96	C3-95	341.9	24	3700.9	3690.9	3689	0.61%	3691.7	0.4	-	5.28	3.92	12.41
C3-97	C3-96	456.3	24	3701	3691.7	3691	0.17%	3692.9	0.6	-	3.72	3.91	6.59
C4-1	B4-19	371.2	30	3655	3650.1	3649	0.18%	3651.5	0.56	-	4.25	6.43	12.2
C4-100	C4-98	338.9	15	3704.3	3698.6	3698	0.28%	3698.9	0.24	-	1.92	0.43	2.39
C4-102	C4-100	324.7	15	3703.6	3699.4	3699	0.25%	3699.8	0.32	-	2.15	0.42	2.25
C4-103	C4-102	327.3	12	3704.9	3701	3699	0.49%	3701.3	0.3	-	2.54	0.4	1.74
C4-105	C4-103	333.6	12	3707.4	3702.6	3701	0.48%	3702.9	0.3	-	2.69	0.39	1.73
C4-107	C4-105	329.8	12	3710.4	3704.2	3703	0.49%	3704.5	0.3	-	2.64	0.37	1.74
C4-109	C4-107	327.3	12	3712.5	3705.9	3704	0.52%	3706.2	0.3	-	2.65	0.35	1.8
C4-111	C4-109	348.3	12	3713.9	3706.7	3706	0.23%	3707.1	0.4	-	2.15	0.33	1.2
C4-114	C4-111	328.7	12	3714.9	3707.6	3707	0.27%	3707.9	0.3	-	1.9	0.31	1.31
C4-116	C4-261	111.1	12	3716.8	3708.4	3708	0.26%	3708.7	0.3	-	1.94	0.3	1.27
C4-118	C4-79	229	18	3712.3	3707.4	3706	0.41%	3708.2	0.53	-	3.75	2.33	4.69
C4-121	C4-118	480.6	18	3715.6	3709.3	3707	0.40%	3710.1	0.53	-	3.92	2.33	4.65
C4-124	C4-291	188.7	18	3720.1	3711.9	3711	0.37%	3712.8	0.6	-	3.83	2.33	4.48
C4-141	C4-309	221.9	10	3733	3722.7	3723	0.01%	3723.2	0.6	-	0.71	0.17	0.18
C4-146	C4-306	282.1	10	3727.5	3719.1	3718	0.33%	3719.7	0.72	-	2.67	0.64	0.88
C4-152	C4-307	278.8	10	3723.1	3717.5	3717	0.29%	3718.1	0.72	-	2.69	0.68	0.83
C4-157	C4-308	248.3	10	3720.7	3715.8	3715	0.22%	3716.6	0.96	-	2.63	0.73	0.72

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C4-163	C4-124	282	18	3722.1	3713	3712	0.40%	3713.7	0.47	-	3.58	2.32	4.63
C4-164	C4-315	165.8	12	3725.8	3717.6	3716	0.78%	3718.1	0.5	-	3.82	0.91	2.2
C4-165	C4-164	485.9	12	3728.3	3719.5	3718	0.38%	3720	0.5	-	3.19	0.85	1.53
C4-166	C4-165	458.9	12	3730.1	3721.4	3720	0.40%	3721.9	0.5	-	3.22	0.84	1.57
C4-167	C4-166	460.8	12	3732.4	3723.2	3721	0.39%	3723.8	0.6	-	3.2	0.83	1.55
C4-168	C4-167	443.4	12	3733.4	3725.3	3724	0.38%	3725.9	0.6	-	3.17	0.82	1.54
C4-169	C4-168	446.3	12	3734.7	3726.8	3725	0.32%	3727.3	0.5	-	2.83	0.81	1.42
C4-171	C4-314	216.3	10	3727.2	3716.9	3716	0.52%	3717.3	0.48	-	2.96	0.69	1.1
C4-179	C4-169	349.8	12	3737.5	3728.1	3727	0.36%	3728.5	0.4	-	2.35	0.47	1.49
C4-183	C4-171	350.7	10	3730.5	3717.9	3717	0.31%	3718.5	0.72	-	2.64	0.67	0.86
C4-192	C4-179	350.4	12	3740.9	3730.3	3728	0.57%	3730.6	0.3	-	2.89	0.38	1.88
C4-196	C4-183	351.3	10	3729	3719	3718	0.29%	3719.5	0.6	-	2.59	0.62	0.82
C4-2	C4-1	449.9	30	3657.8	3651.9	3650	0.34%	3653	0.44	-	4.62	6.43	16.86
C4-20	B4-30	331.3	18	3706.4	3699.9	3699	0.40%	3700.7	0.53	-	3.93	2.48	4.62
C4-207	C4-192	359.9	10	3744	3732.1	3730	0.46%	3732.4	0.36	-	2.49	0.27	1.04
C4-210	C4-196	353.3	10	3727.8	3720.1	3719	0.34%	3720.5	0.48	-	1.47	0.31	0.89
C4-218	C4-207	350.3	8	3748.6	3739	3734	1.41%	3739.2	0.3	-	3.24	0.16	1
C4-220	C4-313	251.2	10	3728.5	3721.7	3721	0.20%	3722.1	0.48	-	1.93	0.24	0.68
C4-227	C4-218	354.4	8	3750.8	3742.5	3739	0.92%	3742.6	0.15	-	2.4	0.1	0.81
C4-228	C4-317	269.5	10	3729.8	3723.8	3723	0.42%	3724	0.24	-	2.22	0.19	1
C4-237	C4-228	246.7	10	3732	3724.8	3724	0.41%	3725	0.24	-	2.06	0.15	0.98
C4-238	C4-237	222.3	10	3735.6	3729.1	3727	1.13%	3729.3	0.24	-	2.86	0.15	1.63
C4-261	C4-114	220.1	12	3719.7	3708.1	3708	0.23%	3708.4	0.3	-	1.93	0.3	1.19
C4-291	C4-121	464.5	18	3718.9	3711.3	3709	0.41%	3712	0.47	-	3.99	2.33	4.73
C4-299	C4-220	166	10	3729	3722.2	3722	0.28%	3722.5	0.36	-	1.79	0.2	0.82
C4-306	C4-152	212.6	10	3725	3718.2	3718	0.33%	3718.7	0.6	-	2.48	0.64	0.88
C4-307	C4-157	222.2	10	3721.8	3716.7	3716	0.40%	3717.2	0.6	-	2.38	0.68	0.97
C4-308	C4-163	248.4	10	3721.5	3715.3	3713	0.72%	3715.7	0.48	-	3.75	0.73	1.31
C4-309	C4-310	256.1	10	3732.3	3722.7	3723	0.01%	3723.2	0.6	-	0.78	0.17	0.17
C4-310	C4-311	246.8	10	3731.6	3722.6	3723	0.02%	3723.1	0.6	-	1.22	0.17	0.2
C4-311	C4-146	238.3	10	3730.8	3722.6	3719	1.44%	3722.7	0.12	-	1.2	0.17	1.84
C4-313	C4-210	257.6	10	3728.1	3721	3720	0.22%	3721.3	0.36	-	2	0.24	0.72
C4-314	C4-163	289.1	10	3723.9	3715.7	3715	0.36%	3716.3	0.72	-	2.99	0.69	0.92
C4-315	C4-163	390.4	12	3724.5	3716.2	3715	0.38%	3716.8	0.6	-	3.25	0.92	1.53
C4-317	C4-299	58.2	10	3727.7	3722.5	3722	0.36%	3722.8	0.36	-	2.12	0.19	0.92
C4-318	C4-238	282.6	10	3741.9	3733.6	3731	0.87%	3733.8	0.24	-	2.51	0.13	1.43
C4-324	C4-323	134.5	10	3733.6	3725.7	3662	53.81%	3725.9	0.24	-	11.17	2.8	11.24
C4-4	C4-2	406.1	30	3665.8	3654.5	3652	0.63%	3655.4	0.36	-	5.42	6.42	22.85
C4-5	C4-4	313.3	30	3665.9	3658.8	3656	0.91%	3659.7	0.36	-	6.81	6.42	27.34
C4-6	C4-101	56.2	30	3665	3659.4	3659	0.12%	3661	0.64	-	3.28	6.39	10.14
C4-7	C4-322	310	30	3667.4	3660.8	3660	0.23%	3661.7	0.36	-	2.63	3.59	13.65
C4-70	C4-20	92	18	3707.1	3700.2	3700	0.37%	3701.1	0.6	-	3.61	2.36	4.47
C4-71	C4-70	441.3	18	3710.3	3701.9	3700	0.39%	3702.7	0.53	-	3.74	2.36	4.59
C4-72	C4-71	426.8	18	3710.3	3703.7	3702	0.41%	3704.4	0.47	-	4	2.36	4.68

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C4-73	C4-72	230.6	18	3710.3	3704.6	3704	0.38%	3705.4	0.53	-	3.85	2.36	4.54
C4-74	C4-73	200.4	18	3710.3	3705.4	3705	0.42%	3706.2	0.53	-	3.8	2.33	4.76
C4-76	C4-74	122.4	18	3710.8	3705.9	3705	0.38%	3706.7	0.53	-	3.74	2.33	4.56
C4-77	C4-76	47.1	18	3711	3706.1	3706	0.40%	3706.9	0.53	-	3.46	2.33	4.67
C4-79	C4-77	100.4	18	3711.4	3706.5	3706	0.43%	3707.3	0.53	-	3.48	2.33	4.81
C4-84	C4-85	342.5	15	3706.9	3697.4	3696	0.29%	3697.8	0.32	-	2.29	0.46	2.44
C4-85	C4-86	307	15	3700.3	3696.4	3696	0.26%	3696.8	0.32	-	2.24	0.47	2.31
C4-86	C4-87	350.7	15	3702.1	3695.6	3695	0.26%	3696	0.32	-	2.14	0.47	2.29
C4-87	C4-91	161.2	15	3704.3	3694.7	3694	0.22%	3695.1	0.32	-	2.05	0.48	2.11
C4-91	C3-157	156.8	15	3701.7	3694.3	3694	0.22%	3694.8	0.4	-	2.08	0.48	2.14
C4-98	C4-84	166.4	15	3705.9	3697.6	3697	0.15%	3698.1	0.4	-	1.96	0.45	1.75
C5-1	C4-7	627.5	21	3669.6	3661.9	3661	0.18%	3663.2	0.74	-	3.65	3.59	4.77
C5-10	C5-9	72	12	3750.6	3671.7	3672	0.18%	3672	0.3	-	0.04	0	1.07
C5-11	C5-9	356.8	15	3676.6	3672.6	3672	0.30%	3673.1	0.4	-	2.69	0.78	2.48
C5-12	C5-11	312	12	3681.9	3676.9	3673	1.30%	3677.3	0.4	-	4.71	0.77	2.84
C5-122	C5-157	140.8	18	3799.1	3793.1	3791	1.76%	3793.5	0.27	-	6.09	1.57	9.76
C5-13	C5-12	475.5	15	3683.3	3678.3	3677	0.30%	3678.8	0.4	-	2.87	0.77	2.47
C5-131	C5-30	236.9	18	3753.2	3748.2	3744	0.75%	3748.9	0.47	-	5.81	2.3	6.38
C5-132	C5-131	538	18	3760.5	3755.6	3748	1.38%	3756.2	0.4	-	5.38	2.29	8.66
C5-14	C5-13	250.4	15	3686.1	3679.1	3678	0.30%	3679.6	0.4	-	2.65	0.77	2.49
C5-15	C5-14	344.8	15	3685.6	3680.1	3679	0.30%	3680.6	0.4	-	2.69	0.77	2.48
C5-156	C5-70	188.7	18	3805.7	3800.4	3797	1.86%	3800.8	0.27	-	6.25	1.57	10.03
C5-157	C5-158	502.8	18	3796.7	3790.6	3780	2.11%	3791	0.27	-	5.6	1.58	10.7
C5-158	C5-159	522.2	18	3788.1	3780	3775	0.87%	3780.5	0.33	-	4.83	1.58	6.87
C5-159	C5-160	398.6	18	3779.4	3775.4	3766	2.43%	3775.8	0.27	-	5.46	1.58	11.46
C5-160	C5-132	707.6	18	3770.5	3765.8	3756	1.43%	3766.3	0.33	-	6.38	2.29	8.8
C5-162	C5-1	142.3	21	3670.6	3662.5	3662	0.34%	3663.5	0.57	-	3.41	3.59	6.51
C5-17	C5-16	154.3	12	3686.9	3682.4	3682	0.46%	3682.7	0.3	-	1.85	0.25	1.69
C5-172	C5-228	400.5	15	3767	3759.2	3755	0.93%	3759.4	0.16	-	3.45	0.42	4.35
C5-173	C5-227	62	12	3775.1	3768.6	3767	3.02%	3768.8	0.2	-	5.22	0.41	4.33
C5-174	C5-173	401.3	12	3779	3774.2	3769	1.38%	3774.5	0.3	-	4.05	0.41	2.93
C5-175	C5-226	41.1	12	3786.6	3778.5	3778	0.18%	3778.7	0.2	-	0.88	0.07	1.04
C5-177	C5-21	40.6	21	3743.8	3737.1	3737	1.55%	3737.7	0.34	-	5.95	2.33	13.83
C5-18	C5-17	429.9	12	3691.4	3684.4	3682	0.46%	3684.6	0.2	-	2.36	0.25	1.69
C5-183	C5-184	205.6	8	3789.9	3783.2	3779	1.86%	3783.5	0.45	-	4.41	0.34	1.16
C5-19	C5-18	247.2	12	3691.4	3685.5	3684	0.46%	3685.8	0.3	-	2.32	0.24	1.69
C5-190	C5-191	246.7	8	3788.5	3785.3	3784	0.35%	3785.7	0.6	-	2.48	0.32	0.5
C5-191	C5-183	246.4	8	3789.1	3784.3	3783	0.41%	3784.7	0.6	-	2.61	0.33	0.54
C5-2	C5-162	148	21	3670.8	3663.1	3662	0.40%	3664	0.51	-	3.85	3.58	7
C5-20	C5-19	441.3	12	3692.3	3687.5	3686	0.46%	3687.8	0.3	-	2.32	0.24	1.7
C5-21	C5-4	233.7	10	3738.4	3735.1	3668	30.22%	3735.4	0.36	-	21.08	2.85	8.43
C5-226	C5-174	212	12	3784.9	3778.5	3774	1.94%	3778.7	0.2	-	4.53	0.41	3.48
C5-227	C5-172	211.5	12	3773.2	3766.6	3759	3.49%	3766.8	0.2	-	5.63	0.42	4.66
C5-228	C5-229	363.7	15	3765.5	3755.3	3748	1.96%	3755.6	0.24	-	4.48	0.42	6.33

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C5-229	C5-230	192	18	3764.5	3748.1	3746	0.64%	3748.4	0.2	-	3.4	0.42	5.86
C5-230	C5-231	247.4	18	3757.5	3746.9	3742	1.99%	3747.1	0.13	-	4.42	0.42	10.37
C5-231	C5-79	74.1	18	3750.4	3741.9	3741	1.70%	3742.1	0.13	-	4.11	0.42	9.59
C5-236	C5-175	78.8	12	3788.6	3783.7	3784	0.27%	3783.9	0.2	-	1.35	0.05	1.29
C5-237	C5-236	376.8	12	3795.5	3789.9	3784	1.61%	3790	0.1	-	2.32	0.05	3.16
C5-238	C5-237	405.8	12	3800	3791.1	3790	0.28%	3791.3	0.2	-	1.33	0.05	1.33
C5-30	C5-177	386.7	18	3749.8	3744.1	3737	2.40%	3746.9	1.87	1.3	6.78	2.33	11.39
C5-5	C5-3	354	15	3672.4	3667.4	3666	0.29%	3667.9	0.4	-	2.87	0.79	2.45
C5-6	C5-5	311.7	15	3674.3	3669.3	3667	0.59%	3669.7	0.32	-	2.99	0.78	3.48
C5-7	C5-6	293.8	15	3675.8	3670.3	3669	0.36%	3670.8	0.4	-	3.01	0.78	2.72
C5-70	C5-122	184.9	18	3802.5	3796.7	3793	1.94%	3797.1	0.27	-	6.1	1.57	10.25
C5-78	C5-73	375.3	8	3740.3	3736.3	3683	14.38%	3736.5	0.3	-	10.57	0.55	3.21
C5-79	C5-78	131.2	18	3744.7	3740.6	3736	3.30%	3740.8	0.13	-	5.46	0.49	13.35
C5-9	C5-7	396.5	15	3678.5	3671.5	3670	0.30%	3672	0.4	-	2.75	0.78	2.48
C6-1	C6-70	289.5	18	3814	3809.8	3808	0.46%	3810.4	0.4	-	3.57	1.54	4.97
C6-10	C6-91	473.5	18	3870.2	3866.3	3863	0.77%	3866.7	0.27	-	3.7	0.72	6.44
C6-107	C6-108	168.8	8	3838.4	3827.5	3827	0.40%	3827.7	0.3	-	2.14	0.14	0.65
C6-108	C6-109	311.8	8	3833.4	3826.8	3825	0.61%	3827.1	0.45	-	3.59	0.45	0.81
C6-109	C6-110	232.7	10	3827.6	3824.7	3824	0.28%	3825.2	0.6	-	2.78	0.46	0.96
C6-110	C6-111	243.3	15	3830.8	3824	3824	0.15%	3824.4	0.32	-	2.29	0.46	2.09
C6-111	C6-112	278	15	3827.8	3823.5	3823	0.29%	3823.9	0.32	-	2.49	0.47	2.46
C6-112	C6-113	77.1	15	3827	3823	3823	0.57%	3822.9	-0.08	-	2.62	0.47	3.42
C6-113	C6-2	256.7	18	3826.7	3822.2	3816	2.37%	3822.5	0.2	-	6.49	1.48	11.33
C6-12	C6-10	104.5	8	3870.4	3867.6	3867	0.39%	3867.8	0.3	-	1.9	0.11	0.53
C6-120	C6-82	263	10	3883.7	3876.1	3875	0.28%	3876.4	0.36	-	1.68	0.17	0.81
C6-121	C6-120	262.9	10	3885.4	3876.8	3876	0.27%	3877.1	0.36	-	1.59	0.14	0.8
C6-122	C6-121	258.8	10	3884.4	3877.6	3877	0.28%	3877.8	0.24	-	1.45	0.11	0.81
C6-143	C6-108	193.4	8	3830.9	3827.9	3827	0.55%	3828.2	0.45	-	3.07	0.3	0.77
C6-144	C6-143	568.5	8	3832.9	3829.4	3828	0.25%	3829.8	0.6	-	2.45	0.3	0.51
C6-145	C6-144	224.1	8	3838.9	3830.4	3830	0.38%	3830.7	0.45	-	2.71	0.3	0.63
C6-146	C6-145	375	8	3839.2	3832.3	3830	0.48%	3832.6	0.45	-	2.93	0.29	0.71
C6-2	C6-1	328	18	3820.4	3816.1	3810	1.92%	3816.5	0.27	-	4.74	1.53	10.18
C6-3	C6-113	49.9	18	3827.6	3822.8	3822	1.22%	3823.2	0.27	-	4.48	1.02	8.13
C6-51	C6-68	427.9	10	3851.8	3845.8	3845	0.28%	3846.1	0.36	-	2.18	0.27	0.81
C6-57	C6-51	433.7	10	3854	3847	3846	0.28%	3847.3	0.36	-	1.67	0.21	0.81
C6-58	C6-69	250.9	10	3854.7	3848.7	3848	0.27%	3848.9	0.24	-	1.79	0.17	0.8
C6-68	C6-93	523.5	18	3849	3843.9	3837	1.38%	3844.3	0.27	-	5.01	1.01	8.63
C6-69	C6-57	352.8	10	3854.4	3848	3847	0.28%	3848.2	0.24	-	1.74	0.18	0.81
C6-70	C6-95	336.3	18	3812.4	3808.5	3807	0.37%	3809.1	0.4	-	3.58	1.55	4.5
C6-81	C6-90	317.4	10	3880.1	3874.7	3874	0.28%	3875	0.36	-	2.09	0.23	0.8
C6-82	C6-81	259.5	10	3883	3875.4	3875	0.28%	3875.7	0.36	-	1.76	0.21	0.8
C6-83	C5-156	384.4	18	3812.7	3805.6	3800	1.36%	3806.1	0.33	-	5.64	1.56	8.59
C6-89	C6-90	466	18	3884.3	3879.7	3873	1.42%	3879.9	0.13	-	3.37	0.39	8.75
C6-90	C6-10	454.5	18	3877.5	3873.1	3866	1.50%	3873.4	0.2	-	3.68	0.61	9

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C6-91	C6-92	336.2	18	3866.4	3862.7	3858	1.33%	3863	0.2	-	4.5	0.73	8.48
C6-92	C6-68	522.4	18	3862.1	3858.2	3844	2.74%	3858.5	0.2	-	4.53	0.73	12.17
C6-93	C6-94	328.9	18	3838.2	3836.7	3829	2.29%	3837	0.2	-	5.43	1.01	11.13
C6-94	C6-3	503.1	18	3833.6	3829.2	3823	1.27%	3829.5	0.2	-	4.59	1.01	8.29
C6-95	C6-83	365.6	18	3812.4	3807.2	3806	0.40%	3807.8	0.4	-	3.64	1.56	4.65
C7-1	C6-89	440	18	3893	3888.4	3880	1.98%	3888.6	0.13	-	4.06	0.39	10.34
C7-10	C7-8	141.6	18	3914	3908.5	3906	1.86%	3908.7	0.13	-	4.06	0.35	10.04
C7-13	C7-10	274.4	18	3918.4	3910.9	3908	0.88%	3911.1	0.13	-	3.1	0.33	6.91
C7-25	C7-20	352	8	3922.6	3916.3	3911	1.43%	3916.6	0.45	-	3.26	0.27	1.01
C7-28	C7-25	385.8	8	3929.1	3920.7	3916	1.14%	3921	0.45	-	3.45	0.26	0.9
C7-30	C7-28	398.7	8	3936.4	3927.5	3921	1.71%	3927.8	0.45	-	3.67	0.26	1.11
C7-37	C7-33	298.7	10	3945.1	3943.1	3943	0.00%	3943.7	0.72	-	1.34	0.25	0.09
C7-38	C7-37	380.7	10	3949.7	3946.5	3943	0.89%	3946.8	0.36	-	1.41	0.25	1.45
C7-39	C7-92	258.1	10	3954	3950.8	3948	0.97%	3951	0.24	-	2.33	0.25	1.51
C7-40	C7-39	484.2	8	3960.3	3955.3	3951	0.91%	3955.6	0.45	-	3.11	0.24	0.81
C7-41	C7-40	395	8	3961	3957.7	3955	0.61%	3958	0.45	-	2.67	0.24	0.66
C7-42	C7-1	341.3	18	3899.4	3893.6	3888	1.51%	3893.8	0.13	-	3.82	0.36	9.03
C7-8	C7-42	569.6	18	3911.2	3905.8	3894	2.16%	3906	0.13	-	4.03	0.35	10.8
C7-91	C7-38	178.9	10	3951.1	3948.3	3947	0.97%	3948.5	0.24	-	3.08	0.25	1.51
C7-92	C7-91	15.7	10	3951.3	3948.3	3948	0.20%	3948.6	0.36	-	2.13	0.25	0.68
C8-1	C7-41	401.7	8	3963.4	3960.1	3958	0.60%	3960.4	0.45	-	2.62	0.23	0.65
C8-10	C8-9	411.4	10	4010.2	4006.9	4004	0.68%	4007.2	0.36	-	2.57	0.19	1.27
C8-11	C8-10	452.7	10	4013	4009.7	4007	0.62%	4010	0.36	-	2.47	0.18	1.21
C8-12	C8-11	336.5	10	4016.7	4012.5	4010	0.83%	4012.7	0.24	-	2.55	0.18	1.4
C8-13	C8-12	353.6	8	4020.1	4016.9	4013	1.24%	4017.1	0.3	-	3.12	0.18	0.94
C8-2	C8-1	399.6	8	3969.3	3962.5	3960	0.60%	3962.8	0.45	-	2.61	0.23	0.66
C8-3	C8-2	331.8	8	3970.1	3966.9	3963	1.33%	3967.2	0.45	-	2.98	0.23	0.97
C8-4	C8-3	451.9	8	3977.7	3971.3	3967	0.97%	3971.6	0.45	-	3.11	0.22	0.83
C8-5	C8-4	416.8	8	3979.9	3977.7	3971	1.54%	3977.9	0.3	-	3.32	0.22	1.05
C8-6	C8-5	375	8	3986.3	3984.1	3978	1.71%	3984.3	0.3	-	3.67	0.21	1.11
C8-7	C8-6	409.8	8	3994.7	3990.5	3984	1.56%	3990.7	0.3	-	3.62	0.21	1.06
C8-8	C8-7	415	8	4001.5	3997.3	3991	1.64%	3997.5	0.3	-	3.59	0.2	1.08
C8-9	C8-8	395.5	8	4008.3	4004.1	3997	1.72%	4004.3	0.3	-	3.64	0.2	1.11
C9-1	C8-13	339.8	8	4025.6	4021.4	4017	1.32%	4021.6	0.3	-	3.17	0.17	0.97
C9-10	C9-9	266.1	10	4095.4	4092.3	4091	0.34%	4092.6	0.36	-	1.81	0.12	0.89
C9-11	C9-10	315.2	8	4096.4	4093	4092	0.20%	4093.2	0.3	-	1.54	0.12	0.38
C9-12	C9-11	119.5	10	4097.9	4094.2	4093	1.04%	4094.3	0.12	-	1.06	0.07	1.56
C9-13	C9-12	511.4	10	4100.9	4095.4	4094	0.24%	4095.6	0.24	-	1.4	0.06	0.76
C9-2	C9-1	409.8	10	4027.4	4022.8	4021	0.34%	4023.1	0.36	-	2.02	0.16	0.9
C9-3	C9-2	369.3	8	4029.4	4027.2	4023	1.19%	4027.4	0.3	-	2.48	0.16	0.92
C9-4	C9-3	337.2	8	4039.3	4036	4027	2.61%	4036.2	0.3	-	3.42	0.15	1.37
C9-5	C9-4	469.2	8	4051.1	4047	4036	2.35%	4047.2	0.3	-	3.8	0.15	1.3
C9-6	C9-5	256.8	8	4063.5	4059.8	4047	4.99%	4060	0.3	-	4.21	0.14	1.89
C9-7	C9-6	386.9	8	4078.1	4072.6	4060	3.31%	4072.8	0.3	-	4.21	0.14	1.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C9-8	C9-7	451.3	8	4092.1	4090.4	4073	3.95%	4090.6	0.3	-	4.2	0.13	1.68
C9-9	C9-8	100.6	6	4093.7	4091.4	4090	0.99%	4091.6	0.4	-	2.71	0.13	0.39
CSR1	D2-264	271	14	3606.3	3602.3	3571	10.53%	3605.7	2.91	2.23	16.88	5.58	12.22
D2-10	D2-274	85	24	3643.5	3634.8	3634	1.24%	3635.6	0.4	-	6.69	5.17	17.61
D2-100	D2-99	347.4	12	3629.9	3625.8	3625	0.20%	3626.1	0.3	-	1.58	0.14	1.11
D2-101	D2-121	25.9	12	3627.2	3626.2	3626	0.23%	3626.5	0.3	-	1.5	0.13	1.2
D2-102	D2-11	305.8	15	3643.1	3638.7	3636	0.79%	3639.3	0.48	-	4.58	2.26	4.02
D2-11	D2-190	306.7	18	3643.1	3636.2	3635	0.31%	3637.1	0.6	-	3.32	2.26	4.07
D2-12	D2-102	268.8	15	3643.5	3640.7	3639	0.76%	3641.4	0.56	-	4.97	2.23	3.94
D2-121	D2-100	135.3	12	3627.4	3626.1	3626	0.20%	3626.4	0.3	-	1.89	0.22	1.12
D2-125	D2-126	70.8	12	3631.7	3612.8	3613	0.20%	3613	0.2	-	1.24	0.05	1.11
D2-126	D2-2	121.2	24	3615	3611.7	3610	1.49%	3612.5	0.4	-	7.71	5.58	19.36
D2-13	D2-12	324.6	15	3646	3642.6	3641	0.60%	3643.4	0.64	-	4.58	2.23	3.51
D2-14	D2-170	177	15	3648.4	3644.4	3643	0.64%	3645.2	0.64	-	4.33	2.1	3.63
D2-15	D2-59	177.4	15	3649.3	3646.3	3646	0.40%	3647.1	0.64	-	3.91	1.97	2.86
D2-152	D2-17	114	15	3652.2	3649.5	3649	0.82%	3650.1	0.48	-	4.75	1.94	4.11
D2-16	D2-15	133.6	15	3650.5	3647.6	3646	0.97%	3648.2	0.48	-	4.19	1.94	4.46
D2-169	D2-152	228.3	15	3654	3651.4	3649	0.85%	3652	0.48	-	4.64	1.82	4.18
D2-17	D2-16	100.4	15	3651.4	3648.6	3648	0.94%	3649.2	0.48	-	4.99	1.94	4.38
D2-170	D2-13	101.4	15	3652.6	3643.3	3643	0.64%	3644	0.56	-	4.26	2.1	3.62
D2-18	D2-169	94.6	15	3654.7	3652.2	3651	0.82%	3652.8	0.48	-	4.7	1.81	4.11
D2-184	D2-61	277.9	30	3645.4	3635.2	3635	0.08%	3636.3	0.44	-	2.77	3.19	8.08
D2-185	D2-184	298.5	30	3649	3635.2	3635	0.00%	3636.5	0.52	-	2.07	3.17	0.53
D2-186	D2-185	299.2	30	3648.6	3635.2	3635	0.03%	3636.6	0.56	-	1.78	3.17	4.98
D2-187	D2-186	299.5	30	3652.1	3635.4	3635	0.06%	3636.8	0.56	-	1.77	3.17	6.84
D2-190	D2-10	14.6	18	3644.9	3635.3	3635	0.01%	3636.2	0.6	-	3.56	2.26	0.61
D2-202	D2-4	246.4	24	3621.7	3617.1	3615	0.86%	3618	0.45	-	5.98	5.52	14.73
D2-264	C2-164	427.6	14	3588.5	3571.3	3526	10.53%	3571.8	0.43	-	16.94	5.58	12.22
D2-265	D2-187	397.2	30	3649.5	3635.7	3635	0.08%	3637	0.52	-	1.89	3.16	7.89
D2-266	D2-265	298.7	30	3645.9	3636.5	3636	0.28%	3637.3	0.32	-	2.63	3.15	15.14
D2-267	D2-266	300.1	30	3646.9	3636.8	3637	0.08%	3637.9	0.44	-	2.95	3.15	8.29
D2-268	D2-267	300.9	30	3645.4	3637.1	3637	0.09%	3638.2	0.44	-	2.39	3.15	8.76
D2-269	D2-268	399	30	3643.3	3637.4	3637	0.08%	3638.5	0.44	-	2.32	3.15	8.13
D2-270	D2-271	368.4	24	3635.4	3630.2	3627	0.83%	3631	0.4	-	6.29	5.17	14.41
D2-271	D2-272	340.1	24	3636.5	3627.1	3624	0.89%	3628	0.45	-	6.23	5.18	14.9
D2-272	D2-273	149.7	24	3634.7	3624.1	3623	0.92%	3625	0.45	-	6.1	5.18	15.15
D2-273	D2-68	283.3	24	3633.8	3622.7	3620	0.86%	3623.6	0.45	-	6.21	5.36	14.73
D2-274	D2-270	319.6	24	3643.6	3633.7	3630	1.11%	3634.5	0.4	-	6.58	5.17	16.69
D2-274	D2-9	488.8	18	3643.6	3635.7	3635	0.20%	3634.5	-0.8	-	0	0	3.26
D2-28	D2-18	299.4	15	3658	3655.6	3652	1.14%	3656.2	0.48	-	5.02	1.8	4.83
D2-3	D2-126	224.8	24	3617	3613.1	3612	0.62%	3614.1	0.5	-	5.69	5.53	12.43
D2-36	D2-28	67.9	12	3658.8	3656.4	3656	1.10%	3657	0.6	-	5.1	1.63	2.62
D2-4	D2-3	310.7	24	3620.4	3615	3613	0.62%	3616	0.5	-	5.55	5.53	12.45
D2-41	D2-36	351.6	12	3661.1	3659.4	3657	0.79%	3660	0.6	-	4.68	1.62	2.21

Appendix F - Existing Model Results

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D2-42	D2-41	54.7	12	3661.4	3660.1	3659	1.26%	3660.7	0.6	-	4.73	1.62	2.8
D2-59	D2-14	171.4	15	3649	3645.6	3644	0.68%	3646.3	0.56	-	4.48	2.1	3.74
D2-6	D2-79	254.3	12	3636.4	3633.4	3627	2.68%	3633.5	0.1	-	3.44	0.11	4.08
D2-61	D2-10	53.6	30	3643	3634.9	3635	0.34%	3635.8	0.36	-	3.49	3.19	16.64
D2-68	D2-77	204.7	24	3627	3620.3	3619	0.85%	3621.2	0.45	-	5.92	5.36	14.56
D2-69	D2-273	25.4	12	3632.3	3623.8	3624	0.20%	3624.1	0.3	-	1.85	0.18	1.11
D2-7	D2-6	569.4	21	3641.9	3633.9	3633	0.08%	3634.1	0.11	-	0.98	0.1	3.15
D2-70	D2-69	102.4	12	3633.9	3624	3624	0.20%	3624.3	0.3	-	1.59	0.18	1.11
D2-77	D2-202	133.9	24	3624	3618.6	3617	0.84%	3619.5	0.45	-	6.24	5.51	14.49
D2-79	D2-77	179.3	12	3630.7	3626.6	3621	3.32%	3626.7	0.1	-	4.14	0.15	4.55
D2-8	D2-7	202.4	18	3645.2	3634.2	3634	0.17%	3634.4	0.13	-	0.88	0.09	3.06
D2-9	D2-8	481.3	18	3644.3	3634.8	3634	0.11%	3634.8	0	-	0.43	0.02	2.44
D2-98	D2-70	178.3	12	3633	3624.4	3624	0.20%	3624.6	0.2	-	1.57	0.18	1.12
D2-99	D2-98	379.2	12	3635.5	3625.1	3624	0.20%	3625.4	0.3	-	1.38	0.13	1.12
D3-100	D3-98	211.6	24	3703.7	3694.5	3693	0.50%	3695.3	0.4	-	3.15	3.77	11.21
D3-103	D3-100	218.9	24	3706.6	3695.6	3695	0.49%	3696.4	0.4	-	4.74	3.73	11.08
D3-105	D3-103	129.1	24	3705.8	3695.9	3696	0.23%	3696.9	0.5	-	3.95	3.72	7.64
D3-110	D3-105	280.6	24	3704.1	3696.3	3696	0.14%	3697.5	0.6	-	3.18	3.72	5.98
D3-111	D3-110	159.1	24	3704.3	3696.4	3696	0.04%	3697.8	0.7	-	2.66	3.72	3.08
D3-126	D3-111	153.1	24	3704.4	3696.4	3696	0.03%	3697.9	0.75	-	2.34	3.72	2.86
D3-127	D3-126	105.9	24	3704.5	3696.5	3696	0.05%	3698	0.75	-	2.19	3.71	3.44
D3-142	D3-353	335.3	21	3707.3	3698.1	3697	0.40%	3699	0.51	-	3.52	3.69	6.99
D3-146	JUB132	89.8	12	3707.1	3699.4	3699	0.22%	3700	0.6	-	0.97	0.08	1.18
D3-147	JUB132	225.1	18	3707.7	3699.1	3699	0.19%	3700.5	0.93	-	3.28	3.58	3.21
D3-149	D3-147	106.3	18	3707.9	3699.4	3699	0.29%	3700.9	1	0	3.15	3.56	3.93
D3-150	D3-149	207.6	18	3708.3	3700.1	3699	0.34%	3701.4	0.87	-	3.41	3.56	4.26
D3-151	D3-150	443.8	18	3709.4	3701.8	3700	0.38%	3702.8	0.67	-	4.01	3.57	4.55
D3-157	D3-358	159.7	12	3707	3700.3	3700	0.22%	3700.5	0.2	-	1.36	0.09	1.17
D3-158	D3-157	63.3	12	3707	3700.5	3700	0.22%	3700.7	0.2	-	1.31	0.09	1.18
D3-159	D3-158	333.2	12	3710.4	3701.2	3700	0.22%	3701.4	0.2	-	1.24	0.07	1.17
D3-160	D3-159	231.8	12	3714.8	3701.7	3701	0.22%	3701.8	0.1	-	0.62	0.02	1.18
D3-205	D3-222	195.3	10	3699.5	3690.1	3689	0.81%	3690.6	0.6	-	4.11	0.94	1.38
D3-209	D3-205	145.5	10	3701.3	3691.8	3690	1.10%	3692.2	0.48	-	4.48	0.83	1.61
D3-210	D3-209	290.9	10	3707.3	3698.8	3692	2.39%	3699.2	0.48	-	6.04	0.83	2.37
D3-222	D3-223	226.5	10	3696.6	3688.4	3686	0.99%	3688.9	0.6	-	4.47	0.94	1.53
D3-223	D3-225	58.1	10	3694.3	3686.2	3685	1.94%	3686.6	0.48	-	5.55	0.94	2.14
D3-225	D3-226	166.5	12	3693.8	3684.6	3684	0.32%	3685.3	0.7	-	2.92	0.95	1.41
D3-226	D3-228	313	12	3693.2	3684.1	3683	0.30%	3684.7	0.6	-	2.57	0.96	1.37
D3-228	D3-307	165.7	12	3690.8	3683.1	3683	0.14%	3683.9	0.8	-	2.7	0.97	0.95
D3-231	D3-232	270.1	10	3688.8	3682.3	3680	0.95%	3682.9	0.72	-	4.45	0.98	1.5
D3-232	D3-233	308.7	10	3686	3679.7	3677	0.93%	3680.2	0.6	-	4.11	0.99	1.48
D3-233	D3-247	299.3	10	3683.8	3676.8	3674	0.90%	3677.4	0.72	-	4.47	1.21	1.45
D3-247	D3-250	313.4	10	3680.3	3674.2	3671	0.86%	3674.8	0.72	-	4.32	1.22	1.42
D3-250	D3-260	291.6	10	3677.7	3671.5	3669	0.87%	3672.5	1.2	0.17	4.11	1.29	1.43

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D3-260	D3-355	15.3	10	3671.7	3668.9	3669	1.57%	3670.4	1.8	0.67	4.21	1.36	1.92
D3-274	D3-356	17.3	10	3669.9	3666.8	3667	1.33%	3668	1.44	0.37	3.97	1.4	1.77
D3-278	D3-280	113.4	12	3670.6	3665.8	3665	0.66%	3666.5	0.7	-	4.06	1.4	2.03
D3-280	D3-281	141	12	3671	3665.1	3664	0.70%	3665.7	0.6	-	4.11	1.4	2.08
D3-281	D3-285	288.8	12	3668.9	3664.1	3662	0.66%	3664.7	0.6	-	4.05	1.47	2.03
D3-285	D2-42	388.6	12	3664.9	3662.2	3660	0.54%	3662.9	0.7	-	4.03	1.47	1.83
D3-303	D3-339	117.7	12	3718.4	3703.8	3704	0.22%	3703.9	0.1	-	0.81	0.01	1.17
D3-307	D3-231	11.2	10	3689	3682.5	3682	1.16%	3683.1	0.72	-	4.05	0.98	1.65
D3-317	C3-6	326.6	10	3670.7	3668.3	3665	0.98%	3668.5	0.24	-	2.04	0.24	1.52
D3-339	D3-338	245.9	12	3716.4	3703.6	3703	0.22%	3702	-1.6	-	0	0	1.17
D3-343	D3-345	340.8	12	3694.9	3676.6	3675	0.48%	3676.8	0.2	-	2.01	0.13	1.72
D3-345	D3-363	240.5	12	3695.7	3674.9	3673	0.64%	3675.1	0.2	-	2.22	0.13	2
D3-353	D3-127	19.2	24	3704.6	3696.5	3696	0.10%	3698.1	0.8	-	2.12	3.72	5.12
D3-355	D3-274	254.7	10	3671.5	3668.7	3667	0.76%	3670.2	1.8	0.67	3.89	1.37	1.34
D3-356	D3-278	125	10	3669.7	3666.5	3666	0.57%	3667.7	1.44	0.37	4.21	1.4	1.16
D3-358	D3-146	259.8	12	3705.7	3699.9	3699	0.22%	3700.1	0.2	-	1.31	0.09	1.17
D3-363	D3-364	100.3	12	3694.3	3673.4	3673	0.74%	3673.6	0.2	-	2.24	0.14	2.14
D3-364	D3-370	98.7	12	3693.8	3672.7	3672	0.63%	3672.8	0.1	-	2.2	0.14	1.98
D3-370	D3-66	33.6	12	3692.7	3672	3672	1.40%	3672.2	0.2	-	1.83	0.14	2.95
D3-373	D3-73	84.9	8	3674.7	3669.9	3670	0.24%	3670.2	0.45	-	1.96	0.19	0.41
D3-62	D3-63	320.6	8	3693.9	3691.6	3685	1.95%	3691.7	0.15	-	3.21	0.1	1.18
D3-63	D3-65	243.8	8	3689.4	3683.1	3682	0.53%	3683.3	0.3	-	2.1	0.12	0.62
D3-65	D3-343	126.1	8	3694.6	3681.8	3680	1.25%	3682	0.3	-	2.85	0.12	0.95
D3-66	D3-72	248.7	8	3692.3	3671.6	3671	0.36%	3671.8	0.3	-	2	0.16	0.51
D3-72	D3-373	195	8	3675	3670.7	3670	0.39%	3670.9	0.3	-	1.72	0.16	0.53
D3-73	D3-317	264.1	10	3674.6	3669.6	3668	0.49%	3669.9	0.36	-	2.42	0.23	1.08
D3-83	D3-86	141.3	24	3699.9	3692.8	3693	0.15%	3694.1	0.65	-	2.71	3.83	6.11
D3-85	D3-83	27	24	3699.9	3692.8	3693	0.07%	3694.2	0.7	-	2.64	3.82	4.31
D3-86	C3-104	327.3	24	3700.1	3692.6	3692	0.12%	3693.9	0.65	-	2.71	3.83	5.47
D3-88	D3-85	178.7	24	3700.1	3693.1	3693	0.15%	3694.4	0.65	-	2.61	3.83	6.04
D3-98	JUB151	146.7	24	3700.7	3693.5	3693	0.08%	3695	0.75	-	2.38	3.78	4.34
D4-1	C4-116	329.7	12	3719.1	3709.3	3708	0.27%	3709.6	0.3	-	1.94	0.28	1.3
D4-10	D4-9	473.6	12	3719.7	3716.3	3715	0.23%	3716.5	0.2	-	1.62	0.16	1.2
D4-104	D4-97	172.6	15	3724.9	3718.5	3718	0.57%	3719.2	0.56	-	4.16	1.7	3.41
D4-118	D4-262	47.5	15	3724	3718.7	3719	0.09%	3719.8	0.88	-	2.36	1.7	1.34
D4-119	D4-118	126.4	15	3726.3	3719.1	3719	0.30%	3720	0.72	-	2.41	1.66	2.47
D4-120	D4-299	116.9	15	3729.4	3719.4	3719	0.17%	3720.4	0.8	-	2.43	1.64	1.87
D4-126	D4-120	135.5	15	3729.6	3720.2	3719	0.62%	3720.8	0.48	-	3.07	1.64	3.56
D4-161	D4-126	563.2	15	3730.5	3723.6	3720	0.60%	3724.2	0.48	-	4.27	1.61	3.49
D4-172	D4-161	252.4	15	3731.6	3724.8	3724	0.46%	3725.4	0.48	-	3.85	1.6	3.07
D4-174	D4-172	342	15	3733.1	3726.4	3725	0.49%	3727.1	0.56	-	3.76	1.57	3.16
D4-180	D4-174	135.2	12	3733.6	3727	3726	0.42%	3727.8	0.8	-	3.68	1.4	1.62
D4-181	D4-180	188.6	12	3735.1	3728.9	3727	1.03%	3729.5	0.6	-	3.98	1.4	2.54
D4-182	D4-181	162.8	12	3736.1	3730.2	3729	0.79%	3730.8	0.6	-	4.46	1.39	2.21

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D4-183	D4-182	257.8	18	3734.4	3730.9	3730	0.21%	3731.5	0.4	-	2.85	1.1	3.4
D4-185	D4-182	252.4	12	3741.5	3734.1	3730	1.49%	3734.3	0.2	-	2.36	0.35	3.04
D4-186	D4-183	229.3	18	3737	3731.6	3731	0.30%	3732.1	0.33	-	2.7	1.1	4.01
D4-187	D4-186	208.3	18	3736.7	3732.1	3732	0.23%	3732.7	0.4	-	2.75	1.1	3.53
D4-188	D4-187	138.5	18	3738.2	3732.4	3732	0.23%	3733	0.4	-	2.53	1.09	3.54
D4-2	D4-1	321.5	12	3721.4	3710.1	3709	0.25%	3710.4	0.3	-	1.91	0.26	1.24
D4-247	D4-249	568.7	8	3731.3	3728.6	3726	0.53%	3728.6	0	-	0.19	0	0.61
D4-249	D4-250	205.2	10	3733	3725.6	3725	0.30%	3725.8	0.24	-	1.42	0.07	0.84
D4-250	D4-251	300.1	10	3733.2	3725	3724	0.26%	3725.2	0.24	-	1.4	0.08	0.79
D4-251	D4-252	255.8	10	3733.5	3724.2	3723	0.58%	3724.4	0.24	-	0.84	0.12	1.17
D4-252	C4-141	263	10	3733.7	3722.7	3723	0.01%	3723.3	0.72	-	0.49	0.12	0.17
D4-256	D4-265	81.5	18	3723	3716.1	3715	0.79%	3716.5	0.27	-	2.34	1.3	6.52
D4-262	D4-104	148	15	3724.2	3718.6	3719	0.09%	3719.7	0.88	-	3	1.7	1.39
D4-264	D4-76	57.2	18	3723.7	3715.2	3715	0.40%	3716.4	0.8	-	3.08	3.02	4.67
D4-265	D4-264	76.8	18	3723.7	3715.4	3715	0.23%	3716.4	0.67	-	1.45	1.3	3.56
D4-299	D4-119	80.2	15	3730.2	3719.2	3719	0.17%	3720.2	0.8	-	2.56	1.65	1.89
D4-3	D4-2	336.8	12	3724.1	3710.9	3710	0.24%	3711.2	0.3	-	1.82	0.24	1.22
D4-318	D4-53	178.2	18	3717.2	3710	3709	0.44%	3711	0.67	-	4.1	3.4	4.9
D4-321	D4-35	122.4	10	3725.1	3718.3	3718	0.29%	3718.6	0.36	-	1.73	0.15	0.82
D4-328	D4-70	128.2	18	3719.8	3713.3	3713	0.44%	3714.2	0.6	-	3.82	3.02	4.89
D4-34	D4-321	385.1	10	3727.7	3719.5	3718	0.30%	3719.7	0.24	-	1.54	0.12	0.84
D4-35	D4-10	545.2	10	3724.5	3718	3716	0.31%	3718.2	0.24	-	1.81	0.15	0.86
D4-36	D3-151	195.7	18	3710.4	3702.8	3702	0.49%	3703.7	0.6	-	4.44	3.56	5.15
D4-38	D4-36	592.2	18	3713.8	3706	3703	0.55%	3706.9	0.6	-	4.73	3.55	5.47
D4-4	D4-3	323.1	12	3726.4	3711.7	3711	0.25%	3712	0.3	-	1.79	0.22	1.24
D4-5	D4-4	330.2	12	3727.3	3712.6	3712	0.27%	3712.9	0.3	-	1.79	0.21	1.3
D4-53	D4-56	669.1	18	3716.8	3709.2	3707	0.36%	3710.2	0.67	-	4.25	3.47	4.4
D4-56	D4-38	145.5	18	3714.6	3706.8	3706	0.53%	3707.8	0.67	-	4.76	3.54	5.35
D4-6	D4-5	374.2	12	3725.3	3713.6	3713	0.26%	3713.8	0.2	-	1.76	0.19	1.26
D4-61	D4-318	271.8	18	3717.8	3711.3	3710	0.48%	3712.2	0.6	-	4.36	3.38	5.11
D4-7	D4-6	291.5	12	3723.7	3714.3	3714	0.25%	3714.5	0.2	-	1.71	0.18	1.26
D4-70	D4-61	377	18	3718.5	3712.7	3711	0.38%	3713.7	0.67	-	4.27	3.35	4.52
D4-76	D4-328	372.1	18	3723.6	3715	3714	0.19%	3716.2	0.8	-	3.61	3.02	3.21
D4-77	D4-256	253.8	18	3724.1	3718	3716	0.78%	3718.5	0.33	-	4.36	1.3	6.51
D4-78	D4-77	391	21	3730.6	3724.4	3718	1.63%	3724.8	0.23	-	4.64	1.3	14.15
D4-8	D4-7	190.5	12	3722.6	3714.8	3714	0.27%	3715.1	0.3	-	1.74	0.18	1.29
D4-82	D4-264	93.8	18	3724	3715.6	3715	0.39%	3716.5	0.6	-	2.46	1.73	4.62
D4-9	D4-8	169.6	12	3721.8	3715.2	3715	0.23%	3715.4	0.2	-	1.59	0.16	1.2
D4-97	D4-82	362.2	18	3724.6	3717.5	3716	0.53%	3718.1	0.4	-	3.45	1.71	5.35
D5-10	D4-185	481.5	12	3746.5	3739.3	3734	1.08%	3739.5	0.2	-	3.51	0.34	2.59
D5-133	D5-135	355.8	12	3704.2	3700.6	3700	0.30%	3700.8	0.2	-	1.99	0.19	1.36
D5-135	D5-136	432.3	12	3705.2	3699.5	3696	0.75%	3699.7	0.2	-	2.62	0.2	2.16
D5-136	D5-137	424.8	12	3701	3696.3	3693	0.75%	3696.5	0.2	-	2.65	0.21	2.16
D5-137	D5-138	373.4	12	3698.3	3693.1	3690	0.75%	3693.3	0.2	-	2.61	0.21	2.16

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D5-138	C5-20	363	12	3695.5	3690.3	3688	0.75%	3690.5	0.2	-	2.52	0.23	2.16
D5-139	D5-133	302.1	12	3704.2	3701.5	3701	0.31%	3701.7	0.2	-	1.22	0.1	1.39
D5-140	D5-139	357.3	12	3712.7	3702.6	3702	0.30%	3702.8	0.2	-	1.54	0.1	1.37
D5-141	D5-140	204.1	12	3714.5	3706.4	3705	0.96%	3706.6	0.2	-	2.3	0.09	2.44
D5-142	D5-141	103.9	12	3714.4	3706.8	3706	0.31%	3707	0.2	-	1.63	0.09	1.38
D5-143	D5-142	238.3	12	3716.2	3707.5	3707	0.31%	3707.7	0.2	-	1.47	0.09	1.4
D5-144	D5-143	352.4	12	3718.5	3708.8	3708	0.35%	3708.9	0.1	-	1.52	0.08	1.49
D5-145	D5-144	243.3	12	3714.3	3709.6	3709	0.33%	3709.7	0.1	-	1.51	0.08	1.44
D5-146	D5-145	355.2	10	3714	3711.6	3710	0.52%	3711.8	0.24	-	1.8	0.07	1.11
D5-147	D5-146	404.8	10	3716.3	3714	3712	0.58%	3714.1	0.12	-	1.73	0.07	1.17
D5-178	D4-188	190.5	18	3739.2	3733.7	3733	0.15%	3734.4	0.47	-	2.66	1.08	2.87
D5-179	D5-178	46.9	18	3739	3733.8	3734	0.19%	3734.5	0.47	-	2.16	1.08	3.22
D5-194	D5-94	113.4	10	3778.2	3771.6	3770	1.29%	3771.6	0	-	1.42	0.04	1.74
D5-20	D5-10	102	12	3747.6	3740.3	3739	1.04%	3740.6	0.3	-	3.35	0.33	2.54
D5-41	D5-20	334.2	12	3748.6	3741.4	3740	0.32%	3741.7	0.3	-	2.3	0.3	1.41
D5-42	D5-41	109.5	12	3749.6	3742.5	3741	1.01%	3742.7	0.2	-	2.39	0.27	2.51
D5-50	D5-42	180.8	12	3751.4	3744.6	3743	1.15%	3744.8	0.2	-	2.92	0.22	2.68
D5-51	D5-50	220.2	12	3754	3747.1	3745	1.12%	3747.2	0.1	-	2.95	0.2	2.64
D5-52	D5-51	190.6	12	3756.3	3749.1	3747	1.09%	3749.3	0.2	-	2.79	0.17	2.61
D5-53	D5-52	200.3	12	3759	3751.6	3749	1.23%	3751.8	0.2	-	2.95	0.17	2.77
D5-85	D5-53	512.3	12	3765.6	3757	3752	1.06%	3757.2	0.2	-	2.42	0.12	2.56
D5-91	D5-85	172.2	12	3769.2	3759.9	3757	1.70%	3760	0.1	-	2.06	0.08	3.25
D5-92	D5-91	321.4	12	3773.7	3763.6	3760	1.14%	3763.7	0.1	-	2.3	0.07	2.67
D5-93	D5-92	554.6	12	3776	3769.9	3764	1.14%	3770	0.1	-	2.01	0.06	2.66
D5-94	D5-93	60.4	10	3777	3770.1	3770	0.33%	3770.2	0.12	-	1.3	0.04	0.88
D5-96	D5-194	540.9	10	3783.1	3777.2	3772	1.04%	3777.3	0.12	-	1.72	0.03	1.57
D5-97	D5-96	616.6	10	3792.1	3782.9	3777	0.92%	3783	0.12	-	1.39	0.02	1.47
D5-98	D5-97	46.8	10	3792.4	3783.1	3783	0.30%	3783.1	0	-	0.93	0.01	0.84
D6-1	D5-147	397.7	10	3721.4	3716.2	3714	0.53%	3716.3	0.12	-	1.68	0.06	1.12
D6-10	D6-9	311.8	12	3799.6	3794.6	3794	0.23%	3794.7	0.1	-	0.92	0.02	1.21
D6-11	D6-10	402	12	3805.2	3798.5	3795	0.93%	3798.5	0	-	1.18	0.01	2.41
D6-12	D6-11	366	12	3807.8	3799.8	3799	0.32%	3799.9	0.1	-	0.73	0	1.4
D6-13	D6-12	106.9	12	3808.7	3800.2	3800	0.34%	3800.2	0	-	0.59	0	1.45
D6-2	D6-1	358	10	3723.4	3718.2	3716	0.53%	3718.3	0.12	-	1.63	0.05	1.12
D6-3	D6-2	282.2	10	3723.5	3719.8	3718	0.53%	3719.9	0.12	-	1.58	0.05	1.12
D6-4	D6-3	271	10	3725.1	3722.3	3720	0.91%	3722.5	0.24	-	1.83	0.04	1.47
D6-5	D6-4	389.9	10	3739	3723.5	3722	0.30%	3723.6	0.12	-	1.28	0.04	0.84
D6-6	D6-5	118.3	10	3729.9	3723.9	3724	0.29%	3724	0.12	-	0.97	0.03	0.83
D6-7	C5-238	239.9	12	3797.8	3791.9	3791	0.27%	3792	0.1	-	1.26	0.04	1.3
D6-8	D6-7	357.4	12	3798.4	3793.2	3792	0.34%	3793.3	0.1	-	1.32	0.04	1.45
D6-9	D6-8	265.7	12	3798.4	3793.7	3793	0.24%	3793.8	0.1	-	0.55	0.03	1.21
E2-10	E2-7	220.6	8	3685.6	3678.6	3678	0.40%	3678.9	0.45	-	2.15	0.2	0.54
E2-100	E2-101	238	8	3671.3	3662.5	3659	1.39%	3662.9	0.6	-	4.61	0.72	1
E2-101	E2-102	137.7	8	3668	3659.2	3657	1.38%	3659.7	0.75	-	4.65	0.77	1

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E2-102	E2-120	147	8	3665.9	3657.3	3655	1.29%	3657.7	0.6	-	4.48	0.77	0.96
E2-120	E2-121	200.7	8	3663.5	3655.4	3653	1.19%	3655.9	0.75	-	4.49	0.77	0.92
E2-121	E2-122	123.3	8	3658.4	3653	3648	4.13%	3653.3	0.45	-	5.34	0.77	1.72
E2-122	E2-123	222.9	10	3654.9	3647.9	3647	0.61%	3648.4	0.6	-	3.5	0.78	1.19
E2-123	E2-124	172.6	10	3652.5	3646.6	3645	0.63%	3647	0.48	-	3.46	0.78	1.22
E2-124	E2-125	177.6	10	3650.9	3645.5	3644	0.57%	3646	0.6	-	3.35	0.78	1.16
E2-125	E2-126	195.6	10	3650.3	3644.4	3643	0.55%	3645	0.72	-	3.46	0.78	1.14
E2-126	E2-128	249.2	10	3648.1	3643.4	3640	1.26%	3643.8	0.48	-	4.69	0.78	1.72
E2-128	D2-269	401.5	30	3643.4	3637.7	3637	0.08%	3638.8	0.44	-	2.29	3.14	8.36
E2-129	E2-128	399.2	30	3644.4	3638.1	3638	0.09%	3639.1	0.4	-	1.98	2.39	8.38
E2-131	E2-129	291.9	30	3642.3	3638.3	3638	0.10%	3639.3	0.4	-	2.11	2.38	8.9
E2-132	E2-131	388	30	3644.2	3638.8	3638	0.10%	3639.6	0.32	-	2.25	2.38	9.22
E2-133	E2-132	356.1	30	3647.2	3639.6	3639	0.24%	3640.3	0.28	-	2.73	2.38	13.95
E2-134	E2-133	196.4	30	3648.9	3640.2	3640	0.30%	3640.9	0.28	-	3.31	2.38	15.74
E2-135	E2-134	247.9	30	3650.7	3640.8	3640	0.26%	3641.5	0.28	-	3.26	2.38	14.59
E2-136	E2-135	493.8	30	3652.5	3642	3641	0.24%	3642.7	0.28	-	3.2	2.37	14.1
E2-137	E2-136	137.5	30	3653.4	3642.3	3642	0.23%	3643.1	0.32	-	3.06	2.37	13.64
E2-138	E2-137	142.1	30	3653.7	3642.6	3642	0.18%	3643.4	0.32	-	2.82	2.37	12.28
E2-139	E2-138	229.6	30	3655.4	3643.3	3643	0.32%	3644	0.28	-	3.11	2.37	16.3
E2-140	E2-139	550	27	3658.2	3646.2	3643	0.51%	3646.7	0.22	-	4.09	2.37	15.56
E2-141	E2-140	401.1	27	3657.2	3648.2	3646	0.51%	3648.8	0.27	-	4.22	2.32	15.43
E2-142	E2-141	218.4	27	3658.8	3649.3	3648	0.51%	3649.9	0.27	-	4.14	2.32	15.53
E2-143	E2-142	149.9	27	3662.3	3650.2	3649	0.57%	3650.8	0.27	-	4.15	2.32	16.42
E2-144	E2-143	431.9	24	3670.4	3656.3	3650	1.43%	3656.8	0.25	-	5.27	2.31	18.96
E2-145	E2-144	227.2	24	3675.4	3659.8	3656	1.53%	3660.3	0.25	-	6.26	2.31	19.58
E2-146	E2-145	55.9	24	3675.7	3660.7	3660	1.61%	3661.2	0.25	-	5.92	2.31	20.1
E2-147	E2-146	133.3	24	3675.1	3662.1	3661	1.03%	3662.6	0.25	-	5.42	2.31	16.11
E2-148	E2-147	99.8	24	3676.2	3663.2	3662	1.07%	3663.7	0.25	-	5.19	2.31	16.4
E2-149	E2-148	91.3	24	3677	3664	3663	0.89%	3664.6	0.3	-	4.97	2.31	14.92
E2-150	E2-149	91.3	24	3676.1	3664.8	3664	0.84%	3665.3	0.25	-	4.73	2.31	14.54
E2-151	E2-150	199.9	24	3677.4	3666.4	3665	0.82%	3666.9	0.25	-	4.8	2.3	14.3
E2-152	E2-151	106.1	24	3678.3	3667.3	3666	0.89%	3667.9	0.3	-	4.88	2.3	14.91
E2-153	E2-152	118.1	24	3679.4	3668.4	3667	0.94%	3669	0.3	-	4.92	2.3	15.36
E2-2	E2-97	308.8	8	3683.8	3673.4	3672	0.42%	3674.9	2.25	0.83	3.4	0.71	0.55
E2-5	E2-2	308.8	8	3686.1	3676	3674	0.57%	3677.1	1.65	0.43	3.36	0.73	0.64
E2-6	E2-5	176.4	8	3684.8	3676.7	3676	0.40%	3677.1	0.6	-	1.47	0.22	0.53
E2-7	E2-6	257	8	3683.7	3677.7	3677	0.40%	3678	0.45	-	2.24	0.22	0.54
E2-9	E2-5	313.6	8	3689	3676.9	3676	0.28%	3678.5	2.4	0.93	2.44	0.55	0.45
E2-97	E2-98	167.8	8	3678.9	3672	3668	2.66%	3672.4	0.6	-	5.36	0.71	1.38
E2-98	E2-99	222.9	8	3676.8	3667.6	3664	1.39%	3668	0.6	-	4.68	0.71	1
E2-99	E2-100	140.9	8	3673.5	3664.5	3663	1.38%	3664.9	0.6	-	4.68	0.72	1
E3-139	E2-9	311.2	8	3691.4	3681.4	3677	1.45%	3681.8	0.6	-	2.97	0.55	1.02
E3-140	E3-139	221.7	8	3693.6	3682.9	3681	0.67%	3683.4	0.75	-	3.38	0.54	0.69
E3-141	E3-140	260.8	8	3694.2	3684.2	3683	0.48%	3684.7	0.75	-	2.95	0.53	0.58

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E3-143	E3-141	270.7	8	3696	3686.8	3684	0.91%	3687.1	0.45	-	3.61	0.52	0.81
E3-152	E2-10	322.9	8	3688.1	3679.9	3679	0.40%	3680.2	0.45	-	2.16	0.2	0.54
E3-154	E3-152	395.8	8	3689.9	3681.5	3680	0.40%	3681.8	0.45	-	2.14	0.19	0.53
E3-201	E3-154	191.1	12	3691	3681.9	3682	0.22%	3682.2	0.3	-	1.64	0.18	1.17
E3-202	E3-201	171.6	12	3691.9	3682.3	3682	0.22%	3682.6	0.3	-	1.64	0.18	1.17
E3-204	E3-202	218.1	12	3693	3682.8	3682	0.22%	3683.1	0.3	-	1.55	0.15	1.17
E3-205	E3-204	127.1	12	3693	3683.1	3683	0.22%	3683.3	0.2	-	1.33	0.11	1.17
E3-207	E3-205	297	12	3692	3683.8	3683	0.22%	3684	0.2	-	1.42	0.1	1.17
E3-209	E3-207	56.3	12	3691.7	3683.9	3684	0.22%	3684.1	0.2	-	1.34	0.1	1.17
E3-210	E3-209	181.8	12	3691	3684.3	3684	0.22%	3684.5	0.2	-	1.36	0.09	1.17
E3-211	E3-210	71.7	12	3690.2	3684.5	3684	0.22%	3684.7	0.2	-	1.35	0.09	1.18
E3-307	E3-308	395.1	24	3712.4	3702.9	3692	2.86%	3703.3	0.2	-	7.71	2.04	26.79
E3-308	E3-309	35.4	30	3706.6	3691.2	3691	0.54%	3691.8	0.24	-	3.26	2.27	21.03
E3-309	E3-310	274	30	3706.5	3691	3690	0.28%	3691.6	0.24	-	3.61	2.27	15.12
E3-310	E3-311	477.8	27	3700.8	3690.2	3688	0.54%	3690.8	0.27	-	4.2	2.28	15.9
E3-311	E3-312	55.4	27	3697.6	3687.6	3687	0.63%	3688.2	0.27	-	5.22	2.28	17.24
E3-312	E3-313	489.8	27	3697.3	3687.3	3677	2.04%	3687.7	0.18	-	5.37	2.29	30.99
E3-313	E3-314	183.8	27	3686	3677.3	3676	0.60%	3677.9	0.27	-	4.36	2.29	16.78
E3-314	E3-315	303.1	27	3685.1	3676.2	3674	0.63%	3676.8	0.27	-	4.66	2.29	17.21
E3-315	E2-153	665.5	24	3687.3	3674.3	3668	0.88%	3674.8	0.25	-	5.13	2.3	14.84
E3-34	D3-210	388.5	10	3714.2	3707.5	3699	2.09%	3707.8	0.36	-	5.64	0.75	2.22
E3-35	E3-34	223.9	10	3716.1	3708.5	3707	0.45%	3709.1	0.72	-	3.25	0.75	1.03
E3-36	E3-35	97.5	10	3716.9	3710.1	3709	1.32%	3710.5	0.48	-	4.63	0.74	1.76
E3-37	E3-36	309.7	10	3720.2	3711	3710	0.26%	3711.7	0.84	-	2.71	0.72	0.78
E3-4	E3-143	230.8	8	3697.9	3693.6	3688	2.56%	3693.9	0.45	-	5.53	0.52	1.35
E3-40	E3-37	388.4	10	3722.2	3711.9	3711	0.25%	3712.5	0.72	-	2.22	0.65	0.77
E3-41	E3-40	52.3	10	3722.6	3712	3712	0.06%	3712.7	0.84	-	2.22	0.65	0.37
E3-43	E3-41	258.9	10	3722.7	3712.7	3712	0.24%	3713.2	0.6	-	2.18	0.64	0.76
E3-44	E3-43	89.2	10	3722.5	3712.8	3713	0.18%	3713.5	0.84	-	2.22	0.6	0.65
E3-45	E3-44	330.3	10	3721.7	3713.7	3713	0.24%	3714.2	0.6	-	2.22	0.6	0.75
E3-47	E3-45	200	8	3721.1	3714.4	3714	0.32%	3715.3	1.35	0.23	2.92	0.59	0.48
E3-5	E3-4	249.1	8	3700.2	3695.3	3694	0.56%	3695.8	0.75	-	3.16	0.5	0.64
E3-6	E3-5	250.4	8	3701.8	3696.3	3695	0.36%	3696.9	0.9	-	2.71	0.49	0.51
E3-64	E3-59	414.5	12	3728.6	3715.8	3715	0.22%	3715.9	0.1	-	1.09	0.04	1.17
E3-7	E3-6	208.8	8	3703.5	3697.5	3696	0.50%	3697.9	0.6	-	2.78	0.46	0.6
E3-73	E3-64	320.5	12	3733.3	3716.5	3716	0.22%	3716.5	0	-	0.5	0.01	1.17
E3-8	E3-7	216.5	8	3706.5	3699.3	3698	0.80%	3699.7	0.6	-	3.46	0.46	0.76
E4-106	E4-227	320.5	18	3766.9	3761.8	3760	0.47%	3762.2	0.27	-	2.86	0.71	5.07
E4-108	E4-106	320.6	18	3767.7	3763.2	3762	0.41%	3763.6	0.27	-	2.91	0.67	4.72
E4-109	E4-108	257.3	18	3769.4	3764.2	3763	0.40%	3764.6	0.27	-	2.84	0.67	4.68
E4-110	E4-226	144	18	3770.9	3765.2	3765	0.46%	3765.5	0.2	-	1.62	0.28	4.98
E4-219	E4-43	185.4	18	3752.9	3742	3742	0.24%	3742.6	0.4	-	3.07	1.28	3.62
E4-220	E4-348	332.2	18	3752.7	3743	3742	0.25%	3743.6	0.4	-	2.71	1.27	3.7
E4-221	E4-220	388.5	18	3754.7	3743.9	3743	0.25%	3744.6	0.47	-	2.86	1.27	3.66

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E4-226	E4-109	93.4	18	3769.9	3764.6	3764	0.39%	3765	0.27	-	2.73	0.67	4.57
E4-227	E4-93	9.8	18	3767	3760.3	3760	1.02%	3760.8	0.33	-	3.84	0.95	7.44
E4-348	E4-219	58.7	18	3754.6	3742.1	3742	0.22%	3742.8	0.47	-	2.61	1.28	3.46
E4-39	D4-78	401.6	18	3732.7	3726.8	3724	0.61%	3727.3	0.33	-	4.01	1.29	5.74
E4-40	E4-39	421.6	18	3736.9	3730.8	3727	0.95%	3731.3	0.33	-	4.32	1.29	7.16
E4-41	E4-40	400.3	18	3744	3734.8	3731	1.00%	3735.3	0.33	-	4.75	1.29	7.35
E4-42	E4-41	426.7	18	3749.7	3738.8	3735	0.94%	3739.3	0.33	-	4.67	1.29	7.12
E4-43	E4-42	238.7	18	3752.9	3741.5	3739	1.12%	3741.9	0.27	-	4.77	1.28	7.79
E4-47	E4-221	57.5	18	3754.5	3744.3	3744	0.50%	3744.9	0.4	-	3.35	1.26	5.22
E4-62	E4-47	340.7	18	3757.6	3747.7	3744	1.00%	3748.1	0.27	-	3.9	1.26	7.36
E4-63	E4-62	298.3	18	3761.4	3750.7	3748	1.00%	3751.1	0.27	-	4.72	1.25	7.35
E4-64	E4-63	576.4	18	3760.9	3753.1	3751	0.41%	3753.6	0.33	-	3.44	1.2	4.74
E4-65	E4-64	274.7	18	3760.9	3754.3	3754	0.05%	3755.1	0.53	-	2.22	1.08	1.66
E4-66	E4-65	290	18	3760.9	3755.6	3754	0.44%	3756	0.27	-	2.11	1	4.89
E4-91	E4-66	289	18	3761.8	3756.3	3756	0.26%	3756.9	0.4	-	2.9	0.99	3.72
E4-92	E4-91	337.2	18	3762.9	3757.2	3756	0.25%	3757.7	0.33	-	2.63	0.99	3.69
E4-93	E4-92	290.1	18	3767	3760.2	3757	1.04%	3760.6	0.27	-	3.39	0.96	7.52
E5-1	D5-179	244	18	3740.9	3734.2	3734	0.13%	3734.8	0.4	-	2.11	1.07	2.68
E5-119	E5-1	446.9	18	3743	3735	3734	0.20%	3735.6	0.4	-	2.3	1.06	3.26
E5-17	E5-7	491.7	15	3744.3	3739.3	3736	0.69%	3739.7	0.32	-	3.64	0.73	3.77
E5-18	E5-17	395.1	12	3747.3	3743.8	3739	1.11%	3744.1	0.3	-	4.29	0.73	2.63
E5-19	E5-18	326.1	15	3750.8	3745.1	3744	0.41%	3745.5	0.32	-	3.04	0.72	2.9
E5-29	E5-19	331.1	8	3755.9	3749.8	3747	0.72%	3750.4	0.9	-	3.63	0.67	0.72
E5-30	E5-29	224.9	10	3757.4	3752.7	3750	1.09%	3753.1	0.48	-	4.28	0.67	1.6
E5-31	E5-30	47.3	10	3759.2	3753.6	3753	1.80%	3753.9	0.36	-	4.47	0.67	2.06
E5-32	E5-31	256.8	10	3759.9	3755.9	3754	0.92%	3756.3	0.48	-	4.01	0.67	1.47
E5-36	E5-32	237.7	10	3762.9	3757.1	3756	0.50%	3757.6	0.6	-	3.24	0.65	1.09
E5-39	E5-36	241.9	10	3765.4	3758.9	3757	0.74%	3759.3	0.48	-	3.4	0.65	1.32
E5-40	E5-39	337.5	10	3766.5	3761.4	3759	0.74%	3761.8	0.48	-	3.68	0.65	1.32
E5-41	E5-40	318.3	12	3771.1	3763.4	3761	0.64%	3763.8	0.4	-	3.35	0.65	1.99
E5-42	E5-41	392.1	12	3770.9	3766.6	3763	0.81%	3767	0.4	-	3.64	0.65	2.24
E5-43	E5-42	252.6	12	3774.4	3767.4	3767	0.34%	3767.9	0.5	-	2.86	0.63	1.46
E5-54	E5-43	429.1	12	3776.4	3769.2	3768	0.70%	3773.1	3.9	2.9	3.51	0.6	2.09
E5-55	E5-54	267.7	12	3779.3	3769.9	3769	0.70%	3774.9	5	4	3.58	0.61	2.09
E5-56	E5-55	369.4	12	3780.5	3770.7	3770	0.46%	3776.7	6	5	3.22	0.62	1.69
E5-62	E5-56	45.4	12	3780.7	3776.5	3776	0.59%	3776.9	0.4	-	2.84	0.58	1.92
E5-63	E5-62	319.7	12	3784.5	3778.3	3777	0.55%	3778.7	0.4	-	3.08	0.58	1.85
E5-64	E5-63	356.7	10	3788.9	3781.5	3778	0.90%	3781.9	0.48	-	3.8	0.59	1.45
E5-7	E5-119	25.4	18	3743.3	3735.2	3735	0.63%	3735.7	0.33	-	2.61	1.02	5.84
E5-75	E5-64	312.4	10	3792.5	3784.7	3781	1.03%	3785	0.36	-	3.52	0.48	1.56
E5-76	E5-75	336.6	10	3795.4	3787.9	3785	0.96%	3788.3	0.48	-	3.74	0.48	1.5
E6-1	E5-76	331.7	12	3797.5	3789.7	3788	0.52%	3790	0.3	-	2.98	0.48	1.81
E6-10	E6-9	400.3	10	3798.9	3794.6	3794	0.28%	3794.8	0.24	-	1.14	0.04	0.81
E6-11	E6-10	374.4	10	3799.3	3795.7	3795	0.28%	3795.8	0.12	-	1.03	0.03	0.81

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E6-12	E6-11	369.8	10	3799.9	3796.8	3796	0.28%	3796.8	0	-	0.94	0.02	0.81
E6-13	E6-12	263.7	8	3801	3797.8	3797	0.40%	3797.9	0.15	-	0.99	0.02	0.53
E6-14	E6-8	245.1	10	3800.9	3793.5	3792	0.52%	3793.9	0.48	-	2.98	0.44	1.1
E6-15	E6-16	348	10	3804.4	3797.3	3787	4.26%	3801.5	5.04	3.37	1.04	0.01	3.16
E6-16	E6-17	489.3	6	3798.8	3786.6	3772	3.06%	3786.7	0.2	-	1.66	0.01	0.69
E6-22	E6-13	65.7	10	3802	3798	3798	0.29%	3798.1	0.12	-	0.87	0.01	0.82
E6-23	E6-1	199	12	3798.6	3790.7	3790	0.49%	3791	0.3	-	2.91	0.49	1.75
E6-7	E6-23	141	12	3799.4	3791.4	3791	0.55%	3791.8	0.4	-	2.94	0.49	1.86
E6-8	E6-7	148.8	12	3800	3792.2	3791	0.52%	3792.6	0.4	-	2.93	0.48	1.81
E6-9	E6-8	399.3	10	3799.5	3793.5	3792	0.28%	3793.6	0.12	-	1.26	0.04	0.81
F3-67	E3-307	659.5	27	3716.2	3707	3703	0.61%	3707.5	0.22	-	5.21	2.04	16.95
F3-68	F3-67	162	27	3717	3708	3707	0.64%	3708.6	0.27	-	4.14	2.03	17.29
F3-69	F3-68	402.9	27	3719.4	3710.5	3708	0.62%	3711.1	0.27	-	4.31	2.03	17.11
F3-70	F3-69	659.9	24	3728.8	3719.9	3711	1.42%	3720.3	0.2	-	5.3	2.03	18.88
F3-71	F3-70	659.8	24	3735.3	3725.2	3720	0.81%	3725.8	0.3	-	5.31	2.03	14.25
F3-72	F3-71	659.4	30	3735.6	3726.9	3725	0.26%	3727.6	0.28	-	3.53	2.02	14.63
F3-73	F3-72	508.8	24	3737.6	3730	3727	0.60%	3730.5	0.25	-	3.93	2.02	12.24
F4-10	F4-7	385.3	18	3776.1	3769.4	3768	0.40%	3769.6	0.13	-	2.18	0.27	4.68
F4-11	F4-10	300	18	3777.9	3770.9	3769	0.50%	3771.1	0.13	-	2.23	0.26	5.22
F4-12	F4-11	451	18	3779.6	3772.8	3771	0.41%	3773	0.13	-	2.21	0.25	4.71
F4-13	F4-12	402.9	18	3780.6	3773.9	3773	0.29%	3774.2	0.2	-	1.98	0.25	3.93
F4-15	F4-13	203.8	18	3781.1	3774.5	3774	0.29%	3774.7	0.13	-	1.5	0.16	3.96
F4-16	F4-15	292.3	18	3783.4	3775.6	3774	0.39%	3775.8	0.13	-	1.77	0.16	4.57
F4-17	F4-16	378.7	18	3784.4	3777.5	3776	0.49%	3777.7	0.13	-	2.01	0.16	5.14
F4-25	F4-81	14	10	3745.6	3740.6	3740	1.07%	3740.7	0.12	-	1.97	0.05	1.59
F4-54	F4-41	120.7	10	3741.6	3735.4	3735	0.22%	3735.5	0.12	-	0.52	0	0.71
F4-6	E4-110	232.8	18	3773.2	3766.7	3765	0.64%	3766.9	0.13	-	2.47	0.28	5.86
F4-7	F4-6	284	18	3773.9	3767.8	3767	0.40%	3768.1	0.2	-	2.24	0.27	4.64
F4-73	F3-73	489.9	24	3742.3	3732.9	3730	0.60%	3733.5	0.3	-	4.4	2.02	12.25
F4-74	F4-73	114.8	27	3742.4	3733.4	3733	0.41%	3734	0.27	-	3.78	2.02	13.88
F4-75	F4-74	125.3	27	3741.4	3733.9	3733	0.42%	3734.5	0.27	-	3.55	2.02	14.1
F4-76	F4-75	102.4	27	3741.5	3734.3	3734	0.41%	3735	0.31	-	3.51	2.02	13.89
F4-77	F4-76	243	27	3743	3735.3	3734	0.38%	3735.9	0.27	-	3.52	2.02	13.42
F4-78	F4-77	248.7	27	3744.5	3736.2	3735	0.38%	3736.8	0.27	-	3.57	2.01	13.33
F4-79	F4-78	143.9	27	3745	3736.8	3736	0.41%	3737.4	0.27	-	3.55	2.01	13.89
F4-80	F4-79	187.9	27	3744.5	3737.5	3737	0.37%	3738.1	0.27	-	3.52	2.01	13.24
F4-81	F4-80	245.3	27	3745.4	3738.4	3737	0.38%	3739	0.27	-	3.52	2	13.35
F4-82	F4-81	709.6	24	3752.7	3743.8	3738	0.76%	3744.3	0.25	-	4.22	1.96	13.78
F4-83	F4-82	592.2	24	3763.4	3755	3744	1.89%	3755.4	0.2	-	5.58	1.95	21.79
F4-84	F4-83	640.3	24	3770.2	3761.1	3755	0.95%	3761.6	0.25	-	5.64	1.94	15.46
F4-85	F4-84	649.1	24	3776.4	3767.8	3761	1.03%	3768.2	0.2	-	5.09	1.93	16.05
F4-86	F4-85	437.3	24	3782.4	3772.3	3768	1.04%	3772.8	0.25	-	5.26	1.91	16.12
F4-87	F4-86	521.6	27	3784.2	3773.7	3772	0.28%	3774.4	0.31	-	3.81	1.91	11.43
F4-88	F4-87	394.3	27	3783.9	3774.8	3774	0.27%	3775.4	0.27	-	3.14	1.9	11.35

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
F4-89	F4-88	76.6	24	3783.4	3775.3	3775	0.56%	3775.8	0.25	-	3.61	1.9	11.87
F5-1	F5-6	369.9	18	3788.1	3781.2	3779	0.50%	3781.4	0.13	-	2	0.15	5.2
F5-10	F5-9	147	18	3802.9	3794.8	3794	0.28%	3795.3	0.33	-	2.42	0.83	3.88
F5-11	F5-10	309.1	18	3802.9	3795.5	3795	0.25%	3796	0.33	-	2.53	0.82	3.65
F5-112	F4-89	656.2	24	3786.3	3778.6	3775	0.50%	3779.1	0.25	-	4.06	1.9	11.2
F5-113	F5-112	659.1	24	3789.6	3781.9	3779	0.50%	3782.5	0.3	-	4.04	1.89	11.24
F5-114	F5-113	659.5	24	3794.4	3785.3	3782	0.51%	3785.8	0.25	-	4.06	1.89	11.32
F5-115	F5-114	603.1	24	3804.8	3789.5	3785	0.70%	3790	0.25	-	4.33	1.89	13.27
F5-116	F5-115	246.4	21	3808	3795.7	3790	2.52%	3796	0.17	-	3.92	1.03	17.63
F5-117	F5-116	575.4	21	3812.2	3800	3796	0.74%	3800.4	0.23	-	4.64	1.02	9.57
F5-118	F5-117	578.3	21	3814.5	3803.5	3800	0.61%	3803.9	0.23	-	3.67	1.01	8.67
F5-119	F5-118	139.2	21	3815.7	3803.7	3804	0.11%	3804.3	0.34	-	2.64	1.01	3.64
F5-12	F5-11	315.3	18	3802.9	3796.3	3796	0.24%	3796.8	0.33	-	2.48	0.82	3.63
F5-120	F5-119	62.5	21	3815.7	3803.8	3804	0.10%	3804.4	0.34	-	1.96	1.01	3.49
F5-121	F5-120	60	21	3815.9	3803.8	3804	0.10%	3804.5	0.4	-	1.84	1.01	3.56
F5-13	F5-12	335.9	18	3804.4	3799.4	3796	0.94%	3799.8	0.27	-	3.13	0.81	7.12
F5-14	F5-13	359.4	18	3807.9	3802.7	3799	0.89%	3803	0.2	-	4.01	0.8	6.94
F5-15	F5-14	172.7	24	3809.4	3804.3	3803	0.96%	3804.6	0.15	-	3.65	0.8	15.53
F5-16	F5-15	435.4	24	3814.4	3808.3	3804	0.92%	3808.6	0.15	-	3.92	0.79	15.18
F5-17	F5-16	264.2	24	3817	3810.7	3808	0.89%	3811	0.15	-	3.82	0.78	14.91
F5-2	F5-1	375.9	18	3790.6	3783.5	3781	0.60%	3783.6	0.07	-	2.05	0.15	5.69
F5-3	F5-2	437.6	18	3793.2	3786.1	3783	0.60%	3786.3	0.13	-	2.12	0.15	5.7
F5-30	F5-5	199.6	12	3807.2	3792.3	3792	0.22%	3792.5	0.2	-	1.67	0.14	1.17
F5-31	F5-30	513.3	12	3810.9	3793.4	3792	0.22%	3793.7	0.3	-	1.55	0.14	1.17
F5-32	F5-31	551.8	12	3813.1	3794.6	3793	0.22%	3794.9	0.3	-	1.58	0.14	1.17
F5-33	F5-51	310.3	8	3815	3796.2	3795	0.40%	3796.4	0.3	-	2.05	0.15	0.53
F5-34	F5-33	231.9	12	3817.4	3802.3	3796	2.62%	3802.4	0.1	-	3.48	0.16	5.37
F5-4	F5-3	315.6	18	3797.2	3788.7	3786	0.82%	3788.9	0.13	-	2.2	0.14	6.68
F5-5	F5-4	321.2	18	3803	3791.3	3789	0.82%	3791.5	0.13	-	2.28	0.14	6.64
F5-51	F5-32	130.6	12	3814	3794.9	3795	0.22%	3795.2	0.3	-	1.64	0.15	1.18
F5-6	F4-17	379.5	18	3786	3779.4	3777	0.50%	3779.6	0.13	-	2	0.15	5.2
F5-7	F5-115	477.5	18	3802.4	3792.6	3791	0.26%	3793.1	0.33	-	2.79	0.85	3.75
F5-8	F5-7	418.8	18	3802.7	3793.7	3793	0.27%	3794.2	0.33	-	2.58	0.84	3.84
F5-86	F5-34	399.9	12	3818	3803.2	3802	0.20%	3803.4	0.2	-	1.62	0.14	1.12
F5-87	F5-86	399.9	12	3819	3804.2	3803	0.24%	3804.5	0.3	-	1.94	0.22	1.22
F5-88	F5-87	94.8	8	3818.9	3804.9	3805	0.40%	3805.5	0.9	-	2.9	0.53	0.54
F5-9	F5-8	313.5	18	3802.9	3794.4	3794	0.20%	3794.9	0.33	-	2.45	0.83	3.32
G5-1	F5-17	507.9	24	3821	3811.9	3811	0.25%	3812.4	0.25	-	2.6	0.78	7.92
G5-2	G5-1	505.2	24	3823	3815.2	3812	0.64%	3815.5	0.15	-	2.78	0.77	12.7
G5-3	G5-2	504	24	3825.1	3816.4	3815	0.25%	3816.9	0.25	-	2.59	0.76	7.92
JUB045	E6-22	221.7	12	3803.8	3798.5	3798	0.22%	3798.6	0.1	-	0.7	0.01	1.17
JUB046	JUB045	71.2	12	3802.6	3798.7	3799	0.23%	3798.7	0	-	0.59	0.01	1.18
JUB098	F5-121	207.9	21	3815.5	3804	3804	0.10%	3804.7	0.4	-	1.83	1	3.53
JUB101	C1-51	44.6	24	3247.5	3237.2	3236	2.20%	3238	0.4	-	7.17	5.6	23.48

Appendix F - Existing Model Results

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
JUB108	C5-175	345	12	3793.6	3784.2	3784	0.20%	3784.3	0.1	-	0.73	0.01	1.11
JUB109	D6-6	1518.4	10	3774.1	3729.2	3725	0.30%	3729.3	0.12	-	0.96	0.01	0.84
JUB132	D3-142	118.9	18	3708.9	3698.7	3698	0.20%	3700	0.87	-	4.05	3.65	3.25
JUB137	B2-69	59.7	10	3634.1	3627.8	3627	1.04%	3627.9	0.12	-	1.81	0.1	1.56
JUB151	D3-88	313.7	24	3703.2	3693.3	3693	0.07%	3694.8	0.75	-	2.54	3.8	4.32

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Appendix G

Committed Model Results

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The City of Twin Falls - 2015 Wastewater Collection System Master Plan
Appendix G - Committed Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B1-10	B1-9	659.1	36	3594	3585.88	3583.8	0.31%	3587.99	0.7	-	5.62	0.01	0.54
B1-108	B1-48	40	10	3596.3	3587.51	3587.2	0.75%	3588.33	0.98	-	4.04	0	0.54
B1-12	B1-17	448.1	36	3609	3602.88	3591.1	2.62%	3604	0.37	-	13.6	0.01	0.54
B1-13	B1-12	510.1	36	3615.6	3604.62	3602.9	0.34%	3606.71	0.7	-	6.49	0.01	0.54
B1-14	B1-13	489.7	36	3614.9	3606.31	3604.6	0.35%	3608.41	0.7	-	6.03	0.02	0.25
B1-15	B1-16	25.6	36	3620	3608.89	3608.8	0.51%	3611.2	0.77	-	5.87	0.01	0.03
B1-16	B1-194	226.1	36	3617.6	3608.76	3607.6	0.50%	3610.72	0.65	-	6.49	0.02	0.25
B1-163	B1-7	286.6	42	3597.7	3581.92	3581.5	0.15%	3584.61	0.77	-	4	0.01	0.51
B1-17	B1-10	645.7	36	3597.8	3587.75	3585.9	0.29%	3589.96	0.74	-	5.82	0	0.54
B1-179	B1-8	330.2	42	3591.6	3583.16	3582.5	0.21%	3585.6	0.7	-	4.26	0.01	0.25
B1-19	B1-5	227.5	42	3594.9	3580.5	3580.2	0.11%	3583.24	0.78	-	4.09	0.01	0.54
B1-194	B1-14	264.9	36	3615.6	3607.63	3606.3	0.50%	3609.57	0.65	-	6.25	0	1.12
B1-2	JUB153	41.3	42	3182.7	3174.54	3173.5	6.03%	3177.57	0.87	-	16.17	0	1.17
B1-28	B1-29	42.6	42	3595.1	3578.44	3576.7	4.16%	3579.71	0.36	-	13.15	1.52	3.88
B1-29	B1-30	430.4	24	3593.7	3576.67	3182.2	229.19%	3577.08	0.2	-	21.51	5.79	11.87
B1-30	B1-32	162.4	24	3191.3	3181.97	3178.8	1.93%	3186.77	2.4	2.8	10.76	0	0.54
B1-32	B1-2	142.4	24	3184.7	3178.83	3176	1.97%	3182.31	1.74	1.48	11.33	0.01	5.2
B1-33	B1-37	296.4	10	3618.4	3609.23	3607.3	0.64%	3609.8	0.68	-	3.65	0	0.54
B1-35	B1-33	253.6	8	3619.2	3610.49	3609.7	0.31%	3612.64	3.23	1.48	3.79	0.09	0.53
B1-36	B1-35	259.8	8	3619	3611.78	3610.6	0.46%	3614.52	4.11	2.07	3.13	0.01	0.54
B1-37	B1-38	298.9	10	3616.1	3607.22	3605.7	0.50%	3609.04	2.18	0.99	3.35	0.61	6.13
B1-38	B1-39	286.4	10	3614.3	3605.62	3604.2	0.50%	3608.16	3.05	1.71	3.01	3.1	3.64
B1-39	B1-40	405.5	10	3612.9	3604.01	3602.4	0.39%	3607.33	3.98	2.49	3.16	1.52	3.63
B1-4	B1-28	49.1	42	3593.5	3579.57	3578.4	2.30%	3581	0.41	-	9.9	0.01	0.54
B1-40	B1-41	406.3	10	3610.4	3602.32	3600.8	0.37%	3605.11	3.35	1.96	3.17	0	0.53
B1-41	B1-76	275.4	10	3608.9	3600.75	3599.8	0.36%	3602.87	2.54	1.29	3.18	0	0.6
B1-42	B1-85	163.9	10	3608.1	3599.18	3598.5	0.42%	3600.45	1.52	0.44	3.39	0.04	2.56
B1-43	B1-86	142	10	3604.6	3597.83	3595.6	1.57%	3598.33	0.6	-	5.36	0.01	0.54
B1-46	B1-108	137.1	10	3596.2	3588.14	3587.5	0.46%	3589.35	1.45	0.38	3.64	0.03	1.18
B1-47	B1-4	248.5	42	3593.9	3579.88	3579.6	0.12%	3582.29	0.69	-	5.59	0.01	0.54
B1-48	B1-47	253.9	10	3595.9	3587.11	3583.7	1.34%	3587.66	0.66	-	5.41	0	0.54
B1-5	B1-47	261.8	42	3594.3	3580.24	3579.9	0.14%	3582.82	0.74	-	4.4	0.02	0.54
B1-6	B1-19	273.9	42	3595.7	3580.86	3580.5	0.13%	3583.65	0.8	-	3.93	0	0.25
B1-68	B1-46	27.9	10	3597.8	3588.27	3588.2	0.43%	3589.67	1.68	0.57	3.63	0.02	0.98
B1-7	B1-6	439.5	42	3596.4	3581.49	3580.9	0.14%	3584.19	0.77	-	3.96	0	0.54
B1-76	B1-42	129.2	10	3607.8	3599.76	3599.3	0.37%	3601.33	1.88	0.74	3.39	0	0.53
B1-8	B1-163	368.4	42	3590	3582.48	3581.9	0.15%	3585.12	0.75	-	4.04	0.01	0.25
B1-85	B1-43	104.6	10	3606	3598.39	3597.9	0.47%	3599.33	1.13	0.11	3.7	0.01	0.54
B1-86	B1-87	399.6	10	3601.7	3595.63	3589.7	1.48%	3596.12	0.59	-	5.22	0	0.54
B1-87	B1-68	182.3	10	3597.8	3589.62	3588.4	0.69%	3590.89	1.52	0.44	3.42	0	0.41
B1-9	B1-179	315.8	42	3592.2	3583.81	3583.2	0.21%	3586.17	0.67	-	4.52	0.02	0.25
B2-1	B1-15	469.3	36	3623	3614.76	3613.4	0.29%	3616.96	0.73	-	6.27	0.01	0.54
B2-10	B2-9	501.3	36	3662.1	3654.14	3650	0.84%	3655.62	0.49	-	8.74	0	0.53
B2-103	B2-19	108.6	21	3638.7	3631.84	3631.1	0.64%	3632.3	0.26	-	3.37	0.01	0.25
B2-11	B2-59	499.7	27	3630	3624.95	3624.5	0.08%	3625.65	0.31	-	1.6	0.07	0.54
B2-12	B2-11	497.3	27	3633.5	3625.39	3625	0.09%	3626.08	0.31	-	1.88	0	0.53
B2-13	B2-12	305.2	27	3631.4	3625.52	3625.4	0.04%	3626.32	0.36	-	1.72	0	0.53
B2-14	B2-13	382.9	27	3635.6	3625.69	3625.5	0.04%	3626.51	0.36	-	1.52	0	0.53

Appendix G - Committed Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B2-143	B2-142	281.9	8	3626	3619.23	3617.2	0.72%	3619.73	0.75	-	3.47	0.06	0.54
B2-144	B2-143	143.1	8	3625.6	3620.23	3619.5	0.51%	3620.78	0.83	-	3.12	0.01	0.53
B2-15	B2-14	399	10	3633.6	3628.23	3627.1	0.28%	3628.33	0.12	-	1.04	0	0.53
B2-16	B2-15	397.6	10	3635	3629.36	3628.2	0.28%	3629.44	0.1	-	0.83	0.01	0.53
B2-17	B2-16	401.7	10	3635.5	3630.49	3629.4	0.28%	3630.56	0.08	-	0.79	0.01	0.53
B2-18	B2-17	311.3	10	3635.4	3631.37	3630.5	0.28%	3631.42	0.06	-	0.54	1.83	7.04
B2-19	B2-20	324.3	21	3640.9	3631.14	3630.2	0.31%	3631.67	0.3	-	2.87	0.01	0.25
B2-2	B2-1	508.3	36	3623.8	3615.97	3614.8	0.24%	3618.39	0.81	-	5.41	0.01	0.54
B2-20	B2-274	94.3	21	3640.1	3630.15	3629.9	0.29%	3630.73	0.33	-	3.01	0	0.54
B2-209	B2-213	214.4	8	3634.9	3626.06	3624.7	0.63%	3626.5	0.66	-	3.25	0	0.54
B2-21	B2-103	298.2	18	3639.4	3633.72	3631.8	0.63%	3634.19	0.31	-	3.97	0.44	0.94
B2-213	B2-214	394.9	8	3632.5	3624.61	3622.1	0.65%	3625.06	0.67	-	3.34	0.07	0.81
B2-214	B2-144	254.8	8	3628.9	3621.95	3620.4	0.62%	3622.43	0.72	-	3.34	0.01	0.53
B2-22	B2-78	127.3	21	3642.9	3635.25	3634.7	0.42%	3635.7	0.26	-	2.78	0	0.54
B2-228	B2-209	212.3	8	3635.4	3627.49	3626.2	0.63%	3627.93	0.66	-	3.24	0	6.68
B2-23	B2-22	392.2	18	3643.2	3636.87	3635.3	0.41%	3637.34	0.31	-	3.23	0.19	1.36
B2-24	B2-23	411.4	18	3645.2	3638.47	3636.9	0.39%	3638.95	0.32	-	3.14	0.03	0.54
B2-269	B2-14	183.9	18	3636.5	3626.49	3626.5	0.02%	3627.38	0.59	-	2.37	0.23	1.29
B2-270	B2-269	36.2	21	3637.2	3627.07	3626.5	1.60%	3627.42	0.2	-	2.54	0.23	3.16
B2-271	B2-270	112.4	21	3637.8	3627.98	3627.1	0.81%	3628.43	0.26	-	4.67	0.01	0.53
B2-272	B2-271	79.9	21	3638.5	3628.18	3628	0.25%	3628.75	0.33	-	3.31	0	0.25
B2-273	B2-272	274.8	21	3641.5	3629.58	3628.2	0.51%	3630.05	0.27	-	3.21	0.01	0.25
B2-274	B2-273	60.7	21	3640.7	3629.88	3629.6	0.49%	3630.39	0.29	-	3.49	0.03	0.54
B2-3	B2-2	497.9	36	3627.8	3619.85	3616	0.78%	3621.34	0.5	-	6.48	0	0.54
B2-31	B2-24	63.7	18	3645.7	3638.77	3638.5	0.47%	3639.25	0.32	-	3.07	0.03	0.53
B2-4	B2-3	533.8	36	3631.7	3623.75	3619.9	0.73%	3625.36	0.54	-	8.47	0.02	0.54
B2-45	B2-70	314.2	18	3647.8	3640.65	3639.9	0.24%	3641.17	0.35	-	2.63	0.04	0.54
B2-47	B2-45	130.2	18	3647.9	3640.95	3640.7	0.23%	3641.48	0.35	-	2.41	0	0.53
B2-48	B2-47	144.3	18	3648.1	3641.31	3641	0.25%	3641.83	0.35	-	2.43	0	0.53
B2-5	B2-4	486	36	3634.8	3628.27	3623.8	0.93%	3629.68	0.47	-	8.25	7.63	14.49
B2-51	B2-48	267.5	18	3648.6	3641.95	3641.3	0.24%	3642.44	0.33	-	2.41	0	0.53
B2-52	B2-51	303.9	18	3649.8	3642.55	3642	0.19%	3643.09	0.36	-	2.4	0.09	8.75
B2-53	B2-52	387.9	18	3649	3643.35	3642.6	0.21%	3643.85	0.33	-	2.29	0.01	0.53
B2-59	B2-4	36.5	27	3631.7	3624.53	3624.5	0.05%	3625.41	0.39	-	2.6	0.02	0.53
B2-6	B2-61	207.9	36	3638.6	3632.49	3630.2	1.12%	3633.92	0.48	-	8.15	0.01	0.54
B2-60	B2-62	257.6	10	3644.1	3636.49	3635.7	0.31%	3636.79	0.36	-	2.12	0.02	0.54
B2-61	B2-5	266.2	36	3636.7	3630.17	3628.3	0.71%	3631.78	0.54	-	8.03	6.19	8.9
B2-62	B2-66	297.5	10	3646.7	3635.62	3634.7	0.32%	3635.95	0.4	-	2.27	0	0.53
B2-66	C2-199	297.6	10	3643.7	3634.61	3633.7	0.32%	3634.95	0.41	-	2.28	0.06	1.09
B2-69	B2-59	167	10	3633.2	3627.15	3624.5	1.57%	3627.52	0.44	-	3.15	0.2	1.17
B2-7	B2-6	512.7	36	3644.9	3638.39	3633	1.05%	3639.77	0.46	-	9.53	0	0.53
B2-70	B2-31	287.9	18	3647.8	3639.89	3638.8	0.39%	3640.36	0.31	-	3.05	0.03	1.12
B2-78	B2-79	334.4	21	3641.9	3634.72	3634	0.22%	3635.25	0.3	-	2.51	0.01	0.54
B2-79	B2-21	69.6	21	3639.9	3633.97	3633.7	0.36%	3634.51	0.31	-	3.23	0	0.53
B2-8	B2-7	504	36	3651	3644.25	3638.4	1.16%	3645.58	0.44	-	9.47	0	0.53
B2-89	B2-90	328.5	8	3621.4	3614.35	3612.9	0.44%	3616.86	3.77	1.84	2.87	0	0.54
B2-9	B2-8	489.4	36	3657.2	3649.95	3644.3	1.16%	3651.29	0.45	-	9.68	0.01	0.53
B2-90	B1-36	189.2	8	3619.3	3612.72	3611.9	0.44%	3615.4	4.02	2.01	2.74	0.1	0.54
B3-1	B2-10	530.3	36	3663.7	3656.71	3654.1	0.48%	3658.45	0.58	-	7.12	0	0.54
B3-10	B3-9	13.1	36	3682	3670.67	3670.6	0.29%	3673.61	0.98	-	4.14	0	0.54
B3-11	B3-158	19.3	36	3683	3671.49	3671.4	0.41%	3674.69	1.07	0.2	4.07	0.04	1.5
B3-12	B3-11	427.8	36	3681.4	3672.15	3671.5	0.15%	3675.51	1.12	0.36	4.07	0.04	0.54
B3-13	B3-12	406.9	36	3681.2	3673.08	3672.2	0.23%	3676.29	1.07	0.21	4.18	0	0.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B3-136	B3-172	74.9	30	3685.4	3674.86	3674.8	0.15%	3677	0.86	-	2.8	0.01	0.54
B3-14	B3-13	317.9	36	3683.5	3674.12	3673.3	0.26%	3676.57	0.82	-	4.53	0	0.54
B3-15	B3-14	311.9	30	3683	3674.61	3674.1	0.16%	3677.4	1.12	0.29	4.77	0	0.54
B3-158	B3-164	72.3	36	3683.3	3671.41	3671.3	0.19%	3674.5	1.03	0.09	4.09	0.04	0.53
B3-16	B3-15	341.9	30	3682	3674.92	3674.6	0.09%	3678.33	1.36	0.91	4.5	12.95	32.98
B3-164	B3-10	312.3	36	3683	3671.27	3670.7	0.19%	3674.22	0.98	-	4.1	0.2	1.11
B3-17	B3-13	169.6	30	3681.2	3673.35	3673.3	0.03%	3676.39	1.22	0.54	1.73	0	0.54
B3-170	B3-8	274.1	36	3680.5	3669.81	3669.3	0.19%	3672.48	0.89	-	4.39	0.03	0.54
B3-171	B3-170	261.6	36	3681.3	3670.32	3669.8	0.19%	3673.02	0.9	-	4.33	0.01	0.54
B3-172	B3-175	389.5	30	3684.9	3674.75	3674.2	0.15%	3676.95	0.88	-	2.46	0	0.53
B3-175	B3-19	205	30	3682.4	3674.15	3673.8	0.17%	3676.84	1.08	0.19	1.87	0.01	0.53
B3-18	B3-289	60.8	30	3681.2	3673.43	3673.4	0.02%	3676.53	1.24	0.6	1.7	3.1	8.67
B3-181	B3-7	380.1	36	3679	3668.64	3667.9	0.21%	3671.27	0.88	-	4.41	0.44	4.97
B3-19	B3-18	584.7	30	3681	3673.8	3673.4	0.06%	3676.75	1.18	0.45	1.69	0.01	0.54
B3-2	B3-1	471.8	36	3666.1	3659.33	3656.7	0.56%	3661.01	0.56	-	7.03	0	0.53
B3-23	B3-136	19.7	30	3685.3	3674.94	3674.9	0.41%	3677.04	0.84	-	2.7	0.03	1.17
B3-24	B3-23	551.3	30	3683.8	3675.26	3674.9	0.06%	3677.24	0.79	-	2.47	0	0.54
B3-25	B3-24	256.7	30	3683.8	3675.62	3675.3	0.14%	3677.36	0.7	-	2.52	0	0.25
B3-26	B3-25	429.1	30	3683.8	3676.04	3675.6	0.10%	3677.62	0.63	-	2.71	0	0.25
B3-27	B3-26	124.5	30	3683.7	3676.18	3676	0.11%	3677.75	0.63	-	2.68	0	0.54
B3-28	B3-90	15.3	12	3659.8	3649.59	3649.4	1.38%	3649.94	0.35	-	3.46	0	0.54
B3-285	B3-28	282.5	12	3662.5	3651.85	3649.6	0.80%	3652.19	0.34	-	3.55	0.05	0.53
B3-289	B3-17	218.3	30	3681.7	3673.41	3673.4	0.02%	3676.49	1.23	0.58	1.7	3.1	9.57
B3-3	B3-2	498.2	36	3671.2	3662.75	3659.3	0.69%	3664.31	0.52	-	7.53	0	0.54
B3-36	B4-24	380.4	15	3693.1	3687.37	3685.3	0.55%	3687.76	0.31	-	2.79	0.04	0.25
B3-37	B3-36	508.4	15	3695.1	3687.79	3687.4	0.08%	3688.54	0.6	-	1.98	0	0.25
B3-38	B3-37	492.3	15	3696.3	3688.89	3687.8	0.22%	3689.38	0.39	-	1.77	0	0.53
B3-4	B3-3	553.8	36	3675.4	3666.53	3662.8	0.68%	3668.09	0.52	-	7.89	0.02	0.53
B3-40	B3-38	437.7	15	3696.8	3690.09	3688.9	0.27%	3690.55	0.37	-	2.48	0.01	0.53
B3-5	B3-4	308.7	36	3676.7	3667.16	3666.5	0.20%	3669.46	0.77	-	5.76	0	0.53
B3-6	B3-5	129.1	36	3677.4	3667.53	3667.2	0.29%	3669.94	0.8	-	4.91	0	0.54
B3-66	B3-67	166	12	3656.9	3647.1	3646	0.67%	3647.51	0.41	-	2.71	0.05	0.54
B3-67	B3-68	173.3	15	3655.6	3645.99	3645.8	0.11%	3646.63	0.51	-	2.19	0.01	0.53
B3-68	B3-73	140.7	15	3655.1	3645.8	3645.2	0.41%	3646.26	0.37	-	2.83	0.01	0.54
B3-7	B3-6	223	36	3678.2	3667.85	3667.5	0.14%	3670.55	0.9	-	4.56	0.01	0.53
B3-73	B3-74	140.9	15	3654.8	3645.23	3644.8	0.33%	3645.72	0.39	-	2.74	0.45	8.59
B3-74	B3-75	261.5	15	3654.1	3644.76	3644	0.31%	3645.25	0.39	-	2.66	0.06	0.81
B3-75	B2-53	297.9	18	3653	3643.95	3643.4	0.20%	3644.47	0.35	-	2.34	0.01	0.54
B3-8	B3-181	300.2	36	3679.6	3669.28	3668.6	0.21%	3671.9	0.87	-	4.47	0.03	0.54
B3-9	B3-171	156.4	36	3681.8	3670.62	3670.3	0.19%	3673.42	0.93	-	4.26	0.13	1.2
B3-90	B3-66	316.5	12	3659.6	3649.38	3647.1	0.72%	3649.73	0.35	-	3.11	0	0.54
B3-91	B3-285	40.8	12	3662.8	3651.94	3651.9	0.22%	3652.43	0.49	-	2.56	0.05	0.81
B4-1	B3-16	621.2	30	3682.5	3675.93	3674.9	0.16%	3679.95	1.61	1.52	4.49	0	0.53
B4-10	B4-9	128.9	36	3640.6	3633.91	3633.5	0.29%	3635.43	0.51	-	3.92	0	0.53
B4-102	B4-4	135.2	30	3694.9	3683.96	3678.3	4.21%	3684.63	0.27	-	6.28	7.66	18.32
B4-105	B4-29	309.8	18	3704.1	3698.04	3696.7	0.43%	3699.01	0.65	-	3.49	0.19	1.08
B4-11	B4-10	197.8	36	3640.4	3634.06	3633.9	0.08%	3635.85	0.6	-	3.6	0	0.54
B4-112	B4-126	453.1	15	3707.4	3698.37	3692.7	1.25%	3698.7	0.26	-	4.4	0	0.53
B4-117	B4-68	62	12	3710.3	3704.31	3702.6	2.80%	3704.36	0.05	-	2.14	0.01	0.53
B4-119	B4-39	181.7	12	3696.9	3679.04	3678.7	0.20%	3680.39	1.35	0.35	1.54	0.01	0.53
B4-12	B4-120	110.4	24	3643.1	3638.23	3636.3	1.79%	3639.23	0.5	-	9.06	0	0.54
B4-120	B4-11	122.2	24	3641.7	3635.65	3634.6	0.89%	3636.97	0.66	-	6.63	0.01	0.54
B4-122	B4-120	124.4	12	3641.4	3637.53	3637.3	0.23%	3638.16	0.63	-	2.79	0	0.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B4-125	B4-124	259.5	12	3696.7	3687.71	3683.6	1.58%	3688.1	0.39	-	6.67	0.01	0.53
B4-126	B4-125	527.1	15	3701.7	3692.71	3687.7	0.95%	3693.07	0.29	-	3.97	0.01	0.53
B4-127	B4-112	30.1	15	3706.4	3701.22	3701.2	0.17%	3701.25	0.02	-	0.33	0.01	0.53
B4-128	B4-21	40	15	3690	3684.9	3684.1	2.03%	3685.72	0.66	-	6.65	0.01	0.54
B4-13	B4-12	154.6	24	3645.7	3640.4	3638.2	1.40%	3641.44	0.52	-	8.15	0.01	0.54
B4-135	B4-112	83	10	3708.8	3699.81	3698.4	1.74%	3700.2	0.47	-	5.39	0.02	0.54
B4-136	B4-135	308.5	10	3713.7	3704.65	3699.8	1.57%	3705.02	0.44	-	5.01	0	0.53
B4-137	B4-136	140.4	10	3721	3706.07	3704.6	1.02%	3706.52	0.54	-	4.55	0.43	3.48
B4-138	B4-137	168.3	10	3720.7	3713.85	3713.4	0.28%	3714.04	0.23	-	1.58	0.02	0.53
B4-14	B4-13	399.3	30	3649.5	3643.78	3640.5	0.82%	3644.81	0.41	-	7.1	0.42	0.92
B4-141	B4-138	263.4	10	3723	3714.68	3714	0.28%	3714.85	0.2	-	1.46	0	0.54
B4-149	B4-157	113.2	10	3724.1	3715.62	3715.3	0.29%	3715.76	0.17	-	1.34	0	0.54
B4-15	B4-14	447.8	36	3650	3644.55	3643.9	0.15%	3646.07	0.51	-	4.31	0.42	0.94
B4-157	B4-141	147.8	10	3724.6	3715.19	3714.8	0.28%	3715.33	0.17	-	1.34	0	0.53
B4-16	B4-15	520.8	36	3651.1	3645.57	3644.6	0.19%	3646.97	0.47	-	3.87	0.44	1.92
B4-17	B4-93	270.9	36	3658.7	3647.19	3646.5	0.27%	3648.52	0.44	-	4.4	13.6	22.03
B4-18	B4-17	367.5	30	3653.6	3648.45	3647.2	0.34%	3649.77	0.53	-	4.89	13.6	143.72
B4-19	B4-18	278.7	30	3655.1	3649.21	3648.5	0.27%	3650.64	0.57	-	4.64	0	0.54
B4-2	B4-1	271	30	3689.8	3676.99	3675.9	0.39%	3680.38	1.36	0.89	3.73	0	0.52
B4-20	B4-1	155.6	15	3684.4	3678.33	3677.4	0.58%	3681.4	2.46	1.82	5.2	0	0.25
B4-21	B4-20	374.9	15	3689.1	3684.09	3678.3	1.54%	3684.97	0.7	-	5.83	0.01	0.54
B4-22	B4-21	175.2	15	3690.2	3684.7	3684.1	0.35%	3685.14	0.35	-	1.8	0.01	0.25
B4-23	B4-128	158.7	15	3693.5	3688.12	3684.9	2.03%	3688.81	0.55	-	7.13	0	0.54
B4-24	B4-22	217.3	15	3691.2	3685.26	3684.7	0.26%	3685.76	0.4	-	2.6	0	0.25
B4-26	B4-23	338.9	15	3697	3690.83	3688.1	0.80%	3691.82	0.79	-	6.28	0.06	0.54
B4-27	B4-26	365.3	18	3701	3693.91	3690.8	0.84%	3694.69	0.52	-	5.09	0.01	0.54
B4-28	B4-27	179.3	18	3702.9	3696.37	3693.9	1.37%	3697.07	0.47	-	6.34	0.01	0.54
B4-29	B4-28	298.1	18	3703.5	3696.72	3696.4	0.12%	3698.31	1.06	0.09	3.93	0.06	0.53
B4-3	B4-2	216.6	30	3688.2	3677.27	3677	0.13%	3680.75	1.39	0.98	4.21	0.01	0.53
B4-30	B4-105	115.8	18	3704	3698.57	3698	0.46%	3699.6	0.69	-	4.35	0.02	0.53
B4-39	B4-2	82.8	12	3695.1	3678.66	3678.5	0.20%	3680.39	1.73	0.73	1.72	0.01	0.53
B4-4	B4-3	398	30	3688.3	3678.27	3677.3	0.25%	3681.31	1.22	0.54	3.93	7.66	12.21
B4-41	B4-119	117.9	12	3698.1	3679.28	3679.1	0.20%	3680.39	1.11	0.11	1.55	0	0.54
B4-62	RCK_LS	211.3	12	3641	3634.8	3633	0.85%	3634.93	0.13	-	2.08	7.66	18.32
B4-63	B4-62	476.3	12	3642.4	3636.38	3635	0.29%	3636.53	0.15	-	1.44	0.03	0.53
B4-64	B4-63	130	12	3676.4	3670.39	3636.4	27.12%	3670.44	0.05	-	2.21	0.01	0.54
B4-65	B4-64	60	12	3685.5	3679.46	3670.4	15.30%	3679.52	0.06	-	5.52	0.04	0.54
B4-66	B4-65	474.9	12	3695.3	3689.34	3679.5	2.08%	3689.42	0.08	-	3.01	0	0.25
B4-67	B4-66	407.9	12	3700.5	3694.49	3689.3	1.26%	3694.57	0.08	-	1.9	0.04	0.53
B4-68	B4-67	411.9	12	3708.6	3702.57	3694.5	1.96%	3702.64	0.07	-	1.83	0	0.54
B4-7	RCK_LS	466.7	36	3640.2	3632.73	3632.1	0.14%	3634.35	0.54	-	4.4	0.01	0.54
B4-8	B4-7	210.7	36	3640.3	3633.3	3632.8	0.25%	3634.79	0.5	-	3.98	0.01	0.54
B4-9	B4-8	106.8	36	3640.5	3633.51	3633.3	0.20%	3635.12	0.54	-	3.91	0.01	0.54
B4-93	B4-16	330.2	36	3651.6	3646.47	3645.6	0.27%	3647.77	0.43	-	4.27	0.44	1
B6-1	C6-146	169.1	8	3840	3834.66	3832.4	1.36%	3834.92	0.39	-	3.84	0.01	0.54
B6-2	B6-1	405.2	8	3848.7	3843.05	3834.8	2.05%	3843.28	0.35	-	4.48	0.04	0.81
B6-3	B6-2	169.9	8	3850.9	3843.99	3843.1	0.49%	3844.34	0.53	-	2.69	0.01	0.54
B6-4	B6-3	308	8	3853.3	3845.58	3844.3	0.42%	3845.77	0.29	-	1.9	0.01	0.54
B6-5	B6-4	308.8	8	3853.3	3847.47	3845.7	0.58%	3847.64	0.26	-	2.01	0	0.54
B6-6	B6-5	308.8	8	3860	3853.24	3847.6	1.84%	3853.36	0.18	-	2.95	0	0.54
B6-9	B6-3	139.8	8	3872.8	3844.65	3844.1	0.40%	3844.95	0.45	-	2.3	0.02	0.53
C1-1	C1-27	247.8	24	3186.8	3180.13	3179.1	0.40%	3180.78	0.33	-	3.69	0.03	0.46
C1-13	C1-16	306.3	21	3623.5	3618.29	3618.2	0.04%	3619.4	0.63	-	2.37	0	0.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C1-14	C1-50	547.3	9	3622.9	3613.65	3224.2	101.32%	3613.89	0.32	-	28.59	3.1	3.56
C1-15	C1-14	65.6	21	3621.5	3617.65	3617.5	0.26%	3618.42	0.44	-	3.43	0	8.41
C1-16	C1-15	197.5	21	3622.7	3618.18	3617.7	0.26%	3618.94	0.43	-	3.11	0.16	0.81
C1-2	C1-1	437.6	18	3197.9	3187.28	3180.1	1.63%	3187.77	0.33	-	5.46	0.01	0.54
C1-27	C1-29	189.8	24	3185.8	3179.13	3178.5	0.35%	3179.8	0.34	-	3.57	0.07	0.81
C1-3	C1-2	452.3	18	3201	3194.13	3187.3	1.51%	3194.64	0.34	-	6.4	0.01	0.53
C1-4	C1-3	518.2	18	3206.3	3201.9	3194.1	1.50%	3202.41	0.34	-	6.39	0	0.54
C1-49	C1-8	272	18	3229.5	3221.37	3220.3	0.39%	3222.12	0.5	-	3.94	0.01	0.25
C1-5	C1-4	420.3	18	3215.5	3210.63	3201.9	2.08%	3211.09	0.31	-	6.86	0.18	1.02
C1-50	C1-49	99	16	3239.4	3223.51	3221.6	1.98%	3224.02	0.38	-	6.24	0	1.18
C1-51	C1-52	65	24	3240.3	3236.21	3235.1	1.75%	3237.47	0.63	-	10.07	0	0.54
C1-52	C1-53	261	24	3239.6	3235.07	3224.9	3.92%	3235.87	0.4	-	9.58	0.02	0.53
C1-53	C1-54	408.9	30	3231.5	3224.86	3222.7	0.52%	3226.2	0.54	-	6.02	0.01	0.54
C1-54	C1-55	246.2	30	3227.9	3222.74	3221.4	0.53%	3224.12	0.55	-	5.87	0.01	0.53
C1-55	C1-56	225	30	3228.5	3221.43	3220.3	0.52%	3222.83	0.56	-	5.68	0	0.53
C1-56	C1-57	254.7	36	3227	3220.25	3219.5	0.31%	3221.7	0.48	-	4.93	0.01	0.54
C1-57	C1-58	352.6	36	3226	3219.45	3218.3	0.32%	3220.86	0.47	-	4.76	0	0.54
C1-58	C1-59	158.9	36	3225.5	3218.33	3217.8	0.31%	3219.86	0.51	-	4.52	0	0.54
C1-59	C1-60	74.7	36	3223.8	3217.83	3217.6	0.33%	3219.36	0.51	-	4.85	0.01	0.54
C1-6	C1-5	350.1	18	3222.9	3217.9	3210.6	2.08%	3218.37	0.31	-	7.15	0	0.49
C1-60	C1-61	157.4	36	3223.3	3217.58	3217.1	0.34%	3218.95	0.46	-	6.24	1.95	4.54
C1-61	C1-62	322.6	24	3223.1	3217.05	3210.7	1.98%	3218.08	0.51	-	10.36	1.95	4.68
C1-62	C1-63	562	24	3216.7	3210.68	3199.4	2.01%	3211.67	0.5	-	10.3	1.95	4.59
C1-63	C1-64	384.9	27	3203.8	3199.38	3193.7	1.47%	3200.42	0.46	-	9.15	0.23	0.83
C1-64	C1-65	452	27	3201.3	3193.72	3187.2	1.45%	3194.76	0.46	-	9.35	0.23	0.83
C1-65	C1-66	430.4	27	3197.7	3187.15	3180.7	1.50%	3188.15	0.44	-	8.59	0.28	0.89
C1-66	C1-67	460.5	30	3187.4	3180.7	3177.6	0.67%	3181.88	0.47	-	5.79	0.07	0.54
C1-67	B1-2	181.4	24	3183.3	3177.6	3176	0.86%	3179.25	0.83	-	7.47	0	1.23
C1-7	C1-6	347.1	24	3224.9	3218.95	3217.9	0.30%	3219.65	0.35	-	3.59	0.17	0.69
C1-8	C1-7	368.6	24	3226.2	3220.29	3219	0.36%	3220.95	0.33	-	3.55	0.01	0.54
C2-10	C2-9	219.2	18	3634.2	3628.43	3627.6	0.40%	3629.06	0.42	-	3.63	0.01	0.54
C2-11	C2-10	290.6	15	3637.3	3629.08	3628.4	0.22%	3629.94	0.69	-	3.22	0.01	1.15
C2-112	C2-8	21.3	18	3626.6	3623.13	3623.1	0.19%	3624.07	0.63	-	2.57	0.03	0.53
C2-115	JUB101	268.8	16.3	3397.5	3390.18	3237.2	69.24%	3390.63	0.33	-	17.33	0.07	2.77
C2-116	C2-6	195.2	15	3623.9	3621.36	3620	0.72%	3621.99	0.5	-	3.6	0	0.53
C2-12	C2-11	235	15	3635.8	3629.49	3629.1	0.17%	3630.41	0.74	-	2.6	0	0.54
C2-120	C2-25	269	10	3651.8	3641.43	3640.7	0.28%	3641.7	0.32	-	1.83	0.28	3.72
C2-13	C2-73	117.4	15	3639.9	3636.47	3635.5	0.84%	3637.03	0.45	-	4.66	0.01	0.54
C2-14	C2-13	474.4	15	3640.9	3638.91	3636.5	0.51%	3639.45	0.43	-	3.66	0.01	0.53
C2-145	C2-146	161.3	18	3629.1	3623.54	3623.3	0.14%	3624.48	0.63	-	2.03	0.01	0.54
C2-146	C2-147	170.5	18	3627.7	3623.32	3623.2	0.10%	3624.32	0.67	-	1.96	0.08	0.95
C2-147	C2-112	47.8	18	3626.7	3623.15	3623.1	0.04%	3624.16	0.67	-	2.03	0.1	0.69
C2-15	C2-14	290.2	15	3642	3640.17	3638.9	0.43%	3640.75	0.46	-	3.55	0	0.25
C2-151	C2-200	36.7	10	3635.9	3629.02	3628.9	0.30%	3629.47	0.54	-	2.59	0	0.53
C2-157	C2-151	321.7	10	3637	3630.11	3629.1	0.32%	3630.5	0.47	-	2.33	0	0.53
C2-158	C2-217	150.1	10	3640.4	3631.42	3630.7	0.47%	3631.76	0.41	-	2.52	0.7	2.56
C2-159	C2-158	339.3	10	3643.8	3632.82	3631.5	0.38%	3633.18	0.43	-	2.54	0.27	7.52
C2-16	C2-15	389.6	15	3646	3641.5	3640.2	0.34%	3642.12	0.5	-	3.27	0	0.25
C2-164	C2-165	439	14	3564.4	3526.47	3480.5	10.53%	3527.35	0.75	-	19.43	0.02	0.53
C2-165	C2-166	483.1	16.3	3504.5	3480.48	3429.9	10.53%	3481.24	0.56	-	19.64	0.01	0.54
C2-166	C2-115	378.7	16.3	3453.3	3429.86	3390.2	10.53%	3430.63	0.57	-	19.78	0.04	0.54
C2-17	C2-16	275.4	12	3649.3	3645.17	3641.8	1.24%	3645.65	0.48	-	5.21	0.01	0.25
C2-18	C2-17	228.2	12	3652.2	3646.71	3645.2	0.67%	3647.28	0.57	-	4.11	0	0.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C2-19	C2-18	337	12	3652	3648.29	3646.7	0.47%	3648.91	0.62	-	3.62	0.02	0.54
C2-199	C2-159	199.6	10	3646.4	3633.59	3632.9	0.34%	3633.93	0.41	-	2.32	1.12	1.01
C2-2	C1-13	394.1	21	3623.4	3618.86	3618.3	0.14%	3619.74	0.5	-	2.19	0.17	0.58
C2-20	C2-19	349.3	12	3655.4	3651.17	3648.3	0.82%	3651.51	0.34	-	2.93	0	0.54
C2-200	B2-228	392.7	10	3635.8	3628.81	3627.6	0.31%	3629.27	0.55	-	2.59	0.01	0.53
C2-217	C2-157	220.3	10	3638.6	3630.62	3630.2	0.21%	3631.07	0.54	-	2.14	0.7	2.91
C2-23	C2-13	465.7	12	3654.1	3638.59	3636.7	0.40%	3638.92	0.33	-	2.55	0.01	0.54
C2-24	C2-23	397.8	12	3655.3	3639.48	3638.6	0.22%	3639.76	0.28	-	1.59	0	0.54
C2-25	C2-24	422.1	10	3653.5	3640.67	3639.5	0.28%	3640.95	0.34	-	1.89	0.01	0.54
C2-26	C2-120	214.4	10	3650.1	3642.04	3641.4	0.28%	3642.18	0.17	-	0.84	0.28	3.69
C2-27	C2-26	346.2	10	3648.7	3643.02	3642.1	0.28%	3643.15	0.16	-	1.17	0	0.53
C2-3	C2-2	380.7	21	3622.7	3619.24	3618.9	0.10%	3620.22	0.56	-	2.38	0	0.54
C2-35	C2-38	246	10	3647.8	3639.24	3638.6	0.28%	3639.48	0.29	-	1.6	0.19	1.1
C2-38	C2-41	260	10	3647.7	3638.55	3637.8	0.28%	3638.81	0.31	-	1.71	0	0.54
C2-4	C2-3	321.3	21	3623.9	3619.41	3619.2	0.05%	3620.51	0.63	-	2.06	0	0.25
C2-41	B2-60	422.2	10	3649.7	3637.81	3636.6	0.29%	3638.12	0.37	-	2.07	0.04	1.12
C2-5	C2-4	81.6	21	3624.7	3619.65	3619.4	0.29%	3620.59	0.54	-	2.1	0.01	0.54
C2-6	C2-5	326.9	21	3625.7	3619.96	3619.7	0.09%	3620.94	0.56	-	2.24	0.02	0.54
C2-63	C2-64	267	10	3652.9	3641.42	3640.7	0.28%	3641.47	0.06	-	0.52	0	0.54
C2-64	C2-65	251.6	10	3650	3640.66	3640	0.28%	3640.73	0.08	-	0.34	0	0.54
C2-65	C2-35	248.3	10	3648.7	3639.95	3639.3	0.28%	3640.14	0.23	-	1.37	0.45	4.65
C2-7	C2-116	116.6	15	3624.5	3622.3	3621.4	0.81%	3622.93	0.5	-	4.59	2	8.92
C2-72	C2-12	99.5	15	3636.8	3633.3	3632.3	1.02%	3633.84	0.43	-	4.98	0	0.25
C2-73	C2-72	218.2	15	3638.9	3635.48	3633.3	1.00%	3636	0.42	-	4.87	0	0.53
C2-8	C2-7	397.7	18	3626.3	3623.09	3622.3	0.20%	3623.96	0.58	-	3.21	0.03	0.53
C2-9	C2-145	125.8	18	3629.9	3623.67	3623.5	0.10%	3624.63	0.64	-	2.08	0.01	0.53
C3-1	C2-20	381.4	12	3663	3654.76	3651.2	0.94%	3655.09	0.33	-	3.78	0.01	0.25
C3-104	C3-167	139.1	24	3700.6	3692.21	3692	0.12%	3693.72	0.75	-	2.96	0.02	1.08
C3-14	C3-259	373.3	30	3683.3	3676.7	3676.3	0.10%	3678.2	0.6	-	2.61	13.02	27.44
C3-147	C3-250	184.6	30	3683.3	3676.8	3677	0.10%	3678.69	0.76	-	2.25	0.04	0.76
C3-157	C3-159	460.1	15	3699.1	3693.99	3692.9	0.24%	3694.48	0.39	-	2.51	5.81	14.63
C3-159	C3-170	340.8	15	3702.1	3692.89	3691.7	0.35%	3693.31	0.34	-	2.32	5.81	14.25
C3-167	C3-97	204.8	24	3700.7	3692.04	3691.7	0.15%	3693.47	0.71	-	3.16	0.02	1.06
C3-170	C3-171	169.5	15	3700.7	3691.69	3691.4	0.16%	3692.23	0.43	-	2.01	0.01	0.25
C3-171	C3-173	234.7	15	3700.5	3691.42	3691	0.18%	3691.95	0.42	-	2.2	0.01	0.53
C3-173	B3-40	387	15	3700.3	3690.99	3690.1	0.23%	3691.49	0.4	-	2.43	0.01	0.53
C3-183	C3-196	345.2	10	3667.2	3660.11	3657.7	0.71%	3660.43	0.38	-	3.22	0.01	0.54
C3-188	C3-183	329.9	10	3669	3662.58	3660.1	0.75%	3662.83	0.3	-	2.44	0	0.54
C3-189	C3-275	258.6	10	3671.2	3664.7	3663.1	0.63%	3664.95	0.3	-	2.44	0.01	0.45
C3-190	C3-189	215.8	10	3671	3665.34	3664.7	0.30%	3665.66	0.38	-	2.16	0.02	0.66
C3-192	C3-190	99.6	10	3671	3665.61	3665.3	0.27%	3665.93	0.38	-	1.87	0	0.53
C3-193	C3-192	362.5	10	3674	3666.01	3665.6	0.11%	3666.45	0.53	-	1.49	0	0.54
C3-196	C3-235	305.7	21	3665	3657.65	3655.2	0.79%	3657.9	0.14	-	2.73	0.03	0.81
C3-197	C3-198	349	21	3663.3	3654.98	3653.8	0.35%	3655.3	0.18	-	2.46	0	0.54
C3-198	B3-91	355.7	21	3661.8	3653.75	3651.9	0.51%	3654.03	0.16	-	1.77	0.1	0.73
C3-2	C3-1	364.2	12	3662	3658.38	3654.8	0.99%	3658.71	0.33	-	3.88	0	0.54
C3-235	C3-197	55.8	21	3664.5	3655.24	3655	0.47%	3655.54	0.17	-	2.3	0.04	0.8
C3-236	C3-64	59.4	21	3677.4	3670.09	3669.7	0.64%	3670.2	0.06	-	1.49	0.01	0.53
C3-250	C3-14	347.5	30	3683.2	3676.99	3676.7	0.08%	3678.52	0.61	-	2.62	0.11	0.53
C3-259	B3-27	164.7	30	3683.6	3676.34	3676.2	0.10%	3677.9	0.62	-	2.62	0.01	0.53
C3-267	C3-3	360.4	12	3666.1	3661.51	3660.4	0.30%	3661.93	0.42	-	2.5	0	0.54
C3-3	C3-2	483	12	3666.6	3660.42	3658.4	0.42%	3660.8	0.38	-	2.81	0	0.54
C3-4	C3-267	94.4	12	3666	3661.79	3661.5	0.30%	3662.22	0.43	-	2.3	0	0.53

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C3-5	C3-4	301	12	3667.5	3664.58	3664	0.20%	3665.08	0.5	-	2.28	13	58.23
C3-6	C3-5	267.7	12	3675.4	3665.08	3664.6	0.19%	3665.54	0.46	-	1.95	0	0.53
C3-63	C3-193	359.9	21	3674.7	3667.96	3666	0.54%	3668.16	0.11	-	1.18	0.01	0.53
C3-64	C3-63	424.9	21	3676.8	3669.71	3668	0.40%	3669.83	0.07	-	1.28	0.09	0.81
C3-65	C3-236	270.7	21	3682.5	3670.37	3670.1	0.10%	3670.57	0.11	-	0.94	0.03	0.54
C3-72	C3-71	113	6	3684.2	3674.46	3674	0.40%	3674.53	0.14	-	0.96	0.01	0.53
C3-73	C3-72	137.4	6	3685.3	3675.02	3674.5	0.40%	3675.07	0.1	-	0.69	0.01	0.53
C3-74	C3-73	354	6	3688.1	3676.45	3675	0.40%	3676.49	0.08	-	0.64	0	0.53
C3-79	C3-78	195.3	24	3686.9	3677.49	3675.8	0.89%	3680.62	1.57	1.13	2.48	5.83	16.95
C3-80	C3-79	138.1	18	3686.5	3678.6	3677.5	0.80%	3681.45	1.9	1.35	4.41	0.01	0.53
C3-83	C3-80	309.4	18	3687.7	3681.83	3678.6	1.04%	3682.93	0.73	-	5.93	0	0.53
C3-84	C3-83	160.3	18	3688.2	3683.3	3681.8	0.92%	3684.31	0.67	-	6.23	0	0.53
C3-86	C3-84	194	24	3691.9	3684.93	3683.3	0.84%	3685.77	0.42	-	5.3	0	0.53
C3-88	C3-86	183.5	24	3695.4	3686.42	3684.9	0.81%	3687.28	0.43	-	5.89	0	0.54
C3-95	C3-88	344.3	24	3698.2	3688.84	3686.4	0.70%	3689.71	0.43	-	5.79	0	0.54
C3-96	C3-95	341.9	24	3701	3690.94	3688.8	0.61%	3691.84	0.45	-	5.55	0.02	0.83
C3-97	C3-96	456.3	24	3701	3691.73	3690.9	0.17%	3693.08	0.67	-	3.94	0.02	1.11
C4-1	B4-19	371.2	30	3655	3650.11	3649.4	0.18%	3651.7	0.64	-	4.56	0	0.54
C4-100	C4-98	338.9	15	3704.3	3698.59	3697.6	0.28%	3699.01	0.34	-	2.11	0	0.25
C4-102	C4-100	324.7	15	3703.6	3699.39	3698.6	0.25%	3699.83	0.35	-	2.34	0	0.25
C4-103	C4-102	327.3	12	3704.9	3700.99	3699.4	0.49%	3701.38	0.39	-	2.77	2.01	0.34
C4-105	C4-103	333.6	12	3707.4	3702.59	3701	0.48%	3702.97	0.38	-	2.93	1.95	15.24
C4-107	C4-105	329.8	12	3710.4	3704.19	3702.6	0.49%	3704.56	0.37	-	2.87	0.01	0.24
C4-109	C4-107	327.3	12	3712.5	3705.89	3704.2	0.52%	3706.25	0.36	-	2.88	0.01	0.53
C4-111	C4-109	348.3	12	3713.9	3706.69	3705.9	0.23%	3707.15	0.46	-	2.34	0	0.54
C4-114	C4-111	328.7	12	3714.9	3707.59	3706.7	0.27%	3707.99	0.4	-	2.07	0.06	2.16
C4-116	C4-261	111.1	12	3716.8	3708.39	3708.1	0.26%	3708.79	0.4	-	2.1	0	0.24
C4-118	C4-79	229	18	3712.3	3707.41	3706.5	0.41%	3708.39	0.65	-	3.97	0	0.54
C4-121	C4-118	480.6	18	3715.6	3709.33	3707.4	0.40%	3710.29	0.64	-	4.22	0	1.17
C4-124	C4-291	188.7	18	3720.1	3711.95	3711.3	0.37%	3712.99	0.69	-	4.11	0.02	0.54
C4-141	C4-309	221.9	10	3733	3722.68	3722.7	0.01%	3723.24	0.67	-	0.72	0	0.54
C4-146	C4-306	282.1	10	3727.5	3719.13	3718.2	0.33%	3719.68	0.66	-	2.68	0.01	0.54
C4-152	C4-307	278.8	10	3723.1	3717.5	3716.7	0.29%	3718.13	0.76	-	2.69	0	0.53
C4-157	C4-308	248.3	10	3720.7	3715.8	3715.3	0.22%	3716.56	0.91	-	2.63	0	0.54
C4-163	C4-124	282	18	3722.1	3712.98	3711.9	0.40%	3713.94	0.64	-	3.88	0.04	0.53
C4-164	C4-315	165.8	12	3725.8	3717.62	3716.3	0.78%	3718.14	0.52	-	3.91	0	0.25
C4-165	C4-164	485.9	12	3728.3	3719.47	3717.6	0.38%	3720.11	0.64	-	3.36	0.01	0.53
C4-166	C4-165	458.9	12	3730.1	3721.37	3719.6	0.40%	3721.99	0.62	-	3.34	0.01	0.54
C4-167	C4-166	460.8	12	3732.5	3723.22	3721.4	0.39%	3723.84	0.62	-	3.32	0.01	0.54
C4-168	C4-167	443.4	12	3733.4	3725.32	3723.6	0.38%	3725.94	0.62	-	3.34	0.01	0.25
C4-169	C4-168	446.3	12	3734.7	3726.75	3725.3	0.32%	3727.39	0.64	-	2.96	1.07	8.67
C4-171	C4-314	216.3	10	3727.2	3716.87	3715.8	0.52%	3720.16	3.95	2.46	4.1	0.02	0.54
C4-179	C4-169	349.8	12	3737.5	3728.08	3726.8	0.36%	3728.48	0.4	-	2.07	0.03	0.53
C4-183	C4-171	350.7	10	3730.5	3717.88	3716.8	0.31%	3723.34	6.55	4.63	4.05	0.01	0.54
C4-192	C4-179	350.4	12	3740.9	3730.32	3728.3	0.57%	3730.63	0.31	-	2.9	0	0.54
C4-196	C4-183	351.3	10	3729	3718.97	3718	0.29%	3726.24	8.72	6.44	3.88	0.07	0.54
C4-2	C4-1	449.9	30	3657.8	3651.87	3650.3	0.34%	3653.16	0.52	-	4.82	0.01	0.53
C4-20	B4-30	331.3	18	3706.4	3699.88	3698.6	0.40%	3700.9	0.68	-	4.19	0.01	1.12
C4-207	C4-192	359.9	10	3744	3732.07	3730.4	0.46%	3732.36	0.35	-	2.5	0.06	0.54
C4-210	C4-196	353.3	10	3727.8	3720.12	3718.9	0.34%	3726.96	8.21	6.01	2.13	0.03	0.53
C4-218	C4-207	350.3	8	3748.6	3738.97	3734	1.41%	3739.15	0.27	-	3.25	0.11	0.34
C4-220	C4-313	251.2	10	3728.5	3721.7	3721.2	0.20%	3727.78	7.3	5.25	2.1	0	0.53
C4-227	C4-218	354.4	8	3750.8	3742.49	3739.2	0.92%	3742.64	0.23	-	2.4	0.13	0.46

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C4-228	C4-317	269.5	10	3729.8	3723.75	3722.6	0.42%	3727.81	4.87	3.23	0.59	0.01	0.54
C4-237	C4-228	246.7	10	3732	3724.79	3723.8	0.41%	3727.83	3.65	2.21	0.47	0.01	0.53
C4-238	C4-237	222.3	10	3735.6	3729.13	3726.6	1.13%	3729.31	0.22	-	0.71	0	0.25
C4-261	C4-114	220.1	12	3719.7	3708.09	3707.6	0.23%	3708.51	0.42	-	2.1	0.06	2.16
C4-291	C4-121	464.5	18	3718.9	3711.25	3709.3	0.41%	3712.2	0.63	-	4.3	13	31.96
C4-299	C4-220	166	10	3729	3722.24	3721.8	0.28%	3727.77	6.64	4.7	0.47	0	0.53
C4-306	C4-152	212.6	10	3725	3718.2	3717.5	0.33%	3718.73	0.64	-	2.49	0	0.54
C4-307	C4-157	222.2	10	3721.8	3716.68	3715.8	0.40%	3717.2	0.62	-	2.39	0.04	1.07
C4-308	C4-163	248.4	10	3721.5	3715.25	3713.5	0.72%	3715.71	0.55	-	3.58	0	0.54
C4-309	C4-310	256.1	10	3732.3	3722.65	3722.6	0.01%	3723.18	0.64	-	0.79	0	0.54
C4-310	C4-311	246.8	10	3731.6	3722.62	3722.6	0.02%	3723.1	0.58	-	1.24	0	0.53
C4-311	C4-146	238.3	10	3730.8	3722.56	3719.1	1.44%	3722.73	0.2	-	1.21	0	0.54
C4-313	C4-210	257.6	10	3728.1	3720.96	3720.4	0.22%	3727.38	7.7	5.59	2.1	0.09	0.67
C4-314	C4-163	289.1	10	3723.9	3715.74	3714.7	0.36%	3718.08	2.81	1.51	4.34	0.04	0.54
C4-315	C4-163	390.4	12	3724.5	3716.24	3714.8	0.38%	3716.91	0.67	-	3.41	0.07	2
C4-317	C4-299	58.2	10	3727.7	3722.51	3722.3	0.36%	3727.74	6.28	4.4	0.49	0	0.53
C4-318	C4-238	282.6	10	3741.9	3733.63	3731.2	0.87%	3733.81	0.22	-	2.57	0.12	0.68
C4-324	C4-323	134.5	10	3733.7	3725.65	3661.9	53.81%	3725.99	0.41	-	24.38	0	0.54
C4-4	C4-2	406.1	30	3665.8	3654.48	3651.9	0.63%	3655.56	0.43	-	5.74	0	0.54
C4-5	C4-4	313.3	30	3665.9	3658.84	3656	0.91%	3659.84	0.4	-	7.28	0.01	0.54
C4-6	C4-101	56.2	30	3665	3659.42	3659.4	0.12%	3661.22	0.72	-	3.55	0.22	0.83
C4-7	C4-322	310	30	3667.4	3660.77	3660.1	0.23%	3661.89	0.45	-	2.58	0.1	0.53
C4-70	C4-20	92	18	3707.1	3700.22	3699.9	0.37%	3701.32	0.73	-	3.87	0.11	8.17
C4-71	C4-70	441.3	18	3710.3	3701.94	3700.2	0.39%	3702.89	0.63	-	4.01	0	0.54
C4-72	C4-71	426.8	18	3710.3	3703.67	3701.9	0.41%	3704.64	0.65	-	4.31	0.02	0.52
C4-73	C4-72	230.6	18	3710.3	3704.55	3703.7	0.38%	3705.57	0.68	-	4.13	0.03	0.58
C4-74	C4-73	200.4	18	3710.3	3705.39	3704.6	0.42%	3706.38	0.66	-	4.07	0	0.54
C4-76	C4-74	122.4	18	3710.8	3705.86	3705.4	0.38%	3706.92	0.71	-	3.99	0.02	0.53
C4-77	C4-76	47.1	18	3711	3706.05	3705.9	0.40%	3707.19	0.76	-	3.7	0.01	0.53
C4-79	C4-77	100.4	18	3711.4	3706.48	3706.1	0.43%	3707.55	0.71	-	3.67	0.58	2.48
C4-84	C4-85	342.5	15	3706.9	3697.39	3696.4	0.29%	3697.83	0.35	-	2.49	0.01	0.54
C4-85	C4-86	307	15	3700.3	3696.39	3695.6	0.26%	3696.85	0.37	-	2.44	0	19.46
C4-86	C4-87	350.7	15	3702.1	3695.59	3694.7	0.26%	3696.04	0.36	-	2.32	0.01	0.25
C4-87	C4-91	161.2	15	3704.3	3694.69	3694.3	0.22%	3695.18	0.39	-	2.22	0.08	0.52
C4-91	C3-157	156.8	15	3701.7	3694.34	3694	0.22%	3694.83	0.39	-	2.26	1.95	4.47
C4-98	C4-84	166.4	15	3705.9	3697.64	3697.4	0.15%	3698.18	0.43	-	2.14	0.01	0.53
C5-1	C4-7	627.5	21	3669.7	3661.93	3660.8	0.18%	3663.41	0.85	-	3.7	0.01	0.54
C5-10	C5-9	72	12	3750.6	3671.66	3671.5	0.18%	3672.3	0.64	-	0.03	0.01	0.54
C5-11	C5-9	356.8	15	3676.6	3672.6	3671.5	0.30%	3673.37	0.62	-	3.21	0	0.53
C5-12	C5-11	312	12	3681.9	3676.9	3672.9	1.30%	3677.46	0.56	-	5.7	0.01	0.53
C5-122	C5-157	140.8	18	3799.1	3793.11	3790.6	1.76%	3793.57	0.31	-	6.3	0	0.54
C5-13	C5-12	475.5	15	3683.3	3678.32	3676.9	0.30%	3679.11	0.63	-	3.49	0.05	0.53
C5-131	C5-30	236.9	18	3753.2	3748.18	3744.2	1.70%	3748.74	0.37	-	6.98	0	0.25
C5-132	C5-131	538	18	3760.5	3755.63	3748.2	1.38%	3756.21	0.39	-	6.56	0.13	1.33
C5-14	C5-13	250.4	15	3686.1	3679.08	3678.3	0.30%	3679.85	0.62	-	3.14	0.05	0.54
C5-15	C5-14	344.8	15	3685.6	3680.12	3679.1	0.30%	3680.88	0.61	-	3.21	0	0.54
C5-156	C5-70	188.7	18	3805.7	3800.36	3796.9	1.86%	3800.8	0.29	-	6.47	0.02	0.25
C5-157	C5-158	502.8	18	3796.7	3790.6	3780	2.11%	3791.02	0.28	-	5.81	0.02	0.54
C5-158	C5-159	522.2	18	3788.1	3779.97	3775.4	0.87%	3780.5	0.35	-	5.01	0.01	0.54
C5-159	C5-160	398.6	18	3779.5	3775.42	3765.8	2.43%	3775.82	0.27	-	5.67	0.34	2.14
C5-160	C5-132	707.6	18	3770.5	3765.75	3755.6	1.43%	3766.32	0.38	-	6.56	0	0.53
C5-162	C5-1	142.3	21	3670.6	3662.46	3662	0.34%	3663.76	0.74	-	3.53	0	0.54
C5-17	C5-16	154.3	12	3686.9	3682.39	3681.7	0.46%	3682.69	0.3	-	1.78	0.01	0.53

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C5-172	C5-228	400.5	15	3767	3759.15	3755.4	0.93%	3759.6	0.36	-	4.6	0.56	0.72
C5-173	C5-227	62	12	3775.1	3768.59	3766.7	3.02%	3768.97	0.38	-	6.85	0	0.54
C5-174	C5-173	401.3	12	3779	3774.24	3768.7	1.38%	3774.68	0.44	-	5.37	0	0.53
C5-175	C5-226	41.1	12	3786.6	3778.53	3778.5	0.18%	3779.07	0.54	-	2.6	0.01	0.53
C5-177	C5-21	40.6	21	3743.8	3737.13	3736.5	1.55%	3737.74	0.35	-	6.15	0	0.53
C5-18	C5-17	429.9	12	3691.5	3684.37	3682.4	0.46%	3684.67	0.3	-	2.57	13	27.28
C5-183	C5-184	205.6	8	3789.9	3783.22	3779.4	1.86%	3783.55	0.5	-	4.97	0	0.53
C5-19	C5-18	247.2	12	3691.4	3685.5	3684.4	0.46%	3685.8	0.3	-	2.52	0.01	0.54
C5-190	C5-191	246.7	8	3788.5	3785.29	3784.4	0.35%	3785.92	0.95	-	2.64	5.92	20.1
C5-191	C5-183	246.4	8	3789.2	3784.33	3783.3	0.41%	3784.92	0.89	-	2.86	0.03	0.54
C5-2	C5-162	148	21	3670.8	3663.05	3662.5	0.40%	3664.23	0.67	-	3.94	0.01	0.54
C5-20	C5-19	441.3	12	3692.3	3687.54	3685.5	0.46%	3687.84	0.3	-	2.52	0	0.54
C5-21	C5-4	233.7	10	3738.4	3735.1	3667.5	30.22%	3735.47	0.44	-	21.74	0	0.54
C5-226	C5-174	212	12	3784.9	3778.46	3774.3	1.94%	3778.87	0.41	-	6.04	0	0.25
C5-227	C5-172	211.5	12	3773.2	3766.62	3759.3	3.49%	3766.97	0.35	-	7.39	0	0.53
C5-228	C5-229	363.7	15	3765.5	3755.34	3748.2	1.96%	3755.71	0.3	-	5.88	0.31	2.39
C5-229	C5-230	192	18	3764.5	3748.11	3747	0.58%	3748.59	0.32	-	3.8	0.01	0.54
C5-230	C5-231	247.4	18	3757.5	3746.89	3742	1.99%	3747.24	0.23	-	5.98	0.22	2.49
C5-231	C5-79	74.1	18	3750.4	3741.87	3740.6	1.70%	3742.26	0.26	-	5.48	0.02	0.54
C5-236	C5-175	78.8	12	3788.6	3783.73	3783.5	0.27%	3784.23	0.5	-	2.68	0.25	1.8
C5-237	C5-236	376.8	12	3795.5	3789.89	3783.8	1.61%	3790.18	0.29	-	3.79	0.02	0.54
C5-238	C5-237	405.8	12	3800	3791.14	3790	0.28%	3791.64	0.5	-	2.68	0.03	0.54
C5-30	C5-177	386.7	18	3749.8	3744.05	3737.1	1.79%	3744.58	0.35	-	6.68	0.08	0.54
C5-5	C5-3	354	15	3672.4	3667.44	3666.4	0.29%	3668.24	0.64	-	3.48	0	0.53
C5-6	C5-5	311.7	15	3674.3	3669.28	3667.4	0.59%	3669.89	0.49	-	3.58	0	0.54
C5-7	C5-6	293.8	15	3675.8	3670.34	3669.3	0.36%	3671.08	0.59	-	3.67	0.01	0.53
C5-70	C5-122	184.9	18	3802.5	3796.7	3793.1	1.94%	3797.13	0.29	-	6.32	0.01	0.25
C5-78	C5-73	375.3	8	3740.3	3736.28	3682.9	14.38%	3736.59	0.46	-	13.61	0.03	0.55
C5-79	C5-78	131.2	18	3744.7	3740.61	3736.3	3.30%	3740.94	0.22	-	7.26	0.24	7.91
C5-9	C5-7	396.5	15	3678.5	3671.53	3670.3	0.30%	3672.3	0.62	-	3.28	0	0.54
C6-1	C6-70	289.5	18	3814	3809.81	3808.5	0.46%	3810.43	0.41	-	3.66	0	0.25
C6-10	C6-91	473.5	18	3870.2	3866.32	3862.7	0.77%	3866.67	0.23	-	3.75	0.03	0.54
C6-107	C6-108	168.8	8	3838.4	3827.53	3826.9	0.40%	3827.78	0.38	-	1.87	0	0.54
C6-108	C6-109	311.8	8	3833.4	3826.76	3824.8	0.61%	3827.2	0.66	-	3.23	0.02	0.81
C6-109	C6-110	232.7	10	3827.6	3824.75	3824.1	0.28%	3825.25	0.6	-	2.57	0	0.54
C6-110	C6-111	243.3	15	3830.8	3824	3823.6	0.15%	3824.49	0.39	-	1.99	0.02	0.54
C6-111	C6-112	278	15	3827.8	3823.54	3823.1	0.15%	3824.04	0.4	-	2.15	0	0.25
C6-112	C6-113	77.1	15	3827	3823.01	3822.7	0.38%	3823.39	0.3	-	2.64	0.04	0.54
C6-113	C6-2	256.7	18	3826.7	3822.18	3816.1	2.37%	3822.57	0.26	-	6.63	0.04	0.53
C6-12	C6-10	104.5	8	3870.4	3867.56	3867.2	0.39%	3867.78	0.33	-	1.93	0	0.25
C6-120	C6-82	263	10	3883.7	3876.12	3875.4	0.28%	3876.38	0.31	-	1.69	0	0.53
C6-121	C6-120	262.9	10	3885.4	3876.84	3876.1	0.27%	3877.08	0.29	-	1.61	0	0.53
C6-122	C6-121	258.8	10	3884.4	3877.56	3876.8	0.28%	3877.77	0.25	-	1.46	2.05	6.44
C6-143	C6-108	193.4	8	3830.9	3827.9	3826.8	0.55%	3828.24	0.51	-	2.68	0.02	0.53
C6-144	C6-143	568.5	8	3832.9	3829.41	3828	0.25%	3829.92	0.77	-	2.18	0.03	0.54
C6-145	C6-144	224.1	8	3838.9	3830.36	3829.5	0.38%	3830.75	0.58	-	2.39	0.06	0.81
C6-146	C6-145	375	8	3839.2	3832.26	3830.5	0.48%	3832.62	0.54	-	2.71	0.02	0.53
C6-2	C6-1	328	18	3820.4	3816.09	3809.8	1.92%	3816.51	0.28	-	4.87	0.02	0.54
C6-3	C6-113	49.9	18	3827.6	3822.79	3822.2	1.22%	3823.2	0.27	-	4.59	0.04	0.54
C6-51	C6-68	427.9	10	3851.8	3845.77	3844.6	0.28%	3846.16	0.47	-	2.28	0.01	0.54
C6-57	C6-51	433.7	10	3854	3846.98	3845.8	0.28%	3847.3	0.38	-	1.78	0	0.25
C6-58	C6-69	250.9	10	3854.7	3848.65	3848	0.27%	3848.95	0.36	-	1.91	2.03	2.52
C6-68	C6-93	523.5	18	3849	3843.92	3836.7	1.38%	3844.29	0.25	-	5.15	0.03	0.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C6-69	C6-57	352.8	10	3854.4	3847.96	3847	0.28%	3848.26	0.36	-	1.86	2.42	5.61
C6-70	C6-95	336.3	18	3812.4	3808.49	3807.2	0.37%	3809.17	0.45	-	3.71	0.22	0.78
C6-81	C6-90	317.4	10	3880.1	3874.67	3873.8	0.28%	3875.01	0.41	-	2.11	0.08	0.81
C6-82	C6-81	259.5	10	3883	3875.39	3874.7	0.28%	3875.68	0.35	-	1.78	0.02	0.81
C6-83	C5-156	384.4	18	3812.7	3805.63	3800.4	1.36%	3806.1	0.31	-	5.85	0.16	1.35
C6-89	C6-90	466	18	3884.3	3879.73	3873.1	1.42%	3879.95	0.15	-	3.47	0	0.53
C6-90	C6-10	454.5	18	3877.5	3873.13	3866.3	1.50%	3873.4	0.18	-	3.72	0.01	7.74
C6-91	C6-92	336.2	18	3866.4	3862.69	3858.2	1.33%	3863	0.21	-	4.58	0.07	0.81
C6-92	C6-68	522.4	18	3862.1	3858.22	3843.9	2.74%	3858.48	0.17	-	4.58	0.06	0.54
C6-93	C6-94	328.9	18	3838.2	3836.71	3829.2	2.29%	3837.03	0.21	-	5.57	0	0.54
C6-94	C6-3	503.1	18	3833.6	3829.18	3822.8	1.27%	3829.55	0.25	-	4.7	0.03	0.53
C6-95	C6-83	365.6	18	3812.4	3807.19	3805.7	0.40%	3807.85	0.44	-	3.78	0	0.53
C7-1	C6-89	440	18	3893	3888.42	3879.7	1.98%	3888.63	0.14	-	4.16	0.06	0.54
C7-10	C7-8	141.6	18	3914	3908.49	3905.9	1.86%	3908.69	0.13	-	4.13	0	0.25
C7-13	C7-10	274.4	18	3918.4	3910.91	3908.5	0.88%	3911.15	0.16	-	3.16	1.77	5.54
C7-25	C7-20	352	8	3922.6	3916.33	3911.3	1.43%	3916.57	0.36	-	3.29	0.01	0.53
C7-28	C7-25	385.8	8	3929.1	3920.74	3916.3	1.14%	3920.99	0.38	-	3.49	0.01	0.25
C7-30	C7-28	398.7	8	3936.4	3927.54	3920.7	1.71%	3927.76	0.33	-	3.72	0.02	0.54
C7-37	C7-33	298.7	10	3945.1	3943.14	3943.1	0.00%	3943.76	0.74	-	1.36	0	0.57
C7-38	C7-37	380.7	10	3949.7	3946.54	3943.1	0.89%	3946.78	0.29	-	1.43	0	0.57
C7-39	C7-92	258.1	10	3954	3950.8	3948.3	0.97%	3951.03	0.28	-	2.36	0	0.78
C7-40	C7-39	484.2	8	3960.3	3955.34	3950.9	0.91%	3955.6	0.39	-	3.15	0.07	0.91
C7-41	C7-40	395	8	3961	3957.74	3955.3	0.61%	3958.03	0.44	-	2.7	0.01	0.54
C7-42	C7-1	341.3	18	3899.4	3893.56	3888.4	1.51%	3893.77	0.14	-	3.92	0	0.54
C7-8	C7-42	569.6	18	3911.2	3905.85	3893.6	2.16%	3906.04	0.13	-	4.12	0.01	0.52
C7-91	C7-38	178.9	10	3951.1	3948.27	3946.5	0.97%	3948.51	0.29	-	3.12	0	0.59
C7-92	C7-91	15.7	10	3951.3	3948.3	3948.3	0.20%	3948.65	0.42	-	2.15	0.03	0.86
C8-1	C7-41	401.7	8	3963.4	3960.14	3957.7	0.60%	3960.42	0.42	-	2.66	0.03	0.53
C8-10	C8-9	411.4	10	4010.2	4006.94	4004.1	0.68%	4007.17	0.28	-	2.62	0.07	0.53
C8-11	C8-10	452.7	10	4013	4009.74	4006.9	0.62%	4009.97	0.28	-	2.51	0	0.54
C8-12	C8-11	336.5	10	4016.7	4012.54	4009.7	0.83%	4012.75	0.25	-	2.6	0.07	0.54
C8-13	C8-12	353.6	8	4020.1	4016.94	4012.5	1.24%	4017.14	0.3	-	3.18	0.02	0.54
C8-2	C8-1	399.6	8	3969.3	3962.54	3960.1	0.60%	3962.82	0.42	-	2.64	0.02	0.54
C8-3	C8-2	331.8	8	3970.1	3966.94	3962.5	1.33%	3967.16	0.33	-	3.02	0.22	2.42
C8-4	C8-3	451.9	8	3977.7	3971.34	3966.9	0.97%	3971.58	0.36	-	3.15	0.01	0.53
C8-5	C8-4	416.8	8	3979.9	3977.74	3971.3	1.54%	3977.95	0.32	-	3.37	0.05	0.54
C8-6	C8-5	375	8	3986.3	3984.14	3977.7	1.71%	3984.34	0.3	-	3.73	0.05	0.54
C8-7	C8-6	409.8	8	3994.7	3990.54	3984.1	1.56%	3990.75	0.32	-	3.67	0.05	0.53
C8-8	C8-7	415	8	4001.5	3997.34	3990.5	1.64%	3997.54	0.3	-	3.65	0.05	0.54
C8-9	C8-8	395.5	8	4008.3	4004.14	3997.3	1.72%	4004.34	0.3	-	3.7	0.07	0.54
C9-1	C8-13	339.8	8	4025.6	4021.44	4016.9	1.32%	4021.64	0.3	-	3.24	0.81	2.36
C9-10	C9-9	266.1	10	4095.4	4092.34	4091.4	0.34%	4092.57	0.28	-	1.86	0.05	0.54
C9-11	C9-10	315.2	8	4096.4	4092.96	4092.3	0.20%	4093.26	0.45	-	1.59	0	0.53
C9-12	C9-11	119.5	10	4097.9	4094.2	4093	1.04%	4094.33	0.16	-	1.09	0	0.54
C9-13	C9-12	511.4	10	4100.9	4095.44	4094.2	0.24%	4095.63	0.23	-	1.45	0.03	0.54
C9-2	C9-1	409.8	10	4027.4	4022.84	4021.4	0.34%	4023.1	0.31	-	2.06	0.07	0.54
C9-3	C9-2	369.3	8	4029.4	4027.24	4022.8	1.19%	4027.43	0.29	-	2.53	0.1	0.54
C9-4	C9-3	337.2	8	4039.3	4036.04	4027.2	2.61%	4036.2	0.24	-	3.5	0.1	0.54
C9-5	C9-4	469.2	8	4051.1	4047.04	4036	2.35%	4047.2	0.24	-	3.9	0.1	0.54
C9-6	C9-5	256.8	8	4063.5	4059.84	4047	4.99%	4059.97	0.19	-	4.33	0.12	0.54
C9-7	C9-6	386.9	8	4078.1	4072.64	4059.8	3.31%	4072.78	0.21	-	4.32	0.12	0.54
C9-8	C9-7	451.3	8	4092.1	4090.44	4072.6	3.95%	4090.57	0.2	-	4.33	0.13	0.55
C9-9	C9-8	100.6	6	4093.7	4091.44	4090.4	0.99%	4091.65	0.42	-	2.78	0	0.54

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
CSR1	D2-264	271	14	3605.8	3602.26	3571.3	11.51%	3603.11	0.73	-	19.48	0	0.54
D2-10	D2-274	85	24	3643.5	3634.76	3633.7	1.24%	3636.04	0.64	-	7.63	0	0.54
D2-100	D2-99	347.4	12	3629.9	3625.83	3625.1	0.20%	3626.24	0.41	-	1.96	0.22	0.83
D2-101	D2-121	25.9	12	3627.2	3626.18	3626.1	0.23%	3626.58	0.4	-	1.65	0.98	3.49
D2-102	D2-11	305.8	15	3643.1	3638.65	3636.2	0.79%	3639.35	0.56	-	4.62	0.08	0.87
D2-11	D2-190	306.7	18	3643.1	3636.24	3635.3	0.31%	3637.07	0.55	-	3.35	0.01	0.57
D2-12	D2-102	268.8	15	3643.5	3640.69	3638.7	0.76%	3641.41	0.58	-	5.02	0	0.53
D2-121	D2-100	135.3	12	3627.4	3626.11	3625.8	0.20%	3626.55	0.44	-	2.05	0	0.53
D2-125	D2-126	70.8	12	3631.7	3612.8	3612.7	0.20%	3612.98	0.18	-	1.33	0.02	0.54
D2-126	D2-2	121.2	24	3615	3611.66	3609.9	1.49%	3612.81	0.58	-	8.76	0	0.53
D2-13	D2-12	324.6	15	3646	3642.64	3640.7	0.60%	3643.41	0.62	-	4.62	0	0.53
D2-14	D2-170	177	15	3648.4	3644.43	3643.3	0.64%	3645.16	0.58	-	4.34	0.05	0.53
D2-15	D2-59	177.4	15	3649.4	3646.31	3645.6	0.40%	3647.14	0.66	-	3.91	0	0.54
D2-152	D2-17	114	15	3652.2	3649.49	3648.6	0.82%	3650.15	0.53	-	4.76	0.01	0.54
D2-16	D2-15	133.6	15	3650.5	3647.61	3646.3	0.97%	3648.22	0.49	-	4.21	0.41	3.6
D2-169	D2-152	228.3	15	3654	3651.44	3649.5	0.85%	3652.03	0.47	-	4.63	0	0.54
D2-17	D2-16	100.4	15	3651.4	3648.55	3647.6	0.94%	3649.19	0.51	-	5.01	0.05	0.54
D2-170	D2-13	101.4	15	3652.6	3643.29	3642.6	0.64%	3644.06	0.62	-	4.26	0	0.54
D2-18	D2-169	94.6	15	3654.7	3652.22	3651.4	0.82%	3652.85	0.5	-	4.71	0	0.54
D2-184	D2-61	277.9	30	3645.4	3635.16	3634.9	0.08%	3636.97	0.72	-	3.63	0.61	1.88
D2-185	D2-184	298.5	30	3649	3635.16	3635.2	0.00%	3637.34	0.87	-	2.9	0	0.53
D2-186	D2-185	299.2	30	3648.6	3635.24	3635.2	0.03%	3637.61	0.95	-	2.6	0	0.53
D2-187	D2-186	299.5	30	3652.1	3635.41	3635.2	0.06%	3637.87	0.98	-	2.51	0	0.53
D2-190	D2-10	14.6	18	3645	3635.3	3635.3	0.01%	3636.24	0.63	-	3.61	0.01	0.44
D2-202	D2-4	246.4	24	3621.7	3617.12	3615	0.86%	3618.41	0.64	-	6.62	0.01	0.53
D2-264	C2-164	427.6	14	3588.5	3571.27	3526.5	10.53%	3572.14	0.75	-	19.18	0	0.54
D2-265	D2-187	397.2	30	3649.5	3635.71	3635.4	0.08%	3638.21	1	0	2.48	0.01	0.53
D2-266	D2-265	298.7	30	3645.9	3636.54	3635.7	0.28%	3638.44	0.76	-	2.82	0.01	0.53
D2-267	D2-266	300.1	30	3646.9	3636.79	3636.5	0.08%	3638.78	0.8	-	3.27	0	0.54
D2-268	D2-267	300.9	30	3645.5	3637.07	3636.8	0.09%	3639.1	0.81	-	2.95	0	0.41
D2-269	D2-268	399	30	3643.4	3637.39	3637.1	0.08%	3639.47	0.83	-	2.86	0.01	0.54
D2-270	D2-271	368.4	24	3635.4	3630.16	3627.1	0.83%	3631.46	0.65	-	7.24	0	0.53
D2-271	D2-272	340.1	24	3636.5	3627.11	3624.1	0.89%	3628.37	0.63	-	7.09	0.01	0.54
D2-272	D2-273	149.7	24	3634.7	3624.1	3622.7	0.92%	3625.44	0.67	-	6.9	0	0.54
D2-273	D2-68	283.3	24	3633.8	3622.73	3620.3	0.86%	3624.06	0.66	-	7.03	0	0.52
D2-274	D2-270	319.6	24	3643.7	3633.71	3630.2	1.11%	3634.88	0.59	-	7.58	0	0.54
D2-274	D2-9	488.8	18	3643.7	3635.71	3634.8	0.20%	3634.88	-0.55	-	0	0	0.54
D2-28	D2-18	299.4	15	3658	3655.63	3652.2	1.14%	3656.16	0.42	-	5.03	0	1.17
D2-3	D2-126	224.8	24	3617	3613.05	3611.7	0.62%	3614.51	0.73	-	6.42	0.15	0.52
D2-36	D2-28	67.9	12	3658.8	3656.38	3655.6	1.10%	3657.02	0.64	-	5.11	0	0.53
D2-4	D2-3	310.7	24	3620.4	3614.98	3613.1	0.62%	3616.42	0.72	-	6.18	1.69	6.99
D2-41	D2-36	351.6	12	3661.1	3659.39	3656.6	0.79%	3660.05	0.66	-	4.69	0	0.53
D2-42	D2-41	54.7	12	3661.4	3660.08	3659.4	1.26%	3660.71	0.63	-	4.74	0	0.54
D2-59	D2-14	171.4	15	3649	3645.6	3644.4	0.68%	3646.32	0.58	-	4.51	0	0.54
D2-6	D2-79	254.3	12	3636.4	3633.41	3626.6	2.68%	3633.55	0.14	-	3.87	0	0.54
D2-61	D2-10	53.6	30	3643	3634.94	3634.8	0.34%	3636.39	0.58	-	4.65	0.01	0.54
D2-68	D2-77	204.7	24	3627	3620.28	3618.6	0.85%	3621.66	0.69	-	6.74	0.01	0.53
D2-69	D2-273	25.4	12	3632.3	3623.78	3623.7	0.20%	3624.19	0.41	-	2.32	0	0.53
D2-7	D2-6	569.4	21	3641.9	3633.87	3633.4	0.08%	3634.19	0.18	-	1.1	0	0.53
D2-70	D2-69	102.4	12	3633.9	3623.99	3623.8	0.20%	3624.42	0.43	-	1.96	0	0.54
D2-77	D2-202	133.9	24	3624	3618.55	3617.4	0.84%	3619.99	0.72	-	7.19	0.04	0.53
D2-79	D2-77	179.3	12	3630.7	3626.6	3620.7	3.32%	3626.75	0.15	-	4.55	0	0.54
D2-8	D2-7	202.4	18	3645.2	3634.22	3633.9	0.17%	3634.44	0.15	-	0.99	0	0.25

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D2-9	D2-8	481.3	18	3644.3	3634.75	3634.2	0.11%	3634.84	0.06	-	0.45	0	0.08
D2-98	D2-70	178.3	12	3633	3624.36	3624	0.20%	3624.78	0.42	-	1.93	0.13	0.76
D2-99	D2-98	379.2	12	3635.5	3625.13	3624.4	0.20%	3625.51	0.38	-	1.86	0.01	1.32
D3-100	D3-98	211.6	24	3703.7	3694.53	3693.5	0.50%	3695.43	0.45	-	3.29	0.01	0.54
D3-103	D3-100	218.9	24	3706.6	3695.6	3694.5	0.49%	3696.56	0.48	-	5	0.02	0.54
D3-105	D3-103	129.1	24	3705.8	3695.9	3695.6	0.23%	3697.08	0.59	-	4.17	0	0.53
D3-110	D3-105	280.6	24	3704.1	3696.3	3695.9	0.14%	3697.67	0.68	-	3.36	0.01	0.54
D3-111	D3-110	159.1	24	3704.3	3696.36	3696.3	0.04%	3697.96	0.8	-	2.85	0.01	0.81
D3-126	D3-111	153.1	24	3704.4	3696.41	3696.4	0.03%	3698.16	0.88	-	2.54	0	0.54
D3-127	D3-126	105.9	24	3704.5	3696.46	3696.4	0.05%	3698.3	0.92	-	2.4	0	0.54
D3-142	D3-353	335.3	21	3707.3	3698.1	3696.8	0.40%	3699.13	0.59	-	3.69	0.03	0.54
D3-146	JUB132	89.8	12	3707.1	3699.37	3699.2	0.22%	3700.22	0.85	-	0.34	1.16	2.01
D3-147	JUB132	225.1	18	3707.8	3699.1	3698.7	0.19%	3701.21	1.41	0.61	3.91	1.52	7.92
D3-149	D3-147	106.3	18	3707.9	3699.4	3699.1	0.29%	3701.74	1.56	0.84	3.89	0.01	0.25
D3-150	D3-149	207.6	18	3708.3	3700.1	3699.4	0.34%	3702.59	1.66	0.99	3.88	1.55	4.9
D3-151	D3-150	443.8	18	3709.4	3701.8	3700.1	0.38%	3704.29	1.66	0.99	4.02	0.04	0.55
D3-157	D3-358	159.7	12	3707	3700.31	3700	0.22%	3700.5	0.19	-	1.36	0	0.53
D3-158	D3-157	63.3	12	3707	3700.46	3700.3	0.22%	3700.65	0.19	-	1.31	0.01	0.53
D3-159	D3-158	333.2	12	3710.4	3701.2	3700.5	0.22%	3701.37	0.17	-	1.24	0	0.25
D3-160	D3-159	231.8	12	3714.9	3701.72	3701.2	0.22%	3701.82	0.1	-	0.63	0.01	0.53
D3-205	D3-222	195.3	10	3699.5	3690.08	3688.5	0.81%	3690.61	0.64	-	4.13	0.21	1.03
D3-209	D3-205	145.5	10	3701.3	3691.78	3690.2	1.10%	3692.23	0.54	-	4.51	0.02	0.91
D3-210	D3-209	290.9	10	3707.3	3698.83	3691.9	2.39%	3699.18	0.42	-	6.06	0.02	0.81
D3-222	D3-223	226.5	10	3696.6	3688.45	3686.2	0.99%	3688.95	0.6	-	4.5	0.21	0.79
D3-223	D3-225	58.1	10	3694.3	3686.15	3685	1.94%	3686.58	0.52	-	5.58	0	0.54
D3-225	D3-226	166.5	12	3693.8	3684.64	3684.1	0.32%	3685.29	0.65	-	2.93	0	0.53
D3-226	D3-228	313	12	3693.2	3684.08	3683.1	0.30%	3684.7	0.62	-	2.58	0.12	0.53
D3-228	D3-307	165.7	12	3690.8	3683.08	3682.8	0.14%	3683.91	0.83	-	2.71	0	0.54
D3-231	D3-232	270.1	10	3688.8	3682.35	3679.8	0.95%	3682.87	0.62	-	4.48	0	0.25
D3-232	D3-233	308.7	10	3686	3679.71	3676.9	0.93%	3680.22	0.61	-	4.21	0.37	14.15
D3-233	D3-247	299.3	10	3683.9	3676.85	3674.2	0.90%	3677.44	0.71	-	4.47	0.37	6.51
D3-247	D3-250	313.4	10	3680.3	3674.17	3671.5	0.86%	3674.77	0.72	-	4.32	0	0.54
D3-250	D3-260	291.6	10	3677.7	3671.49	3669	0.87%	3672.28	0.95	-	4.13	0.01	0.54
D3-260	D3-355	15.3	10	3671.7	3668.95	3668.7	1.57%	3670.41	1.75	0.63	4.21	0	0.53
D3-274	D3-356	17.3	10	3669.9	3666.77	3666.5	1.33%	3668.03	1.51	0.43	3.96	0.19	4.68
D3-278	D3-280	113.4	12	3670.6	3665.83	3665.1	0.66%	3666.49	0.66	-	4.07	0	0.54
D3-280	D3-281	141	12	3671	3665.08	3664.1	0.70%	3665.72	0.64	-	4.11	0.1	1.37
D3-281	D3-285	288.8	12	3668.9	3664.1	3662.2	0.66%	3664.74	0.64	-	4.05	0.01	0.53
D3-285	D2-42	388.6	12	3664.9	3662.18	3660.1	0.54%	3662.88	0.7	-	4.03	0.02	0.54
D3-303	D3-339	117.7	12	3718.4	3703.84	3703.6	0.22%	3703.92	0.08	-	0.8	0	0.53
D3-307	D3-231	11.2	10	3689	3682.49	3682.4	1.16%	3683.08	0.71	-	4.07	0	0.54
D3-317	C3-6	326.6	10	3670.7	3668.29	3665.1	0.98%	3668.54	0.3	-	2.15	0	0.44
D3-339	D3-160	79.2	12	3716.4	3701.91	3701.7	0.23%	3701.98	0.07	-	0.68	0.01	0.54
D3-343	D3-345	340.8	12	3694.9	3676.57	3675	0.48%	3676.77	0.2	-	2.09	0.22	1.21
D3-345	D3-363	240.5	12	3695.7	3674.95	3673.4	0.64%	3675.14	0.19	-	2.33	0.23	1.45
D3-353	D3-127	19.2	24	3704.6	3696.48	3696.5	0.10%	3698.37	0.94	-	2.34	0.03	0.53
D3-355	D3-274	254.7	10	3671.5	3668.71	3666.8	0.76%	3670.16	1.74	0.62	3.9	0	0.53
D3-356	D3-278	125	10	3669.7	3666.54	3665.8	0.57%	3667.71	1.4	0.34	4.2	0.19	4.72
D3-358	D3-146	259.8	12	3705.7	3699.95	3699.4	0.22%	3700.22	0.27	-	0.88	0	0.25
D3-363	D3-364	100.3	12	3694.4	3673.4	3672.7	0.74%	3673.59	0.19	-	2.33	0	0.54
D3-364	D3-370	98.7	12	3693.8	3672.66	3672	0.63%	3672.86	0.2	-	2.3	0.01	0.54
D3-370	D3-66	33.6	12	3692.7	3672.04	3671.6	1.40%	3672.2	0.16	-	1.86	0	0.53
D3-373	D3-73	84.9	8	3674.7	3669.9	3669.7	0.24%	3670.28	0.57	-	2.11	0.01	0.53

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D3-62	D3-63	320.6	8	3693.9	3691.61	3685.4	1.95%	3691.76	0.23	-	3.39	0.01	0.54
D3-63	D3-65	243.8	8	3689.4	3683.09	3681.8	0.53%	3683.31	0.33	-	2.2	0.03	0.83
D3-65	D3-343	126.1	8	3694.6	3681.8	3680.2	1.25%	3681.98	0.27	-	2.98	0	0.81
D3-66	D3-72	248.7	8	3692.3	3671.57	3670.7	0.36%	3671.86	0.43	-	2.09	0	0.54
D3-72	D3-373	195	8	3675	3670.67	3669.9	0.39%	3670.96	0.43	-	1.83	0.01	0.54
D3-73	D3-317	264.1	10	3674.6	3669.59	3668.3	0.49%	3669.89	0.36	-	2.59	0.58	2.48
D3-83	D3-86	141.3	24	3699.9	3692.81	3692.6	0.15%	3694.36	0.78	-	2.81	0.02	0.38
D3-85	D3-83	27	24	3699.9	3692.84	3692.8	0.07%	3694.47	0.81	-	2.75	0.02	1.11
D3-86	C3-104	327.3	24	3700.1	3692.6	3692.2	0.12%	3694.14	0.77	-	2.84	0.02	0.89
D3-88	D3-85	178.7	24	3700.1	3693.11	3692.9	0.15%	3694.7	0.79	-	2.72	0	0.25
D3-98	JUB151	146.7	24	3700.8	3693.47	3693.4	0.08%	3695.24	0.88	-	2.51	5.9	15.9
D4-1	C4-116	329.7	12	3719.1	3709.29	3708.4	0.27%	3709.66	0.37	-	2.1	0.58	2.84
D4-10	D4-9	473.6	12	3719.7	3716.29	3715.2	0.23%	3716.58	0.29	-	1.77	0	0.53
D4-104	D4-97	172.6	15	3724.9	3718.5	3717.5	0.57%	3719.25	0.6	-	4.36	0.29	0.18
D4-118	D4-262	47.5	15	3724	3718.68	3718.6	0.09%	3719.98	1.04	0.05	2.66	1	5.65
D4-119	D4-118	126.4	15	3726.3	3719.06	3718.7	0.30%	3720.3	0.99	-	2.59	1	2.1
D4-120	D4-299	116.9	15	3729.4	3719.4	3719.2	0.17%	3720.81	1.13	0.16	2.56	0.14	0.54
D4-126	D4-120	135.5	15	3729.6	3720.24	3719.4	0.62%	3721.07	0.66	-	3.15	0.07	0.46
D4-161	D4-126	563.2	15	3730.5	3723.6	3720.2	0.60%	3724.29	0.55	-	4.47	0.01	0.53
D4-172	D4-161	252.4	15	3731.6	3724.76	3723.6	0.46%	3725.54	0.62	-	4.1	0	0.54
D4-174	D4-172	342	15	3733.1	3726.43	3724.8	0.49%	3727.16	0.58	-	3.96	0	0.54
D4-180	D4-174	135.2	12	3733.6	3727	3726.4	0.42%	3728.08	1.08	0.08	3.91	0	0.53
D4-181	D4-180	188.6	12	3735.1	3728.95	3727	1.03%	3729.58	0.63	-	4.11	0.14	2.54
D4-182	D4-181	162.8	12	3736.2	3730.23	3729	0.79%	3730.96	0.73	-	4.69	0	0.54
D4-183	D4-182	257.8	18	3734.5	3730.9	3730.4	0.21%	3731.63	0.49	-	3.01	0	0.53
D4-185	D4-182	252.4	12	3741.5	3734.1	3730.4	1.49%	3734.35	0.25	-	2.13	0.03	0.53
D4-186	D4-183	229.3	18	3737.1	3731.58	3730.9	0.30%	3732.21	0.42	-	2.89	0	0.89
D4-187	D4-186	208.3	18	3736.8	3732.06	3731.6	0.23%	3732.77	0.47	-	2.94	0	0.54
D4-188	D4-187	138.5	18	3738.3	3732.38	3732.1	0.23%	3733.09	0.47	-	2.71	0	0.54
D4-2	D4-1	321.5	12	3721.4	3710.09	3709.3	0.25%	3710.46	0.37	-	2.08	0	0.77
D4-247	D4-249	568.7	8	3731.3	3728.6	3725.6	0.53%	3728.64	0.06	-	0.2	0.01	0.54
D4-249	D4-250	205.2	10	3733	3725.6	3725	0.30%	3725.77	0.2	-	1.42	0.01	0.54
D4-250	D4-251	300.1	10	3733.2	3724.99	3724.2	0.26%	3725.17	0.22	-	1.4	2.02	0.3
D4-251	D4-252	255.8	10	3733.5	3724.2	3722.7	0.58%	3724.38	0.22	-	0.84	0.01	0.25
D4-252	C4-141	263	10	3733.7	3722.71	3722.7	0.01%	3723.26	0.66	-	0.49	0.01	0.25
D4-256	D4-265	81.5	18	3723	3716.05	3715.4	0.79%	3716.97	0.61	-	2.5	1	5.69
D4-262	D4-104	148	15	3724.2	3718.64	3718.5	0.09%	3719.82	0.94	-	3.18	1.07	11.66
D4-264	D4-76	57.2	18	3723.8	3715.23	3715	0.40%	3716.87	1.09	0.14	3.38	0	0.53
D4-265	D4-264	76.8	18	3723.7	3715.41	3715.2	0.23%	3716.93	1.01	0.02	1.57	0	0.54
D4-299	D4-119	80.2	15	3730.2	3719.2	3719.1	0.17%	3720.52	1.06	0.07	2.6	0.14	0.54
D4-3	D4-2	336.8	12	3724.1	3710.89	3710.1	0.24%	3711.25	0.36	-	1.98	1.16	4.66
D4-318	D4-53	178.2	18	3717.2	3709.99	3709.2	0.44%	3711.22	0.82	-	4.19	0	0.54
D4-321	D4-35	122.4	10	3725.1	3718.34	3718	0.29%	3718.63	0.35	-	1.87	0	0.25
D4-328	D4-70	128.2	18	3719.8	3713.29	3712.7	0.44%	3714.46	0.78	-	3.99	0.03	0.81
D4-34	D4-321	385.1	10	3727.7	3719.49	3718.3	0.30%	3719.74	0.3	-	1.66	0.04	0.53
D4-35	D4-10	545.2	10	3724.5	3717.99	3716.3	0.31%	3718.27	0.34	-	1.97	0.01	0.25
D4-36	D3-151	195.7	18	3710.4	3702.76	3701.8	0.49%	3705.24	1.65	0.98	4.51	0	0.25
D4-38	D4-36	592.2	18	3713.8	3706.03	3702.8	0.55%	3707.2	0.78	-	4.89	0	0.53
D4-4	D4-3	323.1	12	3726.4	3711.69	3710.9	0.25%	3712.03	0.34	-	1.96	1.16	3.31
D4-5	D4-4	330.2	12	3727.3	3712.59	3711.7	0.27%	3712.91	0.32	-	1.96	0	0.53
D4-53	D4-56	669.1	18	3716.8	3709.2	3706.8	0.36%	3710.5	0.87	-	4.36	0	0.53
D4-56	D4-38	145.5	18	3714.6	3706.8	3706	0.53%	3707.97	0.78	-	4.97	0.07	1
D4-6	D4-5	374.2	12	3725.3	3713.55	3712.6	0.26%	3713.86	0.31	-	1.94	0.01	0.18

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D4-61	D4-318	271.8	18	3717.9	3711.3	3710	0.48%	3712.41	0.74	-	4.47	0	0.54
D4-7	D4-6	291.5	12	3723.7	3714.29	3713.6	0.25%	3714.59	0.3	-	1.89	0.01	0.19
D4-70	D4-61	377	18	3718.5	3712.72	3711.3	0.38%	3713.96	0.83	-	4.41	0	0.54
D4-76	D4-328	372.1	18	3723.6	3715	3714.3	0.19%	3716.6	1.07	0.1	3.89	0	0.54
D4-77	D4-256	253.8	18	3724.1	3718.04	3716.1	0.78%	3718.58	0.36	-	4.62	0.09	1.31
D4-78	D4-77	391	21	3730.6	3724.4	3718	1.63%	3724.82	0.24	-	5.19	0	0.53
D4-8	D4-7	190.5	12	3722.6	3714.8	3714.3	0.27%	3715.1	0.3	-	1.92	0	0.53
D4-82	D4-264	93.8	18	3724	3715.6	3715.2	0.39%	3716.97	0.91	-	2.29	1.07	9.4
D4-9	D4-8	169.6	12	3721.8	3715.19	3714.8	0.23%	3715.48	0.29	-	1.7	0	0.54
D4-97	D4-82	362.2	18	3724.6	3717.52	3715.6	0.53%	3718.18	0.44	-	3.37	0	0.54
D5-10	D4-185	481.5	12	3746.5	3739.28	3734.1	1.08%	3739.55	0.27	-	3.68	0	0.53
D5-133	D5-135	355.8	12	3704.2	3700.56	3699.5	0.30%	3700.88	0.32	-	2.2	0.45	9.59
D5-135	D5-136	432.3	12	3705.2	3699.5	3696.3	0.75%	3699.74	0.24	-	2.89	0.05	0.54
D5-136	D5-137	424.8	12	3701	3696.25	3693.1	0.75%	3696.5	0.25	-	2.93	13.01	27.44
D5-137	D5-138	373.4	12	3698.3	3693.06	3690.3	0.75%	3693.31	0.25	-	2.89	0.07	0.54
D5-138	C5-20	363	12	3695.5	3690.27	3687.5	0.75%	3690.53	0.26	-	2.76	0	1.17
D5-139	D5-133	302.1	12	3704.2	3701.5	3700.6	0.31%	3701.75	0.25	-	1.61	0.01	0.52
D5-140	D5-139	357.3	12	3712.7	3702.57	3701.5	0.30%	3702.82	0.25	-	1.86	0.05	0.54
D5-141	D5-140	204.1	12	3714.5	3706.45	3704.5	0.96%	3706.64	0.19	-	2.79	0	0.53
D5-142	D5-141	103.9	12	3714.4	3706.77	3706.5	0.31%	3707.02	0.25	-	1.96	0	0.53
D5-143	D5-142	238.3	12	3716.2	3707.52	3706.8	0.31%	3707.76	0.24	-	1.81	0.02	0.54
D5-144	D5-143	352.4	12	3718.5	3708.77	3707.5	0.35%	3709	0.23	-	1.89	0	0.54
D5-145	D5-144	243.3	12	3714.3	3709.58	3708.8	0.33%	3709.81	0.23	-	1.87	0.02	0.54
D5-146	D5-145	355.2	10	3714	3711.61	3709.8	0.52%	3711.83	0.26	-	2.23	0.01	0.54
D5-147	D5-146	404.8	10	3716.3	3713.96	3711.6	0.58%	3714.16	0.24	-	2.21	0	0.54
D5-178	D4-188	190.5	18	3739.3	3733.74	3733.5	0.15%	3734.52	0.52	-	2.9	0.02	0.53
D5-179	D5-178	46.9	18	3739.1	3733.83	3733.7	0.19%	3734.64	0.54	-	2.34	1.52	7.12
D5-194	D5-94	113.4	10	3778.3	3771.56	3770.1	1.29%	3771.66	0.12	-	1.58	5.81	14.1
D5-20	D5-10	102	12	3747.6	3740.34	3739.3	1.04%	3740.61	0.27	-	3.5	0.01	0.54
D5-41	D5-20	334.2	12	3748.6	3741.4	3740.3	0.32%	3741.76	0.36	-	2.42	0	0.25
D5-42	D5-41	109.5	12	3749.6	3742.51	3741.4	1.01%	3742.75	0.24	-	2.54	0	0.25
D5-50	D5-42	180.8	12	3751.4	3744.59	3742.5	1.15%	3744.81	0.22	-	3.1	0.01	0.25
D5-51	D5-50	220.2	12	3754	3747.05	3744.6	1.12%	3747.26	0.21	-	3.16	0	0.25
D5-52	D5-51	190.6	12	3756.3	3749.13	3747.1	1.09%	3749.33	0.2	-	3.01	0	0.25
D5-53	D5-52	200.3	12	3759	3751.6	3749.1	1.23%	3751.79	0.19	-	3.16	0	0.25
D5-85	D5-53	512.3	12	3765.6	3757.01	3751.6	1.06%	3757.17	0.16	-	2.51	0	0.25
D5-91	D5-85	172.2	12	3769.2	3759.93	3757	1.70%	3760.05	0.12	-	2.22	0	0.54
D5-92	D5-91	321.4	12	3773.7	3763.6	3759.9	1.14%	3763.73	0.13	-	2.43	0	0.53
D5-93	D5-92	554.6	12	3776	3769.9	3763.6	1.14%	3770.02	0.12	-	2.17	0.02	0.25
D5-94	D5-93	60.4	10	3777	3770.1	3769.9	0.33%	3770.24	0.17	-	1.44	5.81	13.88
D5-96	D5-194	540.9	10	3783.1	3777.2	3771.6	1.04%	3777.29	0.11	-	1.92	5.81	12.25
D5-97	D5-96	616.6	10	3792.1	3782.9	3777.2	0.92%	3782.98	0.1	-	1.46	0.01	0.53
D5-98	D5-97	46.8	10	3792.4	3783.05	3782.9	0.30%	3783.14	0.11	-	1.05	0.01	0.54
D6-1	D5-147	397.7	10	3721.4	3716.17	3714.1	0.53%	3716.37	0.24	-	2.15	0	0.53
D6-10	D6-9	311.8	12	3799.6	3794.58	3793.9	0.23%	3795.08	0.5	-	2.48	0.02	0.54
D6-11	D6-10	402	12	3805.2	3798.49	3794.7	0.93%	3798.81	0.32	-	3.62	0	0.53
D6-12	D6-11	366	12	3807.8	3799.81	3798.7	0.32%	3800.25	0.44	-	2.66	0.05	0.54
D6-13	D6-12	106.9	12	3808.8	3800.2	3799.8	0.34%	3800.63	0.43	-	2.49	0.05	0.53
D6-2	D6-1	358	10	3723.4	3718.18	3716.3	0.53%	3718.38	0.24	-	2.13	0	0.53
D6-3	D6-2	282.2	10	3723.5	3719.78	3718.3	0.53%	3719.97	0.23	-	2.08	0	0.54
D6-4	D6-3	271	10	3725.1	3722.35	3719.9	0.91%	3722.52	0.2	-	2.5	0	0.53
D6-5	D6-4	389.9	10	3739	3723.51	3722.4	0.30%	3723.74	0.28	-	1.88	0.05	0.53
D6-6	D6-5	118.3	10	3729.9	3723.86	3723.5	0.29%	3724.07	0.25	-	1.54	0.01	0.54

Appendix G - Committed Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D6-7	C5-238	239.9	12	3797.8	3791.89	3791.2	0.27%	3792.39	0.5	-	2.65	0.03	0.54
D6-8	D6-7	357.4	12	3798.4	3793.2	3792	0.34%	3793.66	0.46	-	2.8	0.09	0.53
D6-9	D6-8	265.7	12	3798.4	3793.71	3793.1	0.24%	3794.19	0.48	-	2.08	7.64	12.45
E2-10	E2-7	220.6	8	3685.6	3678.61	3677.7	0.40%	3678.91	0.45	-	2.19	0.01	0.54
E2-100	E2-101	238	8	3671.3	3662.51	3659.2	1.39%	3662.97	0.69	-	4.68	0.01	0.54
E2-101	E2-102	137.7	8	3668	3659.19	3657.3	1.38%	3659.69	0.75	-	4.71	0.9	1.62
E2-102	E2-120	147	8	3665.9	3657.28	3655.4	1.29%	3657.79	0.76	-	4.52	0.9	2.54
E2-120	E2-121	200.7	8	3663.5	3655.38	3653	1.19%	3655.91	0.79	-	4.55	0.1	0.7
E2-121	E2-122	123.3	8	3658.4	3652.99	3647.9	4.13%	3653.32	0.5	-	5.48	0	0.53
E2-122	E2-123	222.9	10	3654.9	3647.9	3646.6	0.61%	3648.44	0.65	-	3.57	0.11	1.59
E2-123	E2-124	172.6	10	3652.6	3646.55	3645.5	0.63%	3647.09	0.65	-	3.53	0.11	0.76
E2-124	E2-125	177.6	10	3650.9	3645.46	3644.4	0.57%	3646.01	0.66	-	3.41	0.11	0.68
E2-125	E2-126	195.6	10	3650.3	3644.44	3643.4	0.55%	3645.01	0.68	-	3.55	0	0.54
E2-126	E2-128	249.2	10	3648.1	3643.36	3640.2	1.26%	3643.79	0.52	-	4.81	0.03	1.17
E2-128	D2-269	401.5	30	3643.4	3637.73	3637.4	0.08%	3639.84	0.84	-	2.8	0.02	0.52
E2-129	E2-128	399.2	30	3644.4	3638.07	3637.7	0.09%	3640.12	0.82	-	2.59	0.78	3.4
E2-131	E2-129	291.9	30	3642.3	3638.35	3638.1	0.10%	3640.36	0.8	-	2.62	0.9	2.21
E2-132	E2-131	388	30	3644.2	3638.75	3638.4	0.10%	3640.66	0.76	-	2.7	0	0.25
E2-133	E2-132	356.1	30	3647.2	3639.59	3638.8	0.24%	3641	0.56	-	3.27	0	0.53
E2-134	E2-133	196.4	30	3648.9	3640.18	3639.6	0.30%	3641.49	0.52	-	4.09	0.07	1.08
E2-135	E2-134	247.9	30	3650.7	3640.82	3640.2	0.26%	3642.15	0.53	-	4.15	0.07	1.21
E2-136	E2-135	493.8	30	3652.5	3642.01	3640.8	0.24%	3643.3	0.52	-	4.14	0.03	0.49
E2-137	E2-136	137.5	30	3653.4	3642.32	3642	0.23%	3643.72	0.56	-	3.96	0.02	0.53
E2-138	E2-137	142.1	30	3653.7	3642.58	3642.3	0.18%	3644.04	0.58	-	3.47	0.02	0.5
E2-139	E2-138	229.6	30	3655.4	3643.32	3642.6	0.32%	3644.51	0.48	-	3.81	0	0.53
E2-140	E2-139	550	27	3658.2	3646.15	3643.3	0.51%	3647.18	0.46	-	5.15	0.02	0.53
E2-141	E2-140	401.1	27	3657.2	3648.18	3646.2	0.51%	3649.24	0.47	-	5.51	0.02	0.53
E2-142	E2-141	218.4	27	3658.8	3649.3	3648.2	0.51%	3650.38	0.48	-	5.32	0.02	0.53
E2-143	E2-142	149.9	27	3662.3	3650.16	3649.3	0.57%	3651.24	0.48	-	5.24	0	0.53
E2-144	E2-143	431.9	24	3670.4	3656.35	3650.2	1.43%	3657.15	0.4	-	6.82	0.02	0.53
E2-145	E2-144	227.2	24	3675.4	3659.82	3656.4	1.53%	3660.65	0.41	-	8.2	0.01	0.55
E2-146	E2-145	55.9	24	3675.7	3660.72	3659.8	1.61%	3661.65	0.47	-	7.42	0	0.53
E2-147	E2-146	133.3	24	3675.2	3662.1	3660.7	1.03%	3663.07	0.49	-	6.74	0	0.53
E2-148	E2-147	99.8	24	3676.2	3663.17	3662.1	1.07%	3664.15	0.49	-	6.5	0.02	0.53
E2-149	E2-148	91.3	24	3677	3663.98	3663.2	0.89%	3665.03	0.53	-	6.17	0.01	0.53
E2-150	E2-149	91.3	24	3676.1	3664.75	3664	0.84%	3665.82	0.54	-	5.84	0.01	0.53
E2-151	E2-150	199.9	24	3677.4	3666.38	3664.8	0.82%	3667.39	0.5	-	5.99	0.07	0.53
E2-152	E2-151	106.1	24	3678.3	3667.32	3666.4	0.89%	3668.35	0.51	-	6.11	0	0.54
E2-153	E2-152	118.1	24	3679.5	3668.43	3667.3	0.94%	3669.44	0.51	-	6.1	0	0.53
E2-2	E2-97	308.8	8	3683.8	3673.44	3672.1	0.42%	3675.48	3.06	1.37	3.75	0.02	0.97
E2-5	E2-2	308.8	8	3686.1	3675.97	3674.2	0.57%	3678.25	3.42	1.61	3.48	0.03	0.54
E2-6	E2-5	176.4	8	3684.8	3676.68	3676	0.40%	3678.31	2.45	0.96	1.37	1.61	5.35
E2-7	E2-6	257	8	3683.7	3677.72	3676.7	0.40%	3678.37	0.98	-	2.25	0.01	0.55
E2-9	E2-5	313.6	8	3689	3676.95	3676.1	0.28%	3680.03	4.62	2.41	2.77	1.58	4.4
E2-97	E2-98	167.8	8	3678.9	3672.04	3667.6	2.66%	3672.4	0.54	-	5.48	0	0.54
E2-98	E2-99	222.9	8	3676.8	3667.57	3664.5	1.39%	3668.04	0.7	-	4.76	0	0.97
E2-99	E2-100	140.9	8	3673.5	3664.47	3662.5	1.38%	3664.95	0.72	-	4.78	0.98	3.07
E3-139	E2-9	311.2	8	3691.4	3681.45	3677	1.45%	3681.89	0.66	-	3.16	0	0.53
E3-140	E3-139	221.7	8	3693.7	3682.94	3681.5	0.67%	3683.45	0.76	-	3.48	5.77	22.85
E3-141	E3-140	260.8	8	3694.2	3684.18	3682.9	0.48%	3684.79	0.92	-	2.96	0	0.53
E3-143	E3-141	270.7	8	3696	3686.75	3684.3	0.91%	3687.17	0.63	-	3.61	0	0.53
E3-152	E2-10	322.9	8	3688.1	3679.92	3678.6	0.40%	3680.2	0.42	-	2.17	0.14	1.26
E3-154	E3-152	395.8	8	3689.9	3681.51	3679.9	0.40%	3681.79	0.42	-	2.16	0.01	0.53

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E3-201	E3-154	191.1	12	3691	3681.94	3681.5	0.22%	3682.21	0.27	-	1.65	0	0.55
E3-202	E3-201	171.6	12	3691.9	3682.33	3682	0.22%	3682.6	0.27	-	1.65	0	0.25
E3-204	E3-202	218.1	12	3693	3682.82	3682.3	0.22%	3683.07	0.25	-	1.57	0.01	0.25
E3-205	E3-204	127.1	12	3693	3683.11	3682.8	0.22%	3683.32	0.21	-	1.36	0	0.25
E3-207	E3-205	297	12	3692	3683.77	3683.1	0.22%	3683.98	0.21	-	1.45	0.01	0.54
E3-209	E3-207	56.3	12	3691.7	3683.9	3683.8	0.22%	3684.11	0.21	-	1.37	0.19	1.24
E3-210	E3-209	181.8	12	3691	3684.31	3683.9	0.22%	3684.51	0.2	-	1.39	0	0.54
E3-211	E3-210	71.7	12	3690.2	3684.48	3684.3	0.22%	3684.68	0.2	-	1.38	0.01	0.53
E3-307	E3-308	395.1	24	3712.4	3702.95	3691.7	2.86%	3703.59	0.32	-	9.95	0.04	0.54
E3-308	E3-309	35.4	30	3706.6	3691.15	3691	0.54%	3692.4	0.5	-	4.11	0	0.54
E3-309	E3-310	274	30	3706.5	3690.96	3690.2	0.28%	3692.15	0.48	-	4.67	0	0.54
E3-310	E3-311	477.8	27	3700.8	3690.2	3687.6	0.54%	3691.22	0.45	-	5.48	0	0.54
E3-311	E3-312	55.4	27	3697.6	3687.63	3687.3	0.63%	3688.68	0.47	-	6.89	0	0.54
E3-312	E3-313	489.8	27	3697.3	3687.28	3677.3	2.04%	3687.97	0.31	-	6.97	0.01	0.54
E3-313	E3-314	183.8	27	3686	3677.28	3676.2	0.60%	3678.32	0.46	-	5.61	0.07	0.53
E3-314	E3-315	303.1	27	3685.1	3676.18	3674.3	0.63%	3677.18	0.44	-	6.06	0	0.53
E3-315	E2-153	665.5	24	3687.3	3674.27	3668.4	0.88%	3675.19	0.46	-	6.55	0.43	10.18
E3-34	D3-210	388.5	10	3714.2	3707.49	3699.4	2.09%	3707.83	0.41	-	5.69	0.62	6.45
E3-35	E3-34	223.9	10	3716.1	3708.5	3707.5	0.45%	3709.07	0.68	-	3.28	0	0.54
E3-36	E3-35	97.5	10	3716.9	3710.09	3708.8	1.32%	3710.5	0.49	-	4.67	0.01	0.54
E3-37	E3-36	309.7	10	3720.2	3710.97	3710.2	0.26%	3711.7	0.88	-	2.73	0	0.54
E3-4	E3-143	230.8	8	3697.9	3693.64	3687.7	2.56%	3693.95	0.46	-	5.71	0.62	6.29
E3-40	E3-37	388.4	10	3722.2	3711.94	3711	0.25%	3712.55	0.73	-	2.24	0.01	0.97
E3-41	E3-40	52.3	10	3722.6	3712	3712	0.06%	3712.74	0.89	-	2.25	0	0.53
E3-43	E3-41	258.9	10	3722.7	3712.65	3712	0.24%	3713.27	0.74	-	2.19	0	0.54
E3-44	E3-43	89.2	10	3722.6	3712.85	3712.7	0.18%	3713.51	0.79	-	2.2	0	0.53
E3-45	E3-44	330.3	10	3721.7	3713.66	3712.9	0.24%	3714.23	0.68	-	2.23	0	0.53
E3-47	E3-45	200	8	3721.1	3714.4	3713.8	0.32%	3715.36	1.44	0.29	2.95	0.04	0.54
E3-5	E3-4	249.1	8	3700.2	3695.34	3693.9	0.56%	3695.86	0.78	-	3.24	0.09	0.53
E3-6	E3-5	250.4	8	3701.8	3696.35	3695.4	0.36%	3697.11	1.14	0.09	2.78	0	0.53
E3-64	E3-59	414.5	12	3728.6	3715.75	3714.8	0.22%	3715.88	0.13	-	1.09	0.01	0.54
E3-7	E3-6	208.8	8	3703.6	3697.5	3696.5	0.50%	3697.98	0.72	-	2.78	0.01	0.54
E3-73	E3-64	320.5	12	3733.3	3716.46	3715.8	0.22%	3716.54	0.08	-	0.5	0.01	0.54
E3-8	E3-7	216.5	8	3706.5	3699.33	3697.6	0.80%	3699.74	0.61	-	3.55	0.01	0.54
E4-106	E4-227	320.5	18	3766.9	3761.84	3760.3	0.47%	3762.34	0.33	-	3.35	0	0.54
E4-108	E4-106	320.6	18	3767.7	3763.16	3761.8	0.41%	3763.67	0.34	-	3.34	0	0.54
E4-109	E4-108	257.3	18	3769.4	3764.2	3763.2	0.40%	3764.71	0.34	-	3.25	0	0.53
E4-110	E4-226	144	18	3770.9	3765.22	3764.6	0.46%	3765.59	0.25	-	2.34	0	0.53
E4-219	E4-43	185.4	18	3752.9	3741.98	3741.5	0.24%	3742.76	0.52	-	3.36	0.05	0.54
E4-220	E4-348	332.2	18	3752.7	3742.97	3742.1	0.25%	3743.7	0.49	-	2.93	0.05	0.54
E4-221	E4-220	388.5	18	3754.7	3743.93	3743	0.25%	3744.69	0.51	-	3.1	0	0.54
E4-226	E4-109	93.4	18	3769.9	3764.56	3764.2	0.39%	3765.1	0.36	-	3.12	0	0.54
E4-227	E4-93	9.8	18	3767	3760.31	3760.2	1.02%	3760.86	0.37	-	4.28	0	0.53
E4-348	E4-219	58.7	18	3754.6	3742.12	3742	0.22%	3742.96	0.56	-	2.83	0.01	0.54
E4-39	D4-78	401.6	18	3732.8	3726.85	3724.4	0.61%	3727.44	0.39	-	4.37	0	0.54
E4-40	E4-39	421.6	18	3736.9	3730.85	3726.9	0.95%	3731.36	0.34	-	4.72	0	0.25
E4-41	E4-40	400.3	18	3744	3734.85	3730.9	1.00%	3735.36	0.34	-	5.2	6.57	20.71
E4-42	E4-41	426.7	18	3749.7	3738.85	3734.9	0.94%	3739.37	0.35	-	5.11	0	0.25
E4-43	E4-42	238.7	18	3752.9	3741.53	3738.9	1.12%	3742.03	0.33	-	5.19	5.83	24.25
E4-47	E4-221	57.5	18	3754.6	3744.31	3744	0.50%	3744.99	0.45	-	3.51	0	0.54
E4-62	E4-47	340.7	18	3757.6	3747.72	3744.3	1.00%	3748.22	0.33	-	4.19	0	0.54
E4-63	E4-62	298.3	18	3761.4	3750.7	3747.7	1.00%	3751.21	0.34	-	5.16	0	0.54
E4-64	E4-63	576.4	18	3760.9	3753.09	3750.7	0.41%	3753.72	0.42	-	3.77	0	0.53

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E4-65	E4-64	274.7	18	3760.9	3754.3	3754.2	0.05%	3755.31	0.67	-	2.53	0.43	1.42
E4-66	E4-65	290	18	3760.9	3755.58	3754.3	0.44%	3756.15	0.38	-	2.43	0	0.54
E4-91	E4-66	289	18	3761.8	3756.32	3755.6	0.26%	3757.01	0.46	-	3.23	0.42	1.45
E4-92	E4-91	337.2	18	3762.9	3757.17	3756.3	0.25%	3757.84	0.45	-	2.91	0.07	0.54
E4-93	E4-92	290.1	18	3767	3760.21	3757.2	1.04%	3760.66	0.3	-	3.76	0.02	0.54
E5-1	D5-179	244	18	3740.9	3734.15	3733.8	0.13%	3734.97	0.55	-	2.27	1.52	6.94
E5-119	E5-1	446.9	18	3743	3735.03	3734.2	0.20%	3735.72	0.46	-	2.48	0.01	0.54
E5-17	E5-7	491.7	15	3744.4	3739.35	3735.9	0.69%	3739.79	0.35	-	3.95	0.01	0.53
E5-18	E5-17	395.1	12	3747.4	3743.75	3739.4	1.11%	3744.17	0.42	-	4.64	0	0.53
E5-19	E5-18	326.1	15	3750.9	3745.09	3743.8	0.41%	3745.6	0.41	-	3.28	0	0.53
E5-29	E5-19	331.1	8	3756	3749.83	3747.5	0.72%	3751.79	2.94	1.29	4.16	0.15	0.53
E5-30	E5-29	224.9	10	3757.5	3752.7	3750.3	1.09%	3753.14	0.53	-	4.45	0	0.25
E5-31	E5-30	47.3	10	3759.3	3753.55	3752.7	1.80%	3753.97	0.5	-	4.83	0	0.25
E5-32	E5-31	256.8	10	3760	3755.9	3753.6	0.92%	3756.38	0.58	-	4.29	0.02	0.54
E5-36	E5-32	237.7	10	3763	3757.1	3755.9	0.50%	3757.69	0.71	-	3.48	0	0.54
E5-39	E5-36	241.9	10	3765.4	3758.9	3757.1	0.74%	3759.39	0.59	-	3.54	0.28	1.37
E5-40	E5-39	337.5	10	3766.5	3761.39	3758.9	0.74%	3761.89	0.6	-	3.92	0	0.53
E5-41	E5-40	318.3	12	3771.1	3763.42	3761.4	0.64%	3763.88	0.46	-	3.53	0.29	1.5
E5-42	E5-41	392.1	12	3770.9	3766.59	3763.4	0.81%	3767.01	0.42	-	3.89	0.29	1.48
E5-43	E5-42	252.6	12	3774.4	3767.45	3766.6	0.34%	3768.02	0.57	-	3.07	0	0.25
E5-54	E5-43	429.1	12	3776.4	3769.19	3768.2	0.23%	3769.82	0.63	-	2.69	0	0.25
E5-55	E5-54	267.7	12	3779.3	3769.85	3769.2	0.26%	3770.44	0.59	-	2.42	0	0.54
E5-56	E5-55	369.4	12	3780.6	3770.71	3770.2	0.15%	3771.45	0.74	-	2.38	12.11	17.64
E5-62	E5-56	45.4	12	3780.7	3776.52	3776.3	0.59%	3776.97	0.45	-	3.28	0.01	0.54
E5-63	E5-62	319.7	12	3784.5	3778.28	3776.5	0.55%	3778.71	0.43	-	3.21	0.01	0.54
E5-64	E5-63	356.7	10	3788.9	3781.49	3778.3	0.90%	3781.89	0.48	-	3.89	0.41	2.61
E5-7	E5-119	25.4	18	3743.3	3735.19	3735	0.63%	3735.84	0.43	-	2.8	0	0.54
E5-75	E5-64	312.4	10	3792.5	3784.72	3781.5	1.03%	3785.04	0.38	-	3.35	0.41	2.52
E5-76	E5-75	336.6	10	3795.4	3787.94	3784.7	0.96%	3788.27	0.4	-	3.77	0.41	3.3
E6-1	E5-76	331.7	12	3797.5	3789.68	3787.9	0.52%	3790.04	0.36	-	2.98	0	0.54
E6-10	E6-9	400.3	10	3798.9	3794.64	3793.5	0.28%	3794.78	0.17	-	1.23	0.01	0.53
E6-11	E6-10	374.4	10	3799.3	3795.7	3794.7	0.28%	3795.82	0.14	-	1.07	0.02	0.54
E6-12	E6-11	369.8	10	3799.9	3796.75	3795.7	0.28%	3796.85	0.12	-	1	0.01	0.54
E6-13	E6-12	263.7	8	3801	3797.81	3796.8	0.40%	3797.9	0.14	-	1.09	0.01	0.54
E6-14	E6-8	245.1	10	3800.9	3793.49	3792.2	0.52%	3793.85	0.43	-	2.86	0	0.54
E6-15	E6-16	348	10	3804.4	3797.29	3786.6	3.06%	3797.33	0.05	-	1.24	0.01	0.54
E6-16	E6-17	489.3	6	3798.8	3786.64	3771.7	3.06%	3786.71	0.14	-	2.04	0.28	1.73
E6-22	E6-13	65.7	10	3802	3798.01	3797.8	0.29%	3798.09	0.1	-	0.93	0.01	0.53
E6-23	E6-1	199	12	3798.6	3790.66	3789.7	0.49%	3791.02	0.36	-	2.88	0.02	0.54
E6-7	E6-23	141	12	3799.4	3791.44	3790.7	0.55%	3791.79	0.35	-	2.85	0.02	0.53
E6-8	E6-7	148.8	12	3800	3792.22	3791.4	0.52%	3792.57	0.35	-	2.89	0	0.54
E6-9	E6-8	399.3	10	3799.5	3793.51	3792.4	0.28%	3793.65	0.17	-	1.09	12.12	21.53
F3-67	E3-307	659.5	27	3716.2	3706.98	3703	0.61%	3707.98	0.44	-	7.07	0.52	1.2
F3-68	F3-67	162	27	3717	3708.01	3707	0.64%	3709.01	0.44	-	5.44	0.52	1.28
F3-69	F3-68	402.9	27	3719.4	3710.52	3708	0.62%	3711.47	0.42	-	5.62	0.01	0.45
F3-70	F3-69	659.9	24	3728.8	3719.89	3710.5	1.42%	3720.66	0.38	-	7.15	0.01	0.45
F3-71	F3-70	659.8	24	3735.3	3725.23	3719.9	0.81%	3726.18	0.47	-	7.13	0	0.54
F3-72	F3-71	659.4	30	3735.6	3726.94	3725.2	0.26%	3728.1	0.46	-	4.67	0.1	0.56
F3-73	F3-72	508.8	24	3737.7	3729.98	3726.9	0.60%	3730.98	0.5	-	5.31	0	0.5
F4-10	F4-7	385.3	18	3776.1	3769.39	3767.8	0.40%	3769.77	0.25	-	2.79	0	0.53
F4-11	F4-10	300	18	3777.9	3770.9	3769.4	0.50%	3771.25	0.23	-	2.88	0.01	0.54
F4-12	F4-11	451	18	3779.6	3772.75	3770.9	0.41%	3773.12	0.25	-	2.82	1.03	5.35
F4-13	F4-12	402.9	18	3780.6	3773.9	3772.8	0.29%	3774.31	0.27	-	2.55	0	0.25

Appendix G - Committed Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
F4-15	F4-13	203.8	18	3781.1	3774.49	3773.9	0.29%	3774.85	0.24	-	2.15	0.02	0.86
F4-16	F4-15	292.3	18	3783.4	3775.62	3774.5	0.39%	3775.95	0.22	-	2.46	0.01	0.81
F4-17	F4-16	378.7	18	3784.4	3777.48	3775.6	0.49%	3777.79	0.21	-	2.75	0.01	0.81
F4-25	F4-81	14	10	3745.6	3740.6	3740.5	1.07%	3740.72	0.14	-	2.03	0.01	0.53
F4-54	F4-41	120.7	10	3741.7	3735.41	3735.2	0.22%	3735.46	0.06	-	0.52	0.4	1.56
F4-6	E4-110	232.8	18	3773.2	3766.7	3765.2	0.64%	3767.04	0.23	-	3.17	0	0.54
F4-7	F4-6	284	18	3773.9	3767.83	3766.7	0.40%	3768.22	0.26	-	2.85	0	0.54
F4-73	F3-73	489.9	24	3742.3	3732.91	3730	0.60%	3733.93	0.51	-	5.8	0	0.75
F4-74	F4-73	114.8	27	3742.5	3733.38	3732.9	0.41%	3734.52	0.51	-	4.9	0.4	1.5
F4-75	F4-74	125.3	27	3741.4	3733.91	3733.4	0.42%	3735.07	0.52	-	4.53	0	0.53
F4-76	F4-75	102.4	27	3741.5	3734.33	3733.9	0.41%	3735.52	0.53	-	4.41	0	0.53
F4-77	F4-76	243	27	3743	3735.26	3734.3	0.38%	3736.39	0.5	-	4.48	0.03	0.53
F4-78	F4-77	248.7	27	3744.5	3736.2	3735.3	0.38%	3737.33	0.5	-	4.62	0.17	1.17
F4-79	F4-78	143.9	27	3745	3736.79	3736.2	0.41%	3737.94	0.51	-	4.56	0	0.53
F4-80	F4-79	187.9	27	3744.5	3737.49	3736.8	0.37%	3738.65	0.52	-	4.49	0.01	0.45
F4-81	F4-80	245.3	27	3745.4	3738.42	3737.5	0.38%	3739.55	0.5	-	4.54	0.01	0.45
F4-82	F4-81	709.6	24	3752.7	3743.79	3738.4	0.76%	3744.7	0.45	-	5.66	0.01	0.54
F4-83	F4-82	592.2	24	3763.4	3754.99	3743.8	1.89%	3755.7	0.36	-	7.61	0.08	0.53
F4-84	F4-83	640.3	24	3770.2	3761.09	3755	0.95%	3762	0.45	-	7.65	0.01	0.64
F4-85	F4-84	649.1	24	3776.4	3767.75	3761.1	1.03%	3768.6	0.42	-	6.87	1.94	4.81
F4-86	F4-85	437.3	24	3782.4	3772.28	3767.8	1.04%	3773.14	0.43	-	7.09	0.01	0.25
F4-87	F4-86	521.6	27	3784.2	3773.73	3772.3	0.28%	3774.91	0.52	-	5.15	1.94	4.67
F4-88	F4-87	394.3	27	3783.9	3774.81	3773.7	0.27%	3776.02	0.54	-	4.22	1.94	4.56
F4-89	F4-88	76.6	24	3783.4	3775.25	3774.8	0.56%	3776.45	0.6	-	4.61	0	0.53
F5-1	F5-6	369.9	18	3788.1	3781.23	3779.4	0.50%	3781.54	0.21	-	2.78	0.39	1.81
F5-10	F5-9	147	18	3802.9	3794.77	3794.4	0.28%	3795.54	0.51	-	2.89	0.38	1.5
F5-11	F5-10	309.1	18	3802.9	3795.53	3794.8	0.25%	3796.3	0.51	-	3.03	0.38	2.04
F5-112	F4-89	656.2	24	3786.3	3778.58	3775.3	0.50%	3779.62	0.52	-	5.14	1.94	4.76
F5-113	F5-112	659.1	24	3789.6	3781.9	3778.6	0.50%	3782.95	0.52	-	5.44	0	0.56
F5-114	F5-113	659.5	24	3794.4	3785.27	3781.9	0.51%	3786.31	0.52	-	5.42	0.39	1.75
F5-115	F5-114	603.1	24	3804.8	3789.5	3785.3	0.70%	3790.44	0.47	-	5.81	0.01	0.82
F5-116	F5-115	246.4	21	3808	3795.72	3789.5	2.52%	3796.29	0.33	-	6.94	0	0.54
F5-117	F5-116	575.4	21	3812.2	3800	3795.7	0.74%	3800.86	0.49	-	6.8	0.37	0.89
F5-118	F5-117	578.3	21	3814.5	3803.53	3800	0.61%	3804.39	0.49	-	5.34	0	0.69
F5-119	F5-118	139.2	21	3815.7	3803.68	3803.5	0.11%	3804.84	0.66	-	3.4	0	0.69
F5-12	F5-11	315.3	18	3802.9	3796.3	3795.5	0.24%	3797.07	0.51	-	3.03	0.03	0.54
F5-120	F5-119	62.5	21	3815.7	3803.75	3803.7	0.10%	3805	0.71	-	2.75	0	2.68
F5-121	F5-120	60	21	3815.9	3803.82	3803.8	0.10%	3805.14	0.75	-	2.56	0.37	1.1
F5-13	F5-12	335.9	18	3804.5	3799.45	3796.3	0.94%	3799.96	0.34	-	3.83	0.59	3.77
F5-14	F5-13	359.4	18	3807.9	3802.65	3799.5	0.89%	3803.18	0.35	-	5	0.01	0.54
F5-15	F5-14	172.7	24	3809.4	3804.31	3802.7	0.96%	3804.77	0.23	-	4.49	0.01	0.54
F5-16	F5-15	435.4	24	3814.4	3808.31	3804.3	0.92%	3808.78	0.24	-	4.9	0.02	0.53
F5-17	F5-16	264.2	24	3817	3810.65	3808.3	0.89%	3811.13	0.24	-	4.81	0.02	0.54
F5-2	F5-1	375.9	18	3790.6	3783.48	3781.2	0.60%	3783.77	0.19	-	2.87	0.01	0.53
F5-3	F5-2	437.6	18	3793.2	3786.11	3783.5	0.60%	3786.4	0.19	-	2.96	0.05	4.13
F5-30	F5-5	199.6	12	3806.9	3798.61	3798.2	0.22%	3798.99	0.38	-	2.21	0.09	0.54
F5-31	F5-30	513.3	12	3811.1	3799.7	3798.7	0.19%	3800.1	0.4	-	2.12	0.09	0.54
F5-32	F5-31	551.8	12	3813.3	3800.92	3799.8	0.20%	3801.31	0.39	-	2.14	0	0.25
F5-33	F5-51	310.3	8	3814.3	3801.89	3801.3	0.19%	3802.27	0.57	-	2.02	0	0.53
F5-34	F5-33	231.9	12	3817.4	3802.28	3802	0.13%	3802.71	0.43	-	1.88	0	0.54
F5-4	F5-3	315.6	18	3797.2	3788.71	3786.1	0.82%	3788.97	0.17	-	3.08	0.06	0.53
F5-5	F5-4	321.2	-	3804.5	3791.33	3788.7	0.82%	3791.59	-	-	3.25	0	0.53
F5-51	F5-32	130.6	12	3814	3801.21	3801	0.14%	3801.61	0.4	-	2	0.33	2.44

Appendix G - Committed Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
F5-6	F4-17	379.5	18	3786	3779.38	3777.5	0.50%	3779.69	0.21	-	2.78	0.02	0.81
F5-7	F5-115	477.5	18	3802.4	3792.58	3791.3	0.26%	3793.37	0.53	-	3.43	0	0.54
F5-8	F5-7	418.8	18	3802.7	3793.72	3792.6	0.27%	3794.46	0.49	-	3.14	0.34	2.11
F5-86	F5-34	399.9	12	3818	3803.18	3802.4	0.20%	3803.52	0.34	-	1.91	0.11	0.81
F5-87	F5-86	399.9	12	3819	3804.23	3803.3	0.24%	3805.11	0.88	-	1.01	0.08	0.54
F5-88	F5-87	94.8	8	3818.9	3804.95	3804.6	0.40%	3805.53	0.87	-	3.38	0.08	0.54
F5-9	F5-8	313.5	18	3802.9	3794.36	3793.7	0.20%	3795.19	0.55	-	2.99	0.01	0.54
G5-1	F5-17	507.9	24	3821	3811.92	3810.7	0.25%	3812.59	0.34	-	3.27	0.58	2.63
G5-2	G5-1	505.2	24	3823	3815.17	3811.9	0.64%	3815.67	0.25	-	3.57	0.58	2.9
G5-3	G5-2	504	24	3825.1	3816.43	3815.2	0.25%	3817.1	0.34	-	3.26	0.06	0.53
JUB045	E6-22	221.7	12	3803.8	3798.5	3798	0.22%	3798.58	0.08	-	0.78	0.01	0.53
JUB046	JUB045	71.2	12	3802.6	3798.67	3798.5	0.23%	3798.74	0.07	-	0.66	0.01	0.54
JUB098	F5-121	207.9	21	3815.6	3804.04	3803.8	0.10%	3805.39	0.77	-	2.46	0.01	0.53
JUB101	C1-51	44.6	24	3247.5	3237.2	3236.2	2.20%	3238.45	0.63	-	7.96	0	0.53
JUB108	C5-175	345	12	3793.6	3784.2	3783.5	0.20%	3784.28	0.08	-	0.73	0.05	0.82
JUB109	D6-6	1518.4	10	3774.1	3729.19	3724.6	0.30%	3729.28	0.11	-	1.01	0.02	0.54
JUB132	D3-142	118.9	18	3708.9	3698.66	3698.4	0.20%	3700.22	1.04	0.06	4.4	0.02	1.2
JUB137	B2-69	59.7	10	3634.1	3627.78	3627.2	1.04%	3627.92	0.17	-	1.38	0.07	0.91
JUB151	D3-88	313.7	24	3703.2	3693.35	3693.1	0.07%	3695.05	0.85	-	2.65	0	1.17

City of Twin Falls

Wastewater Collection System Master Plan

Volume 2
Master Plan Development & Capital Improvement Plan

April 2015

Prepared by

J-U-B ENGINEERS, Inc.
115 Northstar Avenue
Twin Falls, Idaho 83301
208-733-2414

Project No. 60-13-103

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City of Twin Falls

Wastewater Collection System
Master Plan

Volume 2
Master Plan Development &
Capital Improvement Plan

April 2015

Prepared by

PROFESSIONAL ENGINEER
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13805
6/17/15
STATE OF IDAHO
GARY M. HADERLIE

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EXECUTIVE SUMMARY

ES.1 REPORT OVERVIEW

The last comprehensive sewer Collection System Master Plan for the City of Twin Falls (City) was completed in 2009[1]. The City has experienced significant growth and infrastructure improvements since completion of the 2009 report. The City authorized J-U-B ENGINEERS, Inc. (JUB) to develop a new Collection System Master Plan, with major goals as follows:

GOAL 1: Update the hydraulic collection system model to assess capacity conditions for three growth and flow scenarios during a 10-Year design storm event:

Scenario	Purpose	Scope and Loads
Existing	Provide a snapshot of existing (March 2014) sewer flows Evaluate capacity of all pipes 10 inches and above	Includes loading for all areas that have an existing connection to the sewer collection system Includes loads for existing permitted industries at their permit value.
Committed	Identify remaining uncommitted capacity in the system Identify potential capacity issues as land develops within or near City limits.	In addition to existing loads, includes loading for vacant areas within city limits and commitments to developments that have started the will-serve process Includes capacity for existing and anticipated permitted industrial loads
Master Plan	Maximize capacity of existing pipes Upsize existing or provide new pipes for capacity restricted areas Provide conceptual alignment of new services areas and pipes following natural topography and drainages	In addition to committed loads, includes loading for areas beyond the City limits extending to the study area boundary. Includes capacity for master plan permitted industrial loads

GOAL 2: Establish a comprehensive Capital Improvement Plan (CIP) for the next five to ten years.

This report is organized into eight chapters and two volumes. The following sections provide a brief summary of each chapter of the 2015 Collection System Master Plan (2015 Plan). Volume 1 details the existing system, planning data and growth projections, and Existing and Committed Model development and analyses. It includes the Executive Summary, Chapters 1-5 and the corresponding appendices. Volume 2 details the Master Plan model development and analysis and the CIP. It contains the Executive Summary, Chapters 6-8, and the corresponding appendices.

[1] MSA, (2009) City of Twin Falls Collection System Report.

The study area for the 2015 Plan corresponds to the boundary identified in the 2009 Twin Falls Comprehensive Plan[2] for water and sewer infrastructure and is shown in **Figure 1-1**. The Comprehensive Plan Boundary also shows the areas beyond the sewer service boundary.

ES.2 EXISTING COLLECTION SYSTEM SUMMARY

The City's collection system data was compiled from multiple sources, including City GIS data, record drawings, hardcopy City maps, field verification, operations staff, and the 2009 sewer model. In summary, the City of Twin Falls has approximately 245 miles of sewer pipe ranging in size from 4- to 42-inch and 6 lift stations as shown in **Table 2-4** and **Table 2-5**. **Figure 2-2** shows the existing collection system. While a condition assessment was not completed, the City is aware of several condition problems, such as the droplines into the Rock Creek and Snake River Canyons, manholes along the Grandview pipeline, the Independent Meat Lift Station and many of the pipes in the downtown area.

ES.3 PLANNING DATA AND GROWTH PROJECTIONS

Recent and historical growth rates provide context that can help the City plan the timing of sewer improvements needed to serve future growth. Based on historical growth rates, the City elected to use a 2.0 percent annual growth rate for population growth projections. Typical industrial growth has a relatively small impact on the collection system due to low unit flows. However, permitted industrial flows can significantly affect the system. There has been a recent trend in similar industries developing in the City, which is anticipated to continue. **Figure 3-3** and **Figure 3-4** show the general areas and peak day flows used for future permitted industrial users in the Committed and Master Plan Models, respectively.

The 2009 Comprehensive Plan is the guiding document for land use in the 2015 Plan. Within the Comprehensive Plan, areas designated as residential land use do not have a specific future density assigned. Therefore, a land use density analysis performed throughout the City for all residential land use types resulted in a value of 4 dwelling units per gross acre and was assigned for future residential areas.

ES.4 EXISTING SYSTEM SUMMARY

The Existing Model in the 2015 Plan was built using GIS base layers for system components and InfoSWMM modeling software. The Existing Model used water meter data provided by the City to establish unit flows for each land use type. Each parcel was assigned a land use type and connected to the system. **Figure A-1** in **Appendix A** shows the land use used in the Existing Model. Diurnal curves (the typical 24-hour shape of the flow) were also developed for each land use type. Dry weather flows, consisting of the unit flows and diurnal curves, were calibrated to flow monitoring performed in several locations throughout the City in March of 2014.

A 10-year Type II SCS design storm was aligned with the sanitary peak flow to evaluate the capacity of the existing collection system. Based on these inputs and the level of service criteria established with the City (see **Appendix C**), no immediate capacity problems were identified in the Existing Model. Results for the existing system are summarized in **Figure 4-1** through **Figure 4-3.** **Appendix F** contains the Existing Model results.

[2] Landmark Design (2009) City of Twin Falls Comprehensive Plan.

ES.5 COMMITTED SYSTEM SUMMARY

The Committed Model includes everything that the City has committed to serve, or is considering to serve, based on known developments. This does not guarantee or imply a will-serve will be granted. It includes estimated loads for developments that have begun the subdividing process, and assumes infill of all vacant areas in the existing City limits. The Committed Model also includes anticipated industrial flows over the next 20 years. The Committed Model is used to evaluate whether the existing system has capacity to accommodate flows in the immediate future and to help prioritize needed improvements.

Figure A-2 in **Appendix A** depicts flow inputs in the Committed Model, and **Figure 5-1** and **Figure 5-2** summarize the available capacity of the existing collection system during a design storm event under the Committed flows. **Appendix G** contains model results for the Committed Model. Two capacity issues were identified during the Committed Model associated with residential, commercial, industrial growth, with another three issues based on anticipated industrial growth:.

<u>Capacity Issues from Residential, Commercial, and Light Industrial Growth</u>

- Along Park View Dr. , north of Federation Rd., Manhole B1-41 & B1-33 – Surcharge (sewer depth over pipe) of 1.07 to 1.87 feet above the top of the pipe.
- Intersection of Candlewood Ave. and Mountain View Dr., Manhole E2-5 – Surcharge of 1.13 to 1.83 feet above the top of the pipe.

<u>Capacity Issue Triggered by Permitted Industrial Growth</u>

- South of Filer Avenue W., between the Wendell St. and Beta St. alignments, Manhole B3-14 – Surcharge of 1.3 to 1.6 feet above the top of the pipe in this area (See Item 3 in **Figure 7-1**)
- North of Kimberly Rd, between the Trade St. and Freightway St. alignments, Manhole E5-19 – Surcharge of 1.3 feet above the top of the pipe (See Item 9 in **Figure 7-1**)
- Along Addison Avenue between 3rd and 4th Avenue N., Manhole C4-163 – Peak surcharge of 0.6 to 2.67 feet above the top of the pipe (See Item 11 in **Figure 7-1**)

Table 5-3 illustrates the capacity of the lift stations and force mains under the Committed flows. In summary:

- The Hankins (Jayco) Lift Station needs to be replaced with the Clif Bar development.
- The Independent Meat Lift Station is nearing capacity at the Committed flows.
- The Rock Creek Trails Lift Station is beyond capacity for the Committed flows if Grandview Farms subdivision to the north is added to it.

ES.6 MASTER PLAN SYSTEM SUMMARY

The Master Plan Model represents the ultimate build-out of the study area. The Master Plan Model is a tool to guide growth and expansion of the collection system and also identify potential future deficiencies in the current collection system. The Master Plan Model's primary purposes are to:

- Provide the size, approximate location and depth for master planned sewer lines 10 inches and larger in size.
- Identify potential capacity issues that may arise in the existing collection system as the City develops new areas and builds out the study area.
- Develop a base model to use in evaluating future wastewater service scenarios.

Figure 6-1 shows the future pipe sizes needed to provide sewer service for build-out of the entire planning area. **Figure 6-2** shows the approximate depth for all the new master plan pipes. **Figure 6-3** shows the pipe capacity in the existing sewer system compared to the Master Plan flows, which helps illustrate which pipes may cause surcharging. All Master Plan results include the design storm event. **Figure ES-1** summarizes the pipe improvements needed based on the Master Plan Model. Additional information can be found in **Table 6-4**.

Table 6-6 summarizes the capacity of the lift stations and force mains with the following lift stations and force mains expected to be beyond capacity based on the Master Plan Model.

- The Hankins (Jayco) Lift Station and Force Main
- The Independent Meat Lift Station and Force Main
- The Rock Creek Trails Lift Station and Force Main
- The Rock Creek Lift Station and Force Main

Rehabilitation expectations for lift stations are shown in **Table 6-7**.

ES.7 CAPITAL IMPROVEMENT PLAN SUMMARY

The CIP identifies and describes the improvements necessary to provide service to the future wastewater service area, while meeting the necessary level of service criteria (see **Appendix C**) over the next 20 years. The Committed Model generally corresponds to anticipated flows that will occur over this timeframe. The schedule for implementing CIP projects not related to rehabilitation/replacement will ultimately depend on realized growth and non-residential development. **Table ES-1** shows the model flows for the Existing, Committed, and Master Plan Models and the estimated year and population to reach that flow.

Table ES-1 – Flow and Population Summary for Each Model Scenario

Model Scenario	Peak Day Dry Weather Loading		Peak Dry Weather Flow at the WWTP[1] (MGD)	Peak Wet Weather Flow at the WWTP[1] (MGD)	City Population	Approximate Year (2% growth)
	Permitted Industrial Flow (MGD)	Domestic Flow (MGD)				
Existing	5.9	4.5	12.5	22.6	46,900	2014
Committed	11.7	5.7	20.3	31.5[2]	78,000	2040
Master Plan	22.4	14.0	47.5	65.8	159,000	2075

(1) Flow values result from peak flow in all collection pipes. Actual influent values observed at the WWTP will differ from the reported peak flows for various reasons as discussed in **Table 7-1.**

(2) This flow value is within 12% of the 20-year peak hour flow (35.6 MGD) in the 2013 Wastewater Treatment Plant Facility Plan by CH2MHill. The higher values in the 2013 WWTP plan are expected due to higher unit flows used in that plan as compared to this plan.

Due to the age and expected life cycle of the existing collection system infrastructure, the City may want to consider adjusting their annual maintenance budget for replacement/rehabilitation. **Table ES-2** summarizes baseline values and several options for budgeting replacement/rehabilitation of the existing collection system (including inflation, engineering, and contingency). Additional cost savings may be possible in some locations by utilizing trenchless rehabilitation, such as cured-in-place pipe (CIPP), slip-lining or pipe bursting. As additional information is acquired, such as a condition assessment, future fiscal year budgets can be adjusted accordingly.

Table ES-2 – Annual Replacement Budget Options

Option	Total Value	Portion of Existing Pipes and Replacement Method[(1), (2)]		Replacement Life Cycle [(3)]	Annual Replacement Budget (in 2014 $)
		Existing Plastic (PVC/HDPE)	Existing Non-Plastic		
1	$332M	100% OT	100 % OT	100	$3.3M
2	$200M	0%	100 % OT	100	$2.0M
3	$282M	50 % OT 50% CIPP	50 % OT 50% CIPP	100	$2.8M
4	$170M	0%	50 % OT 50% CIPP	100	$1.7M

(1) Replacement methods are for open trench (OT) and cured-in-place pipe (CIPP)
(2) Additional costs will be necessary in areas that require new larger pipe.
(3) Actual useful life could be longer for plastic pipe and shorter for non-plastic pipe, and will be determined based on age, as well as condition, and acceptable risk to the City.

Because few capacity issues were identified in the Committed and Existing Models, additional criteria were developed and evaluated with the City to prioritize the improvements in the CIP. The results of the system CIP prioritization and assessment are summarized in **Figure ES-2** and **Table ES-3**.

An on-going annual budget of approximately $1.7 to $3.3 million should be established for replacement or rehabilitation of the existing collection system. The City should budget this amount so that a systematic approach can be used to replace the older deteriorated sewer pipes on a 100 year life cycle. The additional CIP costs identified in the 2015 Plan for lift station replacement/rehabilitation should be reviewed and integrated as budget permits.

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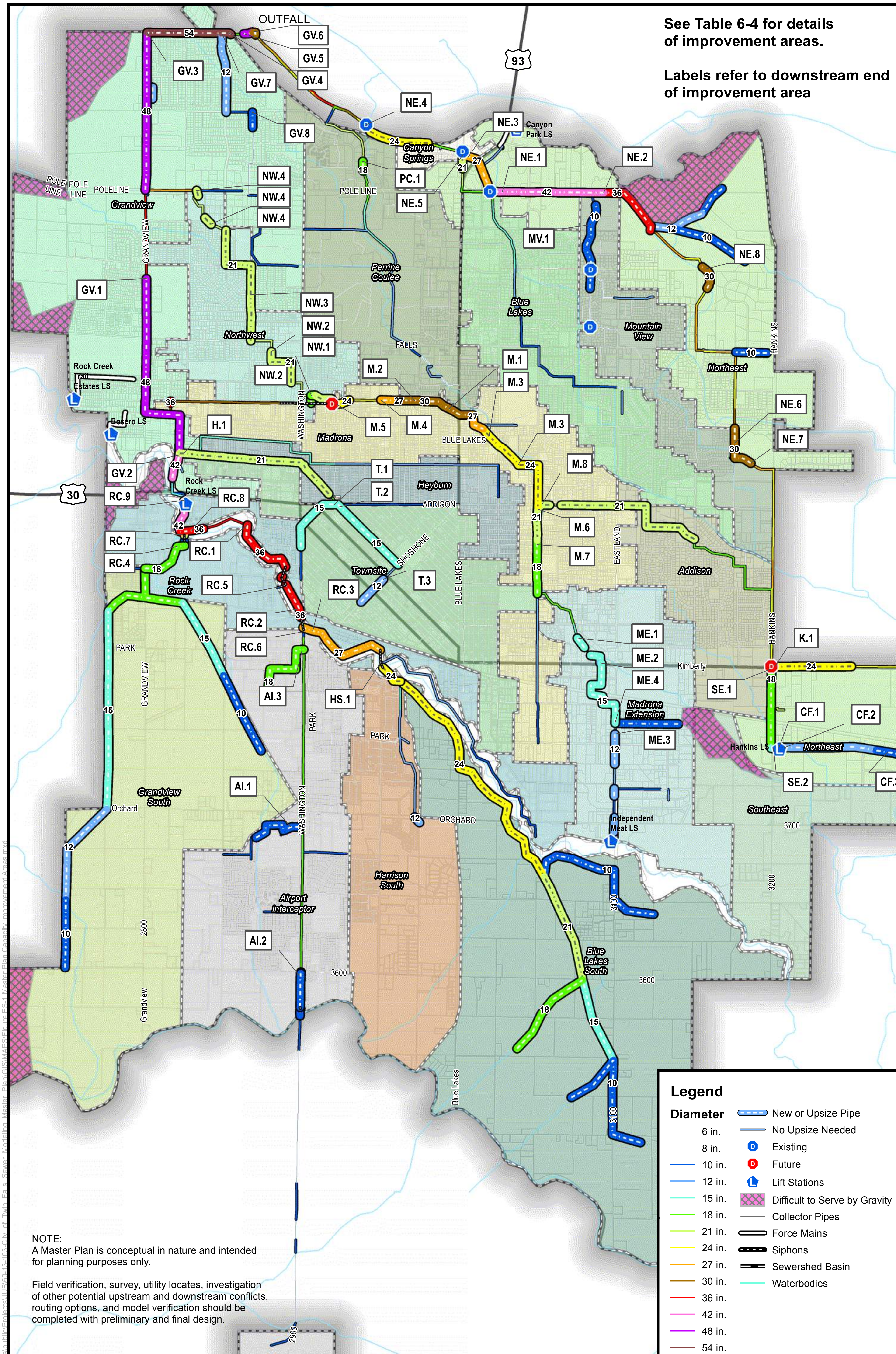

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE ES-1
MASTER PLAN CAPACITY IMPROVEMENTS

J-U-B ENGINEERS, INC.

0 1,500 3,000
SCALE IN FEET

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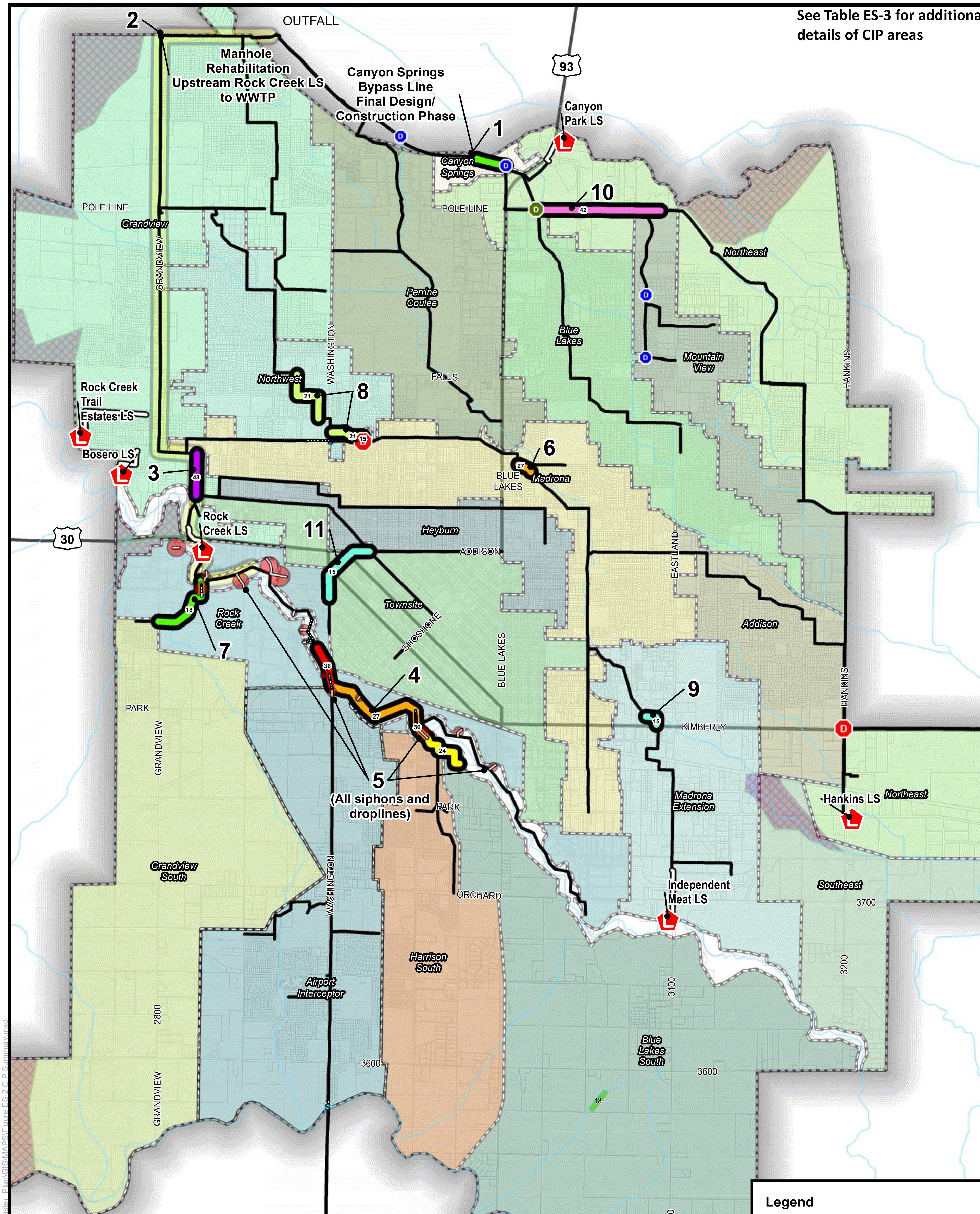

Area	OVER CAPACITY AT COMMITTED	OVER CAPACITY AT COMMITTED + 1 MGD	MASTER PLAN DIAMETER > 18 INCHES	LARGE SERVICE AREA	CHALLENGING DESIGN/ CONSTRUCTION	PROBABLE AGE	REPORTED POOR CONDITION	SURCHARGE HISTORY
1	☑	☑	☑	☑		30 ±		
2			☑	☑	☑	30 ±	☑	
3	☑	☑	☑	☑	☑	30 ±	☑	
4		☑	☑	☑	☑	60 ±	☑	
5			☑	☑	☑	60 ±	☑	
6		☑	☑	☑	☑	60 +		☑
7		☑	☑	☑	☑	60 ±	☑	
8		☑	☑	☑		50 ±		
9	☑	☑				60 ±		
10		☑	☑	☑	☑	< 10		
11	☑	☑				60 +		

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE ES-2 CIP SUMMARY

J-U-B ENGINEERS, INC.

0 1,500 3,000 SCALE IN FEET N

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Table ES-3 – CIP Project Summary

CIP Item #	Project *(See Figure 7-1)*	MH Identifier	Length (ft)	New Size (in)	Recommended Action	0 – 5 Years	5 – 10 Years	10 – 20 Years	As Needed with Growth[A]
1	Canyon Springs Rd	CSR2 to D2-202	956	18	In Progress	$ 262,000			
2	Odor Control[E] & Manhole Rehabilitation	Various, See Figure ES-2 or 7-1	-	-	Begin Now	$ 1,930,000			
3	Grandview Trunkline	B3-14 to B4-1	1,275	48	Begin preliminary design[B]			$ 792,000	
4	Rock Creek Trunkline	C4-7 to End of Benno's Ph 2	7,045	24, 27, 36	Begin preliminary design[C]				$ 3,082,000
5	13 Droplines/Siphons, excluding DL.1,14,16	See Table 6-7			Begin preliminary design				$ 4,165,000
6	Madrona Trunkline	Reroute pipe D3-110 to D3-150 & D3-149 to D3-155	2,150	8, 27, 30	Begin preliminary design[D]				$ 881,000
7	Golf Crse Trunkline	B4-120 to B4-137	3,385	18	Complete with development				$ 570,000
8	Northwest Trunkline	C3-235 to C3-193 & C3-236 to C3-79	3,375	15, 21	Complete with development				$ 1,304,000
9	Madrona Ex.Trunkline	E5-19 to E5-31	603	15	Complete with development				$ 201,000
10	Northeast Trunkline	D2-74 to E2-129	3,810	42	Complete with RAA 4-3				$ 2,182,000
11	Albion Trunkline	C4-163 to C4-299	2,235	15	Complete with development				$ 634,000
	Kimberly Diversion	F5-115 to F5-5 or F4-16 to F4-89	N/A	N/A	Complete after CIP 6 & 8				$ 20,000
Lift Stations	**Name**	**Recommended Action**							
Lift Stations	Bosero	Mechanical / Electrical Rehabilitation						$ 58,000	
Lift Stations	Canyon Park	Mechanical / Electrical Rehabilitation						$ 58,000	
Lift Stations	Hankins (Jayco)	Assume that a New Station is Completed 2015; Electrical Rehabilitation in 15-20 yrs						$ 26,000	
Lift Stations	Independent Meat	Cost reflective of rebuild. Mechanical/electrical rehabitation could be done earlier.[D]					$ 535,000		
Lift Stations	Rock Creek Trails	Cost for Mechanical / Electrical Rehabilitation. Upgrade for capacity may also be needed.						$ 58,000	
Lift Stations	Rock Creek	Electrical Rehabilitation 15-20 years						$ 52,000	
Ongoing Pipe Rehabilitation and Replacement		Select annual budget plan based on system value and begin budgeting for next fiscal year.				Choose Plan 1, 2, 3, or 4 ($3.3M, 2.8M, 2.0M or $1.7M).			
					TOTAL (EXCLUDING ONGOING ANNUAL CIP BUDGET)	**$ 2,192,000**	**$535,000**	**$1,044,000**	**$ 13,039,000**

A. Costs generally assume 30% rock removal, 3% inflation, 25% contingency, 18% engineering/construction admin, 5% legal and bonding, a public works contractor bidded project, no costs for easements or right-of-way, no Davis-Bacon wages, and no buy American Iron or Steel provisions. All costs are an AACE Class 4 projection (-30% to +50%).
B. Consider also 3a, which completes Grandview to Manhole B3-3. The project will require completion to either B3-14 or B3-3 due to crown matching. An intermediate point is likely not acceptable. Therefore, survey will likely be needed up to B3-3 to verify crowns and inverts even if improvements are only planned for CIP improvement 1 to manhole B3-14.
C. Potentially consider the affects of abandoning the Independent Meat Lift Station and routing to the Rock Creek Trunkline
D. Survey may be needed beyond the project limits shown for CIP improvement 6 from the Madrona siphon all the way to Locust to verify actual slopes and inverts.
E. Odor control not evaluated by J-U-B; $500,000 included at the request of the City for odor control.

ES.8 SUMMARY

Overall, the existing collection system has adequate capacity to convey the Existing Model and Committed Model flows with a few improvements. Upgrades to convey Master Plan flows, as indicated in the CIP priority list and the future Master Plan pipe sizes, will be needed to handle build-out growth. The following recommendations will help ensure that the City is able to provide service to the entire future wastewater service area and that the Master Plan is implemented as intended.

A. **CIP Implementation** — Follow and implement the recommendations in the CIP.
B. **On-Call Modeling** — Provide modeling for new developments to ensure the Master Plan assumptions are adequate.
C. **Existing System Replacement** — Establish an adequate annual budget for on-going maintenance based on a realistic expected life cycle for the pipe.
D. **Condition Assessment** — Assess and record the condition of the collection system piping and other infrastructure based on standardized formats.
E. **Risk Assessment** — To stretch the City's limited annual maintenance budget, the City could implement a risk-based analysis to evaluate when and where system failures are most likely to occur ("likelihood of failure") and what the consequence of failure would be if it occurred.
F. **Odor** — Identify locations where odor control needs to be implemented.
G. **Survey Rim/Invert Elevations**— If insufficient data exists, the City infrastructure should be surveyed and mapped with horizontal and vertical locations and/or field verified by the operations staff. Data could be collected systematically by public works zone to make it manageable for the City staff.
H. **Annual Record Drawing Updates** — Record drawings provided by developers to the City should be used to update the model and GIS on an annual basis.
I. **Trenchless Technology** — The City should consider the continued use of CIPP and other trenchless technology as a means to cost effectively rehabilitate the existing infrastructure, if applicable.
J. **GIS or On-line Mapping** — The City may want to consider more advanced GIS and/or on-line mapping of their wastewater system. This will likely require additional resources and staffing. Additional considerations regarding on-line mapping:
   a. Grid maps should be updated or scanned to a location in an online map where the grid map applies
   b. Record drawings should be linked in an online map to where the drawing applies.
   c. On-line mapping can be used to show where ongoing improvement projects are occurring across the city.
   d. On-line mapping can make existing infrastructure information available to the City staff and other authorized users
   e. On-line mapping can keep track of existing maintenance activities across the City.
   f. On-line mapping can be used to document the sources for information that are used to update the system information, such as survey, record drawing, field check, etc.
   g. Several fields should be added to the GIS to document the year of construction, elevations based on drawings, separate sources of information for pipeline and manholes, datum of the elevation, and entry date of the information.

K. **Flow Monitoring** — The City should consider flow monitoring with major infrastructure changes, if significant dischargers are added to the system, or if previous assumptions are found to have changed or be wrong, and as a general modeling update approximately every 5 years.

L. **Update the Master Plan** — Changes to the existing wastewater collection system are expected to occur as the City continues to grow over the next decade. Updates to the Master Plan and model should be considered if major assumptions change, comprehensive plans or service boundaries change, additional system data has been acquired, and improvement projects are implemented. Master Plans should generally be updated approximately every five to ten years

ES.9 ACKNOWLEDGEMENTS

Many people were extremely helpful in providing documentation, information, and input throughout the course of this project. The City council and administrators should be commended for making it possible for this work to be completed. During the preparation and completion of the work, JUB was assisted with support and collaboration by City staff in many departments including administration, IT, utility services, community development, planning and zoning, and the building department. Additionally, JUB worked particularly closely with the engineering and public works staff who provided great support and collaboration. In particular, we wanted to acknowledge the nighttime support of the City sewer staff during flow monitoring. We also appreciate the input and data from CH2MHill and others on the lift stations, the WWTP, and permitted users. Assistance from all is gratefully acknowledged.

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Chapter 6

Master Plan Model Development and Analysis

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6.0 MASTER PLAN MODEL DEVELOPMENT AND ANALYSIS

6.1 GENERAL

The Master Plan Model represents the ultimate build-out of the study area. The Master Plan Model is a tool to guide growth and expansion of the collection system and also identify potential future deficiencies in the current collection system. The Master Plan Model's primary purposes are to:

- Provide the size, approximate location and depth for master planned sewer lines over 10 inches in size.
- Identify potential capacity issues that may arise in the existing collection system as the City develops new areas and builds out the study area.
- Develop a base model to use in evaluating future wastewater service scenarios.

6.2 MASTER PLAN SYSTEM LAYER

The Master Plan Model System Layer consists of the manholes, gravity sewer pipes, force mains, diversions, siphons and lift stations required to serve the entire study area. The Master Plan Model System Layer starts with the Committed Model System Layer and adds new and replacement trunk lines.

6.2.1 Master Plan Trunk lines

The Master Plan Model System Layer was developed to take advantage of existing and future public right-of-way and the low-lying areas along natural drainages. During the development of the system layer, the following information was taken into consideration:

- The prevailing topography in the study area generally slopes to the northwest towards the Snake River and Rock Creek.
- Current and future right-of-way is expected to be along section lines, quarter section lines, and extensions of existing roads.
- Previous master plan routing.

To reduce capital construction costs and operation and maintenance costs, pipe cover for the Master Plan trunk lines (10 inches and larger) was targeted to be between 5 and 7 feet, if possible, while still providing service and minimizing the number of lift stations. Service area "check lines" were included in the model to ensure that the trunk lines have sufficient depth to serve to the boundary of its service area. A minimum cover of 5 feet was generally sufficient, but some check lines were reduced to 3 feet of cover to reduce the depth of a trunk line and/or reduce the likelihood of adding a lift station to the system. The check lines start with a minimum cover at the trunk line and have a minimum slope of 0.45 percent (0.05 percent greater than minimum required slope to account for manhole drops). In some cases, check lines forced the trunk line deeper to help ensure serviceability of the service area. If the proposed depths of trunk lines vary from these assumed conditions based on final design and topography, a separate and specific modeling effort should be conducted to check potential impacts on surrounding trunk lines.

Additionally, a "meander" factor was added to the Master Plan model. This safety factor adds a drop at each manhole to account for possible changes to master plan alignments that may occur as parcels are developed. Manhole drops are based on the length and slope of upstream pipe. Each drop provides 20 percent of additional length if a minimum slope for the given pipe size is maintained. This allows each trunk line to "meander" and add up to 20 percent to its length without lowering the downstream pipe invert or invalidating the master plan. Hydraulic grade line or flow depth was also checked to verify that criteria weren't violated due to the additional friction loss associated with up to 20 percent meander.

Some of the study area has sufficient slope to allow trunk lines to be constructed at steeper than minimum grade. This may allow a reduction in the master planned trunk line size. For Master Plan pipe sizes greater than 24 inches, downstream pipe sizes were generally recommended to be 24 inches in diameter or larger to minimize the potential for debris blocking the pipes. Care must be taken to verify that trunks are designed and installed at the same or steeper slope than those listed in the Master Plan, unless a separate and specific serviceability analysis is completed that determines shallower slopes are adequate. In all cases, it is imperative that all identified and necessary "catch" elevations are satisfied. **Appendix H** lists the proposed sizes, inverts, and slopes of the Master Plan trunk lines, and denotes any trunk lines that require steeper than minimum slopes.

Sizing of Master Plan trunk lines was accomplished using the design parameters listed in **Table 6-1** and **Table 6-2. Appendix C** has further discussion of the parameters and methods used to develop the Master Plan Model System Layer.

Figure 6-1 shows proposed sizes and locations for the Master Plan trunk lines. **Figure 6-2** generally shows the depths anticipated for the new master plan pipes from the rim to the pipe invert.

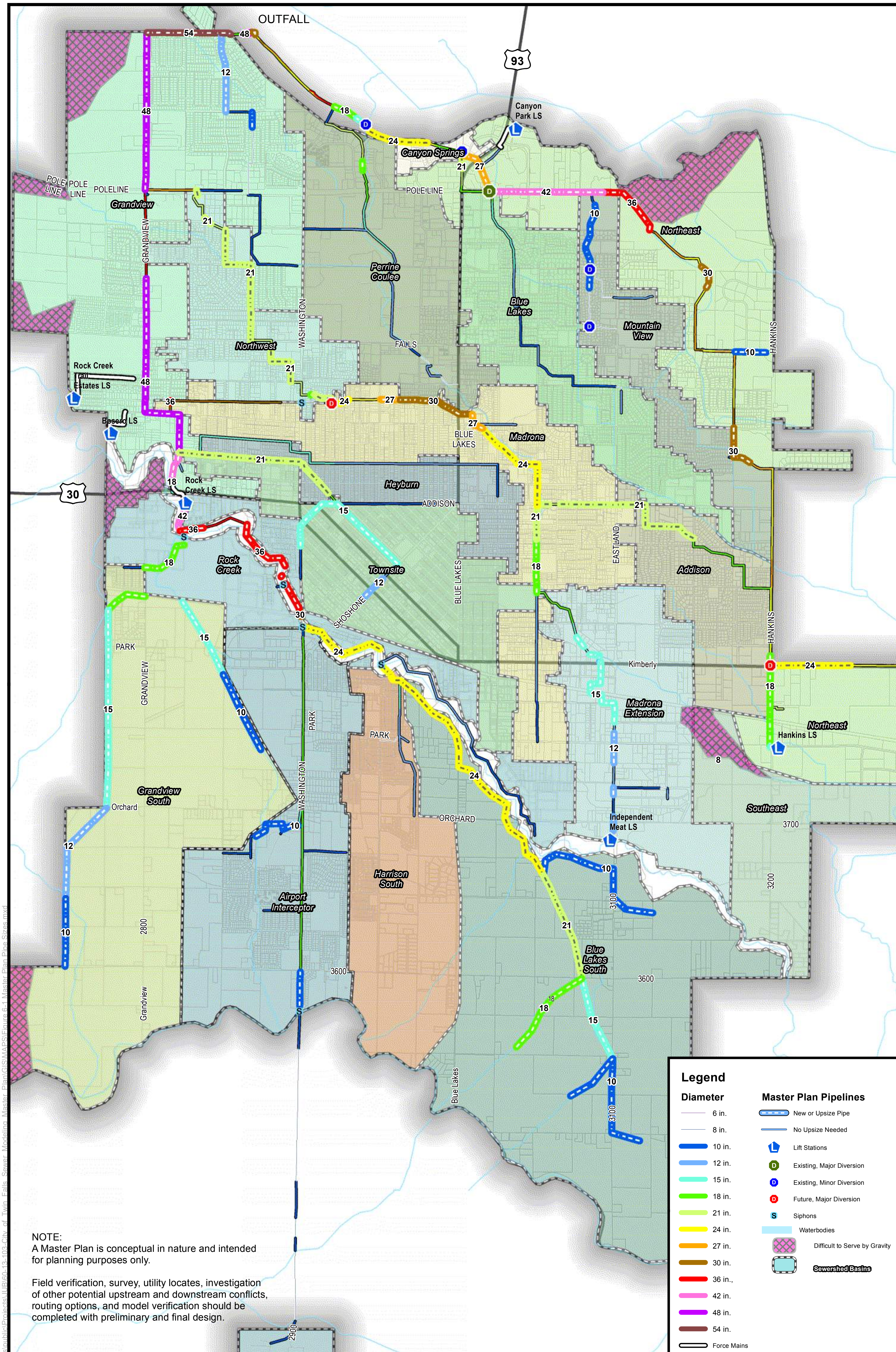
Table 6-1 – Wet Weather Master Plan Pipe Design Criteria[3]

Pipe Diameter (in)	Maximum Allowed Flow Depth	Design Storm
All sizes	1 foot over crown	10-Year SCS Type II: 1.4 inches

Table 6-2 – Dry Weather Master Plan Pipe Design Criteria[4]

Pipe Diameter (in)	Maximum Allowed Depth/Diameter	Minimum Slope
8	0.50	0.40%
10	0.55	0.28%
12	0.60	0.22%
15	0.65	0.15%
18	0.75	0.12%
≥21	0.75	0.10%

[3]Criteria based on preventing backup to a typical 50 ft offset home assuming standard plumbing drop of 0.25in/ft.
[4]Criteria based on the following Manual from ASCE: Bizier, P. (Ed.). (2007). Gravity Sanitary Sewer Design and Construction. 2nd ed. *Manuals and Reports on Engineering Practice No. 60; WEF Manual of Practice No. FD-5*. Virginia: ASCE



NOTE:
A Master Plan is conceptual in nature and intended for planning purposes only.

Field verification, survey, utility locates, investigation of other potential upstream and downstream conflicts, routing options, and model verification should be completed with preliminary and final design.

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FIGURE 6-1

MASTER PLAN PIPE SIZES

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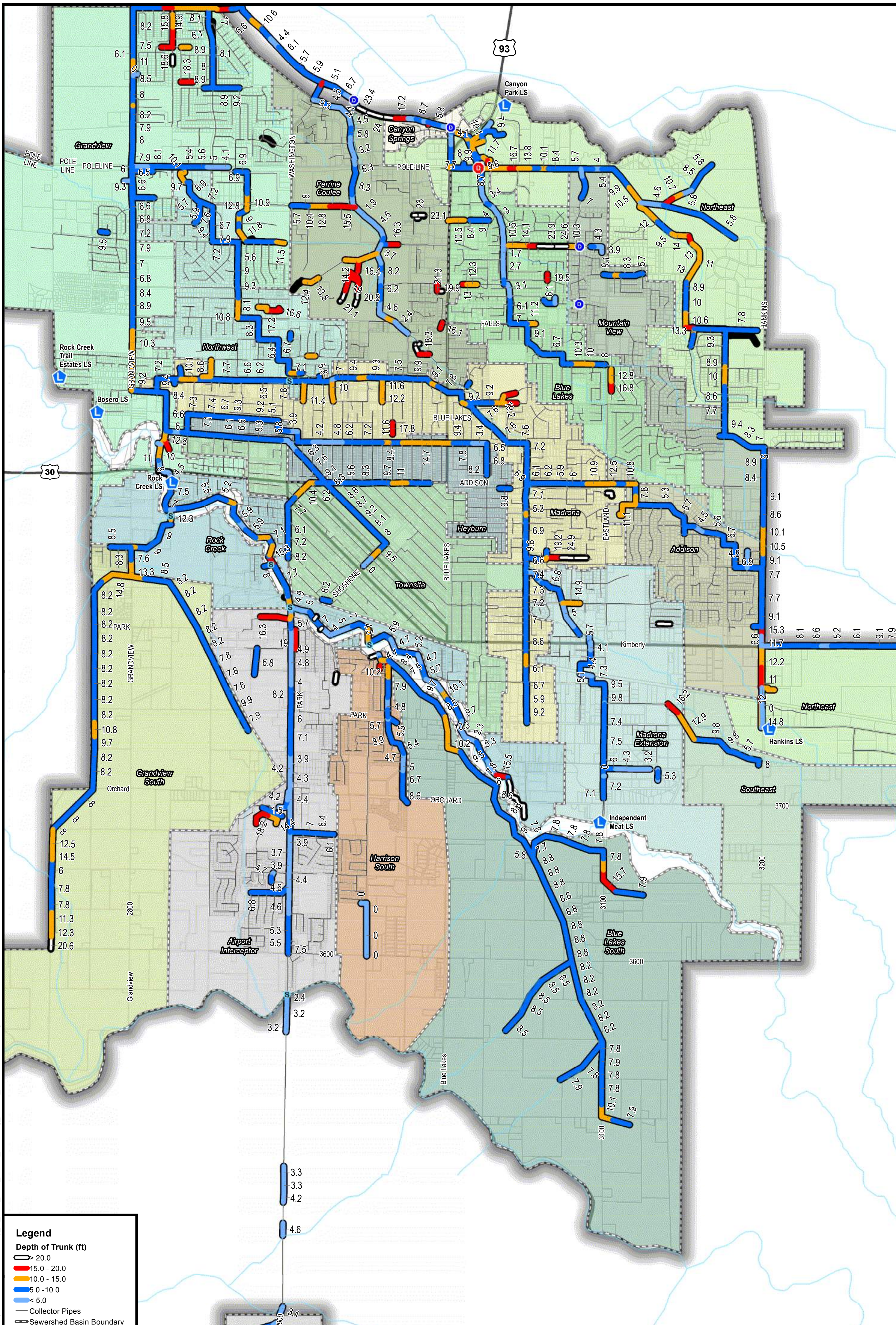

SEWER COLLECTION MASTER PLAN

FIGURE 6-2

MASTER PLAN MODEL TRUNK DEPTH

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A parallel pipe to the existing trunk line may provide an equivalent capacity to the Master Plan pipes shown in **Figure 6-1**; however, parallel pipes were not considered in this analysis. It may be beneficial to consider a parallel pipe during preliminary design for certain trunk lines.

6.3 MASTER PLAN FLOW GENERATION LAYER

6.3.1 Land Use and Unit Flows

The remaining area within the study area not already included in the Existing and Committed Model scenarios was added to the Master Plan Model and assigned a land use type generally following the 2009 Comprehensive Plan. Areas included in the Existing and Committed Models were included in the Master Plan land use layer without modification. No redevelopment[5] was assumed for existing areas. **Figure A-3** in **Appendix A** shows the land use used in the Master Plan Model.

The same unit flows that were used in the Committed Model were used in the Master Plan Model. These are summarized again in **Table 6-3**. Daily peaking factors and hourly diurnal factors are also applied to each of the flows based on land use type. Diurnal curves can be found in **Appendix C**.

Table 6-3 – Master Plan Unit Flows

Land Use Type	Units	Parcel Unit Flow	Density (DU/AC)
Future Residential	GPDU	170	4.0 (1)
Future Commercial	GPAD	1,150 (2)	-
Future Light Industrial	GPAD	200 (2)	-
Future Large Industrial	MGD	See discussion in Section 3.2.1	Point loads in probable areas

(1) Future residential density based on gross parcel areas. Net to gross conversion is estimated to be 0.75 for residential. See section 3.3.1.

(2) Future commercial and industrial unit flows based on parcel areas. Net to gross conversion is estimated to be 0.85 for non-residential. See section 3.3.1

6.3.2 Flow Allocation

Flow from each parcel was injected into the nearest upstream manhole in the system layer. The injections were to existing manholes or new master plan manholes, depending on location in the system. Some large master plan parcels were divided and injected into multiple locations based on topography and trunk line serviceability. **Figure A-3** in **Appendix A** shows the injection points for each parcel used in the Master Plan Model.

Service area boundaries for each trunk line shown on the map are based on aerial mapping and USGS contours, and are therefore approximate. The individual service area boundaries will likely change slightly as field survey is performed and development occurs. While safety factors built into the model allow for these minor changes, significant proposed changes or the cumulative effect of minor changes should be analyzed to prevent over-allocation of trunk capacity in the future.

[5] Any development requests seeking additional flow beyond the master plan loading assumptions are tested in the model to verify capacity on a case-by-case basis

6.3.3 Infiltration and Inflow

As discussed in **Section 4.3.4**, infiltration is not included in the 2015 Plan model.

Inflow from the Master Plan areas, which is assumed to capture any rain induced infiltration, was added to the inflow previously assigned in the Existing and Committed Models. New Master Plan inflow was distributed in the same manner as in the Committed Model (refer to **Section 5.3.5**). The same design storm was also used for the Master Plan Model as discussed in **Section 4.3.4** (10-Year 24-hour Type II SCS design storm, total rainfall of 1.4 inches).

6.4 MASTER PLAN MODEL ANALYSIS

6.4.1 Collection System Analysis

Due to the large amount of flow added for the Master Plan Model, it was not possible to fully analyze capacity of existing system pipes because of overflowing of existing manholes. Once a capacity-limited section of pipe was upsized, the flow would pass to the next downstream restriction and surcharge once more. Accordingly, all existing and master plan pipe sizes were iteratively modified until all pipes met the criteria in **Table 6-1** and **Table 6-2**.

The final result of this process is illustrated in **Figure 6-3,** which shows the remaining existing pipe capacity under Master Plan flows (Remaining Capacity = Existing Pipe Capacity - Master Plan Flows). This figure can be used to identify individual pipes that may be the root cause of surcharging or limited capacity. Pipe surcharging generally, but not always, occurs in areas where existing pipe capacity is less than the Master Plan flow. A pipe may flow slightly more than full pipe capacity without a depth over crown violation if some surcharging occurs or at slightly less than full pipe capacity if the depth has not increased to match a “normal” flow depth based on the manning equation.

Figure 6-4 and **Table 6-4** summarize the proposed improvements to the existing collection system in the Master Plan Model. **Appendix H** contains results from the Master Plan Model analysis.

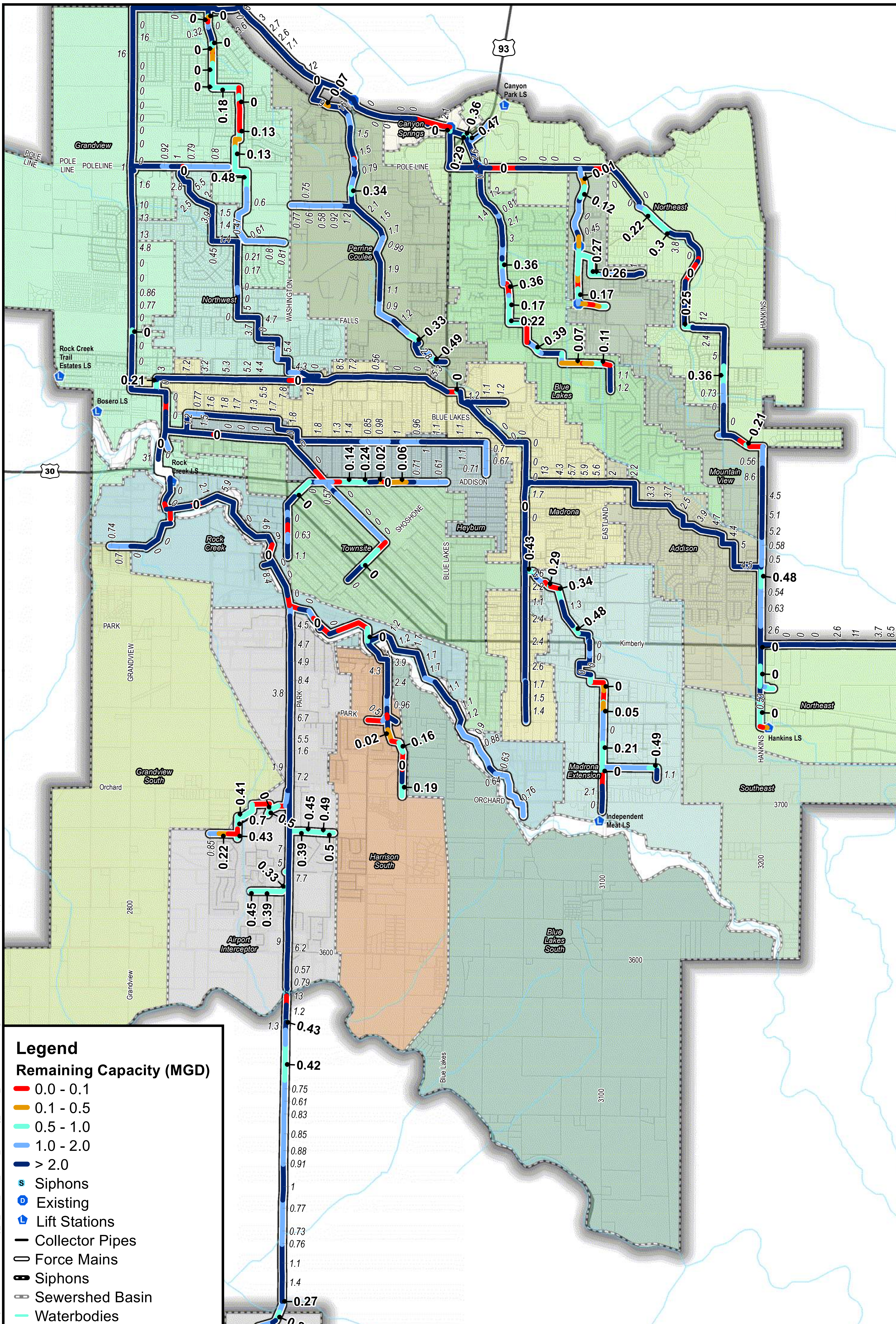
Figure 6-5 shows the system peak flows as percent full pipe after improvements.

The following sections provide additional information relative to the Master Plan Model for each basin.

6.4.1.1 Airport Interceptor Basin

Some items of note regarding this basin**:**

- The pipeline in Washington Street South is expected to handle modest growth at the airport. Some pipes north of the Low Line Canal could be upsized when replaced as part of the regular maintenance program to maintain a consistent downstream diameter.
- The Low Line Canal has an existing single barrel inverted siphon. A double barrel siphon should be constructed when this siphon is replaced to comply with current IDEQ regulations.
- If growth occurs south of Diamond Avenue and/or west or south of Glanbia, larger pipes will be needed up and downstream of Manhole C5-35 extending to Washington Street South, as shown with improvement AI.3. By increasing the slope of this pipe to steeper than the minimum criteria, the pipe diameter was kept to 18 inches to match with the trunkline in Washington Street South. The actual pipe size should be checked as growth occurs in this area.



SEWER COLLECTION MASTER PLAN

FIGURE 6-3

REMAINING EXISTING PIPE CAPACITY AT MASTER PLAN FLOWS

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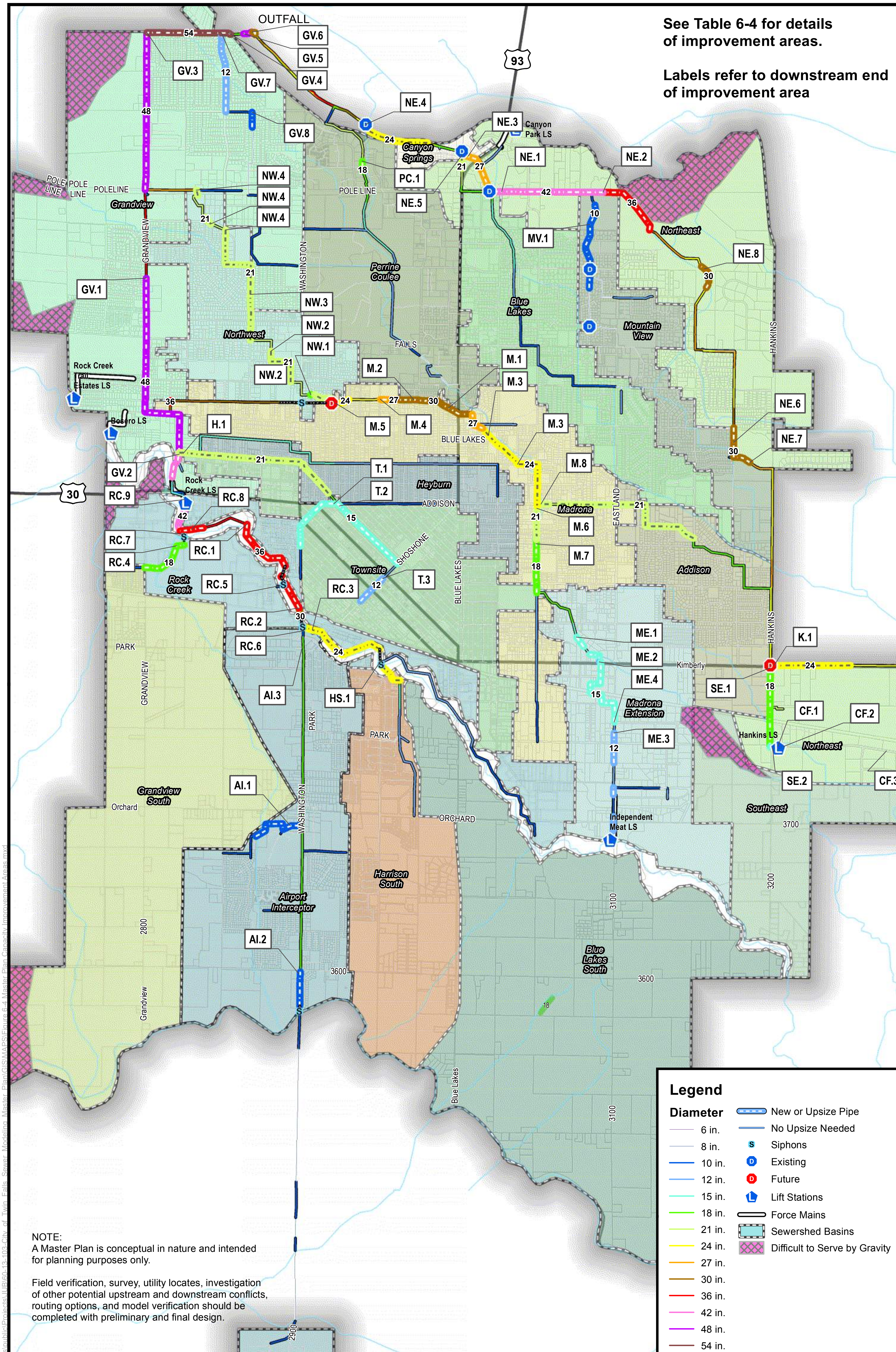

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FIGURE 6-4 MASTER PLAN CAPACITY IMPROVEMENTS

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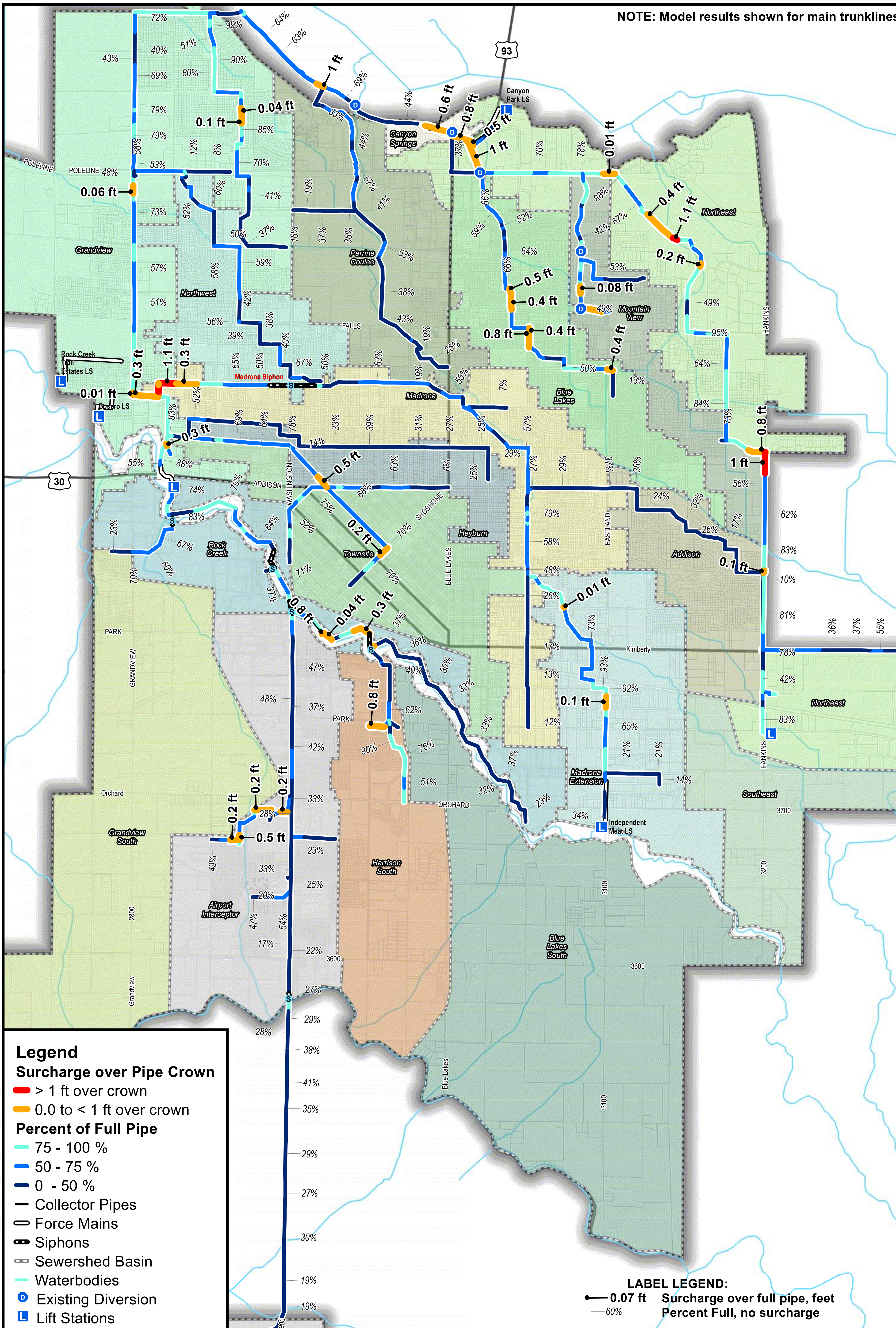

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FIGURE 6-5 MASTER PLAN MODEL PERCENT FULL PIPE

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Table 6-4 – Master Plan Model Existing Pipe Issues/Improvements

Item (See Fig. 6-4 for Locations)	Description	MH Identifiers (Upstream to Downstream)	Length (ft)	Existing Pipe Size (in)	Master Plan Pipe Size (in)	Identified as Issue in Committed Model	Issue: Violated d/D Surcharge Criteria	Issue: Upsize for Uniform Downstream Sizing	Comments
Airport Interceptor Basin									
AI.1	Airport Int: Labor Camp	C6-146 to C6-109	1,673	8	10		X		
AI.2	Airport Int: 3600 to LLC	C7-33 to C7-32	1,331	8	10			X	• Include double barrel siphon under Low Line Canal
AI.3	Airport Int: Diamond	New or C5-35 to C5-30	1,763	8	18		X		• Needed for industrial growth • New design must ***not*** follow minimum or existing slope to match the crown of the downstream tie-in location
Blue Lakes Boulevard Basin									
	No improvement anticipated to existing pipes								
Blue Lakes Boulevard South Basin									
	No improvement anticipated to existing pipes								
Grandview Basin									
GV.1	Grandview Trunk: Heyburn to North College	B4-1 to B2-10	6,919	30 & 36	48	X	X		• Inverts may need dropped to match crowns • Consider parallel pipe • Manholes reportedly in bad condition • New design must ***not*** follow minimum or existing slope to match the crown of the downstream tie-in location
GV.2	Grandview Trunk: Old Hospital to Heyburn	B4-4 to B4-1	886	30	42		X		• Inverts may need dropped to match crowns • Consider parallel pipe • Manholes reportedly in bad condition • New design must ***not*** follow minimum or existing slope to match the crown of the downstream tie-in location
GV.3	Grandview Trunk: Poleline to Canyon Rim	B2-4 to B1-9	5,279	36	48		X		• Consider parallel pipe • Manholes reportedly in bad condition
GV.4	Grandview Trunk: Canyon Rim	B1-9 to B1-29	2,844	42	54		X		• Consider parallel pipe • Manholes reportedly in bad condition
GV.5	Grandview Trunk: Snake River Drop Line	B1-29 to B1-30	430	24	24		X		• Consider parallel/redundant pipe • Manholes reportedly in bad condition

Table 6-4 – Master Plan Model Existing Pipe Issues/Improvements

Item (See Fig. 6-4 for Locations)	Description	MH Identifiers (Upstream to Downstream)	Length (ft)	Existing Pipe Size (in)	Master Plan Pipe Size (in)	Identified as Issue in Committed Model	Issue: Violated d/D Surcharge Criteria	Issue: Upsize for Uniform Downstream Sizing	Comments
GV.6	Grandview Trunk: in Snake River Canyon to WWTP	B1-30 to B1-2	346	24	54		X		• Consider parallel pipe • Manholes reportedly in bad condition especially toward the bottom of the drop.
GV.7	Parkview Trunk: to Grandview	B1-38 to B1-47	2,668	10	12	X	X	X	• Verify existing and/or future basements in this area can be serviced
GV.8	Canyon Trail Road	B1-36 to B1-33	513	8	10	X	X		• Verify existing and/or future basements in this area can be serviced
Grandview South Basin									
	No improvement anticipated to existing pipes								
Harrison South Basin									
HS.1	Rock Creek: Bennos Siphon Drop	New MH at Highland/Marjorie to C5-16	990	8 & 18	24		X		
Heyburn Basin									
H.1	Heyburn: Martin to Addison	C4-291 to B4-1	5,503	15 & 18	21		X		
Kimberly Basin									
K.1	Kimberly Road: East of Hankins	F5-14 to F5-5	2,677	18	24		X		
Madrona Basin									
M.1	Madrona Trunk: Elmwood to Fairway Drive	D3-150 to D3-100	2,059	8,18,21, & 24	27 & 30		X		
M.2	Madrona Trunk: Fairway Drive to Taylor	D3-100 to C3-167	1,485	24	30		X		
M.3	Madrona Trunk: Addison to Filer	D4-76 to D3-150	3,431	18	24		X		
M.4	Madrona Trunk: Taylor to Harrison	C3-167 to C3-96	661	24	27		X		
M.5	Madrona Trunk: Upstream of Siphon	C3-84 to C3-79	608	18	24		X		
M.6	Madrona Trunk: South of Addison	D4-120 to D4-264	1,148	15 & 18	21		X		
M.7	Madrona Trunk: South of Addison	D4-182 to D4-120	1,780	15	18		X		

Table 6-4 – Master Plan Model Existing Pipe Issues/Improvements

Item (See Fig. 6-4 for Locations)	Description	MH Identifiers (Upstream to Downstream)	Length (ft)	Existing Pipe Size (in)	Master Plan Pipe Size (in)	Identified as Issue in Committed Model	Issue: Violated d/D Surcharge Criteria	Issue: Upsize for Uniform Downstream Sizing	Comments
M.8	Addison Avenue: East of Madrona	E4-223 to D4-264	5,730	18	21		X		
M.9	Madrona Trunkline: Near Beta Circle	B3-13 to B3-289	61	30	36		X		• May not be needed if Grandview Trunkline inverts are dropped
Madrona Extension Basin									
ME.1	Madrona Ext.: North of Kimberly Road	E5-18 to E5-17 & E5-31 to E5-19	951	8, 10 & 12	15	X	X		• Needed for industrial growth
ME.2	Madrona Ext.: Kimberly Road to Wright	E5-62 to E5-31	3,150	10 & 12	15		X		• Needed for industrial growth
ME.3	Madrona Ext.: Independent Meat to Wright	E5-76 to E5-63, E6-14 to E6-8 & E6-16 to IMLS	2,083	6, 8, & 10	12		X	X	• Needed for industrial growth
ME.4	Madrona Ext.: Wright Avenue Extension	E6-7 to E5-56	2,114	8	10		X		
Mountain View Basin									
MV.1	Mountain View Trunkline: Near Temple	E2-9 to E2-122	2,309	8	10	X	X		• Pipe depth greater than 10 feet • If existing and/or future basements in this area can be serviced, no further action required
Northeast Basin									
NE.1	Northeast Trunkline: Eastland to Locust	E2-129 to D2-274	3,810	30	42		X		• Trunkline has shallow and adverse slopes • New design must ***not*** follow minimum or existing slope to match the crown of the downstream tie-in location
NE.2	Northeast Trunkline: Near Eastland	E2-138 to E2-129	2,254	30	36		X		• As an alternate, reconstruct line at Blue Lakes and Poleline, lower the inverts of this section, and increase the pipe size
NE.3	Northeast Trunkline: Poleline through the Mall	D2-274 to D2-202	1,800	24	27		X		• Flow is in free flowing supercritical condition, resulting in smaller pipe diameter
NE.4	Northeast Trunkline: Lower Canyon Springs Road	D2-2 to Diss. Box	2,268	16 & 18	24			X	
NE.5	Northeast Trunkline: North of Poleline/Blue Lakes	D2-6 to D2-77	434	12	21			X	

Table 6-4 – Master Plan Model Existing Pipe Issues/Improvements

Item (See Fig. 6-4 for Locations)	Description	MH Identifiers (Upstream to Downstream)	Length (ft)	Existing Pipe Size (in)	Master Plan Pipe Size (in)	Identified as Issue in Committed Model	Issue: Violated d/D Surcharge Criteria	Issue: Upsize for Uniform Downstream Sizing	Comments
NE.6	Northeast Trunkline Sewer: South of Filer	F4-77 to F3-72	1,584	24 & 27	30		X		
NE.7	Northeast Trunkline: Longbow	F4-81 to F4-77	826	27	30		X		
NE.8	Northeast Trunkline: North of Sunridge	E2-153 to E2-146	734	24	30		X		
Northwest Basin									
NW.1	Northwest Trunkline: Siphon to Washington	C3-79 to C3-236	1,147	6 & 8	21		X		• Construct once flows in the Madrona Siphon reach 4-5 MGD
NW.2	Northwest Trunkline: Washington to Falls	C3-193 to C3-235	1,997	10	21		X		• Construct once flows in the Madrona Siphon reach 4-5 MGD
NW.3	Northwest Trunkline: Sparks Street	B3-91 to B3-75	1,665	12 & 15	21		X		• Construct once flows in the Madrona Siphon reach 4-5 MGD
NW.4	Northwest Trunkline: Sparks to Poleline	B3-75 to B3-22, B2-21 to B2-103, & B2-269 to B2-14	3,483	18	21		X	X	• Construct once flows in the Madrona Siphon reach 4-5 MGD
Perrine Coulee Basin									
PC.1	Perrine Coulee Trunkline: North of Poleline	C2-7 to C2-6	312	15	18			X	
Rock Creek Basin									
RC.1	Rock Creek: Washington to 3rd	C5-1 to B4-17	3,791	30	36		X		
RC.2	Rock Creek: Washington to 3rd	C5-4 to C5-1	708	21 & 30	30		X		
RC.3	Rock Creek: North Bennos to Washington	C5-16 to C5-3	3,533	12 & 15	24		X		
RC.4	Rock Creek: Golf Course to Rock Creek	B4-137 to B4-124	1,802	10, 12 & 15	18		X		• New design must ***not*** follow minimum or existing slope to match the crown of the downstream tie-in location • Inverts need to be lowered in order to serve upstream basin
RC.5	Rock Creek: ConAgra Siphon Drop	C4-324 to C4-322	317	16	18		X		
RC.6	Rock Creek: Washington Siphon	C5-21 to C5-4	234	10	18		X		

Table 6-4 – Master Plan Model Existing Pipe Issues/Improvements

Item (See Fig. 6-4 for Locations)	Description	MH Identifiers (Upstream to Downstream)	Length (ft)	Existing Pipe Size (in)	Master Plan Pipe Size (in)	Identified as Issue in Committed Model	Issue: Violated d/D Surcharge Criteria	Issue: Upsize for Uniform Downstream Sizing	Comments
	Drop								
RC.7	Rock Creek: Golf Course Siphon	B4-124 to B4-120	490	12	18		X		
RC.8	Rock Creek: To GC Siphon Connectionn	B4-14 to B4-120	786	24 & 30	36		X		
RC.9	Rock Creek: Golf Course Siphon to Lift Station	B4-120 to RCK_LS	1,111	24 & 36	42		X		
Southeast Industrial Basin									
SE.1	Southeast Industrial: Hankins Road	F5-87 to F5-5	2,737	12	18		X		• New design must ***not*** follow minimum or existing slope to match the crown of the downstream tie-in location
SE.2	Southeast Industrial: Hankins Road	HKS_LS to F5-87	245	12?	15		X		• Needed for Clif Bar
CF.1	Southeast Industrial: Eldridge Road	F5-91 to HKS_LS	205	12	15		X		• Needed for Clif Bar
CF.2	Southeast Industrial: Eldridge Road	F5-99 to F5-91	3,099	8	12		X		• Needed for Clif Bar
CF.3	Southeast Industrial: Eldridge Road	G5-29 to F5-99	1,832	8	10		X		• Needed for Clif Bar
Townsite Basin									
T.1	Townsite: Albion	C4-317 to C4-163	2,235	10	15	X	X		
T.2	Townsite: 3rd/4th	C4-169 to C4-163	2,851	12	15		X		
T.3	Townsite: Shoshone	C4-227 to C4-192	1,974	8 & 10	12		X		

- The 2009 Master Plan reports that the trunkline in Washington Street South was converted from a drinking water pipeline, resulting in several shallow and sealed manholes. This information was not verified with this report.

6.4.1.2 Blue Lakes Boulevard Basin

Some items of note regarding this basin:

- This basin no longer requires capacity improvements based on the flow monitoring and modeling.
- Several pipelines in this basin have very shallow depths.
- Diversions from the Mountain View Basin help balance flow and capacity needs between these two basins.

6.4.1.3 Blue Lakes Boulevard South Basin

Some items of note regarding this basin:

- This basin was previously called Southeast Basin 3 and 4, and also included a portion of Southeast Basin 1. Wastewater from this basin is sent to the Rock Creek Basin Trunkline.
- This area is no longer anticipated to discharge to the trunkline in Rock Creek as in previous master plans, but instead routes to the Harrison South Basin. This reduces the need to construct pipeline improvements within Rock Creek Canyon, including the Blue Lakes fill crossing. This option was also considered preferable because the dropline from the Harrison Basin into the Rock Creek Basin needs to be upsized anyway. By routing flow from both the Harrison Basin and Blue Lakes Boulevard South Basin to this same dropline, a second major dropline into the Rock Creek Basin is not needed.
- Development in this basin will first require the construction of a 24-inch pipe through the Rock Creek and Harrison South Basins.

6.4.1.4 Grandview Basin

Some items of note regarding this basin**:**

- The Rock Creek Lift Station discharges to this basin through a force main that connects to a manhole in the old hospital parking lot.
- Several areas on the west side of this basin are very difficult to serve by gravity and may require lift stations. If the existing service area boundary expands to the west, it may be possible to construct trunkline to serve these areas that flows to a regional pump station in the northwest area of the basin.
- This basin has three of the five pipe sections that appear undersized based on the Committed Model flows.
- Due to the large flows in this trunkline, regular video recording and cleaning does not occur.
- The City may want to consider a diversion structure near the old hospital parking lot and a parallel pipeline to the existing Grandview Trunkline to provide redundancy.
- In general, new pipes should be designed to match the existing pipe crowns rather than inverts, except for the most downstream pipe section where inverts must match. The intricacy of selecting the proper downstream tie in location for any design should be verified after survey to ensure violations do not occur near the downstream connection location.
- The Rock Creek Trail and Bosero Lift Stations will likely need mechanical and electrical rehabilitation during the next couple of decades due to age.

- The area southwest of Grandview Drive and Falls Avenue will likely need to flow by gravity partly to the Grandview Trunkline and partly to the Rock Creek Trails Lift Station. It is anticipated that the lift station and/or force main will need to be upgraded to handle additional development. For this report, it was assumed the 4-inch force main will be limited to 235 gpm at 6 fps.
- The Grandview Trunkline discharges to the Snake River Canyon through a 24-inch dropline. Although flow velocities in the pipeline will exceed the maximum velocity criteria due to the steep slopes, the existing pipe has adequate capacity for the Master Plan flows. Due to the critical nature of this pipeline, the City should consider a redundant pipe. The City GIS shows another 18-inch pipe exists in this area, but the City reports that connections of this pipeline to the rest of the system no longer exist.

6.4.1.5 Grandview South Basin

Some items of note regarding this basin:

- This basin sends wastewater to the Rock Creek Basin Trunkline and was previously called Southwest Basin 1 and 2.
- This basin consists almost entirely of new master planned pipe that is routed closer to the natural drainages than in previous master plans.
- For this area to grow, inverts will need to be lowered on the Golf Course Trunkline from Grandview Drive South downstream. Additionally, the remainder of the downstream pipe to the Rock Creek Trunkline should be replaced due to reportedly poor condition and to maintain a uniform downstream diameter.
- The Master Plan pipe in Grandview Drive South should be designed with slopes steeper than the minimum criteria to provide capacity for future flows. This allows the pipe to be a smaller diameter while still meeting the d/D criteria.
- The southwest corner of this basin will be difficult to serve by gravity.

6.4.1.6 Harrison South Basin

Some items of note regarding this basin:

- This area provides wastewater to the Rock Creek Basin Trunkline and was previously called Southeast Basins 1 and 2.
- The new pipeline is assumed to route through, or adjacent to, the Bennos Point development and is discussed further under the Rock Creek Basin drop lines and siphons.

6.4.1.7 Heyburn Basin

Some items of note regarding this basin:

- This basin has some of the oldest pipe in the City.
- In general, new pipes should be designed to match the existing pipe crowns rather than inverts, except for the most downstream pipe section where inverts must match. The intricacy of selecting the proper downstream tie in location for any design should be verified after survey to ensure violations do not occur near the downstream connection location.

6.4.1.8 Kimberly Basin

Some items of note regarding this basin:

- The City of Kimberly and City of Twin Falls are currently negotiating an agreement to allow Kimberly to continue discharging their wastewater to Twin Falls for treatment. The City of

Kimberly's master planned flows from their 2014 Wastewater Facilities Plan were used for planning purposes in this report.

- Flow from the City of Kimberly is currently routed to the Northeast Basin. Under Master Plan flow scenarios, Kimberly's flow will need to be routed to both the Madrona/Addison Basins and the Northeast Basin.
- Flow should not be diverted to the Madrona Basin until the improvements identified as CIP project number 6 are completed.
- A diversion to direct flow to either the Madrona Basin or Northeast Basin is anticipated to be constructed at the Kimberly/Hankins intersection. However, a diversion at the Elizabeth/Hankins intersection could also be investigated.

6.4.1.9 Madrona Basin

Some items of note regarding this basin**:**

- The Madrona Trunkline is one of the oldest in the City.
- The Madrona Siphon was reportedly clean and in good condition when it was opened up within the last five years.
- Flooding from surcharging occurred on this trunkline during an August 2014 storm.
- In general, new pipes should be designed to match the existing pipe crowns rather than inverts, except for the most downstream pipe section where inverts must match. The intricacy of selecting the proper downstream tie in location for any design should be verified after survey to ensure violations do not occur near the downstream connection location.
- A new large industry or expansion of an existing permitted user that sends flow to the Madrona Trunkline may trigger improvements near Blue Lakes Boulevard.
- Low flows in this basin would be helped by routing the City of Kimberly flows to this basin.
- The surcharge still showing in **Figure 6-5** will go away when improvements are made to the Grandivew Trunkline and the pipeline inverts are lowered.

6.4.1.10 Madrona Extension Basin

Some items of note regarding this basin**:**

- Existing flows in this basin are relatively small, with the exception of a couple industries.
- The timing of potential Master Plan improvements is dependent on the schedule of growth for the existing industries.
- Re-routing flows from the Independent Meat Lift Station to the Rock Creek Trunkline would greatly decrease flows to this basin.
- The Independent Meat Lift Station needs to be rehabilitated and upgraded to accommodate future industrial growth. Alternatively, the flow from this lift station could be routed to the Rock Creek Basin. This would require further verification and modeling to evaluate potential impacts.

6.4.1.11 Mountain View Basin

There are no items of particular note in this basin.

6.4.1.12 Northeast Basin

Some items of note regarding this basin**:**

- Most of the trunkline was installed with recent industrial growth.

- The pipeline in Poleline Road has slopes less than the minimum criteria or at adverse grades and is undersized to serve future growth. The existing pipeline is relatively new and a parallel pipe could be considered.
- The pipeline in Canyon Springs Road has variable diameters with smaller diameter pipes downstream of larger diameter pipes. Although the pipeline has adequate capacity, the City should consider installing a parallel pipe with future roadway improvements to provide redundancy in this critical area. Velocities in this pipeline will exceed the maximum velocity criteria due to the steep slopes, regardless of the pipe diameter.
- The area adjacent to the Snake River Canyon in the northeast part of this basin is difficult to serve by gravity, and may require the use of fill material and/or a lift station.
- This basin provides service to a major industrial area south of Kimberly Road. As a result, the pipeline may require more frequent maintenance than other areas.
- The Canyon Park Lift Station will likely need mechanical and electrical rehabilitation during the next couple of decades due to age.
- Two small areas show a potential surcharge in red just over 1 ft d/D in **Figure 6-5**
- These were deemed close enough to the criteria that they were addressed. If addition growth occurs to the east this would potentially changes sizes on the major Northeast Trunkline.

6.4.1.13 Northwest Basin

The major trunkline in this basin is used to divert flow from the Madrona Trunkline to the Grandview Trunkline. This alleviates flow pressure on the Madrona Siphon and provides a bypass for this siphon during non-peak flows.

6.4.1.14 Perrine Coulee Basin

This basin receives a large flow contribution from the College of Southern Idaho. Depending on future flows from the college, additional pipes may or may not need to be upsized.

6.4.1.15 Rock Creek Basin

Some items of note regarding this basin**:**

- If the City were to add additional area to the west beyond the existing planning area boundary, a new lift station and force main would be needed to connect to the Grandview Basin.
- Diversion structures and/or parallel pipes could be considered for some of the droplines into Rock Creek Canyon to provide redundancy in this environmentally sensitive area.
- Several droplines and inverted single barrel siphons connect upstream basins and collectors to the Rock Creek Trunkline. IDEQ requires double barrel siphons to maintain adequate scouring velocities and to provide redundancy. As a result, the City should consider adding a second pipe to each of these siphons to comply with current regulations. Flow in these droplines and siphons is more complicated than a typical gravity sewer, requiring careful considerations during design. The Rock Creek droplines and siphons are summarized in **Table 6-5**. Improvements to several of these lines are anticipated as part of the CIP. Detailed maps of each dropline are available in **Appendix J.**

Table 6-5 – Rock Creek Dropline and Siphon Summary

Dropline Label	Siphon (Y/N)	Comment	Upstream MH ID for Dropline	Downstream MH ID for Dropline	Dropline Length (ft)	Length Beyond Dropline	Existing[1] Diameter (in)	Larger Size Needed (Y/N)
DL.1[2]	Y	Private Line	B4-65	B4-63	190		8	N
DL.2	Y	From Golf Course	B4-124	B4-123	160		8	N
DL.3	N	From Morrison Dr.	B4-80	B4-12	330		8	N
DL.4	Y	From Animal Shelter	B4-129	B4-15	490		8	N
DL.5	N	From 2nd Ave West	B4-84	B4-103	540		8	N
DL.6	N	From 3rd Ave West	C4-29	B4-17	500		8	N
DL.7	Y	From Balanced Rock	C4-3	C4-2	130		6	Y
DL.8	Y	From Victory Road	C4-9	C4-8	270		8	N
DL.9	Y	New Conagra D1 Dropline, but siphon still needed	C5-143	C5-148	100	150	16	N
DL.10	Y	ConAgra D2 Dropline	C4-324	C4-323	140	174	10	Y
DL.11	N	From Bridge St. area	Not in sewer model due to likely small size or service.		150		Possibly a service	N
DL.12	Y	From Airport Interceptor Basin	C5-21	C5-4	240	80	10	Y
DL.13	N	From Maxwell Ave.	C5-8	C5-7	130		12	N
DL.14	Y	From Harrison South Basin; Cost included with CIP 2	C5-78	C5-73	380	Included with CIP 4	8	Y
DL.15	N	From Stockyard	D5-171	D5-138	280		6	Y
DL.16	N	From Canyon St.	D5-186	D5-133	230		8	N

(1) *Future double barrel siphon sizes should be based on meeting velocity criteria in **Appendix C** for half the master plan flow in each individual barrel.*

(2) *Existing pipe is a private line and was not included in costs.*

- The Rock Creek Lift Station discharges flow from this basin to the Grandview Basin. Historically, three force mains have existed for this lift station. The original force main has been abandoned and a second smaller force main was damaged beyond use. As a result, all flow from the lift station is now discharged through a third, single, 24-inch force main. The City should consider providing a redundant force main at this key location to accommodate maintenance and potential problems with the existing pipe. This could consist of fixing the damaged second force main or providing a new pipe.

6.4.1.16 Southeast Basin

Some items of note regarding this basin:

- Any large Industrial growth in this basin is anticipated to be routed to the Hankins (Jayco) Lift Station.
- Otherwise typical residential and smaller commercial flows can alternatively gravity flow to the Madrona Extension Basin.
- A small area near the railroad tracks west of Hankins Road will be difficult to serve by gravity or by the existing Hankins Lift Station.

6.4.1.17 Townsite Basin

Some items of note regarding this basin**:**

- Much of the pipe in this area is beyond its useful life and needs to be replaced.
- The T-1 improvement shows up in the Committed Model, mainly because the large point load was routed this direction.
- If the large industrial point loads were routed through the T-2 and T-3 pipes, these would actually have a higher priority for improvement than T-1.

6.4.2 Master Plan Lift Station Analysis

The existing system lift stations are shown in **Figure 6-1. Table 6-6** summarizes the capacity analysis of the lift stations under the Master Plan flows. The Rock Creek Trails, Independent Meat, Rock Creek, and Hankins Lift Stations will need improvements to increase capacity and support future growth. It should also be noted that additional pump stations or fill material may be needed for some locations in the service area, as shown in **Figure 6-1**.

Table 6-6 – Master Plan Model Lift Station Summary

Lift Station Name	Design Lift Station Firm Capacity (GPM)	Master Plan Peak Flow (1) (GPM)	Remaining Lift Station Capacity (GPM)	Force Main Design Capacity(2) (GPM)	Remaining Force-Main Capacity (GPM)
Bosero	200	99	101	235	136
Canyon Park	250	218	32	235	17
Hankins (Jayco)	460	2,314	(1,854)	2,115	(199)
Independent Meat	300	1,073	(773)	940	(133)
Rock Creek Trails	160	296 (2)	(136) (2)	235	(61)
Rock Creek (3)	12,438	18,990	(6,552)	8,461	(10,529)

(1) *Peak flow listed is 10% higher than model flows to provide a safety factor for lift station capacity*
(2) *The flow shown here represents all of the area southwest of Falls Avenue and Grandview Drive North. However the force main will be limited to 235 gpm at 6 fps. Therefore, some of this area will be required to flow by gravity to the Grandview Trunkline to prevent the need to modify the force main. A natural high point in the land with the irrigation lateral will help gravity flow to occur toward Grandview for part of this area.*
(3) *These flows listed at Rock Creek do not reflect additional growth to the west beyond the service area. If additional growth area occurs west of the Rock Creek Lift Station along Addison Avenue and beyond the study area, another lift station or additional capacity at Rock Creek may be needed.*

Lift stations should be rehabilitated and replaced, as necessary. Major mechanical rehabilitation is often required every 15 to 30 years, while electrical upgrades are often required every 15 to 20 years. A major rehabilitation or replacement should be expected every 50 years or possibly sooner. A condition evaluation of lift stations was not completed for this project, but **Table 6-7** reflects expected timelines for maintenance based on the year of installation. Additional growth could cause the Rock Creek, Rock

Creek Trails, or Hankins Lift Stations to need additional capacity sooner than this maintenance schedule reflects. For budgetary purposes, the following costs are assumed: a mechanical upgrade is $25,000 to $75,000 and an electrical upgrade is $20,000 to $50,000, depending on the lift station size (2014 dollars).

Table 6-7 – Lift Station Rehabilitation/Replacement Expectations

Lift Station Name	Year Constructed/ Last Major Rehabilitation	Comments	Rehabilitation Expected In...		
			Mechanical (15 to 30 years)	Electrical (15 to 20 years)	Major Rehabilitation/ Replacement (50 years ±)
Independent Meat	Unknown	City staff report very old components	0 – 5 years	0 – 5 years	0 - 10 years
Canyon Park	Since 2000		0 – 15 years	0 – 5 years	35 years
Bosero	Since 2000		0 – 15 years	0 – 5 years	35 years
Rock Creek Trails	Since 2000		0 – 15 years	0 – 5 years	35 years
Rock Creek #1	2012	Originally built 1990s	12 – 27 years	12 – 17 years	45 years
Rock Creek #2	2012		12 – 27 years	12 – 17 years	45 years
Hankins (Jayco)	Since 2000	Budgeted for 2015 replacement.	15 – 30 years	15 – 20 years	50 years

6.4.3 Master Plan Diversions

Proposed diversions for the Master Plan are shown in **Table 6-8.**

Table 6-8 – Master Plan Model Diversions

Location	Description of Diversion
Kimberly / Hankins	The current manhole-drop diversion sends water from the City of Kimberly to the Northeast Trunkline, with no bypass currently in place. Reconstruction of a bypass should be considered as additional flow from growth in the Southeast Basin is routed to the Northeast Trunkline. This proposed diversion would route the City of Kimberly flow to the Madrona Basin. It is also provides additional redundancy.
Madrona Diversion	The Madrona Siphon is nearing capacity (approximately 4 MGD). This proposed diversion will provide additional capacity for the Madrona Extension Basin and bypass the siphon by diverting flow to the Northwest Trunkline.
Southeast Divresion	A diversion may be constructed with Clif Bar to route flow to the Madrona Trunkline

Chapter 7

Capital Improvement Plan

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7.0 CAPITAL IMPROVEMENT PLAN

7.1 CIP OVERVIEW

A Capital Improvement Plan (CIP) prioritizes the improvements that are necessary to relieve capacity issues, replace deteriorated segments of the system, and implement improvements that will be needed as infill occurs in the City and as the wastewater service area is expanded to the future boundary. The CIP is organized into the following categories:

- **Pipe Capacity**– Improvements required due to insufficient capacity based on existing and/or committed growth.
- **System Changes** – Modifications to the existing system required to serve additional area or accomplish goals of the City.
- **Rehabilitation/Replacement** – Improvements required for system components reported by the City to be in poor condition (e.g., droplines and siphons) and for long-term, on-going maintenance.
- **Lift Station** – Improvements for existing lift stations to accommodate existing and committed flows.

7.2 CIP PROJECTS AND PRIORITIZATION

7.2.1 Implementation Timeframe

The timeframe for implementing CIP projects not related to rehabilitation/replacement will ultimately depend on realized growth and non-residential development. **Table 7-1** shows the model flows for the Existing, Committed, and Master Plan Models and the estimated year at which those flows would be reached based on the typical growth rate discussed in **Chapter 3**.

Table 7-1 – Flow and Population Summary for Each Model Scenario

Model Scenario	Peak Day Dry Weather Loading		Peak Dry Weather Flow at the WWTP[1] (MGD)	Peak Wet Weather Flow at the WWTP[1] (MGD)	City Population	Approximate Year (2% growth)
	Permitted Industrial Flow (MGD)	Domestic Flow (MGD)				
Existing	5.9	4.5	12.5	22.6	46,901	2014
Committed	11.7	5.7	20.3	31.5[2]	78,272	2040
Master Plan	22.4	14.0	47.5	65.8	159,000	2075

(1) Flow values result from peak flow in all collection pipes. Actual influent values observed at the WWTP will differ from the reported peak flows for various reasons including: 1. Full permitted industrial peak flows are assumed to occur simultaneously in the collection system model and are included in the values shown in the table; however, at the WWTP, typically observed influent values include only 50-75% of the full permitted peak flows from all industries based on information contained in the 2013 Twin Falls Wastewater Facilities Plan (2013 WWTP FP) prepared by CH2MHill. 2. A 10-year storm, or a flow that has a 10 % chance of exceedance annually, is used in the collection system modeling for inflow. This flow can occur on individual collection system pipes throughout the City, but may not occur for all pipes at the same time or may not occur at the peak dry weather flows typically observed for the WWTP influent. Collection system methods of flow generation are different than methods typically used in WWTP flow predictions and are used for

different purposes, so modeled collection system flows are generally conservative as compared to typical flow prediction methods for WWTP influent flows.
(2) This committed peak flow value is within 12% of the 20-year peak hour flow (35.6 MGD) in the 2013 WWTP FP. The higher values in the 2013 WWTP FP are expected due to higher unit flows used in that plan as compared to this plan.

For this CIP, the implementation timeframe is limited to near term improvements within 20 years (see **Table 7-3**). Within the 20-year timeframe, CIP projects were further subdivided into the following categories:

- **Ongoing**: These items are recommended as part of the City's ongoing efforts to maintain the collection system.
- **0 to 5 Years**: Issues identified in the Existing Model, as discussed in **Chapter 4**, represent problems that could occur "today" and should therefore be addressed within the first planning period.
- **5 to 10 Years or As Needed with Growth**: Issues identified in the Committed Model, as discussed in **Chapter 5**, represent likely problems as currently developed or annexed land is built upon, which is generally expected to occur within the next 5-10 years.
- **10 to 20 Years or As Needed with Growth**: Most issues in this category arise from ongoing maintenance of the City's lift stations. Some electrical rehabilitation may be needed sooner as shown in **Table 6-7** , but was included in this category along with mechanical rehabilitation as there are no reported issues with the stations. If this changes work will need to be completed sooner.
- **As Needed with Growth**: Remaining issues will not become critical until growth begins to develop in the corresponding areas. Because very few issues occurred with the Existing and Committed Models, most of the improvements identified in the CIP fall into this category.

7.2.2 Prioritization Criteria

Because so few capacity issues occurred in the Committed and Existing Models, additional prioritization was deemed necessary to determine which pipes should be replaced first. A number of key characteristics of the collection system were analyzed to provide criteria and guidance for the CIP prioritization, including:

1. Pipes that are over capacity at the Committed Model flow conditions.
2. Pipes that are over capacity at the Committed Model flows plus a 1 MGD point load
    a. This criterion helps answers the question, "After meeting current commitments, what triggers the next improvement?"
    b. This point load was considered in the following basins and areas.
        i. Harrision/Blue Lakes Blvd Basins major trunklines to the WWTP
        ii. Grandview South Basin major trunkline to the WWTP
        iii. Madrona Extension major trunkline to the WWTP
        iv. Madrona/Addison Basin major trunkline to the WWTP
        v. Northwest Basin diversion and major trunkline to the WWTP
        vi. Northeast Basin major trunkline to the WWTP
3. Large diameter (>18 inch) Master Plan pipe size.
4. Pipes downstream of a large service area.
5. Pipe sections with potentially challenging design and/or construction issues.

6. Probable pipe age, which favors replacement of older pipes.
7. Reported poor condition. This step only included currently known major problems because a comprehensive condition assessment was not completed.
8. Pipes with a history of flow surcharging out of a manhole and/or into basements.

The remaining system components, which include lift stations, force mains, droplines, siphons, and diversions, were prioritized based on limited capacity or anticipated poor conditions occurring within the implementation timeframe.

7.2.3 Existing System Replacement

A significant portion of the existing collection is relatively old and may need to be replaced and/or rehabilitated. The timing for the improvements is dependent on the age, material, and condition of the existing pipe. While a condition assessment has not been completed for the overall city, an assessment was recently complete for the URA on the downtown area[6]. It showed that most of the older non-plastic pipes are in need of repair or rehabilitation in the near future. A city-wide condition assessment could help identify pipes that are in need of improvement and the appropriate method of replacement and/or rehabilitation.

Table 7-2 summarizes baseline values and several options for budgeting replacement of the existing collection system (including inflation, engineering, and contingency). Option 1 reflects replacing of the complete system assuming that the pipes will be replaced with open trenching, that at least a half lane of roadway will be replaced, and that 30% of the length could require rock removal. These costs do not reflect the additional costs for upsizing some pipelines for future growth. Additionally, costs may also be higher for pipeline replacement in very deep trenches or alleyways, for areas with a large amount of utility conflicts, or any other unforeseen circumstances. This reflects replacing approximately 2.5 miles of pipe per year.

The City could also focus on replacing the non-plastic pipe as shown in Option 2 with other assumptions similar to Option 1. This reflects replacing approximately 1.5 miles of pipe per year.

Table 7-2 – Annual Replacement Budget Options

Option	Total Value	Portion of Pipes and Replacement Method(1), (2)		Replacement Life Cycle (3)	Annual Replacement Budget (in 2014 $)
		PLASTIC	NON-PLASTIC		
1	$332M	100% OT	100 % OT	100	$3.3M
2	$200M	0%	100 % OT	100	$2.0M
3	$282M	50 % OT 50% CIPP	50 % OT 50% CIPP	100	$2.8M
4	$170M	0%	50 % OT 50% CIPP	100	$1.7M

(1) *Replacement methods are for open trench (OT) and cured-in-place pipe (CIPP)*
(2) *Additional costs will be necessary in areas that require new larger pipe.*
(3) *Actual useful life could be longer for plastic pipe and shorter for non-plastic pipe, and is determined based on age, as well as condition, and acceptable risk to the City.*

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Additional cost savings may be possible in some locations by utilizing trenchless rehabilitation, such as cured-in-place pipe (CIPP), slip-lining or pipe bursting. If half of the pipes are rehabilitated utilizing CIPP and the remaining pipes are replaced via open trench up to 15% savings or more could be realized as reflected in Options 3 and 4.

Due to the age and expected life cycle of the existing collection system infrastructure, the City may want to consider adjusting their annual maintenance budget for replacement/rehabilitation with one of these four options. As addition information is acquired, such as a condition assessment, future fiscal year budgets can be adjusted accordingly.

7.2.4 CIP Summary

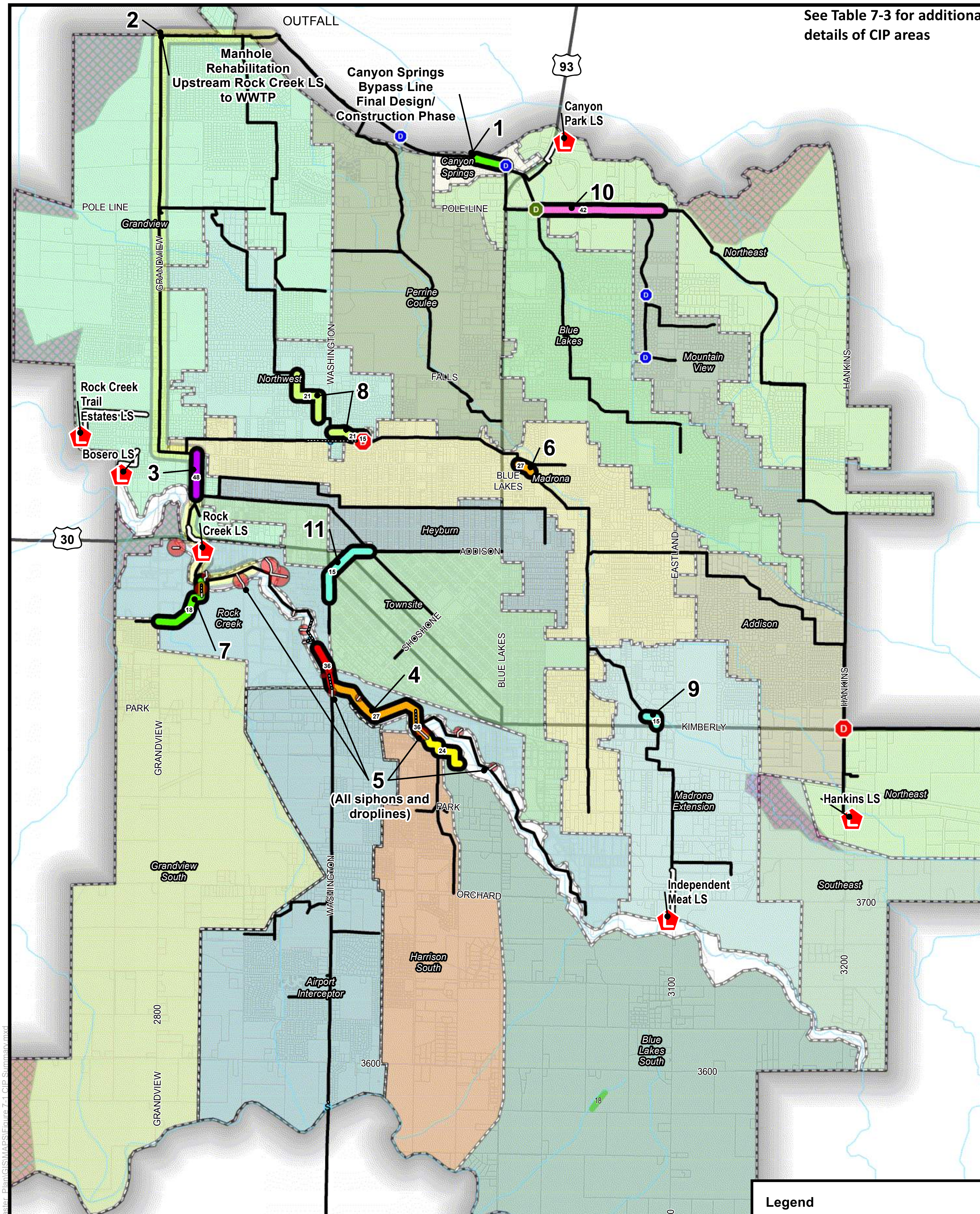
The results of the system CIP prioritization and assessment were reviewed by the City and are summarized in **Figure 7-1. Table 7-3** provides further detail of each selected CIP project, with items generally listed in order of priority. It should be noted that for CIP item 2, the exact number of manholes needing rehabilitation is unknown. This plan estimates that ¾ of the manholes will need rehabilitation. An opinion of probable capital costs in 2014 dollars is shown for each item in the CIP (see **Appendix I** for detailed costs and **Appendix J** for a close aerial view of the CIP areas, excepting the dropline areas). The costs are an AACE Class 4 cost opinion (e.g., -30% to +50%).

During preliminary and final design phases, additional investigation should be considered for the following items:

- Cost opinions
- Routing options
- Pipe sizes
- Coordination with other Public Works projects
- Component condition
- Variable pipe slopes
- Need for parallel pipes
- Pipe materials
- Appropriate replacement/rehabilitation (trenchless) technologies

7.3 BUDGETING ON-GOING CIP PROJECTS

An on-going annual budget of approximately $1.7 to $3.3 million should be established for replacement or rehabilitation of the existing collection system. The City should budget this amount so that a systematic approach can be used to replace the older deteriorated sewer pipes on a 100 year life cycle. The additional CIP costs identified in the 2015 Plan for lift station replacement/rehabilitation should be reviewed and integrated as budget permits.



Area	OVER CAPACITY AT COMMITTED	OVER CAPACITY AT COMMITTED + 1 MGD	MASTER PLAN DIAMETER > 18 INCHES	LARGE SERVICE AREA	CHALLENGING DESIGN/ CONSTRUCTION	PROBABLE AGE	REPORTED POOR CONDITION	SURCHARGE HISTORY
1	☑	☑	☑	☑		30 ±		
2			☑	☑	☑	30 ±	☑	
3	☑	☑	☑	☑	☑	30 ±	☑	
4		☑	☑	☑	☑	60 ±	☑	
5			☑	☑	☑	60 ±	☑	
6		☑	☑	☑	☑	60 +		☑
7		☑	☑	☑	☑	60 ±	☑	
8		☑	☑	☑		50 ±		
9	☑	☑				60 ±		
10		☑	☑	☑	☑	< 10		
11	☑	☑				60 +		

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

FIGURE 7-1 CIP SUMMARY

J-U-B ENGINEERS, INC.

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Table 7-3 – CIP Projects and Summary

CIP Item #	Project *(See Figure 7-1)*	MH Identifier	Length (ft)	New Size (in)	Recommended Action	0 – 5 Years	5 – 10 Years	10 – 20 Years	As Needed with Growth[A]
1	Canyon Springs Rd	CSR2 to D2-202	956	18	In Progress	$ 262,000			
2	Odor Control[E] & Manhole Rehabilitation	Various, See Figure ES-2 or 7-1	-	-	Begin Now	$ 1,930,000			
3	Grandview Trunkline	B3-14 to B4-1	1,275	48	Begin preliminary design[B]			$ 792,000	
4	Rock Creek Trunkline	C4-7 to End of Benno's Ph 2	7,045	24, 27, 36	Begin preliminary design[C]				$ 3,082,000
5	13 Droplines/Siphons, excluding DL.1,14,16	See Table 6-7			Begin preliminary design				$ 4,165,000
6	Madrona Trunkline	Reroute pipe D3-110 to D3-150 & D3-149 to D3-155	2,150	8, 27, 30	Begin preliminary design[D]				$ 881,000
7	Golf Crse Trunkline	B4-120 to B4-137	3,385	18	Complete with development				$ 570,000
8	Northwest Trunkline	C3-235 to C3-193 & C3-236 to C3-79	3,375	15, 21	Complete with development				$ 1,304,000
9	Madrona Ex.Trunkline	E5-19 to E5-31	603	15	Complete with development				$ 201,000
10	Northeast Trunkline	D2-74 to E2-129	3,810	42	Complete with RAA 4-3				$ 2,182,000
11	Albion Trunkline	C4-163 to C4-299	2,235	15	Complete with development				$ 634,000
	Kimberly Diversion	F5-115 to F5-5 or F4-16 to F4-89	N/A	N/A	Complete after CIP 6 & 8				$ 20,000
Lift Stations	**Name**	**Recommended Action**							
	Bosero	Mechanical / Electrical Rehabilitation						$ 58,000	
	Canyon Park	Mechanical / Electrical Rehabilitation						$ 58,000	
	Hankins (Jayco)	Assume that a New Station is Completed 2015; Electrical Rehabilitation in 15-20 yrs						$ 26,000	
	Independent Meat	Cost reflective of rebuild. Mechanical/electrical rehabilitation could be done earlier.[D]					$ 535,000		
	Rock Creek Trails	Cost for Mechanical / Electrical Rehabilitation. Upgrade for capacity may also be needed.						$ 58,000	
	Rock Creek	Electrical Rehabilitation 15-20 years						$ 52,000	
Ongoing Pipe Rehabilitation and Replacement		Select annual budget plan based on system value and begin budgeting for next fiscal year.				Choose Plan 1, 2, 3, or 4 ($3.3M, 2.8M, 2.0M or $1.7M).			
TOTAL (EXCLUDING ONGOING ANNUAL CIP BUDGET)						**$ 2,192,000**	**$535,000**	**$1,044,000**	**$ 13,039,000**

A. Costs generally assume 30% rock removal, 3% inflation, 25% contingency, 18% engineering/construction admin, 5% legal and bonding, a public works contractor bidded project, no costs for easements or right-of-way, no Davis-Bacon wages, and no buy American Iron or Steel provisions. All costs are an AACE Class 4 projection (-30% to +50%).
B. Consider also 3a, which completes Grandview to Manhole B3-3. The project will require completion to either B3-14 or B3-3 due to crown matching. An intermediate point is likely not acceptable. Therefore, survey will likely be needed up to B3-3 to verify crowns and inverts even if improvements are only planned for CIP improvement 1 to manhole B3-14.
C. Potentially consider the affects of abandoning the Independent Meat Lift Station and routing to the Rock Creek Trunkline
D. Survey may be needed beyond the project limits shown for CIP improvement 6 from the Madrona siphon all the way to Locust to verify actual slopes and inverts.
E. Odor control not evaluated by J-U-B; $500,000 included at the request of the City for odor control.

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Chapter 8

Summary, Recommendations and Limitations

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8.0 RECOMMENDATIONS FOR FUTURE AND LIMITATIONS

8.1 SUMMARY AND RECOMMENDATIONS

Overall, the existing collection system has adequate capacity to convey the Existing Model and Committed Model flows, but will need some upgrades to convey Master Plan flows, as indicated in the CIP priority list and the future Master Plan pipe sizes. This Master Plan provides the City with a planning tool to guide the expansion of the sewer system in the wastewater service area. The following recommendations will help ensure that the City is able to provide service to the entire future wastewater service area and that the Master Plan is implemented as intended.

A. **CIP Implementation** — Follow and implement the recommendations in the CIP.
B. **On-Call Modeling** — Provide modeling for new developments to ensure the Master Plan assumptions are adequate.
C. **Existing System Replacement** — Establish an adequate annual budget for on-going maintenance and to replace and/or rehabilitate the existing collection system based on a realistic expected life cycle for the pipe.
D. **Condition Assessment** — Assess and record the condition of the collection system piping and other infrastructure based on standardized formats. A standardized collection system assessment approach using CCTV inspection was developed for the 2013 Twin Falls URA Downtown Facilities Assessment or a different system can be used. Having a systematic approach will help prioritize future improvements and allow for identification of the appropriate method of replacement and/or rehabilitation. Recording this information in GIS, an online map, or other media will help the City assess what improvements to plan for each year.
E. **Risk Assessment** — To stretch the City's limited annual maintenance budget, the City could implement a risk-based analysis to evaluate when and where system failures are most likely to occur ("likelihood of failure") and what the consequence of failure would be if it occurred. This could be recorded in GIS, an online map or other media to prioritize planning and to determine where funding and inspection efforts should be focused.
F. **Odor** — Identify locations where odor control needs to be implemented especially as new industries are added to the system.
G. **Survey Rim/Invert Elevations**— If insufficient data exists, the City infrastructure should be surveyed and mapped with horizontal and vertical locations and/or field verified by the operations staff. Data should be collected systematically by public works zone to make it manageable for the City staff.
H. **Annual Record Drawing Updates** — Record drawings provided by developers to the City should be used to update the model and GIS on a yearly basis including the following data: source, date of source, date entered, datum, rim elevation, invert elevations, manhole location, updated manhole number, and abandoned facilities. This information can be entered into GIS by the City or others. The updated GIS shapefiles should then be transferred yearly to update the modeling files. What was considered proposed infrastructure will then be updated to existing infrastructure within the model.
I. **Trenchless Technology** — The City should consider the continued use of CIPP and other trenchless technology as a means to cost effectively rehabilitate and maintain the existing infrastructure, if applicable.
J. **GIS or On-line Mapping** — The City may want to consider GIS and/or on-line mapping of their wastewater system. This will likely require additional resources and staffing. Additional considerations regarding GIS or on-line mapping:

a. Grid maps should be updated or scanned to a location in an online map where the grid map applies
b. Record drawings should be linked in an online map to where the drawing applies.
c. On-line mapping can be used to show where ongoing improvement projects are occurring across the city.
d. On-line mapping can make existing infrastructure information available to the City staff and other authorized users
e. On-line mapping can keep track of existing maintenance activities across the City.
f. On-line mapping can be used to document the sources for information that are used to update the system information, such as survey, record drawing, field check, etc.
g. Several fields should be added to the GIS to document the year of construction, elevations based on drawings, separate sources of information for pipeline and manholes, datum of the elevation, and entry date of the information.

K. **Flow Monitoring** — The City should consider flow monitoring with major infrastructure changes, if significant dischargers are added to the system, or if previous assumptions are found to have changed or be wrong, and as a general modeling update approximately every 5 years. This is often completed with a model or master plan update, but can also be performed more frequently for critical system changes and basins, if necessary.

L. **Update the Master Plan** — Changes to the existing wastewater collection system are expected to occur as the City continues to grow over the next decade. Updates to the Master Plan and model should be considered if major assumptions change, comprehensive plans or service boundaries change, additional system data has been acquired, and improvement projects are implemented. Master Plans should generally be updated approximately every five to ten years.

8.2 LIMITATIONS OF REPORT AND MODEL

This report documents the assumptions used to prepare a hydraulic model and recommend Master Plan pipe and lift station sizes. If the assumptions change or are found to be wrong, then the hydraulic model will need to be updated to align with the best and most recent data and information available.

Exact pipe and manhole location, size, and elevation are not known for most of the areas with eight inch pipes, and are not presented for analysis. Additional research will be needed to verify exact location, size, and elevation for these pipes to more accurately understand the sewer system in these areas.

Data Sources are documented in **Chapter 2** and **Appendix B**. If these are found to be in error, these records will need to be updated in the model. In particular, record drawings and previous model files were used as a source for most of the data. On occasion record drawings may no longer reflect current conditions.

Appendix A

Large Figures

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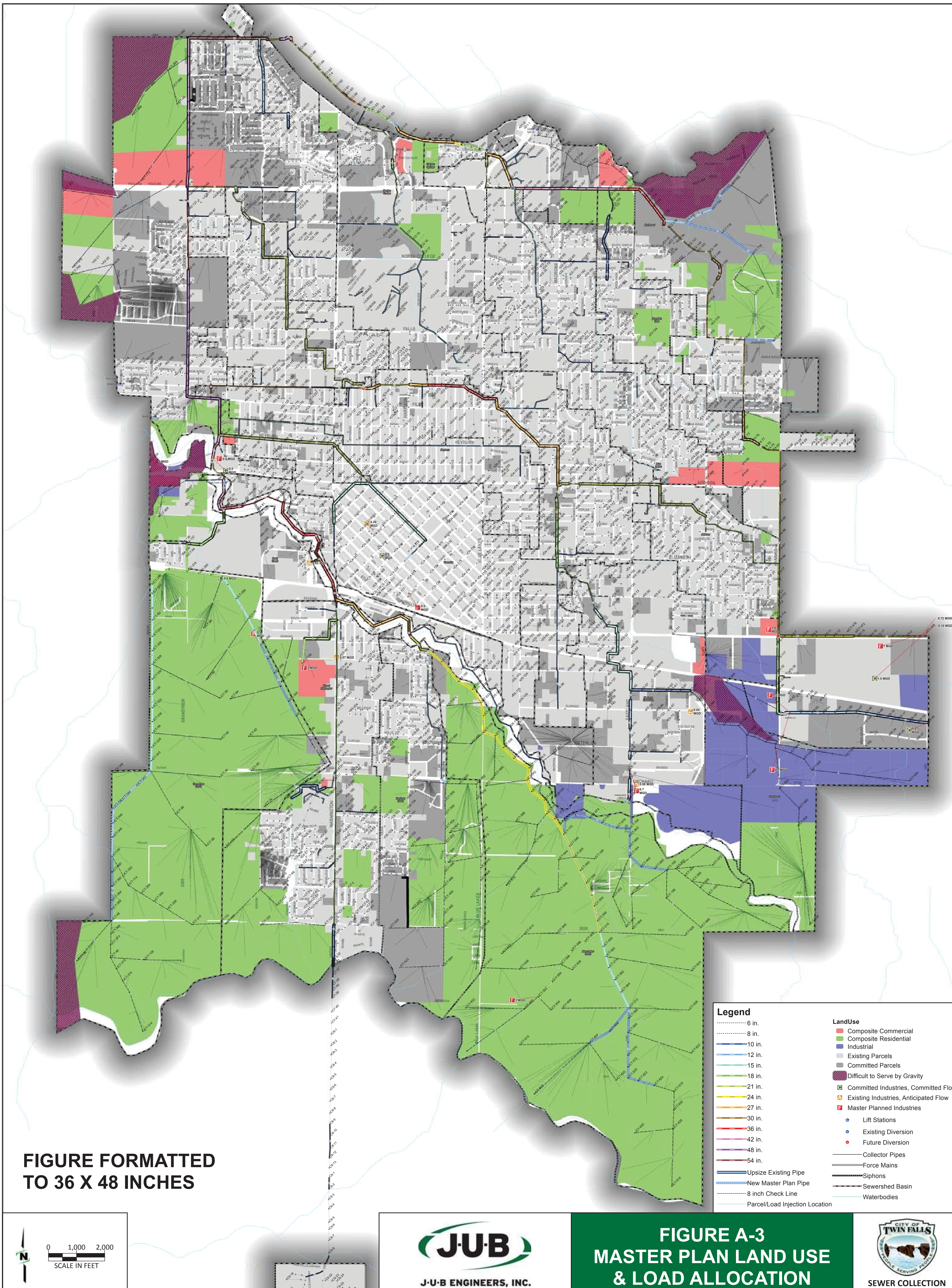

J·U·B ENGINEERS, INC.

FIGURE A-3 MASTER PLAN LAND USE & LOAD ALLOCATION

SEWER COLLECTION MASTER PLAN

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Appendix H

Master Plan Model Results

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Appendix H - Master Plan Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B1-10	B1-9	659.1	48	3594	3585.88	3583.8	0.31	3589.28	0.85	-	6.13	45.01	56.37
B1-108	B1-48	40	12	3596.3	3587.51	3587.2	0.75	3588.28	0.77	-	3.5	1.61	2.16
B1-12	B1-17	448.1	48	3609	3602.88	3595.9	1.55	3604.72	0.46	-	12.67	44.83	125.41
B1-13	B1-12	510.1	48	3615.6	3604.62	3602.9	0.34	3607.59	0.74	-	7.24	44.82	58.74
B1-14	B1-13	489.7	48	3614.9	3606.31	3604.6	0.35	3609.35	0.76	-	6.83	44.81	59.09
B1-15	B1-16	25.6	48	3620	3608.89	3608.8	0.51	3612.31	0.86	-	6.45	44.57	71.63
B1-16	B1-194	226.1	48	3617.6	3608.76	3607.6	0.5	3611.67	0.73	-	7.17	44.57	71.08
B1-163	B1-7	286.6	54	3597.7	3581.92	3581.5	0.15	3586.17	0.94	-	4.48	45.11	53.41
B1-17	B1-10	645.7	48	3603.4	3595.91	3585.9	1.55	3597.61	0.43	-	8.98	44.83	125.38
B1-179	B1-8	330.2	54	3591.6	3583.16	3582.5	0.21	3587.28	0.92	-	4.71	45.1	62.48
B1-19	B1-5	227.5	54	3594.9	3580.5	3580.2	0.11	3584.48	0.88	-	4.64	45.35	46.54
B1-194	B1-14	264.9	48	3615.6	3607.63	3606.3	0.5	3610.52	0.72	-	6.98	44.6	71.02
B1-2	JUB153	41.3	60	3182.7	3174.54	3173.5	6.03	3178.11	0.71	-	16.98	65.83	447.93
B1-28	B1-29	42.6	54	3595.1	3578.44	3576.7	4.16	3580.33	0.42	-	14.23	46.21	280.91
B1-29	B1-30	430.4	24	3593.7	3576.67	3182.2	229.19	3577.31	0.32	-	36.35	46.21	239.8
B1-30	B1-32	162.4	48	3191.3	3181.97	3178.8	1.93	3183.89	0.48	-	11.81	46.22	139.86
B1-32	B1-2	142.4	48	3184.7	3178.83	3176	1.97	3180.78	0.49	-	11.27	46.22	141.04
B1-33	B1-37	296.4	10	3618.4	3609.23	3607.3	0.64	3609.77	0.65	-	2.98	0.87	1.23
B1-35	B1-33	253.6	10	3619.2	3610.49	3609.7	0.31	3611.28	0.95	-	2.41	0.85	0.85
B1-36	B1-35	259.8	10	3619	3611.78	3610.6	0.46	3612.3	0.62	-	2.49	0.71	1.04
B1-37	B1-38	298.9	10	3616.1	3607.22	3605.7	0.5	3607.83	0.73	-	2.74	0.87	1.09
B1-38	B1-39	286.4	10	3614.3	3605.62	3604.2	0.5	3606.23	0.73	-	2.74	0.88	1.08
B1-39	B1-40	405.5	12	3612.9	3604.01	3602.4	0.39	3604.8	0.79	-	2.87	1.34	1.56
B1-4	B1-28	49.1	54	3593.5	3579.57	3578.4	2.3	3581.7	0.47	-	10.44	46.21	208.69
B1-40	B1-41	406.3	12	3610.4	3602.32	3600.8	0.37	3603.11	0.79	-	2.84	1.34	1.53
B1-41	B1-76	275.4	12	3608.9	3600.75	3599.8	0.36	3601.56	0.81	-	2.58	1.34	1.5
B1-42	B1-85	163.9	12	3608.1	3599.18	3598.5	0.42	3600.02	0.84	-	2.95	1.46	1.62
B1-43	B1-86	142	12	3604.6	3597.83	3595.6	1.57	3598.34	0.51	-	4.34	1.47	3.13
B1-46	B1-108	137.1	12	3596.2	3588.14	3587.5	0.46	3589.02	0.88	-	3.05	1.57	1.69
B1-47	B1-4	248.5	54	3593.9	3579.88	3579.6	0.12	3583.21	0.74	-	6.21	46.21	48.63
B1-48	B1-47	253.9	12	3595.9	3587.11	3583.7	1.34	3587.68	0.57	-	4.54	1.61	2.89
B1-5	B1-47	261.8	54	3594.3	3580.24	3579.9	0.14	3583.93	0.82	-	5.05	45.35	51.06
B1-6	B1-19	273.9	54	3595.7	3580.86	3580.5	0.13	3585	0.92	-	4.43	45.34	49.92
B1-68	B1-46	27.9	12	3597.8	3588.27	3588.2	0.43	3589.25	0.98	-	2.79	1.57	1.64
B1-7	B1-6	439.5	54	3596.3	3581.49	3580.9	0.14	3585.67	0.93	-	4.44	45.34	52.13
B1-76	B1-42	129.2	12	3607.8	3599.76	3599.3	0.37	3600.65	0.89	-	2.86	1.46	1.52
B1-8	B1-163	368.4	54	3590	3582.48	3581.9	0.15	3586.75	0.95	-	4.51	45.1	53.63
B1-85	B1-43	104.6	12	3606	3598.39	3597.9	0.47	3599.2	0.81	-	2.99	1.46	1.71
B1-86	B1-87	399.6	12	3601.7	3595.63	3589.7	1.48	3596.14	0.51	-	4.62	1.47	3.03
B1-87	B1-68	182.3	12	3597.8	3589.62	3588.4	0.69	3590.26	0.64	-	3.37	1.47	2.07
B1-9	B1-179	315.8	54	3592.2	3583.81	3583.2	0.21	3587.8	0.89	-	4.97	45.09	62.47
B2-1	B1-15	469.3	48	3623	3614.76	3613.4	0.29	3617.88	0.78	-	7.01	44.57	54.54
B2-10	B2-9	501.3	36	3662.1	3654.14	3649.9	0.84	3656.78	0.88	-	9.75	38.77	42.7
B2-103	B2-19	108.6	21	3638.7	3631.84	3631.1	0.64	3633	0.66	-	4.29	5.15	8.91
B2-11	B2-59	499.7	27	3629.9	3624.95	3624.5	0.08	3626.63	0.75	-	2.45	5.19	6.29
B2-12	B2-11	497.3	27	3633.5	3625.39	3624.9	0.09	3627.07	0.75	-	2.44	5.19	6.45
B2-13	B2-12	305.2	27	3631.3	3625.52	3625.4	0.04	3627.36	0.82	-	2.31	5.18	4.33
B2-14	B2-13	382.9	27	3635.6	3625.69	3625.5	0.04	3627.65	0.87	-	2.1	5.18	4.43
B2-142	B2-89	400.9	8	3625.1	3616.34	3614.4	0.47	3616.89	0.82	-	2.4	0.54	0.58
B2-143	B2-142	281.9	8	3626	3619.23	3617.2	0.72	3619.69	0.69	-	2.71	0.53	0.72

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B2-144	B2-143	143.1	8	3625.6	3620.23	3619.5	0.51	3620.78	0.83	-	2.4	0.52	0.61
B2-15	B2-14	399	10	3633.6	3628.23	3627.1	0.28	3628.33	0.12	-	0	0.02	0.81
B2-16	B2-15	397.6	10	3635	3629.36	3628.2	0.28	3629.44	0.1	-	0	0.02	0.81
B2-17	B2-16	401.7	10	3635.5	3630.49	3629.4	0.28	3630.56	0.08	-	0	0.01	0.81
B2-18	B2-17	311.3	10	3635.4	3631.37	3630.5	0.28	3631.42	0.06	-	0	0.01	0.81
B2-19	B2-20	324.3	21	3640.8	3631.14	3630.2	0.31	3632.52	0.79	-	3.74	5.15	6.13
B2-2	B2-1	508.3	48	3623.8	3615.97	3614.8	0.24	3619.46	0.87	-	6.19	44.57	49.07
B2-20	B2-274	94.3	21	3640.1	3630.15	3629.9	0.29	3631.61	0.83	-	3.87	5.18	5.94
B2-209	B2-213	214.4	8	3634.9	3626.06	3624.7	0.63	3626.5	0.66	-	2.47	0.47	0.67
B2-21	B2-103	298.2	21	3639.4	3633.72	3631.8	0.63	3634.76	0.59	-	4.93	5.14	8.81
B2-213	B2-214	394.9	8	3632.5	3624.61	3622.1	0.65	3625.06	0.67	-	2.56	0.5	0.68
B2-214	B2-144	254.8	8	3628.9	3621.95	3620.4	0.62	3622.43	0.72	-	2.57	0.52	0.67
B2-22	B2-78	127.3	21	3642.9	3635.25	3634.7	0.42	3636.63	0.79	-	3.64	5.01	7.16
B2-228	B2-209	212.3	8	3635.4	3627.49	3626.2	0.63	3627.93	0.66	-	2.45	0.47	0.67
B2-23	B2-22	392.2	21	3643.2	3636.87	3635.3	0.41	3638.01	0.65	-	4.2	5.01	7.13
B2-24	B2-23	411.4	21	3645.2	3638.47	3636.9	0.39	3639.68	0.69	-	4.35	5.01	6.92
B2-269	B2-14	183.9	21	3636.5	3626.49	3626.4	0.02	3628.35	1.06	0.11	3.4	5.18	1.64
B2-270	B2-269	36.2	21	3637.2	3627.07	3626.5	1.6	3628.5	0.82	-	3.4	5.18	14.04
B2-271	B2-270	112.4	21	3637.8	3627.98	3627.1	0.81	3629.02	0.59	-	5.1	5.18	9.98
B2-272	B2-271	79.9	21	3638.5	3628.18	3628	0.25	3629.56	0.79	-	4.37	5.18	5.55
B2-273	B2-272	274.8	21	3641.5	3629.58	3628.2	0.51	3630.68	0.63	-	4.25	5.18	7.92
B2-274	B2-273	60.7	21	3640.7	3629.88	3629.6	0.49	3631.14	0.72	-	4.53	5.18	7.8
B2-3	B2-2	497.9	48	3627.8	3619.85	3616	0.78	3621.96	0.53	-	7.36	44.56	88.78
B2-31	B2-24	63.7	21	3645.7	3638.77	3638.5	0.47	3640.08	0.75	-	4.1	5.01	7.61
B2-4	B2-3	533.8	48	3631.7	3623.75	3619.8	0.73	3626.03	0.57	-	9.53	44.55	85.97
B2-45	B2-70	314.2	21	3647.8	3640.65	3639.9	0.24	3642.12	0.84	-	3.78	4.96	5.46
B2-47	B2-45	130.2	21	3647.8	3640.95	3640.7	0.23	3642.53	0.9	-	3.34	4.95	5.33
B2-48	B2-47	144.3	21	3648.1	3641.31	3640.9	0.25	3642.93	0.93	-	3.26	4.95	5.54
B2-5	B2-4	486	36	3634.8	3628.27	3623.8	0.93	3630.76	0.83	-	9.99	38.77	45.04
B2-51	B2-48	267.5	21	3648.6	3641.95	3641.3	0.24	3643.55	0.91	-	3.34	4.92	5.43
B2-52	B2-51	303.9	21	3649.8	3642.55	3642	0.19	3644.25	0.97	-	3.32	4.92	4.85
B2-53	B2-52	387.9	21	3648.9	3643.35	3642.6	0.21	3645.15	1.03	0.05	3.24	4.92	5.04
B2-59	B2-4	36.5	27	3631.7	3624.53	3624.5	0.05	3626.19	0.74	-	2.95	5.69	5.08
B2-6	B2-61	207.9	36	3638.6	3632.49	3630.2	1.12	3635.95	1.15	0.46	8.83	38.77	49.33
B2-60	B2-62	257.6	10	3644.1	3636.49	3635.7	0.31	3636.79	0.36	-	1.58	0.22	0.85
B2-61	B2-5	266.2	36	3636.7	3630.17	3628.3	0.71	3633.65	1.16	0.48	8.92	38.77	39.45
B2-62	B2-66	297.5	10	3646.7	3635.62	3634.7	0.32	3635.95	0.4	-	1.62	0.27	0.87
B2-66	C2-199	297.6	10	3643.7	3634.61	3633.7	0.32	3634.95	0.41	-	1.62	0.27	0.87
B2-69	B2-59	167	10	3633.2	3627.15	3624.5	1.57	3627.53	0.46	-	1.78	0.82	1.92
B2-7	B2-6	512.7	36	3644.9	3638.39	3633	1.05	3640.69	0.77	-	10.7	38.77	47.93
B2-70	B2-31	287.9	21	3647.8	3639.89	3638.8	0.39	3641.11	0.7	-	4.08	5	6.92
B2-78	B2-79	334.4	21	3641.9	3634.72	3634	0.22	3636.25	0.87	-	3.6	5.02	5.25
B2-79	B2-21	69.6	21	3639.8	3633.97	3633.7	0.36	3635.26	0.74	-	4.52	5.14	6.65
B2-8	B2-7	504	36	3651	3644.25	3638.4	1.16	3646.47	0.74	-	10.52	38.77	50.36
B2-89	B2-90	328.5	8	3621.4	3614.35	3612.9	0.44	3615	0.98	-	2.35	0.54	0.56
B2-9	B2-8	489.4	36	3657.2	3649.95	3644.3	1.16	3652.18	0.74	-	10.77	38.77	50.4
B2-90	B1-36	189.2	8	3619.3	3612.72	3611.9	0.44	3613.35	0.95	-	2.36	0.55	0.56
B3-1	B2-10	530.3	48	3663.7	3656.71	3654.1	0.48	3659.09	0.6	-	7.52	38.77	70.02
B3-10	B3-9	13.1	48	3682	3670.67	3670.6	0.29	3674.97	1.07	0.3	4.53	38.5	54.18
B3-11	B3-158	19.3	48	3683	3671.49	3671.4	0.41	3676.3	1.2	0.81	4.3	38.41	64.01
B3-12	B3-11	427.8	48	3681.4	3672.15	3671.5	0.15	3677.21	1.26	1.06	4.29	38.4	39.44
B3-13	B3-12	406.9	48	3681.2	3673.08	3672.2	0.23	3678.08	1.25	1	4.63	38.36	48.03
B3-136	B3-172	74.9	30	3685.3	3674.86	3674.8	0.15	3678.71	1.54	1.35	2.73	5.53	11
B3-14	B3-13	317.9	48	3683.5	3674.12	3673.3	0.26	3678.66	1.13	0.54	5.15	33.69	51.02
B3-15	B3-14	311.9	48	3683	3674.61	3674.1	0.16	3679.21	1.15	0.6	4.97	33.83	39.78

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B3-158	B3-164	72.3	48	3683.3	3671.41	3671.3	0.19	3676.04	1.16	0.63	4.46	38.5	43.93
B3-16	B3-15	341.9	48	3682	3674.92	3674.6	0.09	3679.82	1.23	0.9	4.46	33.9	30.19
B3-164	B3-10	312.3	48	3683	3671.27	3670.7	0.19	3675.69	1.11	0.42	4.47	38.52	44.01
B3-17	B3-13	169.6	30	3681.2	3673.35	3673.3	0.03	3678.16	1.92	2.31	1.38	5.73	4.93
B3-170	B3-8	274.1	48	3680.5	3669.81	3669.3	0.19	3673.62	0.95	-	4.97	38.48	44.14
B3-171	B3-170	261.6	48	3681.3	3670.32	3669.8	0.19	3674.23	0.98	-	4.88	38.47	44.32
B3-172	B3-175	389.5	30	3684.8	3674.75	3674.2	0.15	3678.65	1.56	1.4	2.3	5.57	11.27
B3-175	B3-19	205	30	3682.4	3674.15	3673.8	0.17	3678.52	1.75	1.87	1.71	5.65	11.87
B3-18	B3-289	60.8	36	3681.2	3673.43	3673.4	0.02	3678.26	1.61	1.83	1.13	5.7	5.99
B3-181	B3-7	380.1	48	3679	3668.64	3667.8	0.21	3672.31	0.92	-	4.89	38.73	45.79
B3-19	B3-18	584.7	30	3681	3673.8	3673.4	0.06	3678.45	1.86	2.15	1.42	5.67	7.13
B3-2	B3-1	471.8	48	3666.1	3659.33	3656.7	0.56	3661.63	0.58	-	7.84	38.76	74.95
B3-23	B3-136	19.7	30	3685.3	3674.94	3674.9	0.41	3678.73	1.52	1.29	2.62	5.48	18.31
B3-24	B3-23	551.3	30	3683.8	3675.26	3674.9	0.06	3678.89	1.45	1.13	2.36	5.35	6.92
B3-25	B3-24	256.7	30	3683.8	3675.62	3675.3	0.14	3678.99	1.35	0.87	2.38	5.23	10.76
B3-26	B3-25	429.1	30	3683.8	3676.04	3675.6	0.1	3679.13	1.24	0.59	2.57	5.11	8.99
B3-27	B3-26	124.5	30	3683.7	3676.18	3676	0.11	3679.18	1.2	0.5	2.54	4.98	9.63
B3-28	B3-90	15.3	21	3659.8	3649.59	3649.4	1.38	3650.69	0.63	-	4.92	4.78	13.02
B3-285	B3-28	282.5	21	3662.5	3651.85	3649.6	0.8	3652.79	0.54	-	5.07	4.77	9.9
B3-289	B3-17	218.3	30	3681.7	3673.41	3673.4	0.02	3678.24	1.93	2.33	1.38	5.72	4.39
B3-3	B3-2	498.2	48	3671.2	3662.75	3659.3	0.69	3664.88	0.53	-	8.39	38.76	83.33
B3-36	B4-24	380.4	15	3693.1	3687.37	3685.3	0.55	3687.76	0.31	-	2.57	0.57	3.37
B3-37	B3-36	508.4	15	3695.1	3687.79	3687.4	0.08	3688.54	0.6	-	1.81	0.57	1.31
B3-38	B3-37	492.3	15	3696.3	3688.89	3687.8	0.22	3689.38	0.39	-	1.61	0.56	2.14
B3-4	B3-3	553.8	48	3675.4	3666.53	3662.8	0.68	3668.65	0.53	-	8.81	38.75	83.09
B3-40	B3-38	437.7	15	3696.8	3690.09	3688.9	0.27	3690.55	0.37	-	2.3	0.55	2.37
B3-5	B3-4	308.7	48	3676.7	3667.16	3666.5	0.2	3670.23	0.77	-	6.37	38.73	45.36
B3-6	B3-5	129.1	48	3677.4	3667.53	3667.2	0.29	3670.84	0.83	-	5.47	38.73	53.7
B3-66	B3-67	166	21	3656.9	3647.1	3646	0.67	3648.17	0.61	-	3.71	4.89	9.07
B3-67	B3-68	173.3	21	3655.6	3645.99	3645.8	0.11	3647.81	1.04	0.07	3.31	4.89	3.67
B3-68	B3-73	140.7	21	3655.1	3645.8	3645.2	0.41	3647.35	0.89	-	3.86	4.92	7.06
B3-7	B3-6	223	48	3678.2	3667.85	3667.5	0.14	3671.52	0.92	-	5.01	38.73	37.98
B3-73	B3-74	140.9	21	3654.8	3645.23	3644.8	0.33	3647	1.01	0.02	3.8	4.92	6.41
B3-74	B3-75	261.5	21	3654.1	3644.76	3643.9	0.31	3646.59	1.05	0.08	3.51	4.92	6.17
B3-75	B2-53	297.9	21	3652.9	3643.95	3643.3	0.2	3645.91	1.12	0.21	3.27	4.92	4.98
B3-8	B3-181	300.2	48	3679.6	3669.28	3668.6	0.21	3672.99	0.93	-	5.04	38.73	46.36
B3-9	B3-171	156.4	48	3681.8	3670.62	3670.3	0.19	3674.71	1.02	0.09	4.75	38.49	43.91
B3-90	B3-66	316.5	21	3659.6	3649.38	3647.1	0.72	3650.35	0.55	-	5.26	4.78	9.42
B3-91	B3-285	40.8	21	3662.8	3651.94	3651.8	0.22	3653.3	0.78	-	3.91	4.77	5.21
B4-1	B3-16	621.2	48	3682.5	3675.93	3674.9	0.16	3680.77	1.21	0.84	4.42	33.98	40.51
B4-10	B4-9	128.9	42	3640.6	3633.91	3633.5	0.29	3636.63	0.78	-	4.77	24.72	45.29
B4-102	B4-4	135.2	30	3694.9	3683.96	3678.3	4.21	3685.8	0.74	-	9.38	28.42	58.93
B4-105	B4-29	309.8	21	3704.1	3698.04	3696.7	0.43	3699.02	0.56	-	3.47	4.35	7.24
B4-11	B4-10	197.8	42	3640.4	3634.06	3633.9	0.08	3637.1	0.87	-	4.46	24.72	23.28
B4-112	B4-126	453.1	18	3707.4	3698.37	3692.7	1.25	3699.25	0.59	-	7.62	5.47	9.86
B4-117	B4-68	62	12	3710.3	3704.31	3702.6	2.8	3704.38	0.07	-	2.11	0.05	4.17
B4-119	B4-39	181.7	12	3696.9	3679.04	3678.7	0.2	3681.52	2.48	1.48	1.1	0.14	1.13
B4-12	B4-120	110.4	36	3643.1	3638.23	3636.3	1.79	3639.53	0.43	-	10.89	19.3	75.07
B4-120	B4-11	122.2	36	3641.7	3635.65	3634.6	0.89	3637.76	0.7	-	6.75	24.72	52.93
B4-122	B4-120	124.4	21	3641.4	3637.53	3637.3	0.23	3639.01	0.85	-	4.4	5.5	6.32
B4-125	B4-124	259.5	18	3696.7	3687.71	3683.6	1.58	3688.57	0.57	-	8.71	5.49	11.08
B4-126	B4-125	527.1	18	3701.7	3692.71	3687.7	0.95	3693.7	0.66	-	7.33	5.49	8.6
B4-127	B4-112	30.1	15	3706.3	3701.22	3701.2	0.17	3701.25	0.02	-	0	0	2.21
B4-128	B4-21	40	21	3690	3684.9	3684.1	2.03	3685.67	0.44	-	6.3	4.41	15.79
B4-13	B4-12	154.6	36	3645.7	3640.4	3638.2	1.4	3641.74	0.45	-	9.94	19.29	66.4

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
B4-135	B4-112	83	18	3708.8	3699.81	3698.4	1.74	3700.74	0.62	-	7.95	5.47	11.63
B4-136	B4-135	308.4	18	3713.7	3704.65	3699.8	1.57	3705.48	0.55	-	8.21	5.47	11.06
B4-137	B4-136	140.4	18	3720.9	3706.07	3704.7	1.01	3707.13	0.71	-	7.15	5.47	8.89
B4-138	B4-137	168.3	10	3720.7	3713.85	3713.4	0.28	3714.1	0.3	-	1.32	0.13	0.81
B4-14	B4-13	399.3	36	3649.5	3643.78	3640.5	0.82	3645.22	0.48	-	9.25	19.29	50.64
B4-141	B4-138	263.4	10	3723	3714.68	3713.9	0.28	3714.91	0.28	-	1.21	0.11	0.81
B4-149	B4-157	113.2	10	3724.1	3715.62	3715.3	0.29	3715.82	0.24	-	1.11	0.09	0.83
B4-15	B4-14	447.8	36	3650	3644.55	3643.9	0.15	3647.2	0.88	-	5.14	19.29	17.93
B4-157	B4-141	147.8	10	3724.6	3715.19	3714.8	0.28	3715.4	0.25	-	1.1	0.09	0.81
B4-16	B4-15	520.8	36	3651.1	3645.57	3644.6	0.19	3648.27	0.9	-	4.44	19.27	20.46
B4-17	B4-93	270.9	36	3658.7	3647.19	3646.5	0.27	3649.7	0.84	-	4.9	19.27	24.08
B4-18	B4-17	367.5	36	3653.6	3648.45	3647.2	0.34	3650.42	0.66	-	5.44	19.14	32.81
B4-19	B4-18	278.6	36	3655.1	3649.21	3648.4	0.27	3651.32	0.7	-	5.9	19.14	29.27
B4-2	B4-1	271	42	3689.8	3676.99	3675.9	0.39	3681.51	1.29	1.02	5.13	29.73	44.02
B4-20	B4-1	155.6	21	3684.4	3678.33	3677.4	0.58	3681.08	1.57	1	4.63	4.93	8.44
B4-21	B4-20	374.9	21	3689.1	3684.09	3678.3	1.54	3684.82	0.42	-	6	4.95	13.75
B4-22	B4-21	175.2	15	3690.2	3684.7	3684.1	0.35	3685.14	0.35	-	1.85	0.58	2.67
B4-23	B4-128	158.7	21	3693.5	3688.12	3684.9	2.03	3688.78	0.38	-	6.88	4.41	15.81
B4-24	B4-22	217.3	15	3691.2	3685.26	3684.7	0.26	3685.76	0.4	-	2.41	0.58	2.3
B4-26	B4-23	338.9	21	3697	3690.83	3688.1	0.8	3691.71	0.5	-	6.14	4.38	9.92
B4-27	B4-26	365.3	21	3701	3693.91	3690.8	0.84	3694.74	0.47	-	5.35	4.38	10.19
B4-28	B4-27	179.3	21	3702.9	3696.37	3693.9	1.37	3697.1	0.42	-	6.02	4.38	13
B4-29	B4-28	298.1	21	3703.5	3696.72	3696.4	0.12	3698.18	0.83	-	3.99	4.37	3.8
B4-3	B4-2	216.6	42	3688.2	3677.27	3677	0.13	3682.17	1.4	1.4	5.18	29.72	25.23
B4-30	B4-105	115.8	21	3704	3698.57	3698	0.46	3699.64	0.61	-	4.25	4.33	7.51
B4-39	B4-2	82.8	12	3695.1	3678.66	3678.5	0.2	3681.53	2.87	1.87	0.66	0.17	1.11
B4-4	B4-3	398	42	3688.3	3678.27	3677.3	0.25	3683.18	1.4	1.41	4.94	29.77	35.28
B4-41	B4-119	117.9	12	3698.1	3679.28	3679.1	0.2	3681.53	2.25	1.25	1.21	0.15	1.11
B4-62	RCK_LS	211.3	12	3641	3634.8	3633	0.85	3635.02	0.22	-	2.52	0.24	2.3
B4-63	B4-62	476.3	12	3642.4	3636.38	3635	0.29	3636.67	0.29	-	1.83	0.22	1.34
B4-64	B4-63	130	12	3676.4	3670.39	3636.4	27.12	3670.48	0.09	-	3.05	0.21	12.99
B4-65	B4-64	60	12	3685.5	3679.46	3670.4	15.3	3679.57	0.11	-	7.43	0.21	9.76
B4-66	B4-65	474.9	12	3695.3	3689.34	3679.5	2.08	3689.51	0.17	-	4.18	0.19	3.6
B4-67	B4-66	407.9	12	3700.5	3694.49	3689.3	1.26	3694.61	0.12	-	1.5	0.09	2.81
B4-68	B4-67	411.9	12	3708.6	3702.57	3694.5	1.96	3702.67	0.1	-	2.22	0.07	3.49
B4-7	RCK_LS	466.7	42	3640.2	3632.73	3632.1	0.14	3635.25	0.72	-	5.67	24.71	32.03
B4-8	B4-7	210.7	42	3640.3	3633.3	3632.8	0.25	3635.81	0.72	-	5.17	24.71	41.99
B4-9	B4-8	106.8	42	3640.5	3633.51	3633.3	0.2	3636.25	0.78	-	4.9	24.71	37.48
B4-93	B4-16	330.2	36	3651.6	3646.47	3645.6	0.27	3649	0.84	-	4.71	19.27	24.25
B6-1	C6-146	169.1	8	3840	3834.66	3832.4	1.36	3835.14	0.72	-	4.16	0.8	0.99
B6-2	B6-1	405.2	8	3848.7	3843.05	3834.8	2.05	3843.45	0.6	-	4.89	0.78	1.21
B6-3	B6-2	169.9	8	3850.9	3843.99	3843.1	0.49	3845.27	1.92	0.61	2.93	0.77	0.6
B6-4	B6-3	308	8	3853.3	3845.58	3844.3	0.42	3846.76	1.77	0.51	2.73	0.57	0.55
B6-5	B6-4	308.8	8	3853.3	3847.47	3845.7	0.58	3848.04	0.86	-	2.98	0.57	0.65
B6-6	B6-5	308.8	8	3860	3853.24	3847.6	1.84	3853.58	0.51	-	4.41	0.55	1.15
B6-9	B6-3	139.8	8	3872.8	3844.65	3844.1	0.4	3845.37	1.08	0.05	0.89	0.22	0.54
C1-1	C1-27	247.8	24	3186.8	3180.13	3179.1	0.4	3181.38	0.63	-	4.43	6.03	10.01
C1-13	C1-16	306.3	21	3623.5	3618.29	3618.2	0.04	3619.43	0.65	-	2.12	1.95	2.1
C1-14	C1-50	547.3	9	3622.9	3613.65	3224.2	101.32	3613.9	0.33	-	25.86	2.11	11.66
C1-15	C1-14	65.6	21	3621.5	3617.65	3617.5	0.26	3618.44	0.45	-	3.11	1.95	5.65
C1-16	C1-15	197.5	21	3622.7	3618.18	3617.7	0.26	3618.96	0.45	-	2.85	1.95	5.69
C1-2	C1-1	437.6	18	3197.9	3187.28	3180.1	1.63	3188.18	0.6	-	6.81	6.03	9.4
C1-27	C1-29	189.8	24	3185.8	3179.13	3178.5	0.35	3180.43	0.65	-	4.6	6.03	9.41
C1-3	C1-2	452.3	18	3201	3194.13	3187.3	1.51	3195.09	0.64	-	7.93	6.03	9.05
C1-4	C1-3	518.2	18	3206.3	3201.9	3194.1	1.5	3202.85	0.63	-	7.86	6.03	9

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C1-49	C1-8	272	18	3229.5	3221.37	3220.3	0.39	3223.81	1.63	0.94	4.75	6.03	4.62
C1-5	C1-4	420.3	18	3215.5	3210.63	3201.9	2.08	3211.47	0.56	-	8.44	6.03	10.6
C1-50	C1-49	99	16	3239.4	3223.51	3221.6	1.98	3224.03	0.39	-	2.59	2.11	7.56
C1-51	C1-52	65	24	3240.3	3236.21	3235.1	1.75	3237.78	0.79	-	10.11	13.76	20.98
C1-52	C1-53	261	24	3239.6	3235.07	3224.9	3.92	3236.02	0.47	-	9.63	13.76	31.34
C1-53	C1-54	408.9	30	3231.5	3224.86	3222.7	0.52	3226.51	0.66	-	6.05	13.76	20.68
C1-54	C1-55	246.2	30	3227.9	3222.74	3221.4	0.53	3224.45	0.68	-	5.89	13.76	20.95
C1-55	C1-56	225	30	3228.5	3221.43	3220.3	0.52	3223.17	0.7	-	5.71	13.76	20.8
C1-56	C1-57	254.7	36	3227	3220.25	3219.4	0.31	3222.02	0.59	-	4.95	13.76	26.17
C1-57	C1-58	352.6	36	3226	3219.45	3218.3	0.32	3221.17	0.57	-	4.78	13.77	26.32
C1-58	C1-59	158.9	36	3225.4	3218.33	3217.8	0.31	3220.21	0.63	-	4.54	13.77	26.19
C1-59	C1-60	74.7	36	3223.8	3217.83	3217.6	0.33	3219.69	0.62	-	4.87	13.77	27.02
C1-6	C1-5	350.1	18	3222.9	3217.9	3210.6	2.08	3218.77	0.58	-	8.86	6.03	10.6
C1-60	C1-61	157.4	36	3223.3	3217.58	3217.1	0.34	3219.21	0.54	-	6.26	13.77	27.1
C1-61	C1-62	322.6	24	3223.1	3217.05	3210.7	1.98	3218.31	0.63	-	10.4	13.77	22.26
C1-62	C1-63	562	24	3216.7	3210.68	3199.4	2.01	3211.88	0.6	-	10.35	13.77	22.46
C1-63	C1-64	384.9	27	3203.8	3199.38	3193.7	1.47	3200.63	0.56	-	9.19	13.77	26.3
C1-64	C1-65	452	27	3201.3	3193.72	3187.2	1.45	3194.98	0.56	-	9.41	13.77	26.14
C1-65	C1-66	430.4	27	3197.7	3187.15	3180.7	1.5	3188.36	0.54	-	8.54	13.77	26.55
C1-66	C1-67	460.5	30	3187.4	3180.7	3177.6	0.67	3182.14	0.58	-	5.96	13.77	23.56
C1-67	B1-2	181.4	30	3183.3	3177.6	3176	0.86	3179.58	0.79	-	7.13	19.75	26.63
C1-7	C1-6	347.1	24	3224.9	3218.95	3217.9	0.3	3220.3	0.68	-	4.5	6.03	8.67
C1-8	C1-7	368.6	24	3226.2	3220.29	3219	0.36	3221.54	0.63	-	4.33	6.03	9.51
C2-10	C2-9	219.2	18	3634.2	3628.43	3627.6	0.4	3629.07	0.43	-	3.29	1.5	4.66
C2-11	C2-10	290.6	15	3637.3	3629.08	3628.4	0.22	3629.96	0.7	-	2.93	1.5	2.14
C2-112	C2-8	21.3	18	3626.6	3623.13	3623.1	0.19	3624.09	0.64	-	2.34	1.77	3.19
C2-115	JUB101	268.8	24	3397.5	3390.18	3237.2	69.24	3390.69	0.26	-	17.26	17.74	131.8
C2-116	C2-6	195.2	18	3623.9	3621.36	3620	0.72	3621.95	0.39	-	2.95	1.87	6.23
C2-12	C2-11	235	15	3635.8	3629.49	3629.1	0.17	3630.43	0.75	-	2.39	1.48	1.89
C2-120	C2-25	269	10	3651.8	3641.43	3640.7	0.28	3641.7	0.32	-	1.59	0.16	0.81
C2-13	C2-73	117.4	15	3639.9	3636.47	3635.5	0.84	3637.04	0.46	-	4.24	1.45	4.15
C2-14	C2-13	474.4	15	3640.9	3638.91	3636.5	0.51	3639.46	0.44	-	3.35	1.15	3.24
C2-145	C2-146	161.3	18	3629.1	3623.54	3623.3	0.14	3624.5	0.64	-	1.9	1.5	2.72
C2-146	C2-147	170.5	18	3627.7	3623.32	3623.2	0.1	3624.34	0.68	-	1.77	1.5	2.32
C2-147	C2-112	47.8	18	3626.7	3623.15	3623.1	0.04	3624.18	0.69	-	1.82	1.5	1.5
C2-15	C2-14	290.2	15	3642	3640.17	3638.9	0.43	3640.76	0.47	-	3.2	1.14	2.98
C2-151	C2-200	36.7	10	3635.9	3629.02	3628.9	0.3	3629.47	0.54	-	1.89	0.42	0.84
C2-157	C2-151	321.7	10	3637	3630.11	3629.1	0.32	3630.5	0.47	-	1.76	0.37	0.87
C2-158	C2-217	150.1	10	3640.4	3631.42	3630.7	0.47	3631.76	0.41	-	1.92	0.34	1.05
C2-159	C2-158	339.3	10	3643.8	3632.82	3631.5	0.38	3633.18	0.43	-	1.84	0.34	0.95
C2-16	C2-15	389.6	15	3646	3641.5	3640.2	0.34	3642.13	0.5	-	2.98	1.14	2.64
C2-164	C2-165	439	24	3564.4	3526.47	3480.5	10.53	3527.33	0.43	-	21.09	17.74	51.41
C2-165	C2-166	483.1	24	3504.4	3480.48	3429.9	10.53	3481.33	0.42	-	20.98	17.74	51.41
C2-166	C2-115	378.7	24	3453.3	3429.86	3390.2	10.53	3430.73	0.43	-	21.14	17.74	51.4
C2-17	C2-16	275.4	12	3649.3	3645.17	3641.8	1.24	3645.65	0.48	-	4.68	1.09	2.78
C2-18	C2-17	228.2	12	3652.2	3646.71	3645.2	0.67	3647.29	0.58	-	3.73	1.09	2.05
C2-19	C2-18	337	12	3652	3648.29	3646.7	0.47	3648.91	0.62	-	3.28	1.03	1.71
C2-199	C2-159	199.6	10	3646.4	3633.59	3632.9	0.34	3633.93	0.41	-	1.64	0.28	0.89
C2-2	C1-13	394.1	21	3623.4	3618.86	3618.3	0.14	3619.77	0.52	-	1.99	1.95	4.22
C2-20	C2-19	349.3	12	3655.4	3651.17	3648.3	0.82	3651.51	0.34	-	2.32	0.56	2.27
C2-200	B2-228	392.7	10	3635.8	3628.81	3627.6	0.31	3629.27	0.55	-	1.92	0.43	0.86
C2-217	C2-157	220.3	10	3638.6	3630.62	3630.2	0.21	3631.07	0.54	-	1.56	0.35	0.7
C2-23	C2-13	465.7	12	3654.1	3638.59	3636.7	0.4	3638.92	0.33	-	2.25	0.32	1.58
C2-24	C2-23	397.8	12	3655.3	3639.48	3638.6	0.22	3639.76	0.28	-	1.23	0.19	1.17
C2-25	C2-24	422.1	10	3653.5	3640.67	3639.5	0.28	3640.95	0.34	-	1.62	0.18	0.81

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C2-26	C2-120	214.4	10	3650.1	3642.04	3641.4	0.28	3642.18	0.17	-	0.54	0.05	0.81
C2-27	C2-26	346.2	10	3648.7	3643.02	3642.1	0.28	3643.15	0.16	-	0.96	0.04	0.81
C2-3	C2-2	380.7	21	3622.7	3619.24	3618.9	0.1	3620.25	0.58	-	2.2	1.95	3.51
C2-35	C2-38	246	10	3647.8	3639.24	3638.6	0.28	3639.48	0.29	-	1.18	0.14	0.81
C2-38	C2-41	260	10	3647.7	3638.55	3637.8	0.28	3638.81	0.31	-	1.27	0.18	0.81
C2-4	C2-3	321.3	21	3623.9	3619.41	3619.2	0.05	3620.55	0.65	-	1.86	1.94	2.55
C2-41	B2-60	422.2	10	3649.7	3637.81	3636.6	0.29	3638.12	0.37	-	1.55	0.21	0.82
C2-5	C2-4	81.6	21	3624.7	3619.65	3619.4	0.29	3620.62	0.55	-	1.95	1.93	6.02
C2-6	C2-5	326.9	21	3625.7	3619.96	3619.7	0.09	3620.97	0.58	-	2.09	1.87	3.42
C2-63	C2-64	267	10	3652.9	3641.42	3640.7	0.28	3641.47	0.06	-	0	0	0.81
C2-64	C2-65	251.6	10	3649.9	3640.66	3640	0.28	3640.73	0.08	-	0.04	0.01	0.81
C2-65	C2-35	248.3	10	3648.7	3639.95	3639.3	0.28	3640.14	0.23	-	1.01	0.09	0.81
C2-7	C2-116	116.6	18	3624.5	3622.3	3621.4	0.81	3622.89	0.39	-	4.15	1.77	6.6
C2-72	C2-12	99.5	15	3636.8	3633.3	3632.3	1.02	3633.85	0.44	-	4.52	1.46	4.58
C2-73	C2-72	218.2	15	3638.9	3635.48	3633.3	1	3636.01	0.42	-	4.45	1.46	4.52
C2-8	C2-7	397.7	18	3626.3	3623.09	3622.3	0.2	3623.98	0.59	-	2.91	1.77	3.28
C2-9	C2-145	125.8	18	3629.9	3623.67	3623.5	0.1	3624.66	0.66	-	1.95	1.5	2.36
C3-1	C2-20	381.4	12	3663	3654.76	3651.2	0.94	3655.09	0.33	-	3.12	0.55	2.42
C3-104	C3-167	139.1	30	3700.6	3692.21	3692	0.12	3694.4	0.88	-	2.99	9	10.04
C3-14	C3-259	373.3	30	3683.3	3676.7	3676.3	0.1	3679.35	1.06	0.15	2.47	4.84	8.92
C3-147	C3-250	184.6	30	3683.3	3676.8	3677	0.1	3679.52	1.09	0.22	2.06	4.97	9.21
C3-157	C3-159	460.1	15	3699.1	3693.99	3692.9	0.24	3694.48	0.39	-	2.32	0.53	2.21
C3-159	C3-170	340.8	15	3702.1	3692.89	3691.7	0.35	3693.31	0.34	-	2.16	0.53	2.68
C3-167	C3-97	204.8	27	3700.7	3692.04	3691.7	0.15	3694.17	0.95	-	3.47	9	8.3
C3-170	C3-171	169.5	15	3700.7	3691.69	3691.4	0.16	3692.23	0.43	-	1.87	0.53	1.81
C3-171	C3-173	234.7	15	3700.5	3691.42	3691	0.18	3691.95	0.42	-	2.04	0.55	1.94
C3-173	B3-40	387	15	3700.3	3690.99	3690.1	0.23	3691.49	0.4	-	2.25	0.55	2.18
C3-183	C3-196	345.2	21	3667.2	3660.11	3657.7	0.71	3661.08	0.55	-	5.33	4.69	9.37
C3-188	C3-183	329.9	21	3668.9	3662.58	3660.1	0.75	3663.52	0.54	-	5.2	4.59	9.6
C3-189	C3-275	258.6	21	3671.2	3664.7	3663.1	0.63	3665.71	0.58	-	4.71	4.58	8.78
C3-190	C3-189	215.8	21	3671	3665.34	3664.7	0.3	3666.64	0.74	-	4.01	4.57	6.04
C3-192	C3-190	99.6	21	3670.9	3665.61	3665.3	0.27	3667.04	0.82	-	3.47	4.57	5.78
C3-193	C3-192	362.5	21	3673.9	3666.01	3665.6	0.11	3667.85	1.05	0.09	2.91	4.57	3.69
C3-196	C3-235	305.7	21	3664.9	3657.65	3655.2	0.79	3658.55	0.51	-	4.52	4.69	9.85
C3-197	C3-198	349	21	3663.3	3654.98	3653.8	0.35	3656.22	0.71	-	4.22	4.71	6.59
C3-198	B3-91	355.7	21	3661.8	3653.75	3651.9	0.51	3654.78	0.59	-	3.99	4.71	7.91
C3-2	C3-1	364.2	12	3662	3658.38	3654.8	0.99	3658.71	0.33	-	3.21	0.55	2.49
C3-235	C3-197	55.8	21	3664.5	3655.24	3655	0.47	3656.56	0.75	-	3.85	4.69	7.57
C3-236	C3-64	59.4	21	3677.3	3670.09	3669.7	0.64	3671.24	0.66	-	4.17	4.46	8.87
C3-250	C3-14	347.5	30	3683.2	3676.99	3676.7	0.08	3679.44	0.98	-	2.48	4.92	8.15
C3-259	B3-27	164.7	30	3683.6	3676.34	3676.2	0.1	3679.23	1.16	0.39	2.48	4.88	8.95
C3-267	C3-3	360.4	12	3666.1	3661.51	3660.4	0.3	3661.93	0.42	-	2.08	0.46	1.37
C3-3	C3-2	483	12	3666.6	3660.42	3658.4	0.42	3660.8	0.38	-	2.35	0.47	1.62
C3-4	C3-267	94.4	12	3666	3661.79	3661.5	0.3	3662.22	0.43	-	1.94	0.46	1.36
C3-5	C3-4	301	12	3667.5	3664.58	3664	0.2	3665.08	0.5	-	1.89	0.46	1.1
C3-6	C3-5	267.7	12	3675.3	3665.08	3664.6	0.19	3665.54	0.46	-	1.63	0.46	1.08
C3-63	C3-193	359.9	21	3674.7	3667.96	3666	0.54	3668.95	0.57	-	3.37	4.56	8.17
C3-64	C3-63	424.9	21	3676.8	3669.71	3668	0.4	3670.85	0.65	-	4.29	4.46	7
C3-65	C3-236	270.7	21	3682.5	3670.37	3670.1	0.1	3672.05	0.96	-	3.22	4.46	3.57
C3-72	C3-71	113	21	3684.2	3674.46	3674	0.4	3675.65	0.68	-	4.14	4.43	7
C3-73	C3-72	137.4	21	3685.3	3675.02	3674.5	0.4	3676.23	0.69	-	3.92	4.43	7.02
C3-74	C3-73	354	21	3688.1	3676.45	3675	0.4	3677.57	0.64	-	4.06	4.43	7.03
C3-79	C3-78	195.3	24	3686.9	3677.49	3675.8	0.89	3681.02	1.77	1.53	1.91	4.93	14.95
C3-80	C3-79	138.1	24	3686.5	3678.6	3677.5	0.8	3681.69	1.55	1.09	4.06	9.28	14.2
C3-83	C3-80	309.4	24	3687.7	3681.83	3678.6	1.04	3683.06	0.62	-	6.69	9.27	16.18

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C3-84	C3-83	160.3	24	3688.2	3683.3	3681.8	0.92	3684.57	0.63	-	6.84	9.14	15.17
C3-86	C3-84	194	24	3691.9	3684.93	3683.3	0.84	3686.22	0.64	-	6.41	9.12	14.52
C3-88	C3-86	183.5	24	3695.4	3686.42	3684.9	0.81	3687.73	0.65	-	6.3	9.11	14.27
C3-95	C3-88	344.3	24	3698.2	3688.84	3686.4	0.7	3690.16	0.66	-	6.24	9.09	13.25
C3-96	C3-95	341.9	24	3700.9	3690.94	3688.8	0.61	3692.32	0.69	-	6	9.09	12.41
C3-97	C3-96	456.3	27	3701	3691.73	3690.9	0.17	3693.68	0.87	-	4.29	9.08	9.02
C4-1	B4-19	371.1	36	3655	3650.11	3649.4	0.18	3652.39	0.76	-	5.65	19.14	23.81
C4-100	C4-98	338.9	15	3704.3	3698.59	3697.6	0.28	3699.01	0.34	-	1.94	0.47	2.39
C4-102	C4-100	324.7	15	3703.6	3699.39	3698.6	0.25	3699.83	0.35	-	2.17	0.46	2.25
C4-103	C4-102	327.3	12	3704.9	3700.99	3699.4	0.49	3701.38	0.39	-	2.56	0.44	1.74
C4-105	C4-103	333.6	12	3707.4	3702.59	3701	0.48	3702.97	0.38	-	2.71	0.42	1.73
C4-107	C4-105	329.8	12	3710.4	3704.19	3702.6	0.49	3704.56	0.37	-	2.66	0.41	1.74
C4-109	C4-107	327.3	12	3712.5	3705.89	3704.2	0.52	3706.24	0.35	-	2.67	0.39	1.8
C4-111	C4-109	348.3	12	3713.9	3706.69	3705.9	0.23	3707.15	0.46	-	2.17	0.37	1.2
C4-114	C4-111	328.7	12	3714.9	3707.59	3706.7	0.27	3707.99	0.4	-	1.92	0.35	1.31
C4-116	C4-261	111.1	12	3716.8	3708.39	3708.1	0.26	3708.79	0.4	-	1.96	0.33	1.27
C4-118	C4-79	229	21	3712.3	3707.41	3706.5	0.41	3708.44	0.59	-	3.92	4.15	7.07
C4-121	C4-118	480.6	21	3715.6	3709.33	3707.4	0.4	3710.33	0.57	-	4.12	4.15	7.01
C4-124	C4-291	188.7	18	3720.1	3711.95	3711.3	0.37	3713.2	0.83	-	4.19	4.15	4.48
C4-141	C4-309	221.9	10	3733	3722.68	3722.7	0.01	3723.24	0.67	-	0.53	0.17	0.18
C4-146	C4-306	282.1	10	3727.5	3719.13	3718.2	0.33	3719.68	0.66	-	2.21	0.64	0.88
C4-152	C4-307	278.8	10	3723.1	3717.5	3716.7	0.29	3718.13	0.76	-	2.26	0.68	0.83
C4-157	C4-308	248.3	10	3720.7	3715.8	3715.3	0.22	3716.56	0.91	-	2.17	0.73	0.72
C4-163	C4-124	282	18	3722.1	3712.98	3711.9	0.4	3714.18	0.8	-	3.79	4.14	4.63
C4-164	C4-315	165.8	15	3725.8	3717.62	3716.3	0.78	3718.31	0.55	-	4.28	2.13	3.99
C4-165	C4-164	485.9	15	3728.3	3719.47	3717.6	0.38	3720.32	0.68	-	3.66	2.06	2.78
C4-166	C4-165	458.9	15	3730.1	3721.37	3719.6	0.4	3722.19	0.66	-	3.71	2.05	2.85
C4-167	C4-166	460.8	15	3732.4	3723.22	3721.4	0.39	3724.05	0.66	-	3.68	2.04	2.82
C4-168	C4-167	443.4	15	3733.4	3725.32	3723.6	0.38	3726.16	0.67	-	3.65	2.03	2.78
C4-169	C4-168	446.3	15	3734.7	3726.75	3725.3	0.32	3727.62	0.7	-	3.3	2.02	2.57
C4-171	C4-314	216.3	15	3727.2	3716.87	3715.8	0.52	3717.43	0.45	-	3.28	1.27	3.25
C4-179	C4-169	349.8	12	3737.5	3728.08	3726.8	0.36	3729.24	1.16	0.16	3.48	1.65	1.49
C4-183	C4-171	350.7	15	3730.5	3717.88	3716.8	0.31	3718.52	0.51	-	2.88	1.25	2.52
C4-192	C4-179	350.4	12	3740.9	3730.32	3728.3	0.57	3731.02	0.7	-	3.97	1.56	1.88
C4-196	C4-183	351.3	15	3729	3718.97	3718	0.29	3719.62	0.52	-	3	1.19	2.43
C4-2	C4-1	449.9	36	3657.8	3651.87	3650.3	0.34	3653.75	0.63	-	6.1	19.14	32.89
C4-20	B4-30	331.3	21	3706.4	3699.88	3698.6	0.4	3700.93	0.6	-	4.1	4.33	6.98
C4-207	C4-192	359.9	12	3744	3732.07	3730.4	0.46	3732.84	0.77	-	3.73	1.44	1.69
C4-210	C4-196	353.3	15	3727.8	3720.12	3718.9	0.34	3720.5	0.3	-	1.18	0.51	2.64
C4-218	C4-207	350.3	12	3748.6	3738.97	3734	1.41	3739.46	0.49	-	5.53	1.34	2.96
C4-220	C4-313	251.2	15	3728.5	3721.7	3721.2	0.2	3722.02	0.26	-	1.22	0.24	2.02
C4-227	C4-218	354.4	12	3750.8	3742.49	3739.2	0.92	3742.89	0.4	-	4.12	0.78	2.39
C4-228	C4-317	269.5	10	3729.8	3723.75	3722.6	0.42	3724.01	0.31	-	1.43	0.19	1
C4-237	C4-228	246.7	10	3732	3724.79	3723.8	0.41	3725.03	0.29	-	1.29	0.15	0.98
C4-238	C4-237	222.3	10	3735.6	3729.13	3726.6	1.13	3729.31	0.22	-	1.73	0.15	1.63
C4-261	C4-114	220.1	12	3719.7	3708.09	3707.6	0.23	3708.51	0.42	-	1.94	0.33	1.19
C4-291	C4-121	464.5	21	3718.9	3711.25	3709.3	0.41	3712.24	0.57	-	4.2	4.15	7.13
C4-299	C4-220	166	15	3729	3722.24	3721.8	0.28	3722.49	0.2	-	1.22	0.19	2.41
C4-306	C4-152	212.6	10	3725	3718.2	3717.5	0.33	3718.73	0.64	-	2.06	0.64	0.88
C4-307	C4-157	222.2	10	3721.8	3716.68	3715.8	0.4	3717.2	0.62	-	1.99	0.69	0.97
C4-308	C4-163	248.4	10	3721.5	3715.25	3713.4	0.72	3715.7	0.54	-	2.39	0.73	1.31
C4-309	C4-310	256.1	10	3732.3	3722.65	3722.6	0.01	3723.18	0.64	-	0.56	0.17	0.17
C4-310	C4-311	246.8	10	3731.6	3722.62	3722.6	0.02	3723.1	0.58	-	0.92	0.17	0.2
C4-311	C4-146	238.3	10	3730.8	3722.56	3719.1	1.44	3722.73	0.2	-	1.01	0.18	1.84
C4-313	C4-210	257.6	15	3728.1	3720.96	3720.4	0.22	3721.27	0.25	-	1.27	0.24	2.13

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C4-314	C4-163	289.1	15	3723.9	3715.74	3714.7	0.36	3716.37	0.5	-	3.2	1.27	2.7
C4-315	C4-163	390.4	15	3724.5	3716.24	3714.8	0.38	3717.12	0.7	-	3.69	2.14	2.78
C4-317	C4-299	58.2	10	3727.7	3722.51	3722.3	0.36	3722.79	0.34	-	1.37	0.19	0.92
C4-318	C4-238	282.6	10	3741.9	3733.63	3731.2	0.87	3733.81	0.22	-	1.52	0.13	1.43
C4-324	C4-323	134.6	10	3733.7	3725.65	3661.9	53.81	3725.97	0.38	-	30.67	3.68	13.36
C4-4	C4-2	406.1	36	3665.8	3654.48	3651.9	0.63	3656.02	0.51	-	7.26	19.13	44.58
C4-5	C4-4	313.3	36	3665.9	3658.84	3656	0.91	3660.26	0.47	-	9.49	19.13	53.36
C4-6	C4-101	56.2	36	3665	3659.42	3659.3	0.12	3662.07	0.88	-	4.54	19.11	19.78
C4-7	C4-322	310	36	3667.4	3660.77	3660.1	0.23	3662.98	0.74	-	3.98	15.44	26.63
C4-70	C4-20	92	21	3707.1	3700.22	3699.9	0.37	3701.36	0.65	-	3.82	4.18	6.74
C4-71	C4-70	441.3	21	3710.3	3701.94	3700.2	0.39	3702.93	0.57	-	3.92	4.18	6.93
C4-72	C4-71	426.8	21	3710.3	3703.67	3701.9	0.41	3704.68	0.58	-	4.2	4.17	7.06
C4-73	C4-72	230.6	21	3710.3	3704.55	3703.7	0.38	3705.61	0.61	-	4.05	4.17	6.85
C4-74	C4-73	200.4	21	3710.3	3705.39	3704.6	0.42	3706.42	0.59	-	4	4.15	7.18
C4-76	C4-74	122.4	21	3710.8	3705.86	3705.4	0.38	3706.96	0.63	-	3.92	4.15	6.87
C4-77	C4-76	47.1	21	3711	3706.05	3705.9	0.4	3707.24	0.68	-	3.62	4.15	7.05
C4-79	C4-77	100.4	21	3711.4	3706.48	3706.1	0.43	3707.6	0.64	-	3.62	4.15	7.26
C4-84	C4-85	342.5	15	3706.9	3697.39	3696.4	0.29	3697.83	0.35	-	2.31	0.51	2.44
C4-85	C4-86	307	15	3700.3	3696.39	3695.6	0.26	3696.85	0.37	-	2.26	0.51	2.31
C4-86	C4-87	350.7	15	3702.1	3695.59	3694.7	0.26	3696.04	0.36	-	2.16	0.51	2.29
C4-87	C4-91	161.2	15	3704.3	3694.69	3694.3	0.22	3695.18	0.39	-	2.07	0.52	2.11
C4-91	C3-157	156.8	15	3701.7	3694.34	3694	0.22	3694.83	0.39	-	2.1	0.53	2.14
C4-98	C4-84	166.4	15	3705.9	3697.64	3697.4	0.15	3698.18	0.43	-	1.98	0.49	1.75
C5-1	C4-7	627.5	36	3669.7	3661.93	3660.8	0.18	3663.9	0.66	-	4.69	15.44	24.1
C5-10	C5-9	72	12	3750.6	3671.66	3671.5	0.18	3673.29	1.63	0.63	0.01	0.01	1.07
C5-11	C5-9	356.8	24	3676.6	3672.6	3671.5	0.3	3674.42	0.91	-	4.97	8.99	10.41
C5-12	C5-11	312	24	3681.9	3676.9	3672.8	1.3	3677.86	0.48	-	7.62	8.98	21.66
C5-122	C5-157	140.8	18	3799.1	3793.11	3790.6	1.76	3793.7	0.39	-	5.71	2.73	9.76
C5-13	C5-12	475.6	24	3683.3	3678.32	3676.9	0.3	3680.04	0.86	-	5.27	8.98	10.39
C5-131	C5-30	236.9	18	3753.2	3748.18	3744.2	1.7	3748.82	0.43	-	5.23	3.57	9.59
C5-132	C5-131	538	18	3760.5	3755.63	3748.2	1.38	3756.32	0.46	-	6.15	3.56	8.66
C5-14	C5-13	250.4	24	3686.1	3679.08	3678.3	0.3	3680.93	0.92	-	4.93	8.98	10.47
C5-15	C5-14	344.8	24	3685.6	3680.12	3679.1	0.3	3681.99	0.93	-	4.88	8.98	10.44
C5-156	C5-70	188.7	18	3805.7	3800.36	3796.8	1.86	3800.93	0.38	-	5.86	2.72	10.03
C5-157	C5-158	502.8	18	3796.7	3790.6	3780	2.11	3791.13	0.35	-	5.25	2.74	10.7
C5-158	C5-159	522.2	18	3788.1	3779.97	3775.4	0.87	3780.65	0.45	-	4.52	2.74	6.87
C5-159	C5-160	398.6	18	3779.4	3775.42	3765.8	2.43	3775.93	0.34	-	4.85	2.75	11.46
C5-160	C5-132	707.6	18	3770.5	3765.75	3755.6	1.43	3766.43	0.45	-	6.15	3.56	8.8
C5-162	C5-1	142.3	30	3670.6	3662.46	3662	0.34	3664.6	0.86	-	5.55	15.44	20.22
C5-17	C5-16	154.3	12	3686.9	3682.39	3681.7	0.46	3683.28	0.89	-	0.39	0.38	1.69
C5-172	C5-228	400.5	15	3767	3759.15	3755.4	0.93	3759.8	0.52	-	4.66	1.92	4.35
C5-173	C5-227	62	12	3775.1	3768.59	3766.7	3.02	3769.16	0.57	-	6.95	1.91	4.33
C5-174	C5-173	401.3	12	3779	3774.24	3768.7	1.38	3774.91	0.67	-	5.46	1.91	2.93
C5-175	C5-226	41.1	12	3786.6	3778.53	3778.5	0.18	3779.45	0.92	-	3.35	1.32	1.04
C5-177	C5-21	40.6	21	3743.8	3737.13	3736.5	1.55	3738.2	0.61	-	7.11	6.57	13.83
C5-18	C5-17	429.9	12	3691.4	3684.37	3682.4	0.46	3684.7	0.33	-	1.79	0.4	1.69
C5-183	C5-184	205.6	8	3789.9	3783.22	3779.4	1.86	3783.59	0.56	-	4.44	0.58	1.16
C5-19	C5-18	247.2	12	3691.4	3685.5	3684.4	0.46	3685.84	0.34	-	1.82	0.39	1.69
C5-190	C5-191	246.7	8	3788.5	3785.29	3784.4	0.35	3786.83	2.31	0.87	2.51	0.56	0.5
C5-191	C5-183	246.4	8	3789.2	3784.33	3783.3	0.41	3785.36	1.55	0.36	2.63	0.57	0.54
C5-2	C5-162	148	30	3670.8	3663.05	3662.5	0.4	3665.2	0.86	-	5.37	15.44	21.76
C5-20	C5-19	441.3	12	3692.3	3687.54	3685.5	0.46	3687.87	0.33	-	1.82	0.39	1.7
C5-21	C5-4	233.7	10	3738.4	3735.1	3667.5	30.22	3735.66	0.67	-	27.96	7.13	10.01
C5-226	C5-174	212	12	3784.9	3778.46	3774.3	1.94	3779.07	0.61	-	6.13	1.91	3.48
C5-227	C5-172	211.5	12	3773.2	3766.62	3759.3	3.49	3767.11	0.49	-	7.48	1.92	4.66

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C5-228	C5-229	363.7	15	3765.5	3755.34	3748.2	1.96	3755.86	0.42	-	6.12	1.93	6.33
C5-229	C5-230	192	18	3764.5	3748.11	3745.8	0.64	3748.75	0.43	-	2.79	1.93	5.86
C5-230	C5-231	247.4	24	3757.5	3746.89	3742	1.99	3747.84	0.48	-	8.81	8.55	22.34
C5-231	C5-79	74.1	24	3750.4	3741.87	3740.6	1.7	3743.01	0.57	-	8.09	8.55	20.66
C5-236	C5-175	78.8	12	3788.6	3783.73	3783.5	0.27	3784.69	0.96	-	2.98	1.32	1.29
C5-237	C5-236	376.8	12	3795.5	3789.89	3783.8	1.61	3790.38	0.49	-	4.01	1.31	3.16
C5-238	C5-237	405.8	12	3800	3791.14	3790	0.28	3792.42	1.28	0.28	2.96	1.31	1.33
C5-30	C5-177	386.7	18	3749.8	3744.05	3737.1	1.79	3744.97	0.61	-	7.76	6.57	9.84
C5-5	C5-3	354	24	3672.4	3667.44	3666.4	0.29	3669.19	0.88	-	5.2	8.99	10.3
C5-6	C5-5	311.7	24	3674.3	3669.28	3667.4	0.59	3670.59	0.65	-	5.58	8.99	14.6
C5-7	C5-6	293.8	24	3675.8	3670.34	3669.3	0.36	3671.95	0.8	-	5.55	8.99	11.42
C5-70	C5-122	184.9	18	3802.5	3796.7	3793.1	1.94	3797.25	0.37	-	5.75	2.72	10.25
C5-78	C5-73	375.3	24	3740.3	3736.28	3682.8	14.38	3736.84	0.28	-	19.06	8.71	60.07
C5-79	C5-78	131.2	24	3744.7	3740.61	3736.3	3.3	3741.5	0.44	-	10.79	8.63	28.75
C5-9	C5-7	396.5	24	3678.5	3671.53	3670.3	0.3	3673.29	0.88	-	5.15	8.99	10.41
C6-1	C6-70	289.5	18	3814	3809.81	3808.5	0.46	3810.63	0.55	-	3.37	2.67	4.97
C6-10	C6-91	473.5	18	3870.2	3866.32	3862.7	0.77	3866.76	0.29	-	3.37	1.12	6.44
C6-107	C6-108	168.8	8	3838.4	3827.53	3826.9	0.4	3827.78	0.38	-	1.36	0.15	0.54
C6-108	C6-109	311.8	10	3833.4	3826.76	3824.8	0.61	3827.35	0.71	-	3.07	1	1.2
C6-109	C6-110	232.7	10	3827.6	3824.75	3824.1	0.28	3825.84	1.31	0.26	2.59	1.01	0.81
C6-110	C6-111	243.3	15	3830.8	3824	3823.6	0.15	3824.72	0.58	-	2	1.01	1.74
C6-111	C6-112	278	15	3827.8	3823.54	3823.1	0.15	3824.27	0.58	-	2.16	1.01	1.78
C6-112	C6-113	77.1	15	3827	3823.01	3822.7	0.38	3823.58	0.46	-	2.65	1.02	2.77
C6-113	C6-2	256.7	18	3826.7	3822.18	3816.1	2.37	3822.68	0.33	-	6	2.55	11.33
C6-12	C6-10	104.5	8	3870.3	3867.56	3867.2	0.39	3867.78	0.33	-	1.7	0.11	0.53
C6-120	C6-82	263	10	3883.7	3876.12	3875.4	0.28	3876.56	0.53	-	1.94	0.42	0.81
C6-121	C6-120	262.9	10	3885.4	3876.84	3876.1	0.27	3877.26	0.5	-	1.91	0.39	0.8
C6-122	C6-121	258.8	10	3884.4	3877.56	3876.8	0.28	3877.96	0.48	-	1.87	0.36	0.81
C6-143	C6-108	193.4	10	3830.8	3827.9	3826.8	0.55	3828.46	0.67	-	2.97	0.84	1.14
C6-144	C6-143	568.5	10	3832.9	3829.41	3828	0.25	3830.5	1.31	0.26	2.38	0.84	0.76
C6-145	C6-144	224.1	10	3838.9	3830.36	3829.5	0.38	3831.11	0.9	-	2.6	0.81	0.94
C6-146	C6-145	375	10	3839.2	3832.26	3830.5	0.48	3832.83	0.68	-	2.88	0.81	1.06
C6-2	C6-1	328	18	3820.4	3816.09	3809.8	1.92	3816.62	0.35	-	4.47	2.66	10.18
C6-3	C6-113	49.9	18	3827.6	3822.79	3822.2	1.22	3823.29	0.33	-	3.71	1.53	8.13
C6-51	C6-68	427.9	10	3851.8	3845.77	3844.6	0.28	3846.21	0.53	-	1.71	0.38	0.81
C6-57	C6-51	433.7	10	3854	3846.98	3845.8	0.28	3847.34	0.43	-	1.33	0.31	0.81
C6-58	C6-69	250.9	10	3854.7	3848.65	3848	0.27	3848.98	0.4	-	1.44	0.26	0.8
C6-68	C6-93	523.5	18	3849	3843.92	3836.7	1.38	3844.36	0.29	-	4.4	1.52	8.63
C6-69	C6-57	352.8	10	3854.4	3847.96	3847	0.28	3848.3	0.41	-	1.41	0.28	0.81
C6-70	C6-95	336.3	18	3812.4	3808.49	3807.2	0.37	3809.38	0.59	-	3.37	2.69	4.5
C6-81	C6-90	317.4	10	3880.1	3874.67	3873.8	0.28	3875.19	0.62	-	2.17	0.48	0.8
C6-82	C6-81	259.5	10	3883	3875.39	3874.7	0.28	3875.85	0.55	-	1.92	0.46	0.8
C6-83	C5-156	384.4	18	3812.7	3805.63	3800.4	1.36	3806.23	0.4	-	5.29	2.71	8.59
C6-89	C6-90	466	18	3884.3	3879.73	3873.1	1.42	3879.97	0.16	-	1.87	0.46	8.75
C6-90	C6-10	454.5	18	3877.5	3873.13	3866.3	1.5	3873.46	0.22	-	3.11	0.95	9
C6-91	C6-92	336.2	18	3866.4	3862.69	3858.2	1.33	3863.07	0.25	-	4.09	1.13	8.48
C6-92	C6-68	522.4	18	3862.1	3858.22	3843.9	2.74	3858.53	0.21	-	4.33	1.14	12.17
C6-93	C6-94	328.9	18	3838.2	3836.71	3829.2	2.29	3837.09	0.25	-	4.75	1.53	11.13
C6-94	C6-3	503.1	18	3833.6	3829.18	3822.8	1.27	3829.62	0.29	-	4.09	1.53	8.29
C6-95	C6-83	365.6	18	3812.4	3807.19	3805.7	0.4	3808.06	0.58	-	3.42	2.7	4.65
C7-1	C6-89	440	18	3893	3888.42	3879.7	1.98	3888.64	0.15	-	2.91	0.45	10.34
C7-10	C7-8	141.6	18	3914	3908.49	3905.8	1.86	3908.7	0.14	-	2.81	0.39	10.04
C7-13	C7-10	274.4	18	3918.4	3910.91	3908.5	0.88	3911.16	0.17	-	2.14	0.38	6.91
C7-25	C7-20	352	10	3922.6	3916.33	3911.3	1.43	3916.56	0.28	-	1.76	0.29	1.84
C7-28	C7-25	385.8	10	3929.1	3920.74	3916.3	1.14	3920.99	0.3	-	1.76	0.29	1.64

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
C7-30	C7-28	398.7	10	3936.4	3927.54	3920.7	1.71	3927.76	0.26	-	1.9	0.28	2
C7-37	C7-33	298.7	10	3945.1	3943.14	3943.1	0	3943.78	0.77	-	0.58	0.26	0.09
C7-38	C7-37	380.7	10	3949.7	3946.54	3943.1	0.89	3946.78	0.29	-	0.6	0.24	1.45
C7-39	C7-92	258.1	10	3954	3950.8	3948.3	0.97	3951.03	0.28	-	1.2	0.24	1.51
C7-40	C7-39	484.2	8	3960.3	3955.34	3950.9	0.91	3955.6	0.39	-	1.67	0.23	0.81
C7-41	C7-40	395	8	3961	3957.74	3955.3	0.61	3958.03	0.44	-	1.46	0.23	0.66
C7-42	C7-1	341.3	18	3899.4	3893.56	3888.4	1.51	3893.78	0.15	-	2.69	0.41	9.03
C7-8	C7-42	569.6	18	3911.2	3905.85	3893.6	2.16	3906.05	0.13	-	2.84	0.4	10.8
C7-91	C7-38	178.9	10	3951.1	3948.27	3946.5	0.97	3948.51	0.29	-	1.63	0.24	1.51
C7-92	C7-91	15.7	10	3951.3	3948.3	3948.3	0.2	3948.65	0.42	-	1.13	0.24	0.68
C8-1	C7-41	401.7	8	3963.4	3960.14	3957.7	0.6	3960.42	0.42	-	1.44	0.23	0.65
C8-10	C8-9	411.4	10	4010.2	4006.94	4004.1	0.68	4007.17	0.28	-	1.45	0.19	1.27
C8-11	C8-10	452.7	10	4013	4009.74	4006.9	0.62	4009.97	0.28	-	1.42	0.18	1.21
C8-12	C8-11	336.5	10	4016.7	4012.54	4009.7	0.83	4012.75	0.25	-	1.49	0.18	1.4
C8-13	C8-12	353.6	8	4020.1	4016.94	4012.5	1.24	4017.14	0.3	-	1.82	0.17	0.94
C8-2	C8-1	399.6	8	3969.3	3962.54	3960.1	0.6	3962.82	0.42	-	1.44	0.22	0.66
C8-3	C8-2	331.8	8	3970.1	3966.94	3962.5	1.33	3967.16	0.33	-	1.65	0.22	0.97
C8-4	C8-3	451.9	8	3977.7	3971.34	3966.9	0.97	3971.58	0.36	-	1.71	0.21	0.83
C8-5	C8-4	416.8	8	3979.9	3977.74	3971.3	1.54	3977.95	0.32	-	1.85	0.21	1.05
C8-6	C8-5	375	8	3986.3	3984.14	3977.7	1.71	3984.34	0.3	-	2.02	0.2	1.11
C8-7	C8-6	409.8	8	3994.7	3990.54	3984.1	1.56	3990.75	0.32	-	2.02	0.2	1.06
C8-8	C8-7	415	8	4001.5	3997.34	3990.5	1.64	3997.54	0.3	-	2.03	0.2	1.08
C8-9	C8-8	395.5	8	4008.3	4004.14	3997.3	1.72	4004.33	0.29	-	2.02	0.19	1.11
C9-1	C8-13	339.8	8	4025.6	4021.44	4016.9	1.32	4021.63	0.29	-	1.89	0.17	0.97
C9-10	C9-9	266.1	10	4095.4	4092.34	4091.4	0.34	4092.57	0.28	-	1.2	0.12	0.89
C9-11	C9-10	315.2	8	4096.4	4092.96	4092.3	0.2	4093.26	0.45	-	1.01	0.12	0.38
C9-12	C9-11	119.5	10	4097.9	4094.2	4093	1.04	4094.33	0.16	-	0.72	0.07	1.56
C9-13	C9-12	511.4	10	4100.9	4095.44	4094.2	0.24	4095.63	0.23	-	0.94	0.06	0.76
C9-2	C9-1	409.8	10	4027.4	4022.84	4021.4	0.34	4023.1	0.31	-	1.23	0.16	0.9
C9-3	C9-2	369.3	8	4029.4	4027.24	4022.8	1.19	4027.43	0.29	-	1.47	0.16	0.92
C9-4	C9-3	337.2	8	4039.3	4036.04	4027.2	2.61	4036.2	0.24	-	2.09	0.15	1.37
C9-5	C9-4	469.2	8	4051.1	4047.04	4036	2.35	4047.2	0.24	-	2.28	0.15	1.3
C9-6	C9-5	256.8	8	4063.5	4059.84	4047	4.99	4059.97	0.19	-	2.65	0.14	1.89
C9-7	C9-6	386.9	8	4078.1	4072.64	4059.8	3.31	4072.78	0.21	-	2.6	0.14	1.54
C9-8	C9-7	451.3	8	4092.1	4090.44	4072.6	3.95	4090.57	0.2	-	2.71	0.13	1.68
C9-9	C9-8	100.6	6	4093.7	4091.44	4090.4	0.99	4091.65	0.42	-	1.78	0.13	0.39
CSR1	D2-264	271	24	3605.8	3602.26	3571.3	11.51	3603.11	0.42	-	21.19	17.73	53.73
D2-10	D2-274	85	42	3643.5	3634.76	3633.7	1.24	3636.2	0.41	-	6.76	17.13	78.31
D2-100	D2-99	347.4	12	3629.9	3625.83	3625.1	0.2	3626.26	0.43	-	1.85	0.39	1.11
D2-101	D2-121	25.9	12	3627.2	3626.18	3626.1	0.23	3626.59	0.41	-	1.65	0.16	1.2
D2-102	D2-11	305.8	15	3643.1	3638.65	3636.2	0.79	3639.36	0.57	-	3.77	2.39	4.02
D2-11	D2-190	306.7	18	3643.1	3636.24	3635.3	0.31	3637.1	0.57	-	2.64	2.39	4.07
D2-12	D2-102	268.8	15	3643.5	3640.69	3638.7	0.76	3641.42	0.58	-	4.11	2.36	3.94
D2-121	D2-100	135.3	12	3627.4	3626.11	3625.8	0.2	3626.56	0.45	-	2.04	0.41	1.12
D2-125	D2-126	70.8	12	3631.7	3612.8	3612.7	0.2	3613.05	0.25	-	1.25	0.09	1.11
D2-126	D2-2	121.2	24	3615	3611.66	3609.8	1.49	3613.02	0.68	-	9.1	12.45	19.36
D2-13	D2-12	324.6	15	3646	3642.64	3640.7	0.6	3643.42	0.62	-	3.79	2.36	3.51
D2-14	D2-170	177	15	3648.4	3644.43	3643.3	0.64	3645.17	0.59	-	3.62	2.2	3.63
D2-15	D2-59	177.4	15	3649.3	3646.31	3645.6	0.4	3647.15	0.67	-	3.12	2.04	2.86
D2-152	D2-17	114	15	3652.2	3649.49	3648.6	0.82	3650.15	0.53	-	3.9	2	4.11
D2-16	D2-15	133.6	15	3650.5	3647.61	3646.3	0.97	3648.22	0.49	-	3.5	2	4.46
D2-169	D2-152	228.3	15	3654	3651.44	3649.5	0.85	3652.03	0.47	-	3.78	1.82	4.18
D2-17	D2-16	100.4	15	3651.4	3648.55	3647.6	0.94	3649.19	0.51	-	4.11	2	4.38
D2-170	D2-13	101.4	15	3652.6	3643.29	3642.6	0.64	3644.07	0.62	-	3.51	2.2	3.62
D2-18	D2-169	94.6	15	3654.7	3652.22	3651.4	0.82	3652.85	0.5	-	3.84	1.8	4.11

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D2-184	D2-61	277.9	42	3645.4	3635.16	3634.9	0.08	3637.38	0.63	-	4.1	15.28	19.82
D2-185	D2-184	298.5	42	3649	3635.16	3635.2	0	3637.79	0.75	-	3.23	15.25	1.29
D2-186	D2-185	299.2	42	3648.6	3635.24	3635.2	0.03	3638.06	0.81	-	2.82	15.25	12.22
D2-187	D2-186	299.5	42	3652.1	3635.41	3635.2	0.06	3638.3	0.83	-	2.71	15.25	16.78
D2-190	D2-10	14.6	24	3644.9	3635.3	3635.3	0.01	3636.28	0.49	-	2.24	2.39	1.31
D2-202	D2-4	246.4	24	3621.7	3617.12	3615	0.86	3618.96	0.92	-	6.71	12.39	14.73
D2-264	C2-164	427.6	24	3588.5	3571.27	3526.5	10.53	3572.13	0.43	-	20.99	17.74	51.41
D2-265	D2-187	397.2	42	3649.5	3635.71	3635.4	0.08	3638.58	0.82	-	2.72	15.23	19.36
D2-266	D2-265	298.7	42	3645.9	3636.54	3635.7	0.28	3638.78	0.64	-	3.26	15.23	37.14
D2-267	D2-266	300.1	42	3646.9	3636.79	3636.5	0.08	3639.19	0.69	-	3.73	15.24	20.33
D2-268	D2-267	300.9	42	3645.4	3637.07	3636.8	0.09	3639.53	0.7	-	3.37	15.24	21.49
D2-269	D2-268	399	42	3643.3	3637.39	3637.1	0.08	3639.92	0.72	-	3.24	15.2	19.95
D2-270	D2-271	368.4	27	3635.4	3630.16	3627.1	0.83	3632.02	0.83	-	7.78	17.14	19.73
D2-271	D2-272	340.1	27	3636.5	3627.11	3624.1	0.89	3628.92	0.8	-	7.58	17.14	20.4
D2-272	D2-273	149.7	27	3634.7	3624.1	3622.7	0.92	3626.12	0.9	-	7.44	17.14	20.75
D2-273	D2-68	283.3	27	3633.8	3622.73	3620.3	0.86	3624.66	0.86	-	7.48	17.47	20.17
D2-274	D2-270	319.6	27	3643.7	3633.71	3630.2	1.11	3635.35	0.73	-	8.15	17.14	22.85
D2-274	D2-9	488.8	18	3643.7	3635.71	3634.8	0.2	3635.35	-0.24	-	0	0	3.26
D2-28	D2-18	299.4	15	3658	3655.63	3652.2	1.14	3656.16	0.42	-	4.06	1.8	4.83
D2-3	D2-126	224.8	24	3617	3613.05	3611.7	0.62	3615.08	1.01	0.03	6.53	12.38	12.43
D2-36	D2-28	67.9	12	3658.8	3656.38	3655.6	1.1	3657.02	0.64	-	4.21	1.63	2.62
D2-4	D2-3	310.7	24	3620.4	3614.98	3613.1	0.62	3617.33	1.17	0.35	6.24	12.39	12.45
D2-41	D2-36	351.6	12	3661.1	3659.39	3656.6	0.79	3660.05	0.66	-	3.84	1.62	2.21
D2-42	D2-41	54.7	12	3661.4	3660.08	3659.4	1.26	3660.7	0.62	-	3.99	1.62	2.8
D2-59	D2-14	171.4	15	3649	3645.6	3644.4	0.68	3646.33	0.58	-	3.72	2.19	3.74
D2-6	D2-79	254.3	21	3636.4	3633.41	3626.6	2.68	3633.53	0.07	-	3.39	0.15	18.15
D2-61	D2-10	53.6	42	3643	3634.94	3634.8	0.34	3636.72	0.51	-	5.25	15.28	40.82
D2-68	D2-77	204.7	27	3627	3620.28	3618.6	0.85	3622.41	0.95	-	7.2	17.47	19.93
D2-69	D2-273	25.4	12	3632.3	3623.78	3623.7	0.2	3624.67	0.89	-	1.85	0.41	1.11
D2-7	D2-6	569.4	21	3641.9	3633.87	3633.4	0.08	3634.19	0.18	-	1.02	0.13	3.15
D2-70	D2-69	102.4	12	3633.9	3623.99	3623.8	0.2	3624.7	0.71	-	1.69	0.41	1.11
D2-77	D2-202	133.9	27	3624	3618.55	3617.4	0.84	3620.66	0.94	-	7.7	17.65	19.84
D2-79	D2-77	179.3	21	3630.7	3626.6	3620.7	3.32	3626.73	0.07	-	3.89	0.19	20.22
D2-8	D2-7	202.4	18	3645.2	3634.22	3633.9	0.17	3634.44	0.15	-	0.95	0.12	3.06
D2-9	D2-8	481.3	18	3644.3	3634.75	3634.2	0.11	3634.84	0.06	-	0.31	0.02	2.44
D2-98	D2-70	178.3	12	3632.9	3624.36	3624	0.2	3624.79	0.43	-	1.8	0.42	1.12
D2-99	D2-98	379.2	12	3635.5	3625.13	3624.4	0.2	3625.54	0.41	-	1.75	0.38	1.12
D3-100	D3-98	211.6	30	3703.7	3694.53	3693.5	0.5	3696.16	0.65	-	3.57	8.98	20.33
D3-103	D3-100	218.9	30	3706.6	3695.6	3694.5	0.49	3696.89	0.52	-	5.39	8.98	20.08
D3-105	D3-103	129.1	30	3705.8	3695.9	3695.6	0.23	3697.48	0.63	-	4.5	8.96	13.85
D3-110	D3-105	280.6	30	3704.1	3696.3	3695.9	0.14	3698.12	0.73	-	3.66	8.96	10.84
D3-111	D3-110	159.1	30	3704.3	3696.36	3696.3	0.04	3698.46	0.84	-	3.09	8.95	5.58
D3-126	D3-111	153.1	30	3704.4	3696.41	3696.4	0.03	3698.71	0.92	-	2.72	8.95	5.19
D3-127	D3-126	105.9	30	3704.5	3696.46	3696.4	0.05	3698.89	0.97	-	2.55	8.95	6.24
D3-142	D3-353	335.3	27	3707.3	3698.1	3696.8	0.4	3699.55	0.64	-	3.91	8.93	13.66
D3-146	JUB132	89.8	12	3707.1	3699.37	3699.2	0.22	3700.37	1	0	0.09	0.08	1.18
D3-147	JUB132	225.1	27	3707.8	3699.1	3698.7	0.19	3700.98	0.84	-	3.78	8.82	9.48
D3-149	D3-147	106.3	24	3707.9	3699.4	3699.1	0.29	3701.48	1.04	0.08	3.94	8.8	8.46
D3-150	D3-149	207.6	24	3708.3	3700.1	3699.4	0.34	3702.32	1.11	0.22	4.04	8.79	9.18
D3-151	D3-150	443.8	24	3709.4	3701.8	3700.1	0.38	3703.91	1.05	0.11	4.61	8.79	9.8
D3-157	D3-358	159.7	12	3707	3700.31	3700	0.22	3700.5	0.19	-	1.01	0.09	1.17
D3-158	D3-157	63.3	12	3707	3700.46	3700.3	0.22	3700.65	0.19	-	0.98	0.08	1.18
D3-159	D3-158	333.2	12	3710.4	3701.2	3700.5	0.22	3701.38	0.18	-	0.97	0.07	1.17
D3-160	D3-159	231.8	12	3714.8	3701.72	3701.2	0.22	3701.82	0.1	-	0.42	0.02	1.18
D3-205	D3-222	195.3	10	3699.5	3690.08	3688.5	0.81	3690.63	0.66	-	3.44	0.99	1.38

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D3-209	D3-205	145.5	10	3701.3	3691.78	3690.2	1.1	3692.24	0.55	-	3.75	0.88	1.61
D3-210	D3-209	290.9	10	3707.3	3698.83	3691.9	2.39	3699.19	0.43	-	5	0.88	2.37
D3-222	D3-223	226.5	10	3696.6	3688.45	3686.2	0.99	3688.96	0.61	-	3.72	0.99	1.53
D3-223	D3-225	58.1	10	3694.3	3686.15	3685	1.94	3686.76	0.73	-	4.62	0.99	2.14
D3-225	D3-226	166.5	10	3693.8	3684.64	3684.1	0.32	3686.51	2.24	1.04	2.48	0.99	0.87
D3-226	D3-228	313	10	3693.2	3684.08	3683.1	0.3	3685.74	1.99	0.83	2.14	0.99	0.85
D3-228	D3-307	165.7	10	3690.8	3683.08	3682.8	0.14	3684.32	1.49	0.41	2.19	1	0.58
D3-231	D3-232	270.1	10	3688.8	3682.35	3679.8	0.95	3682.87	0.62	-	3.7	1.02	1.5
D3-232	D3-233	308.7	10	3686	3679.71	3676.8	0.93	3680.23	0.62	-	3.55	1.02	1.48
D3-233	D3-247	299.3	10	3683.8	3676.85	3674.2	0.9	3677.45	0.72	-	3.65	1.2	1.45
D3-247	D3-250	313.4	10	3680.3	3674.17	3671.5	0.86	3674.77	0.72	-	3.6	1.22	1.42
D3-250	D3-260	291.6	10	3677.7	3671.49	3668.9	0.87	3672.25	0.91	-	3.57	1.29	1.43
D3-260	D3-355	15.3	10	3671.7	3668.95	3668.7	1.57	3670.39	1.73	0.61	3.61	1.37	1.92
D3-274	D3-356	17.3	10	3669.9	3666.77	3666.5	1.33	3667.98	1.45	0.38	3.24	1.39	1.77
D3-278	D3-280	113.4	12	3670.6	3665.83	3665.1	0.66	3666.48	0.65	-	3.32	1.39	2.03
D3-280	D3-281	141	12	3671	3665.08	3664.1	0.7	3665.71	0.63	-	3.35	1.39	2.08
D3-281	D3-285	288.8	12	3668.9	3664.1	3662.2	0.66	3664.73	0.63	-	3.31	1.45	2.03
D3-285	D2-42	388.6	12	3664.9	3662.18	3660.1	0.54	3662.88	0.7	-	3.21	1.45	1.83
D3-303	D3-339	117.7	12	3718.4	3703.84	3703.6	0.22	3703.92	0.08	-	0	0.01	1.17
D3-307	D3-231	11.2	10	3689	3682.49	3682.4	1.16	3683.09	0.72	-	3.45	1.01	1.65
D3-317	C3-6	326.6	10	3670.7	3668.29	3665.1	0.98	3668.54	0.3	-	1.9	0.29	1.52
D3-339	D3-160	79.2	12	3716.4	3701.91	3701.7	0.23	3701.98	0.07	-	0	0.01	1.19
D3-343	D3-345	340.8	12	3694.9	3676.57	3674.9	0.48	3676.77	0.2	-	1.84	0.15	1.72
D3-345	D3-363	240.5	12	3695.7	3674.95	3673.4	0.64	3675.14	0.19	-	2.02	0.15	2
D3-353	D3-127	19.2	30	3704.6	3696.48	3696.5	0.1	3698.99	1	0.01	2.46	8.95	9.28
D3-355	D3-274	254.7	10	3671.5	3668.71	3666.8	0.76	3670.14	1.72	0.6	3.46	1.36	1.34
D3-356	D3-278	125	10	3669.7	3666.54	3665.8	0.57	3667.7	1.39	0.33	3.19	1.39	1.16
D3-358	D3-146	259.8	12	3705.7	3699.95	3699.4	0.22	3700.37	0.42	-	0.21	0.09	1.17
D3-363	D3-364	100.3	12	3694.3	3673.4	3672.7	0.74	3673.59	0.19	-	2.04	0.15	2.14
D3-364	D3-370	98.7	12	3693.8	3672.66	3672	0.63	3672.86	0.2	-	1.99	0.15	1.98
D3-370	D3-66	33.6	12	3692.7	3672.04	3671.6	1.4	3672.2	0.16	-	1.63	0.15	2.95
D3-373	D3-73	84.9	8	3674.7	3669.9	3669.7	0.24	3670.28	0.57	-	1.86	0.22	0.41
D3-62	D3-63	320.6	8	3693.9	3691.61	3685.4	1.95	3691.76	0.23	-	2.88	0.12	1.18
D3-63	D3-65	243.8	8	3689.4	3683.09	3681.8	0.53	3683.31	0.33	-	1.92	0.14	0.62
D3-65	D3-343	126.1	8	3694.6	3681.8	3680.2	1.25	3681.98	0.27	-	2.58	0.14	0.95
D3-66	D3-72	248.7	8	3692.3	3671.57	3670.7	0.36	3671.86	0.43	-	1.83	0.19	0.51
D3-72	D3-373	195	8	3675	3670.67	3669.9	0.39	3670.96	0.43	-	1.55	0.2	0.53
D3-73	D3-317	264.1	10	3674.6	3669.59	3668.3	0.49	3669.89	0.36	-	2.21	0.28	1.08
D3-83	D3-86	141.3	30	3699.9	3692.81	3692.6	0.15	3695.01	0.88	-	3	9	11.07
D3-85	D3-83	27	30	3699.9	3692.84	3692.8	0.07	3695.14	0.92	-	2.92	9	7.81
D3-86	C3-104	327.3	30	3700.1	3692.6	3692.2	0.12	3694.79	0.88	-	2.97	9	9.91
D3-88	D3-85	178.7	30	3700.1	3693.11	3692.8	0.15	3695.38	0.91	-	2.89	9.01	10.95
D3-98	JUB151	146.7	30	3700.8	3693.47	3693.4	0.08	3695.97	1	0	2.7	8.97	7.87
D4-1	C4-116	329.7	12	3719.1	3709.29	3708.4	0.27	3709.66	0.37	-	1.94	0.31	1.3
D4-10	D4-9	473.6	12	3719.7	3716.29	3715.2	0.23	3716.58	0.29	-	1.64	0.17	1.2
D4-104	D4-97	172.6	21	3724.9	3718.5	3717.5	0.57	3719.36	0.49	-	4.45	3.49	8.36
D4-118	D4-262	47.5	21	3724	3718.68	3718.6	0.09	3720.06	0.79	-	2.49	3.48	3.3
D4-119	D4-118	126.4	21	3726.3	3719.06	3718.7	0.3	3720.26	0.69	-	2.66	3.45	6.07
D4-120	D4-299	116.9	21	3729.4	3719.4	3719.2	0.17	3720.7	0.74	-	2.68	3.43	4.59
D4-126	D4-120	135.5	18	3729.6	3720.24	3719.4	0.62	3721.15	0.61	-	3.65	3.43	5.79
D4-161	D4-126	563.2	18	3730.5	3723.6	3720.2	0.6	3724.46	0.57	-	4.66	3.4	5.68
D4-172	D4-161	252.4	18	3731.6	3724.76	3723.6	0.46	3725.74	0.65	-	4.2	3.39	4.99
D4-174	D4-172	342	18	3733.1	3726.43	3724.8	0.49	3727.36	0.62	-	4.16	3.36	5.14
D4-180	D4-174	135.2	18	3733.6	3727	3726.4	0.42	3728	0.67	-	3.93	3.2	4.78
D4-181	D4-180	188.6	18	3735.1	3728.95	3727	1.03	3729.66	0.47	-	4.53	3.19	7.48

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D4-182	D4-181	162.8	18	3736.2	3730.23	3728.9	0.79	3731.03	0.53	-	5.01	3.19	6.52
D4-183	D4-182	257.8	18	3734.4	3730.9	3730.3	0.21	3732.03	0.75	-	3.42	2.86	3.4
D4-185	D4-182	252.4	12	3741.5	3734.1	3730.3	1.49	3734.35	0.25	-	1.2	0.38	3.04
D4-186	D4-183	229.3	18	3737.1	3731.58	3730.9	0.3	3732.6	0.68	-	3.14	2.86	4.01
D4-187	D4-186	208.3	18	3736.8	3732.06	3731.6	0.23	3733.17	0.74	-	3.18	2.86	3.53
D4-188	D4-187	138.5	18	3738.3	3732.38	3732.1	0.23	3733.53	0.77	-	2.95	2.85	3.54
D4-2	D4-1	321.5	12	3721.4	3710.09	3709.3	0.25	3710.46	0.37	-	1.92	0.29	1.24
D4-247	D4-249	568.7	8	3731.3	3728.6	3725.6	0.53	3728.64	0.06	-	0.06	0	0.61
D4-249	D4-250	205.2	10	3733	3725.6	3725	0.3	3725.77	0.2	-	1.12	0.07	0.84
D4-250	D4-251	300.1	10	3733.2	3724.99	3724.2	0.26	3725.17	0.22	-	1.1	0.08	0.79
D4-251	D4-252	255.8	10	3733.5	3724.2	3722.7	0.58	3724.38	0.22	-	0.61	0.12	1.17
D4-252	C4-141	263	10	3733.7	3722.71	3722.7	0.01	3723.26	0.66	-	0.32	0.12	0.17
D4-256	D4-265	81.5	21	3723	3716.05	3715.4	0.79	3717.87	1.04	0.07	3.47	4.79	9.83
D4-262	D4-104	148	21	3724.2	3718.64	3718.5	0.09	3719.9	0.72	-	3.21	3.48	3.41
D4-264	D4-76	57.2	24	3723.8	3715.23	3715	0.4	3717.39	1.08	0.16	3.69	8.31	10.05
D4-265	D4-264	76.8	21	3723.7	3715.41	3715.2	0.23	3717.64	1.27	0.48	2.72	4.78	5.37
D4-299	D4-119	80.2	21	3730.2	3719.2	3719.1	0.17	3720.47	0.73	-	2.87	3.44	4.64
D4-3	D4-2	336.8	12	3724.1	3710.89	3710.1	0.24	3711.25	0.36	-	1.83	0.27	1.22
D4-318	D4-53	178.2	24	3717.2	3709.99	3709.2	0.44	3711.63	0.82	-	4.79	8.68	10.55
D4-321	D4-35	122.4	10	3725.1	3718.34	3718	0.29	3718.63	0.35	-	1.74	0.16	0.82
D4-328	D4-70	128.2	24	3719.8	3713.29	3712.7	0.44	3714.93	0.82	-	4.64	8.32	10.53
D4-34	D4-321	385.1	10	3727.7	3719.49	3718.3	0.3	3719.74	0.3	-	1.53	0.13	0.84
D4-35	D4-10	545.2	10	3724.5	3717.99	3716.3	0.31	3718.27	0.34	-	1.82	0.16	0.86
D4-36	D3-151	195.7	24	3710.4	3702.76	3701.8	0.49	3704.63	0.93	-	5.06	8.81	11.1
D4-38	D4-36	592.2	24	3713.8	3706.03	3702.8	0.55	3707.35	0.66	-	5.43	8.83	11.77
D4-4	D4-3	323.1	12	3726.4	3711.69	3710.9	0.25	3712.03	0.34	-	1.81	0.26	1.24
D4-5	D4-4	330.2	12	3727.3	3712.59	3711.7	0.27	3712.91	0.32	-	1.81	0.24	1.3
D4-53	D4-56	669.1	24	3716.8	3709.2	3706.8	0.36	3710.85	0.83	-	4.98	8.74	9.49
D4-56	D4-38	145.5	24	3714.6	3706.8	3706	0.53	3708.31	0.75	-	5.5	8.81	11.52
D4-6	D4-5	374.2	12	3725.3	3713.55	3712.6	0.26	3713.86	0.31	-	1.79	0.22	1.26
D4-61	D4-318	271.8	24	3717.8	3711.3	3710	0.48	3712.79	0.74	-	5	8.67	11
D4-7	D4-6	291.5	12	3723.7	3714.29	3713.6	0.25	3714.59	0.3	-	1.75	0.2	1.26
D4-70	D4-61	377	24	3718.5	3712.72	3711.3	0.38	3714.34	0.81	-	4.98	8.64	9.73
D4-76	D4-328	372.1	24	3723.6	3715	3714.3	0.19	3717.07	1.04	0.07	4.35	8.32	6.92
D4-77	D4-256	253.8	21	3724.1	3718.04	3716.1	0.78	3718.91	0.5	-	5.12	4.79	9.82
D4-78	D4-77	391	21	3730.6	3724.4	3718	1.63	3725.1	0.4	-	6.57	4.79	14.15
D4-8	D4-7	190.5	12	3722.6	3714.8	3714.3	0.27	3715.1	0.3	-	1.78	0.2	1.29
D4-82	D4-264	93.8	21	3724	3715.6	3715.2	0.39	3717.54	1.11	0.19	2.54	3.54	6.97
D4-9	D4-8	169.6	12	3721.8	3715.19	3714.8	0.23	3715.48	0.29	-	1.58	0.17	1.2
D4-97	D4-82	362.2	21	3724.6	3717.52	3715.6	0.53	3718.34	0.47	-	3.6	3.51	8.08
D5-10	D4-185	481.5	12	3746.5	3739.28	3734.1	1.08	3739.55	0.27	-	2.95	0.37	2.59
D5-133	D5-135	355.8	12	3704.2	3700.56	3699.5	0.3	3700.92	0.36	-	1.65	0.33	1.36
D5-135	D5-136	432.3	12	3705.2	3699.5	3696.3	0.75	3699.77	0.27	-	2.16	0.34	2.16
D5-136	D5-137	424.8	12	3701	3696.25	3693.1	0.75	3696.53	0.28	-	2.16	0.35	2.16
D5-137	D5-138	373.4	12	3698.3	3693.06	3690.3	0.75	3693.34	0.28	-	2.15	0.36	2.16
D5-138	C5-20	363	12	3695.5	3690.27	3687.5	0.75	3690.56	0.29	-	1.99	0.38	2.16
D5-139	D5-133	302.1	12	3704.2	3701.5	3700.6	0.31	3701.79	0.29	-	1.22	0.25	1.39
D5-140	D5-139	357.3	12	3712.7	3702.57	3701.5	0.3	3702.86	0.29	-	1.4	0.24	1.37
D5-141	D5-140	204.1	12	3714.5	3706.45	3704.5	0.96	3706.67	0.22	-	2.09	0.24	2.44
D5-142	D5-141	103.9	12	3714.4	3706.77	3706.4	0.31	3707.07	0.3	-	1.5	0.23	1.38
D5-143	D5-142	238.3	12	3716.2	3707.52	3706.8	0.31	3707.8	0.28	-	1.37	0.23	1.4
D5-144	D5-143	352.4	12	3718.5	3708.77	3707.5	0.35	3709.04	0.27	-	1.45	0.23	1.49
D5-145	D5-144	243.3	12	3714.3	3709.58	3708.8	0.33	3709.85	0.27	-	1.45	0.22	1.44
D5-146	D5-145	355.2	10	3714	3711.61	3709.8	0.52	3711.86	0.3	-	1.74	0.21	1.11
D5-147	D5-146	404.8	10	3716.3	3713.96	3711.6	0.58	3714.2	0.29	-	1.75	0.2	1.17

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
D5-178	D4-188	190.5	18	3739.3	3733.74	3733.4	0.15	3734.93	0.79	-	3.25	2.84	2.87
D5-179	D5-178	46.9	18	3739.1	3733.83	3733.7	0.19	3735.1	0.85	-	2.61	2.84	3.22
D5-194	D5-94	113.4	10	3778.3	3771.56	3770.1	1.29	3771.66	0.12	-	1.14	0.04	1.74
D5-20	D5-10	102	12	3747.6	3740.34	3739.3	1.04	3740.61	0.27	-	2.84	0.36	2.54
D5-41	D5-20	334.2	12	3748.6	3741.4	3740.3	0.32	3741.76	0.36	-	1.96	0.33	1.41
D5-42	D5-41	109.5	12	3749.6	3742.51	3741.4	1.01	3742.75	0.24	-	2.06	0.29	2.51
D5-50	D5-42	180.8	12	3751.4	3744.59	3742.5	1.15	3744.81	0.22	-	2.38	0.25	2.68
D5-51	D5-50	220.2	12	3754	3747.05	3744.6	1.12	3747.26	0.21	-	2.53	0.22	2.64
D5-52	D5-51	190.6	12	3756.3	3749.13	3747.1	1.09	3749.33	0.2	-	2.45	0.19	2.61
D5-53	D5-52	200.3	12	3759	3751.6	3749.1	1.23	3751.79	0.19	-	2.55	0.19	2.77
D5-85	D5-53	512.3	12	3765.6	3757.01	3751.6	1.06	3757.17	0.16	-	1.6	0.13	2.56
D5-91	D5-85	172.2	12	3769.2	3759.93	3757	1.7	3760.05	0.12	-	1.42	0.09	3.25
D5-92	D5-91	321.4	12	3773.7	3763.6	3759.9	1.14	3763.73	0.13	-	1.6	0.08	2.67
D5-93	D5-92	554.6	12	3776	3769.9	3763.6	1.14	3770.02	0.12	-	1.53	0.07	2.66
D5-94	D5-93	60.4	10	3777	3770.1	3769.9	0.33	3770.24	0.17	-	1.02	0.05	0.88
D5-96	D5-194	540.9	10	3783.1	3777.2	3771.6	1.04	3777.29	0.11	-	1.43	0.04	1.57
D5-97	D5-96	616.6	10	3792.1	3782.9	3777.2	0.92	3782.98	0.1	-	1.23	0.02	1.47
D5-98	D5-97	46.8	10	3792.4	3783.05	3782.9	0.3	3783.14	0.11	-	0.84	0.02	0.84
D6-1	D5-147	397.7	10	3721.4	3716.17	3714.1	0.53	3716.41	0.29	-	1.74	0.18	1.12
D6-10	D6-9	311.8	12	3799.6	3794.58	3793.8	0.23	3797.09	2.51	1.51	2.77	1.26	1.21
D6-11	D6-10	402	12	3805.2	3798.49	3794.7	0.93	3799.06	0.57	-	3.74	1.25	2.41
D6-12	D6-11	366	12	3807.8	3799.81	3798.7	0.32	3800.8	0.99	-	3.03	1.23	1.4
D6-13	D6-12	106.9	12	3808.8	3800.2	3799.8	0.34	3801.21	1.01	0.01	2.77	1.22	1.45
D6-2	D6-1	358	10	3723.4	3718.18	3716.3	0.53	3718.41	0.28	-	1.74	0.18	1.12
D6-3	D6-2	282.2	10	3723.5	3719.78	3718.3	0.53	3720.01	0.28	-	1.74	0.17	1.12
D6-4	D6-3	271	10	3725.1	3722.35	3719.9	0.91	3722.55	0.24	-	2.1	0.16	1.47
D6-5	D6-4	389.9	10	3739	3723.51	3722.3	0.3	3723.78	0.32	-	1.6	0.16	0.84
D6-6	D6-5	118.3	10	3729.9	3723.86	3723.5	0.29	3724.11	0.3	-	1.32	0.15	0.83
D6-7	C5-238	239.9	12	3797.8	3791.89	3791.2	0.27	3793.42	1.53	0.53	2.82	1.31	1.3
D6-8	D6-7	357.4	12	3798.4	3793.2	3792	0.34	3794.84	1.64	0.64	2.99	1.3	1.45
D6-9	D6-8	265.7	12	3798.4	3793.71	3793.1	0.24	3795.91	2.2	1.2	2.41	1.29	1.21
E2-10	E2-7	220.6	8	3685.6	3678.61	3677.7	0.4	3678.96	0.52	-	1.94	0.28	0.54
E2-100	E2-101	238	10	3671.3	3662.51	3659.2	1.39	3662.96	0.54	-	4.07	0.96	1.81
E2-101	E2-102	137.7	10	3668	3659.19	3657.3	1.38	3659.67	0.58	-	4.16	1.05	1.8
E2-102	E2-120	147	10	3665.9	3657.28	3655.4	1.29	3657.77	0.59	-	3.97	1.05	1.74
E2-120	E2-121	200.7	10	3663.5	3655.38	3653	1.19	3655.88	0.6	-	3.97	1.06	1.67
E2-121	E2-122	123.3	10	3658.4	3652.99	3647.9	4.13	3653.33	0.41	-	4.16	1.06	3.12
E2-122	E2-123	222.9	10	3654.9	3647.9	3646.6	0.61	3648.55	0.78	-	3.1	1.07	1.19
E2-123	E2-124	172.6	10	3652.6	3646.55	3645.5	0.63	3647.18	0.76	-	2.96	1.07	1.22
E2-124	E2-125	177.6	10	3650.9	3645.46	3644.4	0.57	3646.19	0.88	-	3.06	1.12	1.16
E2-125	E2-126	195.6	10	3650.3	3644.44	3643.4	0.55	3645.22	0.94	-	3.08	1.12	1.14
E2-126	E2-128	249.2	10	3648.1	3643.36	3640.2	1.26	3643.88	0.62	-	4.18	1.13	1.72
E2-128	D2-269	401.5	42	3643.4	3637.73	3637.4	0.08	3640.29	0.73	-	3.17	15.21	20.5
E2-129	E2-128	399.2	42	3644.4	3638.07	3637.7	0.09	3640.6	0.72	-	3.05	14.27	20.56
E2-131	E2-129	291.9	36	3642.3	3638.35	3638.1	0.1	3641.01	0.89	-	3.43	14.27	14.46
E2-132	E2-131	388	36	3644.2	3638.75	3638.3	0.1	3641.48	0.91	-	3.34	14.27	15
E2-133	E2-132	356.1	36	3647.2	3639.59	3638.8	0.24	3641.89	0.77	-	3.71	14.28	22.68
E2-134	E2-133	196.4	36	3648.9	3640.18	3639.6	0.3	3642.25	0.69	-	4.46	14.28	25.59
E2-135	E2-134	247.9	36	3650.7	3640.82	3640.2	0.26	3642.81	0.66	-	4.61	14.29	23.73
E2-136	E2-135	493.8	36	3652.5	3642.01	3640.8	0.24	3643.9	0.63	-	4.68	14.26	22.93
E2-137	E2-136	137.5	36	3653.4	3642.32	3642	0.23	3644.38	0.69	-	4.51	14.19	22.18
E2-138	E2-137	142.1	36	3653.7	3642.58	3642.3	0.18	3644.74	0.72	-	4.03	13.45	19.98
E2-139	E2-138	229.6	30	3655.3	3643.32	3642.6	0.32	3645.46	0.86	-	4.69	13.44	16.3
E2-140	E2-139	550	27	3658.2	3646.15	3643.3	0.51	3647.89	0.77	-	5.85	13.44	15.56
E2-141	E2-140	401.1	27	3657.2	3648.18	3646.2	0.51	3650.02	0.82	-	6.33	13.39	15.43

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E2-142	E2-141	218.4	27	3658.8	3649.3	3648.2	0.51	3651.25	0.87	-	5.99	13.39	15.53
E2-143	E2-142	149.9	27	3662.3	3650.16	3649.3	0.57	3652.15	0.88	-	5.83	13.38	16.42
E2-144	E2-143	431.9	24	3670.4	3656.35	3650.2	1.43	3657.63	0.64	-	7.78	13.37	18.96
E2-145	E2-144	227.2	24	3675.4	3659.82	3656.3	1.53	3661.2	0.69	-	9.48	13.37	19.58
E2-146	E2-145	55.9	24	3675.7	3660.72	3659.8	1.61	3662.34	0.81	-	8.35	13.36	20.1
E2-147	E2-146	133.3	27	3675.2	3662.1	3660.7	1.03	3663.64	0.68	-	7.14	13.36	22.06
E2-148	E2-147	99.8	27	3676.2	3663.17	3662.1	1.07	3664.74	0.7	-	7.23	13.36	22.46
E2-149	E2-148	91.3	27	3677	3663.98	3663.2	0.89	3665.66	0.75	-	6.87	13.36	20.42
E2-150	E2-149	91.3	27	3676.1	3664.75	3664	0.84	3666.51	0.78	-	6.5	13.35	19.91
E2-151	E2-150	199.9	27	3677.4	3666.38	3664.8	0.82	3667.99	0.72	-	6.66	13.35	19.58
E2-152	E2-151	106.1	24	3678.3	3667.32	3666.4	0.89	3669.37	1.02	0.05	7.21	13.31	14.91
E2-153	E2-152	118.1	30	3679.4	3668.43	3667.3	0.94	3669.97	0.62	-	6.04	13.32	27.84
E2-2	E2-97	308.8	10	3683.8	3673.44	3672.1	0.42	3674.18	0.89	-	2.76	0.95	1
E2-5	E2-2	308.8	10	3686.1	3675.97	3674.2	0.57	3676.57	0.72	-	2.98	0.92	1.16
E2-6	E2-5	176.4	8	3684.8	3676.68	3676	0.4	3677.05	0.56	-	1.51	0.3	0.53
E2-7	E2-6	257	8	3683.7	3677.72	3676.7	0.4	3678.09	0.56	-	2	0.3	0.54
E2-9	E2-5	313.6	10	3689	3676.95	3676.1	0.28	3677.6	0.78	-	2.2	0.66	0.81
E2-97	E2-98	167.8	10	3678.9	3672.04	3667.6	2.66	3672.4	0.43	-	4.71	0.95	2.5
E2-98	E2-99	222.9	10	3676.8	3667.57	3664.5	1.39	3668.02	0.54	-	4.13	0.95	1.81
E2-99	E2-100	140.9	10	3673.5	3664.47	3662.5	1.38	3664.93	0.55	-	4.11	0.96	1.8
E3-139	E2-9	311.2	8	3691.4	3681.45	3676.9	1.45	3681.85	0.6	-	2.81	0.66	1.02
E3-140	E3-139	221.7	8	3693.7	3682.94	3681.4	0.67	3683.53	0.89	-	2.84	0.65	0.69
E3-141	E3-140	260.8	8	3694.2	3684.18	3682.9	0.48	3685.06	1.32	0.21	2.54	0.64	0.58
E3-143	E3-141	270.7	8	3696	3686.75	3684.3	0.91	3687.21	0.69	-	3.14	0.64	0.81
E3-152	E2-10	322.9	8	3688.1	3679.92	3678.6	0.4	3680.26	0.51	-	1.94	0.27	0.54
E3-154	E3-152	395.8	8	3689.9	3681.51	3679.9	0.4	3681.85	0.51	-	1.94	0.26	0.53
E3-201	E3-154	191.1	12	3691	3681.94	3681.5	0.22	3682.27	0.33	-	1.49	0.25	1.17
E3-202	E3-201	171.6	12	3691.9	3682.33	3681.9	0.22	3682.66	0.33	-	1.48	0.25	1.17
E3-204	E3-202	218.1	12	3693	3682.82	3682.3	0.22	3683.12	0.3	-	1.45	0.22	1.17
E3-205	E3-204	127.1	12	3693	3683.11	3682.8	0.22	3683.34	0.23	-	0.9	0.14	1.17
E3-207	E3-205	297	12	3692	3683.77	3683.1	0.22	3684	0.23	-	1.15	0.13	1.17
E3-209	E3-207	56.3	12	3691.7	3683.9	3683.8	0.22	3684.13	0.23	-	1.07	0.12	1.17
E3-210	E3-209	181.8	12	3691	3684.31	3683.9	0.22	3684.53	0.22	-	1.1	0.12	1.17
E3-211	E3-210	71.7	12	3690.2	3684.48	3684.3	0.22	3684.7	0.22	-	1.09	0.12	1.18
E3-307	E3-308	395.1	24	3712.4	3702.95	3691.7	2.86	3703.95	0.5	-	9.71	12.84	26.79
E3-308	E3-309	35.4	30	3706.6	3691.15	3691	0.54	3693.35	0.88	-	4.67	13.25	21.03
E3-309	E3-310	274	30	3706.5	3690.96	3690.2	0.28	3693.02	0.82	-	5.27	13.25	15.12
E3-310	E3-311	477.8	27	3700.8	3690.2	3687.6	0.54	3691.95	0.78	-	6.4	13.25	15.9
E3-311	E3-312	55.4	27	3697.6	3687.63	3687.3	0.63	3689.31	0.75	-	8.17	13.26	17.24
E3-312	E3-313	489.8	27	3697.3	3687.28	3677.3	2.04	3688.33	0.47	-	7.94	13.26	30.99
E3-313	E3-314	183.8	27	3686	3677.28	3676.2	0.6	3679.09	0.8	-	6.38	13.27	16.78
E3-314	E3-315	303.1	27	3685.1	3676.18	3674.3	0.63	3677.86	0.75	-	6.79	13.27	17.21
E3-315	E2-153	665.5	24	3687.3	3674.27	3668.4	0.88	3675.9	0.82	-	7.9	13.31	14.84
E3-34	D3-210	388.5	10	3714.2	3707.49	3699.4	2.09	3707.84	0.42	-	4.68	0.8	2.22
E3-35	E3-34	223.9	10	3716.1	3708.5	3707.5	0.45	3709.09	0.71	-	2.72	0.8	1.03
E3-36	E3-35	97.5	10	3716.9	3710.09	3708.8	1.32	3710.51	0.5	-	3.9	0.79	1.76
E3-37	E3-36	309.7	10	3720.2	3710.97	3710.2	0.26	3711.73	0.91	-	2.33	0.77	0.78
E3-4	E3-143	230.8	8	3697.9	3693.64	3687.7	2.56	3693.97	0.49	-	4.55	0.63	1.35
E3-40	E3-37	388.4	10	3722.2	3711.94	3711	0.25	3712.58	0.77	-	1.97	0.7	0.77
E3-41	E3-40	52.3	10	3722.6	3712	3712	0.06	3712.77	0.92	-	1.88	0.7	0.37
E3-43	E3-41	258.9	10	3722.7	3712.65	3712	0.24	3713.32	0.8	-	1.84	0.69	0.76
E3-44	E3-43	89.2	10	3722.6	3712.85	3712.7	0.18	3713.55	0.84	-	1.96	0.64	0.65
E3-45	E3-44	330.3	10	3721.7	3713.66	3712.9	0.24	3714.26	0.72	-	1.93	0.64	0.75
E3-47	E3-45	200	8	3721.1	3714.4	3713.8	0.32	3715.51	1.67	0.44	2.41	0.64	0.48
E3-5	E3-4	249.1	8	3700.2	3695.34	3693.9	0.56	3695.95	0.91	-	2.6	0.62	0.64

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E3-6	E3-5	250.4	8	3701.8	3696.35	3695.4	0.36	3697.44	1.64	0.42	2.32	0.61	0.51
E3-64	E3-59	414.5	12	3728.6	3715.75	3714.8	0.22	3715.88	0.13	-	0.81	0.04	1.17
E3-7	E3-6	208.8	8	3703.6	3697.5	3696.4	0.5	3698.52	1.53	0.35	2.48	0.58	0.6
E3-73	E3-64	320.5	12	3733.3	3716.46	3715.8	0.22	3716.54	0.08	-	0.36	0.01	1.17
E3-8	E3-7	216.5	8	3706.5	3699.33	3697.6	0.8	3699.78	0.68	-	2.88	0.58	0.76
E4-106	E4-227	320.5	18	3766.9	3761.84	3760.3	0.47	3762.95	0.74	-	4.62	4.17	5.07
E4-108	E4-106	320.6	18	3767.7	3763.16	3761.8	0.41	3764.33	0.78	-	4.38	4.12	4.72
E4-109	E4-108	257.3	18	3769.4	3764.2	3763.2	0.4	3765.39	0.79	-	4.23	4.12	4.68
E4-110	E4-226	144	18	3770.9	3765.22	3764.6	0.46	3766.32	0.73	-	3.93	3.66	4.98
E4-219	E4-43	185.4	21	3752.9	3741.98	3741.5	0.24	3743.31	0.76	-	4.08	4.76	5.47
E4-220	E4-348	332.2	21	3752.7	3742.97	3742.1	0.25	3744.32	0.77	-	3.45	4.76	5.58
E4-221	E4-220	388.5	21	3754.7	3743.93	3743	0.25	3745.27	0.77	-	3.64	4.76	5.51
E4-226	E4-109	93.4	18	3769.9	3764.56	3764.2	0.39	3765.86	0.87	-	4	4.11	4.57
E4-227	E4-93	9.8	18	3767	3760.31	3760.2	1.02	3761.39	0.72	-	5.49	4.42	7.44
E4-348	E4-219	58.7	21	3754.6	3742.12	3742	0.22	3743.59	0.84	-	3.41	4.76	5.22
E4-39	D4-78	401.6	21	3732.8	3726.85	3724.4	0.61	3727.82	0.55	-	5.28	4.78	8.67
E4-40	E4-39	421.6	21	3736.9	3730.85	3726.8	0.95	3731.68	0.47	-	5.69	4.78	10.81
E4-41	E4-40	400.3	21	3744	3734.85	3730.8	1	3735.68	0.47	-	6.28	4.78	11.09
E4-42	E4-41	426.7	21	3749.7	3738.85	3734.8	0.94	3739.7	0.49	-	6.17	4.78	10.74
E4-43	E4-42	238.7	21	3752.9	3741.53	3738.8	1.12	3742.34	0.46	-	6.26	4.77	11.76
E4-47	E4-221	57.5	21	3754.6	3744.31	3744	0.5	3745.56	0.71	-	3.96	4.75	7.88
E4-62	E4-47	340.7	21	3757.6	3747.72	3744.3	1	3748.52	0.46	-	4.89	4.75	11.1
E4-63	E4-62	298.3	21	3761.4	3750.7	3747.7	1	3751.54	0.48	-	6.29	4.73	11.09
E4-64	E4-63	576.4	21	3760.9	3753.09	3750.7	0.41	3754.17	0.62	-	4.62	4.68	7.14
E4-65	E4-64	274.7	21	3760.9	3754.3	3754.2	0.05	3756	0.97	-	3.33	4.56	2.5
E4-66	E4-65	290	21	3760.9	3755.58	3754.3	0.44	3756.57	0.57	-	3.31	4.48	7.37
E4-91	E4-66	289	21	3761.8	3756.32	3755.6	0.26	3757.58	0.72	-	4.08	4.47	5.61
E4-92	E4-91	337.2	21	3762.9	3757.17	3756.3	0.25	3758.44	0.73	-	3.6	4.47	5.57
E4-93	E4-92	290.1	18	3767	3760.21	3757.2	1.04	3761.04	0.55	-	5.06	4.44	7.52
E5-1	D5-179	244	18	3740.9	3734.15	3733.8	0.13	3735.52	0.91	-	2.49	2.83	2.68
E5-119	E5-1	446.9	18	3743	3735.03	3734.2	0.2	3736.21	0.79	-	2.7	2.82	3.26
E5-17	E5-7	491.7	15	3744.3	3739.35	3735.9	0.69	3740.1	0.6	-	4.66	2.39	3.77
E5-18	E5-17	395.1	15	3747.3	3743.75	3739.3	1.11	3744.38	0.5	-	5.06	2.38	4.77
E5-19	E5-18	326.1	15	3750.8	3745.09	3743.8	0.41	3746.01	0.74	-	3.91	2.37	2.9
E5-29	E5-19	331.1	15	3755.9	3749.83	3747.5	0.72	3750.56	0.58	-	4.68	2.34	3.83
E5-30	E5-29	224.9	15	3757.4	3752.7	3750.3	1.09	3753.35	0.52	-	5.43	2.33	4.72
E5-31	E5-30	47.3	15	3759.3	3753.55	3752.7	1.8	3754.17	0.5	-	5.49	2.33	6.07
E5-32	E5-31	256.8	15	3759.9	3755.9	3753.6	0.92	3756.58	0.54	-	5.1	2.33	4.33
E5-36	E5-32	237.7	15	3762.9	3757.1	3755.9	0.5	3757.93	0.66	-	4.06	2.32	3.21
E5-39	E5-36	241.9	15	3765.4	3758.9	3757.1	0.74	3759.61	0.57	-	4.29	2.3	3.9
E5-40	E5-39	337.5	15	3766.5	3761.39	3758.9	0.74	3762.11	0.58	-	4.67	2.3	3.89
E5-41	E5-40	318.3	15	3771.1	3763.42	3761.4	0.64	3764.17	0.6	-	4.46	2.3	3.61
E5-42	E5-41	392.1	15	3770.9	3766.59	3763.4	0.81	3767.27	0.54	-	4.63	2.3	4.07
E5-43	E5-42	252.6	15	3774.4	3767.45	3766.6	0.34	3768.42	0.78	-	3.7	2.28	2.64
E5-54	E5-43	429.1	15	3776.4	3769.19	3768.2	0.23	3770.36	0.94	-	3.32	2.25	2.18
E5-55	E5-54	267.7	15	3779.3	3769.85	3769.2	0.26	3771.01	0.93	-	2.93	2.25	2.31
E5-56	E5-55	369.4	15	3780.6	3770.71	3770.2	0.15	3772.08	1.1	0.12	2.99	2.25	1.75
E5-62	E5-56	45.4	12	3780.7	3776.52	3776.3	0.59	3777.39	0.87	-	3.95	1.74	1.92
E5-63	E5-62	319.7	12	3784.5	3778.28	3776.5	0.55	3779.08	0.8	-	3.82	1.73	1.85
E5-64	E5-63	356.7	12	3788.9	3781.49	3778.3	0.9	3782.13	0.64	-	4.42	1.73	2.37
E5-7	E5-119	25.4	15	3743.3	3735.19	3735	0.63	3736.42	0.98	-	3.41	2.77	3.59
E5-75	E5-64	312.4	12	3792.5	3784.72	3781.5	1.03	3785.29	0.57	-	4.82	1.55	2.54
E5-76	E5-75	336.6	12	3795.4	3787.94	3784.7	0.96	3788.54	0.6	-	4.91	1.54	2.44
E6-1	E5-76	331.7	12	3797.5	3789.68	3787.9	0.52	3790.44	0.76	-	3.96	1.54	1.81
E6-10	E6-9	400.3	10	3798.9	3794.64	3793.5	0.28	3794.82	0.22	-	0.95	0.07	0.81

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
E6-11	E6-10	374.4	10	3799.3	3795.7	3794.7	0.28	3795.86	0.19	-	0.8	0.06	0.81
E6-12	E6-11	369.8	10	3799.9	3796.75	3795.7	0.28	3796.9	0.18	-	0.79	0.05	0.81
E6-13	E6-12	263.7	8	3801	3797.81	3796.8	0.4	3797.95	0.21	-	0.89	0.05	0.53
E6-14	E6-8	245.1	12	3800.9	3793.49	3792.2	0.52	3794.19	0.7	-	3.7	1.44	1.8
E6-15	E6-16	348	10	3804.4	3797.29	3786.6	3.06	3797.66	0.44	-	7.3	1.03	2.68
E6-16	E6-17	489.3	12	3798.8	3786.64	3771.7	3.06	3786.98	0.34	-	6.87	1.03	4.36
E6-22	E6-13	65.7	10	3802	3798.01	3797.8	0.29	3798.15	0.17	-	0.78	0.04	0.82
E6-23	E6-1	199	12	3798.6	3790.66	3789.7	0.49	3791.44	0.78	-	3.68	1.53	1.75
E6-7	E6-23	141	12	3799.4	3791.44	3790.7	0.55	3792.19	0.75	-	3.67	1.52	1.86
E6-8	E6-7	148.8	12	3800	3792.22	3791.4	0.52	3792.99	0.77	-	3.7	1.52	1.81
E6-9	E6-8	399.3	10	3799.5	3793.51	3792.4	0.28	3793.69	0.22	-	0.15	0.08	0.81
F3-67	E3-307	659.5	27	3716.2	3706.98	3702.9	0.61	3708.64	0.74	-	8.29	12.83	16.95
F3-68	F3-67	162	27	3717	3708.01	3707	0.64	3709.7	0.75	-	6.24	12.35	17.29
F3-69	F3-68	402.9	27	3719.4	3710.52	3708	0.62	3712.07	0.69	-	6.4	12.35	17.11
F3-70	F3-69	659.9	24	3728.8	3719.89	3710.5	1.42	3721.1	0.61	-	8.39	12.35	18.88
F3-71	F3-70	659.8	24	3735.3	3725.23	3719.9	0.81	3726.84	0.81	-	8.27	12.35	14.25
F3-72	F3-71	659.4	30	3735.6	3726.94	3725.2	0.26	3728.9	0.78	-	5.27	12.35	14.63
F3-73	F3-72	508.8	30	3737.7	3729.98	3726.9	0.6	3731.34	0.54	-	5.63	12.23	22.2
F4-10	F4-7	385.3	18	3776.1	3769.39	3767.8	0.4	3770.42	0.69	-	4.21	3.64	4.68
F4-11	F4-10	300	18	3777.9	3770.9	3769.4	0.5	3771.86	0.64	-	4.45	3.62	5.22
F4-12	F4-11	451	18	3779.6	3772.75	3770.9	0.41	3773.78	0.69	-	4.43	3.61	4.71
F4-13	F4-12	402.9	18	3780.6	3773.9	3772.8	0.29	3775.12	0.81	-	3.89	3.6	3.93
F4-15	F4-13	203.8	18	3781.1	3774.49	3773.9	0.29	3775.7	0.81	-	3.58	3.48	3.96
F4-16	F4-15	292.3	18	3783.4	3775.62	3774.5	0.39	3776.63	0.67	-	3.86	3.47	4.57
F4-17	F4-16	378.7	18	3784.4	3777.48	3775.6	0.49	3778.41	0.62	-	4.44	3.47	5.14
F4-25	F4-81	14	10	3745.6	3740.6	3740.4	1.07	3741.01	0.49	-	3.22	0.49	1.59
F4-54	F4-41	120.7	10	3741.7	3735.41	3735.2	0.22	3735.46	0.06	-	0.41	0	0.71
F4-6	E4-110	232.8	18	3773.2	3766.7	3765.2	0.64	3767.59	0.59	-	4.56	3.66	5.86
F4-7	F4-6	284	18	3773.9	3767.83	3766.7	0.4	3768.9	0.71	-	4.45	3.65	4.64
F4-73	F3-73	489.9	30	3742.3	3732.91	3730	0.6	3734.34	0.57	-	6.84	12.23	22.21
F4-74	F4-73	114.8	30	3742.4	3733.38	3732.9	0.41	3735.09	0.68	-	5.95	12.23	18.38
F4-75	F4-74	125.3	30	3741.4	3733.91	3733.4	0.42	3735.72	0.72	-	5.24	12.23	18.67
F4-76	F4-75	102.4	30	3741.5	3734.33	3733.9	0.41	3736.23	0.76	-	4.96	12.22	18.39
F4-77	F4-76	243	30	3743	3735.26	3734.3	0.38	3737.04	0.71	-	5.02	12.22	17.77
F4-78	F4-77	248.7	27	3744.5	3736.2	3735.3	0.38	3738.2	0.89	-	5.44	12.22	13.33
F4-79	F4-78	143.9	27	3745	3736.79	3736.2	0.41	3738.9	0.94	-	5.09	12.14	13.89
F4-80	F4-79	187.9	27	3744.5	3737.49	3736.8	0.37	3739.71	0.99	-	4.96	12.14	13.24
F4-81	F4-80	245.3	27	3745.4	3738.42	3737.5	0.38	3740.74	1.03	0.07	5	12.14	13.35
F4-82	F4-81	709.6	24	3752.7	3743.79	3738.4	0.76	3745.26	0.74	-	6.42	11.78	13.78
F4-83	F4-82	592.2	24	3763.4	3754.99	3743.8	1.89	3756.05	0.53	-	8.86	11.66	21.79
F4-84	F4-83	640.3	24	3770.2	3761.09	3755	0.95	3762.31	0.61	-	8.26	9.6	15.46
F4-85	F4-84	649.1	24	3776.4	3767.75	3761.1	1.03	3768.91	0.58	-	7.76	9.59	16.05
F4-86	F4-85	437.3	24	3782.3	3772.28	3767.8	1.04	3773.46	0.59	-	7.93	9.59	16.12
F4-87	F4-86	521.6	27	3784.2	3773.73	3772.3	0.28	3775.42	0.75	-	5.64	9.59	11.43
F4-88	F4-87	394.3	27	3783.9	3774.81	3773.7	0.27	3776.56	0.78	-	4.63	9.59	11.35
F4-89	F4-88	76.6	24	3783.4	3775.25	3774.8	0.56	3777.09	0.92	-	5.08	9.59	11.87
F5-1	F5-6	369.9	18	3788.1	3781.23	3779.4	0.5	3782.16	0.62	-	4.62	3.43	5.2
F5-10	F5-9	147	24	3802.9	3794.77	3794.4	0.28	3796.44	0.84	-	3.79	6.8	8.36
F5-11	F5-10	309.1	24	3802.9	3795.53	3794.8	0.25	3797.14	0.8	-	3.89	6.8	7.85
F5-112	F4-89	656.2	24	3786.3	3778.58	3775.3	0.5	3780.01	0.72	-	5.52	9.49	11.2
F5-113	F5-112	659.1	24	3789.6	3781.9	3778.6	0.5	3783.4	0.75	-	6.04	9.49	11.24
F5-114	F5-113	659.5	24	3794.4	3785.27	3781.9	0.51	3786.75	0.74	-	5.94	9.49	11.32
F5-115	F5-114	603.1	24	3804.8	3789.5	3785.3	0.7	3790.8	0.65	-	6.4	9.49	13.27
F5-116	F5-115	246.4	21	3808	3795.72	3789.5	2.52	3796.42	0.4	-	8.16	5.91	17.63
F5-117	F5-116	575.4	21	3812.2	3800	3795.7	0.74	3801.09	0.62	-	7.37	5.91	9.57

Appendix H - Master Plan Model Results - Existing Pipes

Upstream Manhole	Downstream Manhole	Length (ft)	Size (in)	Upstream Ground (ft)	Upstream Invert (ft)	Downstream Invert (ft)	Slope	Upstream Max HGL (ft)	d/D	Depth Over Crown (ft)	Peak Velocity (ft/s)	Peak Flow (mgd)	Full Pipe Capacity (mgd)
F5-118	F5-117	578.3	21	3814.5	3803.53	3800	0.61	3804.63	0.63	-	5.76	5.9	8.67
F5-119	F5-118	139.2	21	3815.7	3803.68	3803.5	0.11	3804.91	0.7	-	2.89	3.11	3.64
F5-12	F5-11	315.3	24	3802.9	3796.3	3795.5	0.24	3797.89	0.79	-	3.97	6.8	7.83
F5-120	F5-119	62.5	21	3815.7	3803.75	3803.7	0.1	3805.06	0.75	-	2.6	3.11	3.49
F5-121	F5-120	60	21	3815.9	3803.82	3803.8	0.1	3805.18	0.78	-	2.47	3.11	3.56
F5-13	F5-12	335.9	24	3804.4	3799.45	3796.3	0.94	3800.39	0.47	-	5.12	6.8	15.34
F5-14	F5-13	359.4	24	3807.9	3802.65	3799.4	0.89	3803.65	0.5	-	6.96	6.8	14.95
F5-15	F5-14	172.7	24	3809.4	3804.31	3802.7	0.96	3805.32	0.51	-	6.7	6.79	15.53
F5-16	F5-15	435.4	24	3814.4	3808.31	3804.3	0.92	3809.28	0.49	-	6.81	6.79	15.18
F5-17	F5-16	264.2	24	3817	3810.65	3808.3	0.89	3811.66	0.5	-	6.81	6.79	14.91
F5-2	F5-1	375.9	18	3790.6	3783.48	3781.2	0.6	3784.34	0.57	-	4.8	3.41	5.69
F5-3	F5-2	437.6	18	3793.2	3786.11	3783.5	0.6	3786.97	0.57	-	4.99	3.41	5.7
F5-30	F5-5	199.6	18	3806.9	3798.61	3798.2	0.22	3798.96	0.23	-	1.9	0.36	3.41
F5-31	F5-30	513.3	18	3811.1	3799.7	3798.7	0.19	3800.07	0.25	-	1.82	0.36	3.23
F5-32	F5-31	551.8	18	3813.3	3800.92	3799.8	0.2	3801.27	0.23	-	1.85	0.35	3.31
F5-33	F5-51	310.3	18	3814.3	3801.89	3801.3	0.19	3802.23	0.23	-	1.81	0.32	3.19
F5-34	F5-33	231.9	18	3817.4	3802.28	3802	0.13	3802.66	0.25	-	1.64	0.31	2.61
F5-4	F5-3	315.6	18	3797.2	3788.71	3786.1	0.82	3789.49	0.52	-	5.29	3.38	6.68
F5-5	F5-4	321.2	18	3803	3791.33	3788.7	0.82	3791.57	0.16	-	1.54	0.38	6.64
F5-51	F5-32	130.6	18	3814	3801.21	3801	0.14	3801.57	0.24	-	1.74	0.32	2.79
F5-6	F4-17	379.5	18	3786	3779.38	3777.5	0.5	3780.31	0.62	-	4.62	3.45	5.2
F5-7	F5-115	477.5	24	3802.4	3792.58	3791.3	0.26	3793.61	0.52	-	4.07	3.81	8.07
F5-8	F5-7	418.8	24	3802.7	3793.72	3792.6	0.27	3795.21	0.75	-	4.78	6.81	8.26
F5-86	F5-34	399.9	18	3818	3803.18	3802.4	0.2	3803.48	0.2	-	1.76	0.26	3.29
F5-87	F5-86	399.9	18	3819	3804.23	3803.3	0.24	3806.74	1.67	1.01	0.37	0.25	3.58
F5-88	F5-87	94.8	18	3818.9	3804.95	3804.6	0.4	3806.97	1.35	0.52	2.52	3.05	4.66
F5-9	F5-8	313.5	24	3802.9	3794.36	3793.7	0.2	3796.04	0.84	-	3.97	6.8	7.16
G5-1	F5-17	507.9	24	3821	3811.92	3810.7	0.25	3813.46	0.77	-	4.67	6.79	7.92
G5-2	G5-1	505.2	24	3823	3815.17	3811.9	0.64	3816.21	0.52	-	5.03	6.79	12.7
G5-3	G5-2	504	24	3825.1	3816.43	3815.2	0.25	3817.96	0.77	-	4.67	6.78	7.92
JUB045	E6-22	221.7	12	3803.8	3798.5	3798	0.22	3798.64	0.14	-	0.64	0.04	1.17
JUB046	JUB045	71.2	12	3802.6	3798.67	3798.5	0.23	3798.79	0.12	-	0.54	0.04	1.18
JUB098	F5-121	207.9	21	3815.6	3804.04	3803.8	0.1	3805.41	0.78	-	2.4	3.1	3.53
JUB101	C1-51	44.6	24	3247.5	3237.2	3236.2	2.2	3238.81	0.81	-	7.98	13.76	23.48
JUB108	C5-175	345	12	3793.6	3784.2	3783.5	0.2	3784.28	0.08	-	0.68	0.01	1.11
JUB109	D6-6	1518.4	10	3774.1	3729.19	3724.6	0.3	3729.36	0.2	-	1.4	0.07	0.84
JUB132	D3-142	118.9	27	3708.8	3698.66	3698.4	0.2	3700.37	0.76	-	4.49	8.87	9.58
JUB137	B2-69	59.7	10	3634.1	3627.78	3627.2	1.04	3627.92	0.17	-	1.3	0.09	1.56
JUB151	D3-88	313.7	30	3703.2	3693.35	3693.1	0.07	3695.75	0.96	-	2.84	8.99	7.83

Appendix I

Cost

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Table 7-3 – CIP Projects and Summary

CIP Item #	Project *(See Figure 7-1)*	MH Identifier	Length (ft)	New Size (in)	Recommended Action	0 – 5 Years	5 – 10 Years	10 – 20 Years	As Needed with Growth[A]
1	Canyon Springs Rd	CSR2 to D2-202	956	18	In Progress	$ 262,000			
2	Odor Control[E] & Manhole Rehabilitation	Various, See Figure ES-2 or 7-1	-	-	Complete	$ 1,930,000			
3	Grandview Trunkline	B3-14 to B4-1	1,275	48	Begin preliminary design[B]			$ 792,000	
4	Rock Creek Trunkline	C4-7 to End of Benno's Ph 2	7,045	24, 27, 36	Begin preliminary design[C]				$ 3,082,000
5	13 Droplines/Siphons, excluding DL.1,14,16	See Table 6-7			Begin preliminary design				$ 4,165,000
6	Madrona Trunkline	Reroute pipe D3-110 to D3-150 & D3-149 to D3-155	2,150	8, 27, 30	Begin preliminary design[D]				$ 881,000
7	Golf Crse Trunkline	B4-120 to B4-137	3,385	18	Complete with development				$ 570,000
8	Northwest Trunkline	C3-235 to C3-193 & C3-236 to C3-79	3,375	15, 21	Complete with development				$ 1,304,000
9	Madrona Ex.Trunkline	E5-19 to E5-31	603	15	Complete with development				$ 201,000
10	Northeast Trunkline	D2-74 to E2-129	3,810	42	Complete with RAA 4-3				$ 2,182,000
11	Albion Trunkline	C4-163 to C4-299	2,235	15	Complete with development				$ 634,000
	Kimberly Diversion	F5-115 to F5-5 or F4-16 to F4-89	N/A	N/A	Complete after CIP 6 & 8				$ 20,000
Lift Stations	**Name**	**Recommended Action**							
Lift Stations	Bosero	Mechanical / Electrical Rehabilitation						$ 58,000	
Lift Stations	Canyon Park	Mechanical / Electrical Rehabilitation						$ 58,000	
Lift Stations	Hankins (Jayco)	Assume that a New Station is Completed 2015; Electrical Rehabilitation in 15-20 yrs						$ 26,000	
Lift Stations	Independent Meat	Cost reflective of rebuild. Mechanical/electrical rehabitation could be done earlier.[D]					$ 535,000		
Lift Stations	Rock Creek Trails	Cost for Mechanical / Electrical Rehabilitation. Upgrade for capacity may also be needed.						$ 58,000	
Lift Stations	Rock Creek	Electrical Rehabilitation 15-20 years						$ 52,000	
Ongoing Pipe Rehabilitation and Replacement		Select annual budget plan based on system value and begin budgeting for next fiscal year.				Choose Plan 1, 2, 3, or 4 ($3.3M, 2.8M, 2.0M or $1.7M).			
TOTAL (EXCLUDING ONGOING ANNUAL CIP BUDGET)						**$ 2,192,000**	**$535,000**	**$1,044,000**	**$ 13,039,000**

A. Costs generally assume 30% rock removal, 3% inflation, 25% contingency, 18% engineering/construction admin, 5% legal and bonding, a public works contractor bidded project, no costs for easements or right-of-way, no Davis-Bacon wages, and no buy American Iron or Steel provisions. All costs are an AACE Class 4 projection (-30% to +50%).
B. Consider also 3a, which completes Grandview to Manhole B3-3. The project will require completion to either B3-14 or B3-3 due to crown matching. An intermediate point is likely not acceptable. Therefore, survey will likely be needed up to B3-3 to verify crowns and inverts even if improvements are only planned for CIP improvement 1 to manhole B3-14.
C. Potentially consider the affects of abandoning the Independent Meat Lift Station and routing to the Rock Creek Trunkline
D. Survey may be needed beyond the project limits shown for CIP improvement 6 from the Madrona siphon all the way to Locust to verify actual slopes and inverts.
E. Odor control not evaluated; $500,000 included at the request of the City for odor control.

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**1. Canyon Springs Road New Trunkline: MH CSR2 to D2-202**	**ESTIMATED IMPROVEMENT COST:**	**$ 262,000**
ALTERNATIVE:	*A portion of NE.8 Sewer Upgrade*		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.05	18" PVC Gravity Sewer Pipe	956	LF	$ 70.00	$ 66,936.10
1.14	Connections to Existing Manhole Pipes	2	EA	$ 2,800.00	$ 5,600.00
1.15	Sewerline Video/Testing	956	LF	$ 1.50	$ 1,434.35
1.17	Sewer Service Reconnection	10	EA	$ 700.00	$ 7,000.00
2.00	**Trench Excavation/Backfill Adders**				
2.01	4-10 ft. (Included in Sewer Costs)	956	LF	$ -	$ -
2.07	Rock, Rural (Assume 30% of length)	287	LF	$ 90.00	$ 25,812.00
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	4	EA	$ 3,000.00	$ 12,000.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	956	LF	$ 2.00	$ 1,912.46
5.02	City - Asphalt - Full Lane Width	956	LF	$ 50.00	$ 47,811.50
6.00	**Construction Traffic Control**				
6.01	Typical Traffic Control - Rural	19	Day	$ 200.00	$ 3,824.92
7.00	**Project Specific Considerations**				
7.01	Dewatering	956	LF	$ 4.00	$ 3,824.92
11.00	**Contractor Mobilization/Demobilization**		LS	5%	$ 8,808
12.00	**Contingency**	1	LS	25%	$ 46,241
				ESTIMATED CONSTRUCTION COSTS	**$ 231,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 7,000**
15.02	*Engineering/Construction Admin*			5%	**$ 12,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 12,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 262,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT: City of Twin Falls 2015 Sewer Master Plan — Revision Date: 3-Apr-15

IMPROVEMENT: **2. Manhole Rehabilitation and Oder Control**

ALTERNATIVE: *Rehabilitate manholes from upstream of Rock Creek Lift Station to WWTP. Oder control as needed.*

ESTIMATED IMPROVEMENT COST: $ 1,929,000

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.16	Bypass Pumping	72	DAYS	$ 800.00	$ 57,600.00
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	6	EA	$ 3,000.00	$ 18,000.00
3.03	48" Manholes, 16-20 ft.	1	EA	$ 6,000.00	$ 6,000.00
3.04	60" Manholes, 4-10 ft.	4	EA	$ 7,500.00	$ 30,000.00
3.05	60" Manholes, 10-16 ft.	4	EA	$ 8,000.00	$ 32,000.00
3.07	72" Manholes, 4-10 ft.	32	EA	$ 9,000.00	$ 288,000.00
3.08	72" Manholes, 10-16 ft.	13	EA	$ 10,000.00	$ 130,000.00
3.10	96" Manholes, 4-10 ft.	4	EA	$ 10,000.00	$ 40,000.00
3.11	96" Manholes, 10-16 ft.	7	EA	$ 12,000.00	$ 84,000.00
3.12	96" Manholes, 16-20 ft.	1	EA	$ 16,000.00	$ 16,000.00
3.13	Abandon Existing Manhole	72	EA	$ 1,000.00	$ 72,000.00
5.00	**Surface Restoration**				
5.02	City - Asphalt - Full Lane Width	1440	LF	$ 50.00	$ 72,000.00
6.00	**Construction Traffic Control**				
6.01	Typical Traffic Control - Rural	60	Day	$ 200.00	$ 12,080.00
6.02	Typical Traffic Control - Urban	22	Day	$ 300.00	$ 6,480.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 43,208
12.00	**Contingency**		LS	*25%*	$ 226,842
				ESTIMATED CONSTRUCTION COSTS	**$ 1,134,000**
15.00	***Other Project Costs***				
15.01	*Inflation*		0	3%	**$ 34,000**
15.02	*Engineering/Construction Admin*		0	18%	**$ 204,000**
15.03	*Legal/Administration/Bonding*		0	5%	**$ 57,000**
15.05	*Odor Control (Cost provided by the City)*	1	LS	$500,000	**$ 500,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 1,929,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**3. Grandview Trunkline: MH B3-14 to B4-1**	**ESTIMATED IMPROVEMENT COST: $**	**792,000**
NOTES:	Consider 3a or parallel pipe option (See Appendix J)		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.12	48" PVC Gravity Sewer Pipe	1275	LF	$ 275.00	$ 350,625.00
1.14	Connections to Existing Manhole Pipes	2	EA	$ 2,800.00	$ 5,600.00
1.15	Sewerline Video/Testing	1275	LF	$ 1.50	$ 1,912.50
1.16	Bypass Pumping	17	DAYS	$ 800.00	$ 13,600.00
2.00	**Trench Excavation/Backfill Adders**				
2.08	Rock, Urban (Assume 30% of length)	383	LF	$ 110.00	$ 42,075.00
3.00	**Manholes**				
3.10	96" Manholes, 4-10 ft.	4	EA	$ 10,000.00	$ 40,000.00
3.13	Abandon Existing Manhole	4	EA	$ 1,000.00	$ 4,000.00
4.00	**Crossings**				
4.12	Utility Service Crossings - Rural	1275	LF	$ 1.00	$ 1,275.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	1275	LF	$ 2.00	$ 2,550.00
5.02	City - Asphalt - Full Lane Width	25	LF	$ 50.00	$ 1,250.00
5.08	Natural Surface Repair	1250	LF	$ 5.00	$ 6,250.00
6.00	**Construction Traffic Control**				
6.01	Typical Traffic Control - Rural	26	Day	$ 200.00	$ 5,100.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	1275	LF	$ 4.00	$ 5,100.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 23,967
12.00	**Contingency**		LS	*25%*	$ 125,826
				ESTIMATED CONSTRUCTION COSTS	**$ 629,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 19,000**
15.02	*Engineering/Construction Admin*			18%	**$ 113,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 31,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 792,000**

J·U·B ENGINEERS, INC.
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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**4. Rock Creek Trunkline: MH C4-7 to Bennos Pt Ph 2**	**ESTIMATED IMPROVEMENT COST:**	**$ 3,082,000**
NOTES:	Assumes a bore across rock creek and down the canyon		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.07	24" PVC Gravity Sewer Pipe	2000	LF	$ 90.00	$ 180,000.00
1.08	27" PVC Gravity Sewer Pipe	3535	LF	$ 105.00	$ 371,175.00
1.10	36" PVC Gravity Sewer Pipe	1260	LF	$ 140.00	$ 176,400.00
1.14	Connections to Existing Manhole Pipes	5	EA	$ 2,800.00	$ 14,000.00
1.15	Sewerline Video/Testing	7045	LF	$ 1.50	$ 10,567.50
1.16	Bypass Pumping	94	DAYS	$ 800.00	$ 75,200.00
1.17	Sewer Service Reconnection	5	EA	$ 700.00	$ 3,500.00
2.00	**Trench Excavation/Backfill Adders**				
2.07	Rock, Rural (Assume 30% of length)	2039	LF	$ 90.00	$ 183,510.00
2.10	Difficult construction area	7045	LF	$ 10.00	$ 70,450.00
3.00	**Manholes**				
3.04	60" Manholes, 4-10 ft.	20	EA	$ 7,500.00	$ 150,000.00
3.07	72" Manholes, 4-10 ft.	4	EA	$ 9,000.00	$ 36,000.00
3.13	Abandon Existing Manhole	20	EA	$ 1,000.00	$ 20,000.00
4.00	**Crossings**				
4.05	Bore - 24" line - 36" Casing - Rock	250	LF	$ 990.00	$ 247,500.00
4.12	Utility Service Crossings - Rural	6795	LF	$ 1.00	$ 6,795.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	7045	LF	$ 2.00	$ 14,090.00
5.03	City - Asphalt - Half Lane Width	4795	LF	$ 40.00	$ 191,800.00
5.09	Gravel Shoulder Repair	2000	LF	$ 10.00	$ 20,000.00
6.00	**Construction Traffic Control**				
6.01	Typical Traffic Control - Rural	50	Day	$ 200.00	$ 10,000.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	7045	LF	$ 4.00	$ 28,180.00
7.11	Siphon Diversion Structure	2	LS	$ 15,000.00	$ 30,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 91,958
12.00	**Contingency**		LS	*25%*	$ 482,781
				ESTIMATED CONSTRUCTION COSTS	**$ 2,414,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 72,000**
15.02	*Engineering/Construction Admin*			18%	**$ 435,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 121,000**
15.04	*Environmental Review*			LS	**$ 40,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 3,082,000**

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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**5. Rock Creek Droplines/Siphons: for MH see Table 6-7**	**ESTIMATED IMPROVEMENT COST:**	**$ 4,165,000**
NOTES:	Assumes two 80' bores for siphons and 150' bore down the canyon for each drop line; DL.1 is part of CIP 2. This scope includes DL.2-D.8, DL.10-DL.13, DL.15 and siphon only for DL.9. Other construction methods could be used.		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.01	8" PVC Gravity Sewer Pipe	1200	LF	$ 40.00	$ 48,015.60
1.05	18" PVC Gravity Sewer Pipe	212	LF	$ 70.00	$ 14,855.40
1.06	21" PVC Gravity Sewer Pipe	120	LF	$ 77.00	$ 9,240.00
1.14	Connections to Existing Manhole Pipes	26	EA	$ 2,800.00	$ 72,800.00
1.15	Sewerline Video/Testing	4933	LF	$ 1.50	$ 7,398.92
1.16	Bypass Pumping	63	DAYS	$ 800.00	$ 50,481.17
1.17	Sewer Service Reconnection	5	EA	$ 700.00	$ 3,500.00
2.00	**Trench Excavation/Backfill Adders**				
2.07	Rock, Rural (Assume 30% of length)	460	LF	$ 90.00	$ 41,380.47
2.10	Difficult construction area	4933	LF	$ 10.00	$ 49,326.10
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	22	EA	$ 3,000.00	$ 66,000.00
3.13	Abandon Existing Manhole	36	EA	$ 1,000.00	$ 36,000.00
4.00	**Crossings**				
4.01	Bore - 8" line - 16" Casing - Rock	2620	LF	$ 400.00	$ 1,048,000.00
4.03	Bore - 18" line - 30" Casing - Rock	780	LF	$ 700.00	$ 546,000.00
4.09	Irrigation Canal/Coulee Crossing	1	EA	$ 24,000.00	$ 24,000.00
4.10	Sewer/StormDrain/Irrig Crossing	1	EA	$ 3,000.00	$ 3,000.00
4.12	Utility Service Crossings - Rural	1533	LF	$ 1.00	$ 1,532.61
5.00	**Surface Restoration**				
5.01	Stormwater Management	4933	LF	$ 2.00	$ 9,865.22
5.02	City - Asphalt - Full Lane Width	150	LF	$ 50.00	$ 7,500.00
5.08	Natural Surface Repair	4783	LF	$ 5.00	$ 23,913.05
7.00	**Project Specific Considerations**				
7.01	Dewatering	4933	LF	$ 4.00	$ 19,730.44
7.11	Siphon Diversion Structure	28	LS	$ 15,000.00	$ 420,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 122,726
12.00	**Contingency**		LS	*25%*	$ 656,316
				ESTIMATED CONSTRUCTION COSTS	**$ 3,282,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 98,000**
15.02	*Engineering/Construction Admin*			18%	**$ 591,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 164,000**
15.04	*Environmental Review*			LS	**$ 30,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 4,165,000**

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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan			Revision Date:	2-Apr-15
IMPROVEMENT:	**6. Madrona Trunkline: MH D3-110 to D3-150 reroute and D3-149 to D3-155 reroute.**			**ESTIMATED IMPROVEMENT COST: $**	**881,000**
NOTES:	Actual problem from MH D3-142 to D3-149, Could also need to extend downstream of D3-110 another 620' depending on slopes based on actual survey.				

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.01	8" PVC Gravity Sewer Pipe	500	LF	$ 40.00	$ 20,000.00
1.08	27" PVC Gravity Sewer Pipe	1210	LF	$ 105.00	$ 127,050.00
1.09	30" PVC Gravity Sewer Pipe	440	LF	$ 120.00	$ 52,800.00
1.14	Connections to Existing Manhole Pipes	8	EA	$ 2,800.00	$ 22,400.00
1.15	Sewerline Video/Testing	2150	LF	$ 1.50	$ 3,225.00
1.16	Bypass Pumping	29	DAYS	$ 800.00	$ 23,200.00
1.17	Sewer Service Reconnection	5	EA	$ 700.00	$ 3,500.00
2.00	**Trench Excavation/Backfill Adders**				
2.08	Rock, Urban (Assume 30% of length)	645	LF	$ 110.00	$ 70,950.00
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	2	EA	$ 3,000.00	$ 6,000.00
3.04	60" Manholes, 4-10 ft.	6	EA	$ 7,500.00	$ 45,000.00
3.13	Abandon Existing Manhole	9	EA	$ 1,000.00	$ 9,000.00
4.00	**Crossings**				
4.10	Sewer/StormDrain/Irrig Crossing	1	EA	$ 3,000.00	$ 3,000.00
4.11	Utility Service Crossings - Urban	2150	LF	$ 2.00	$ 4,300.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	2150	LF	$ 2.00	$ 4,300.00
5.02	City - Asphalt - Full Lane Width	1770	LF	$ 50.00	$ 88,500.00
5.04	ITD - Asphalt - Full Lane Width (SuperPave)	380	LF	$ 70.00	$ 26,600.00
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	43	Day	$ 300.00	$ 12,900.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	2150	LF	$ 4.00	$ 8,600.00
7.07	Signalized Intersection (per Loop)	1	LS	$ 2,500.00	$ 2,500.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 25,691
12.00	**Contingency**		LS	*25%*	$ 139,879
				ESTIMATED CONSTRUCTION COSTS	**$ 699,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 21,000**
15.02	*Engineering/Construction Admin*			18%	**$ 126,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 35,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 881,000**

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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**7. Golf Course Trunkline: MH B4-120 to B4-137**	**ESTIMATED IMPROVEMENT COST:**	**$ 570,000**
NOTES:	Dropline and siphon costs under a different project		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.05	18" PVC Gravity Sewer Pipe	1795	LF	$ 70.00	$ 125,650.00
1.14	Connections to Existing Manhole Pipes	2	EA	$ 2,800.00	$ 5,600.00
1.15	Sewerline Video/Testing	1795	LF	$ 1.50	$ 2,692.50
1.16	Bypass Pumping	24	DAYS	$ 800.00	$ 19,200.00
1.17	Sewer Service Reconnection	5	EA	$ 700.00	$ 3,500.00
2.00	**Trench Excavation/Backfill Adders**				
2.03	10-16 ft.	140	LF	$ 15.00	$ 2,100.00
2.07	Rock, Rural (Assume 30% of length)	539	LF	$ 90.00	$ 48,465.00
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	5	EA	$ 3,000.00	$ 15,000.00
3.02	48" Manholes, 10-16 ft.	3	EA	$ 3,500.00	$ 10,500.00
3.13	Abandon Existing Manhole	8	EA	$ 1,000.00	$ 8,000.00
4.00	**Crossings**				
4.09	Irrigation Canal/Coulee Crossing	1	EA	$ 24,000.00	$ 24,000.00
4.10	Sewer/StormDrain/Irrig Crossing	1	EA	$ 3,000.00	$ 3,000.00
4.12	Utility Service Crossings - Rural	1580	LF	$ 1.00	$ 1,580.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	1795	LF	$ 2.00	$ 3,590.00
5.02	City - Asphalt - Full Lane Width	600	LF	$ 50.00	$ 30,000.00
5.07	Sod	480	LF	$ 15.00	$ 7,200.00
5.08	Natural Surface Repair	715	LF	$ 5.00	$ 3,575.00
6.00	**Construction Traffic Control**				
6.01	Typical Traffic Control - Rural	36	Day	$ 200.00	$ 7,180.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	1580	LF	$ 4.00	$ 6,320.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 16,358
12.00	**Contingency**		LS	*25%*	$ 85,878
				ESTIMATED CONSTRUCTION COSTS	**$ 429,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 13,000**
15.02	*Engineering/Construction Admin*			18%	**$ 77,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 21,000**
15.04	*Environmental Review*			LS	**$ 30,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 570,000**

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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan			Revision Date:	2-Apr-15
IMPROVEMENT:	**8. Northwest Diversion Trunkline: MH C3-235 to C3-193 & C3-236 to C3-79**			**ESTIMATED IMPROVEMENT COST:**	**$ 1,304,000**
NOTES:					

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.04	15" PVC Gravity Sewer Pipe	385	LF	$ 55.00	$ 21,175.00
1.06	21" PVC Gravity Sewer Pipe	2990	LF	$ 77.00	$ 230,230.00
1.14	Connections to Existing Manhole Pipes	9	EA	$ 2,800.00	$ 25,200.00
1.15	Sewerline Video/Testing	3375	LF	$ 1.50	$ 5,062.50
1.16	Bypass Pumping	45	DAYS	$ 800.00	$ 36,000.00
1.17	Sewer Service Reconnection	45	EA	$ 700.00	$ 31,500.00
2.00	**Trench Excavation/Backfill Adders**				
2.03	10-16 ft.	680	LF	$ 15.00	$ 10,200.00
2.08	Rock, Urban (Assume 30% of length)	1013	LF	$ 110.00	$ 111,375.00
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	1	EA	$ 3,000.00	$ 3,000.00
3.04	60" Manholes, 4-10 ft.	10	EA	$ 7,500.00	$ 75,000.00
3.05	60" Manholes, 10-16 ft.	2	EA	$ 8,000.00	$ 16,000.00
3.13	Abandon Existing Manhole	13	EA	$ 1,000.00	$ 13,000.00
4.00	**Crossings**				
4.10	Sewer/StormDrain/Irrig Crossing	2	EA	$ 3,000.00	$ 6,000.00
4.11	Utility Service Crossings - Urban	3375	LF	$ 2.00	$ 6,750.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	3375	LF	$ 2.00	$ 6,750.00
5.02	City - Asphalt - Full Lane Width	2725	LF	$ 50.00	$ 136,250.00
5.09	Gravel Shoulder Repair	650	LF	$ 10.00	$ 6,500.00
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	68	Day	$ 300.00	$ 20,250.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	3375	LF	$ 4.00	$ 13,500.00
7.02	Diversion Structure	1	EA	$ 15,000.00	$ 15,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 39,437
12.00	**Contingency**		LS	*25%*	$ 207,045
				ESTIMATED CONSTRUCTION COSTS	**$ 1,035,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 31,000**
15.02	*Engineering/Construction Admin*			18%	**$ 186,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 52,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 1,304,000**

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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**9. Madrona Extension Trunkline: MH E5-19 to E5-31**	**ESTIMATED IMPROVEMENT COST: $**	**201,000**
NOTES:	Consider rerouting the Independent Meat Lift Station to Rock Creek, making additional improvements in Rock Creek and potentially avoiding this improvement for many years.		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.04	15" PVC Gravity Sewer Pipe	603	LF	$ 55.00	$ 33,165.00
1.14	Connections to Existing Manhole Pipes	2	EA	$ 2,800.00	$ 5,600.00
1.15	Sewerline Video/Testing	603	LF	$ 1.50	$ 904.50
1.16	Bypass Pumping	8	DAYS	$ 800.00	$ 6,400.00
1.17	Sewer Service Reconnection	3	EA	$ 700.00	$ 2,100.00
2.00	**Trench Excavation/Backfill Adders**				
2.07	Rock, Rural (Assume 30% of length)	181	LF	$ 90.00	$ 16,281.00
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	4	EA	$ 3,000.00	$ 12,000.00
3.13	Abandon Existing Manhole	4	EA	$ 1,000.00	$ 4,000.00
4.00	**Crossings**				
4.09	Irrigation Canal/Coulee Crossing	1	EA	$ 24,000.00	$ 24,000.00
4.12	Utility Service Crossings - Rural	603	LF	$ 1.00	$ 603.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	603	LF	$ 2.00	$ 1,206.00
5.03	City - Asphalt - Half Lane Width	250	LF	$ 40.00	$ 10,000.00
5.08	Natural Surface Repair	353	LF	$ 5.00	$ 1,765.00
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	5	Day	$ 300.00	$ 1,500.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	603	LF	$ 4.00	$ 2,412.00
11.00	**Contractor Mobilization/Demobilization**		LS	5%	$ 6,097
12.00	**Contingency**	1	LS	25%	$ 30,484
				ESTIMATED CONSTRUCTION COSTS	**$ 159,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 5,000**
15.02	*Engineering/Construction Admin*			18%	**$ 29,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 8,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 201,000**

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115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**10. Northeast Trunkline: D2-74 to E2-129**	**ESTIMATED IMPROVEMENT COST: $**	**2,182,000**
NOTES:	***Also consider a parellel pipe alternative option here.***		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.11	42" PVC Gravity Sewer Pipe	3810	LF	$ 200.00	$ 762,000.00
1.14	Connections to Existing Manhole Pipes	6	EA	$ 2,800.00	$ 16,800.00
1.15	Sewerline Video/Testing	3810	LF	$ 1.50	$ 5,715.00
1.16	Bypass Pumping	51	DAYS	$ 800.00	$ 40,800.00
1.17	Sewer Service Reconnection	2	EA	$ 700.00	$ 1,400.00
2.00	**Trench Excavation/Backfill Adders**				
2.07	Rock, Rural (Assume 30% of length)	1143	LF	$ 90.00	$ 102,870.00
3.00	**Manholes**				
3.07	72" Manholes, 4-10 ft.	6	EA	$ 9,000.00	$ 54,000.00
3.13	Abandon Existing Manhole	6	EA	$ 1,000.00	$ 6,000.00
4.00	**Crossings**				
4.10	Sewer/StormDrain/Irrig Crossing	3	EA	$ 3,000.00	$ 9,000.00
4.11	Utility Service Crossings - Urban	3810	LF	$ 2.00	$ 7,620.00
5.00	**Surface Restoration**				
5.01	Stormwater Management	3810	LF	$ 2.00	$ 7,620.00
5.04	ITD - Asphalt - Full Lane Width (SuperPave)	3810	LF	$ 70.00	$ 266,700.00
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	76	Day	$ 300.00	$ 22,860.00
7.00	**Project Specific Considerations**				
7.01	Dewatering	3810	LF	$ 4.00	$ 15,240.00
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 65,931
12.00	**Contingency**		LS	*25%*	$ 346,139
				ESTIMATED CONSTRUCTION COSTS	**$ 1,731,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 52,000**
15.02	*Engineering/Construction Admin*			18%	**$ 312,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 87,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 2,182,000**

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ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan		Revision Date:	2-Apr-15	
IMPROVEMENT:	**11. Albion Trunkline: MH C4-163 to C4-299**		**ESTIMATED IMPROVEMENT COST:**	**$**	**634,000**
ALTERNATIVE:					

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.04	15" PVC Gravity Sewer Pipe	2235	LF	$ 55.00	$ 122,947.55
1.14	Connections to Existing Manhole Pipes	2	EA	$ 2,800.00	$ 5,600.00
1.15	Sewerline Video/Testing	2235	LF	$ 1.50	$ 3,353.12
1.16	Bypass Pumping	30	DAYS	$ 800.00	$ 24,000.00
1.17	Sewer Service Reconnection	8	EA	$ 700.00	$ 5,600.00
2.00	**Trench Excavation/Backfill Adders**				
2.03	10-16 ft.	300	LF	$ 15.00	$ 4,500.00
2.08	Rock, Urban (Assume 30% of length)	671	LF	$ 110.00	$ 73,768.53
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	10	EA	$ 3,000.00	$ 30,000.00
3.02	48" Manholes, 10-16 ft.	1	EA	$ 3,500.00	$ 3,500.00
3.13	Abandon Existing Manhole	11	EA	$ 1,000.00	$ 11,000.00
4.00	**Crossings**				
4.11	Utility Service Crossings - Urban	2235	LF	$ 2.00	$ 4,470.82
5.00	**Surface Restoration**				
5.01	Stormwater Management	2235	LF	$ 2.00	$ 4,470.82
5.02	City - Asphalt - Full Lane Width	2235	LF	$ 50.00	$ 111,770.50
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	45	Day	$ 300.00	$ 13,412.46
7.00	**Project Specific Considerations**				
7.01	Dewatering	2235	LF	$ 4.00	$ 8,941.64
11.00	**Contractor Mobilization/Demobilization**		LS	5%	$ 21,367
12.00	**Contingency**	1	LS	25%	$ 112,176
				ESTIMATED CONSTRUCTION COSTS	**$ 561,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 17,000**
15.02	*Engineering/Construction Admin*			5%	**$ 28,000**
15.03	*Legal/Administration/Bonding*			5%	**$ 28,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 634,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date: 2-Apr-15
IMPROVEMENT:	**K.2: Kimberly Trunkline Diversion**	**ESTIMATED IMPROVEMENT COST: $ 20,000**
ALTERNATIVE:		

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.16	Bypass Pumping	2	DAYS	$ 800.00	$ 1,600.00
6.00	**Construction Traffic Control**				
6.01	Typical Traffic Control - Rural	2	Day	$ 200.00	$ 400.00
7.00	**Project Specific Considerations**				
7.12	Small Diversion Work	1	LS	$ 10,000.00	$ 10,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	5%	$ 600
12.00	**Contingency**	1	LS	25%	$ 3,150
	ESTIMATED CONSTRUCTION COSTS				**$ 16,000**
15.00	***Other Project Costs***				
15.01	*Inflation*		0	3%	**$ -**
15.02	*Engineering/Construction Admin*		0	18%	**$ 3,000**
15.03	*Legal/Administration/Bonding*		0	5%	**$ 1,000**
	TOTAL PROBABLE COST IN 2014 DOLLARS				**$ 20,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15		
IMPROVEMENT:	**BSO Bosero Lift Station Upgrade**	**ESTIMATED IMPROVEMENT COST:**	**$ 58,000**		
ALTERNATIVE:					

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
8.00	**Lift Station**				
8.04	Mechanical Rehabilitation	1	LS	$ 25,000.00	$ 25,000.00
8.05	Electrical Rehabilitation	1	LS	$ 20,000.00	$ 20,000.00
11.00	**Contractor Mobilization/Demobilization**	0	LS	0%	$ -
12.00	**Contingency**	1	LS	25%	$ 11,250
	ESTIMATED CONSTRUCTION COSTS				**$ 56,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 2,000**
15.02	*Engineering/Construction Admin*			0%	**$ -**
	TOTAL PROBABLE COST IN 2014 DOLLARS				**$ 58,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date:	2-Apr-15
IMPROVEMENT:	**CNP Canyon Park Lift Station Upgrade**	**ESTIMATED IMPROVEMENT COST: $**	**58,000**
ALTERNATIVE:			

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
8.00	**Lift Station**				
8.04	Mechanical Rehabilitation	1	LS	$ 25,000.00	$ 25,000.00
8.05	Electrical Rehabilitation	1	LS	$ 20,000.00	$ 20,000.00
11.00	**Contractor Mobilization/Demobilization**	0	LS	0%	$ -
12.00	**Contingency**	1	LS	25%	$ 11,250
	ESTIMATED CONSTRUCTION COSTS				**$ 56,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 2,000**
15.02	*Engineering/Construction Admin*			0%	**$ -**
	TOTAL PROBABLE COST IN 2014 DOLLARS				**$ 58,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan			Revision Date:	2-Apr-15
IMPROVEMENT:	**HKS Hankins Lift Station Upgrade**				
ALTERNATIVE:	This station will need additional capacity not budgeted here for the Grandview Farms development.	**ESTIMATED IMPROVEMENT COST:**		**$**	**26,000**

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
8.00	**Lift Station**				
8.05	Electrical Rehabilitation	1	LS	$ 20,000.00	$ 20,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	0%	$ -
12.00	**Contingency**	1	LS	25%	$ 5,000
	ESTIMATED CONSTRUCTION COSTS				**$ 25,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 1,000**
15.02	*Engineering/Construction Admin*			0%	**$ -**
	TOTAL PROBABLE COST IN 2014 DOLLARS				**$ 26,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan		Revision Date:	2-Apr-15	
IMPROVEMENT:	**IDM Independent Meat Lift Station Upgrade**		**ESTIMATED IMPROVEMENT COST:**	**$**	**535,000**
ALTERNATIVE:					

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.14	Connections to Existing Manhole Pipes	2	EA	$ 2,800.00	$ 5,600.00
1.16	Bypass Pumping	8	DAYS	$ 800.00	$ 6,400.00
8.00	**Lift Station**				
8.01	New Lift Station	1	LS	$ 300,000.00	$ 300,000.00
8.03	Abandon Lift Station	1	LS	$ 25,000.00	$ 25,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	5%	$ 16,850
12.00	**Contingency**	1	LS	25%	$ 88,463
				ESTIMATED CONSTRUCTION COSTS	**$ 442,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 13,000**
15.02	*Engineering/Construction Admin*			18%	**$ 80,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 535,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan	Revision Date: 2-Apr-15
IMPROVEMENT:	**RCT Rock Creek Trails LS Upgrade**	**ESTIMATED IMPROVEMENT COST: $ 58,000**
ALTERNATIVE:	This station will need additional capacity not budgeted here if the Grandview Farms development occurs.	

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
8.00	**Lift Station**				
8.04	Mechanical Rehabilitation	1	LS	$ 25,000.00	$ 25,000.00
8.05	Electrical Rehabilitation	1	LS	$ 20,000.00	$ 20,000.00
11.00	**Contractor Mobilization/Demobilization**		LS	0%	$ -
12.00	**Contingency**	1	LS	25%	$ 11,250
				ESTIMATED CONSTRUCTION COSTS	**$ 56,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 2,000**
15.02	*Engineering/Construction Admin*			0%	**$ -**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 58,000**

J·U·B ENGINEERS, INC.
115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan			Revision Date:	2-Apr-15
IMPROVEMENT:	**RCK: Rock Creek Lift Station Upgrade**			**ESTIMATED IMPROVEMENT COST: $**	**52,000**
ALTERNATIVE:					

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
8.00	**Lift Station**				
8.05	Electrical Rehabilitation	2	LS	$ 20,000.00	$ 40,000.00
12.00	**Contingency**	1	LS	25%	$ 10,000
	ESTIMATED CONSTRUCTION COSTS				**$ 50,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 2,000**
15.02	*Engineering/Construction Admin*			0%	**$ -**
	TOTAL PROBABLE COST IN 2014 DOLLARS				**$ 52,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT: City of Twin Falls 2015 Sewer Master Plan

Revision Date: 2-Apr-15

IMPROVEMENT: **Replacement cost for all pipe.**

ALTERNATIVE:

ESTIMATED IMPROVEMENT COST: $ 332,203,000

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.01	8" PVC Gravity Sewer Pipe	994,942	LF	$ 40.00	$ 39,797,695
1.02	10" PVC Gravity Sewer Pipe	65,330	LF	$ 45.00	$ 2,939,855
1.03	12" PVC Gravity Sewer Pipe	75,768	LF	$ 50.00	$ 3,788,385
1.04	15" PVC Gravity Sewer Pipe	23,997	LF	$ 55.00	$ 1,319,822
1.05	18" PVC Gravity Sewer Pipe	49,096	LF	$ 70.00	$ 3,436,738
1.06	21" PVC Gravity Sewer Pipe	10,735	LF	$ 77.00	$ 826,565
1.07	24" PVC Gravity Sewer Pipe	29,820	LF	$ 90.00	$ 2,683,836
1.08	27" PVC Gravity Sewer Pipe	10,042	LF	$ 105.00	$ 1,054,431
1.09	30" PVC Gravity Sewer Pipe	18,590	LF	$ 120.00	$ 2,230,804
1.10	36" PVC Gravity Sewer Pipe	18,214	LF	$ 140.00	$ 2,549,999
1.11	42" PVC Gravity Sewer Pipe	2,844	LF	$ 200.00	$ 568,792
1.15	Sewerline Video/Testing	1,299,379	LF	$ 1.50	$ 1,949,068
1.16	Bypass Pumping	17325	DAYS	$ 800.00	$ 13,860,000
1.17	Sewer Service Reconnection	18000	EA	$ 700.00	$ 12,600,000
2.00	**Trench Excavation/Backfill Adders**				
2.03	10-16 ft. (Assume 10% of Length)	129,938	LF	$ 15.00	$ 1,949,068
2.07	Rock, Rural (Assume 30% of length)(1/2 Total Length)	194,907	LF	$ 90.00	$ 17,541,612
2.08	Rock, Urban (Assume 30% of length)(1/2 Total Length)	194,907	LF	$ 110.00	$ 21,439,749
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	4000	EA	$ 3,000.00	$ 12,000,000
3.02	48" Manholes, 10-16 ft.	750	EA	$ 3,500.00	$ 2,625,000
3.04	60" Manholes, 4-10 ft.	300	EA	$ 7,500.00	$ 2,250,000
3.05	60" Manholes, 10-16 ft.	50	EA	$ 8,000.00	$ 400,000
3.07	72" Manholes, 4-10 ft.	150	EA	$ 9,000.00	$ 1,350,000
3.08	72" Manholes, 10-16 ft.	50	EA	$ 10,000.00	$ 500,000
3.13	Abandon Existing Manhole	5300	EA	$ 1,000.00	$ 5,300,000
4.00	**Crossings**				
4.11	Utility Service Crossings - Urban	1,299,379	LF	$ 2.00	$ 2,598,757
5.00	**Surface Restoration**				
5.01	Stormwater Management	1,299,379	LF	$ 2.00	$ 2,598,757
5.03	City - Asphalt - Half Lane Width	1,299,379	LF	$ 40.00	$ 51,975,148
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	25,988	Day	$ 300.00	$ 7,796,272
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 8,859,640
12.00	**Contingency**		LS	*20%*	$ 45,757,999
				ESTIMATED CONSTRUCTION COSTS	**$ 274,548,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 8,236,000**
15.02	*Engineering/Construction Admin*			18%	**$ 49,419,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 332,203,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS ASSUMING 15% SAVINGS WITH CIPP	**$ 282,400,000**

J·U·B ENGINEERS, INC.

115 Northstar Avenue, Twin Falls, ID 83301 208.733.2414

ENGINEERS OPINION OF PROBABLE COST

PROJECT:	City of Twin Falls 2015 Sewer Master Plan		Revision Date:	2-Apr-15	
IMPROVEMENT:	**Replacement of all nonplastic pipe**		**ESTIMATED IMPROVEMENT COST:**	**$ 199,772,000**	
NOTE:					

ITEM No.	Description	Est. Quant.	Unit	Unit Price	Total Price
1.00	**Sewer Main - Installed w/ Bedding 4-10 ft deep**				
1.01	8" PVC Gravity Sewer Pipe	553,200	LF	$ 40.00	$ 22,127,996
1.02	10" PVC Gravity Sewer Pipe	43,360	LF	$ 45.00	$ 1,951,212
1.03	12" PVC Gravity Sewer Pipe	41,694	LF	$ 50.00	$ 2,084,714
1.04	15" PVC Gravity Sewer Pipe	21,006	LF	$ 55.00	$ 1,155,319
1.05	18" PVC Gravity Sewer Pipe	47,386	LF	$ 70.00	$ 3,317,040
1.06	21" PVC Gravity Sewer Pipe	5,887	LF	$ 77.00	$ 453,291
1.07	24" PVC Gravity Sewer Pipe	14,913	LF	$ 90.00	$ 1,342,203
1.08	27" PVC Gravity Sewer Pipe	2,394	LF	$ 105.00	$ 251,332
1.09	30" PVC Gravity Sewer Pipe	12,723	LF	$ 120.00	$ 1,526,732
1.10	36" PVC Gravity Sewer Pipe	17,162	LF	$ 140.00	$ 2,402,660
1.11	42" PVC Gravity Sewer Pipe	2,844	LF	$ 200.00	$ 568,792
1.15	Sewerline Video/Testing	762,569	LF	$ 1.50	$ 1,143,854
1.16	Bypass Pumping	10,168	DAYS	$ 800.00	$ 8,134,400
1.17	Sewer Service Reconnection	12,000	EA	$ 700.00	$ 8,400,000
2.00	**Trench Excavation/Backfill Adders**				
2.03	10-16 ft. (Assume 10% of Length)	76,257	LF	$ 15.00	$ 1,143,854
2.07	Rock, Rural (Assume 30% of length)(1/2 Total Length)	114,385	LF	$ 90.00	$ 10,294,682
2.08	Rock, Urban (Assume 30% of length)(1/2 Total Length)	114,385	LF	$ 110.00	$ 12,582,389
3.00	**Manholes**				
3.01	48" Manholes, 4-10 ft.	2400	EA	$ 3,000.00	$ 7,200,000
3.02	48" Manholes, 10-16 ft.	400	EA	$ 3,500.00	$ 1,400,000
3.04	60" Manholes, 4-10 ft.	200	EA	$ 7,500.00	$ 1,500,000
3.05	60" Manholes, 10-16 ft.	70	EA	$ 8,000.00	$ 560,000
3.07	72" Manholes, 4-10 ft.	100	EA	$ 9,000.00	$ 900,000
3.08	72" Manholes, 10-16 ft.	40	EA	$ 10,000.00	$ 400,000
3.13	Abandon Existing Manhole	3210	EA	$ 1,000.00	$ 3,210,000
4.00	**Crossings**				
4.11	Utility Service Crossings - Urban	762,569	LF	$ 2.00	$ 1,525,138
5.00	**Surface Restoration**				
5.01	Stormwater Management	762,569	LF	$ 2.00	$ 1,525,138
5.03	City - Asphalt - Half Lane Width	762,569	LF	$ 40.00	$ 30,502,761
6.00	**Construction Traffic Control**				
6.02	Typical Traffic Control - Urban	15,251	Day	$ 300.00	$ 4,575,414
11.00	**Contractor Mobilization/Demobilization**		LS	*5%*	$ 5,404,986
12.00	**Contingency**		LS	*20%*	$ 27,516,781
				ESTIMATED CONSTRUCTION COSTS	**$ 165,101,000**
15.00	***Other Project Costs***				
15.01	*Inflation*			3%	**$ 4,953,000**
15.02	*Engineering/Construction Admin*			18%	**$ 29,718,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS	**$ 199,772,000**
				TOTAL PROBABLE COST IN 2014 DOLLARS ASSUMING 15% SAVINGS WITH CIPP	**$ 169,800,000**

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Appendix J

CIP Supporting Documentation

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Contents

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Figures

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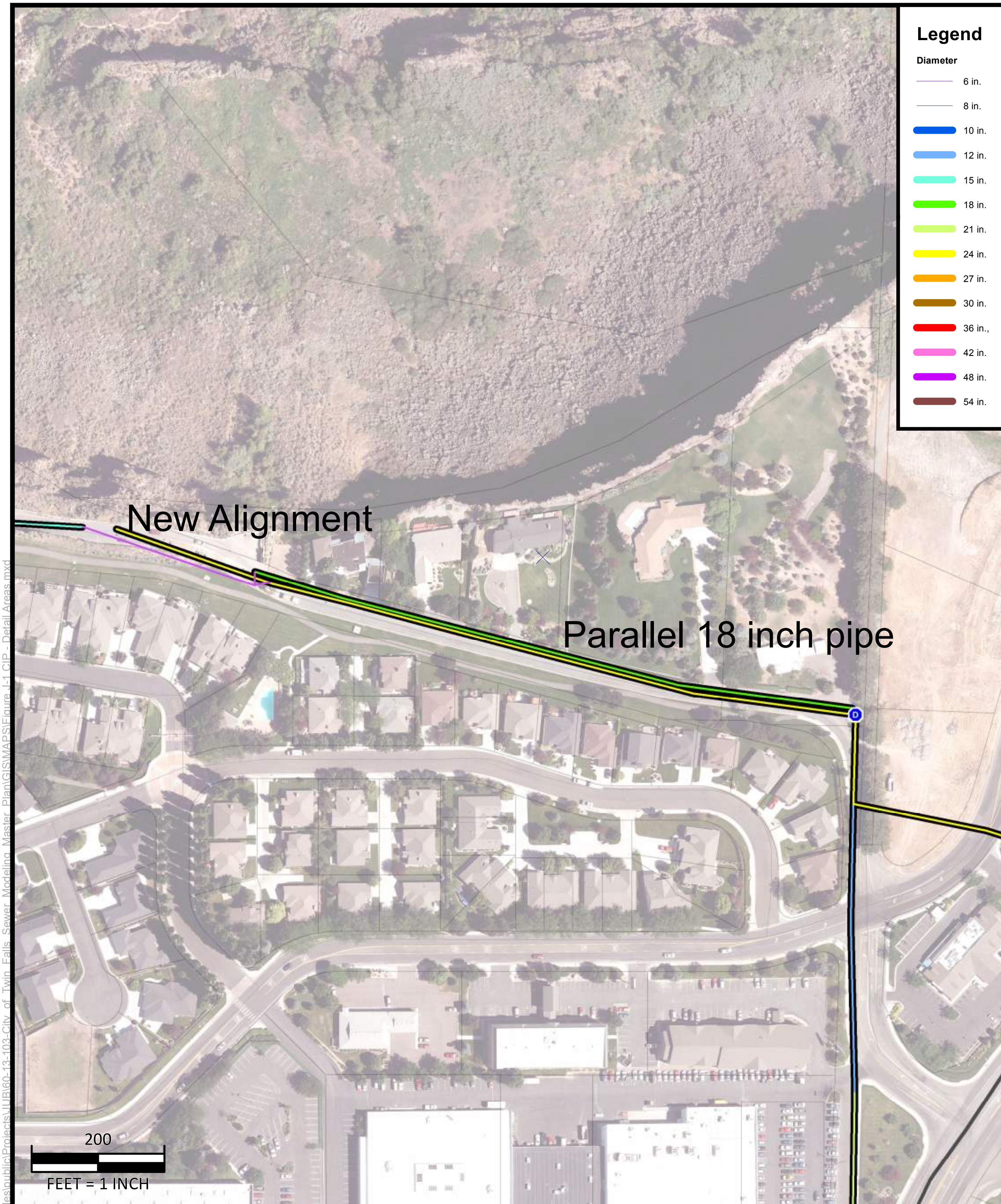
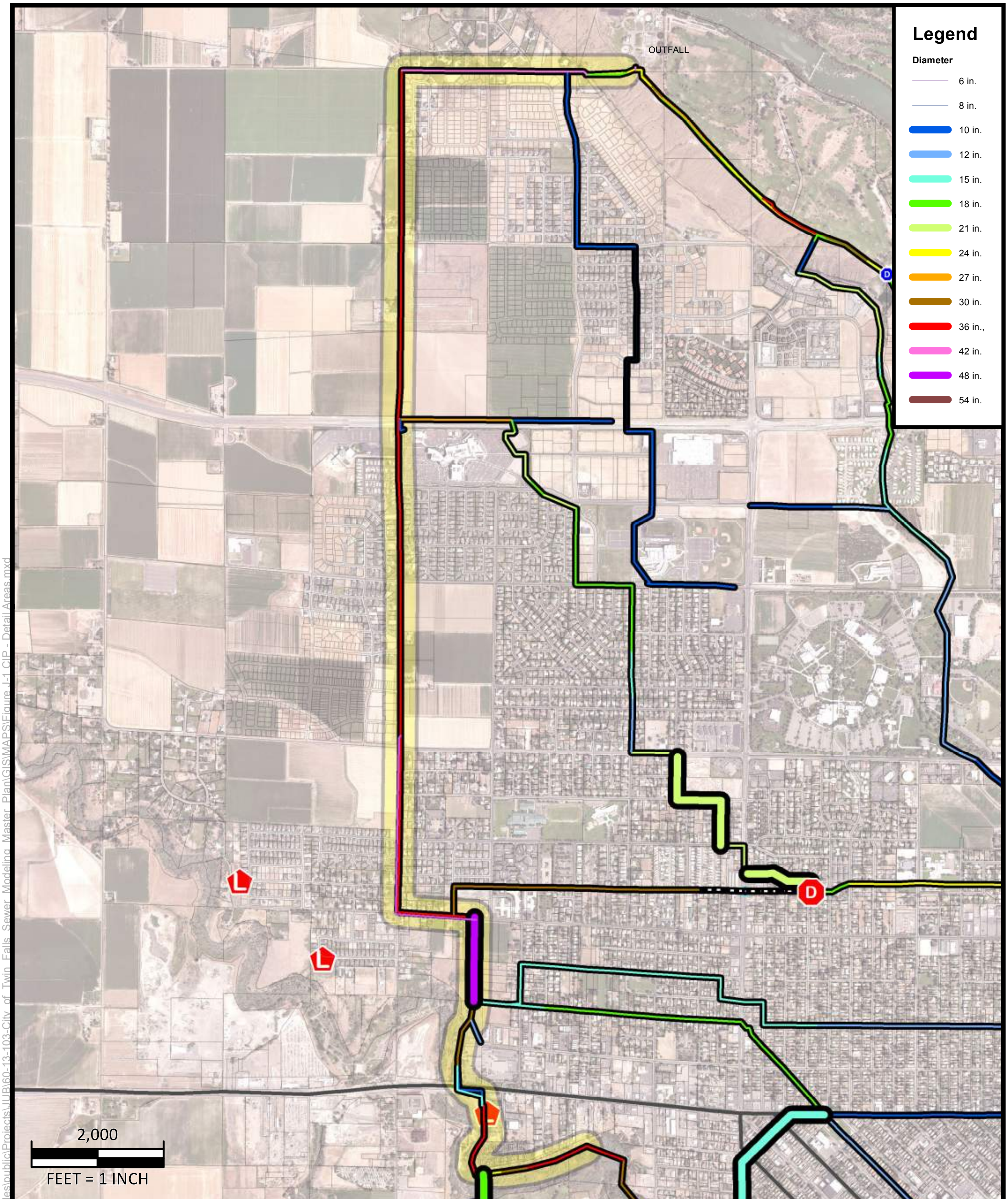


SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 1
Canyon Springs Rd.

J·U·B ENGINEERS, INC.



CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 2
Rehabilitate Manholes

J·U·B ENGINEERS, INC.

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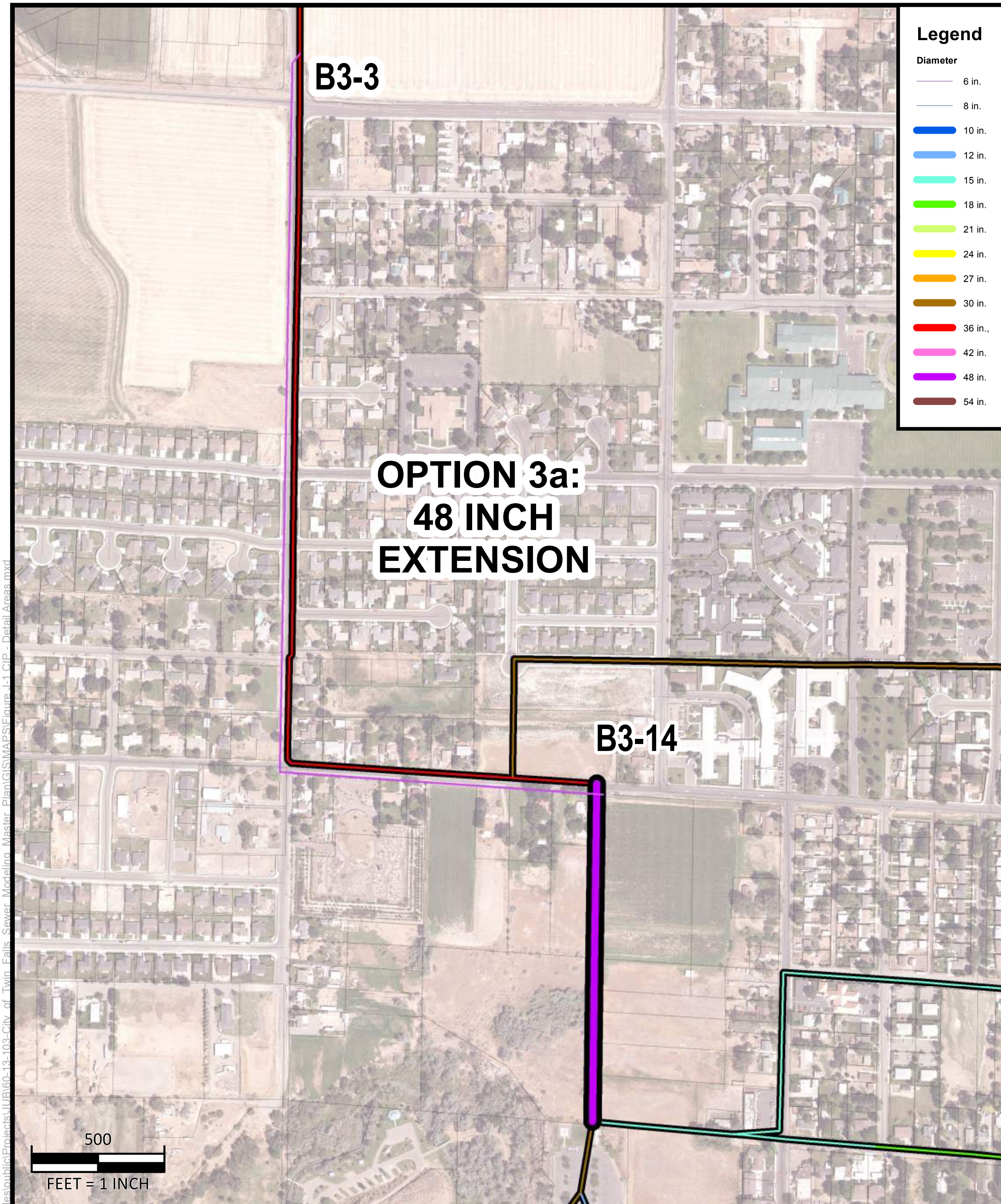
03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure J-1 CIP - Detail Areas.mxd

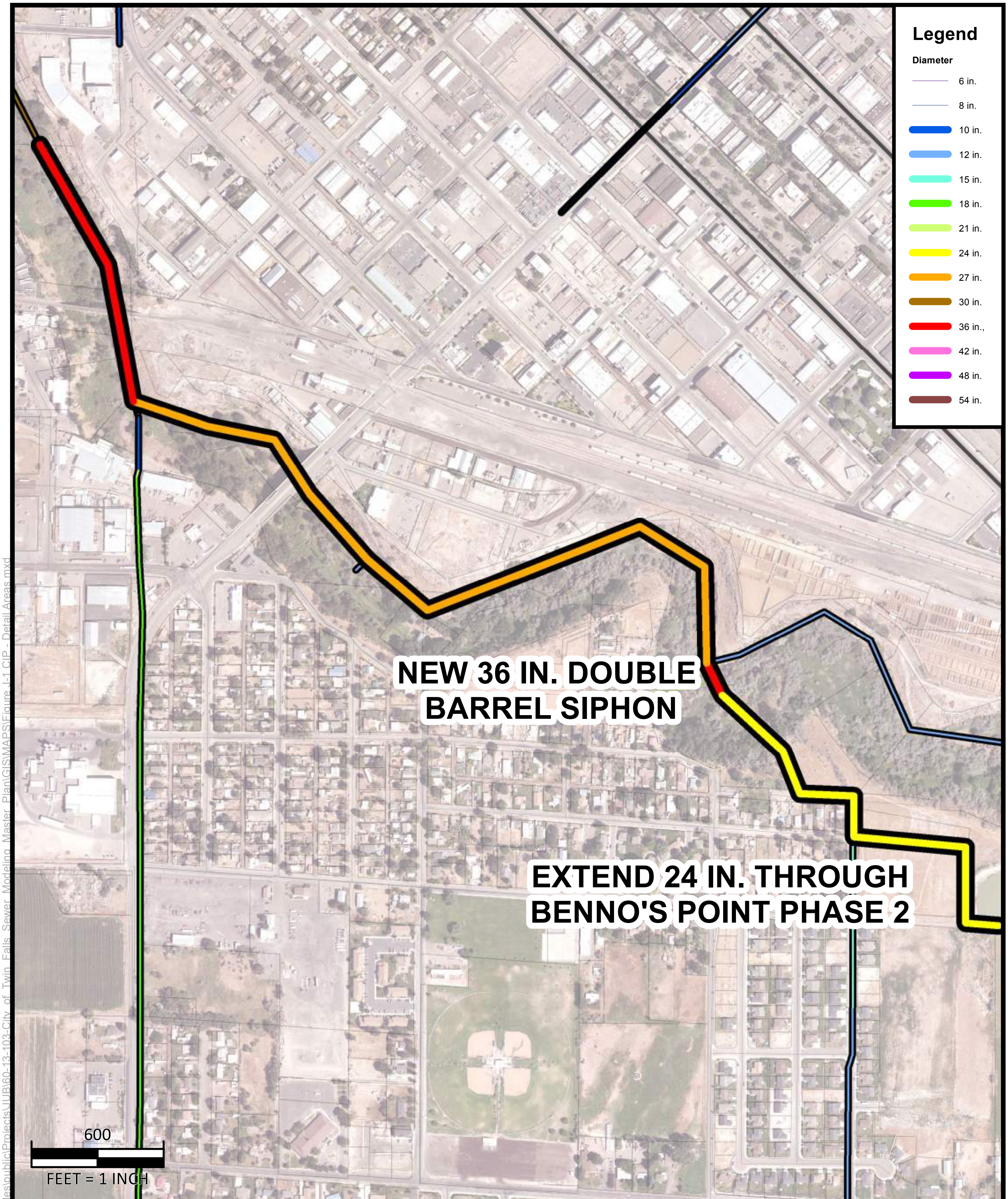


SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 3
Grandview Trunkline

J-U-B ENGINEERS, INC.

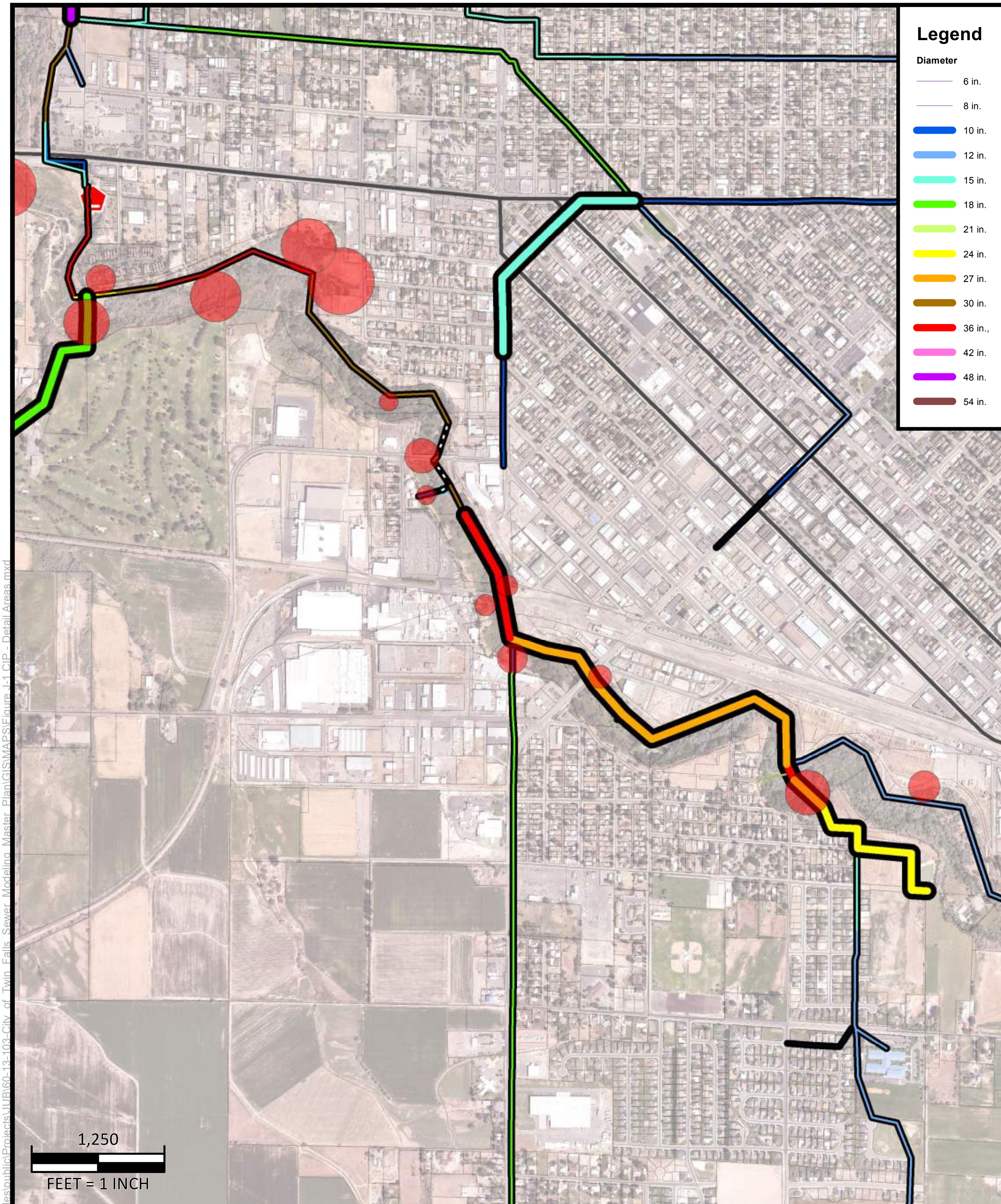
03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure J-1 CIP - Detail Areas.mxd



SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 4
Rock Creek Trunkline

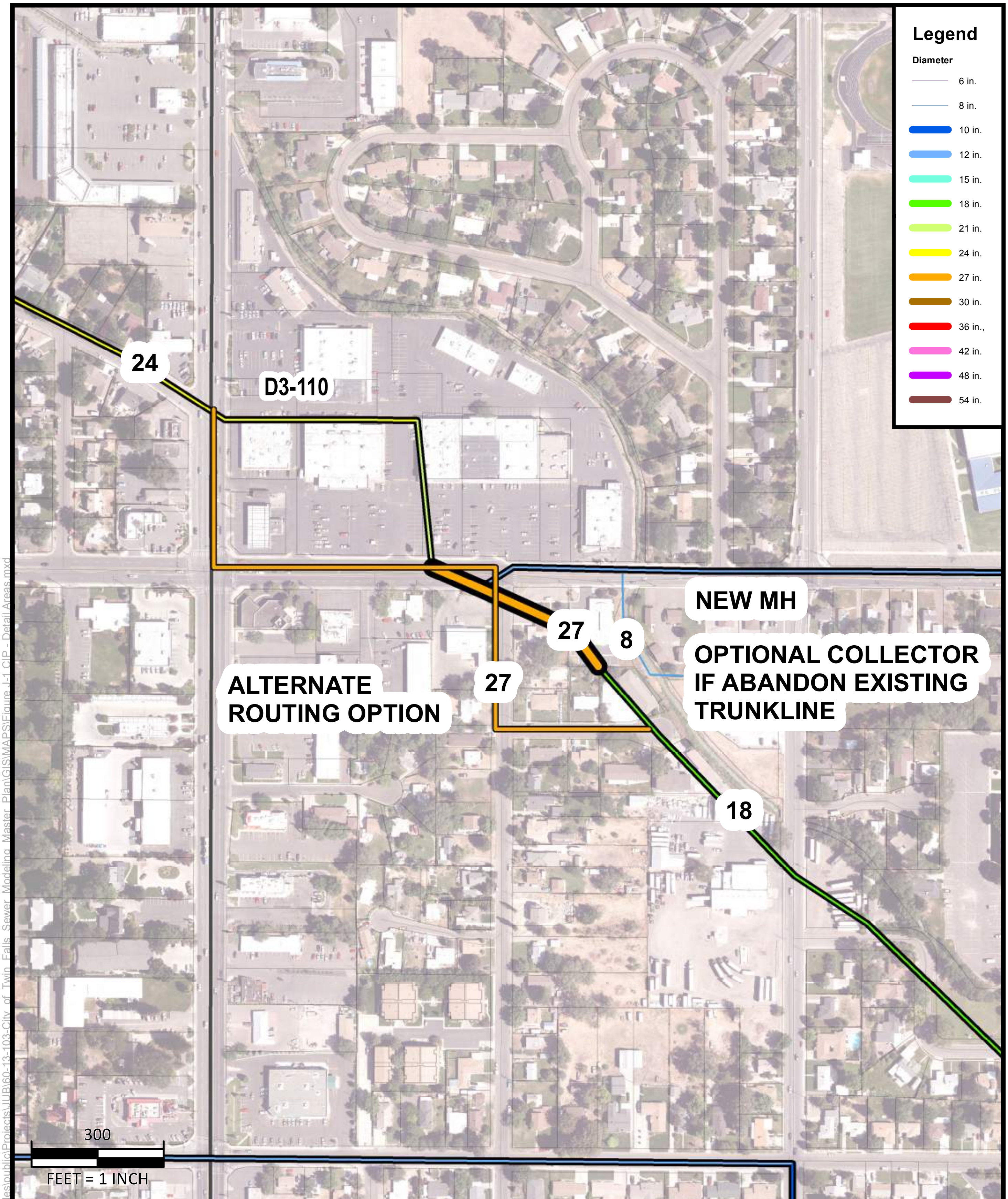
J-U-B ENGINEERS, INC.



SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 5
Droplines/Siphons

J·U·B ENGINEERS, INC.



CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 6
Madrona Trunkline

J·U·B ENGINEERS, INC.

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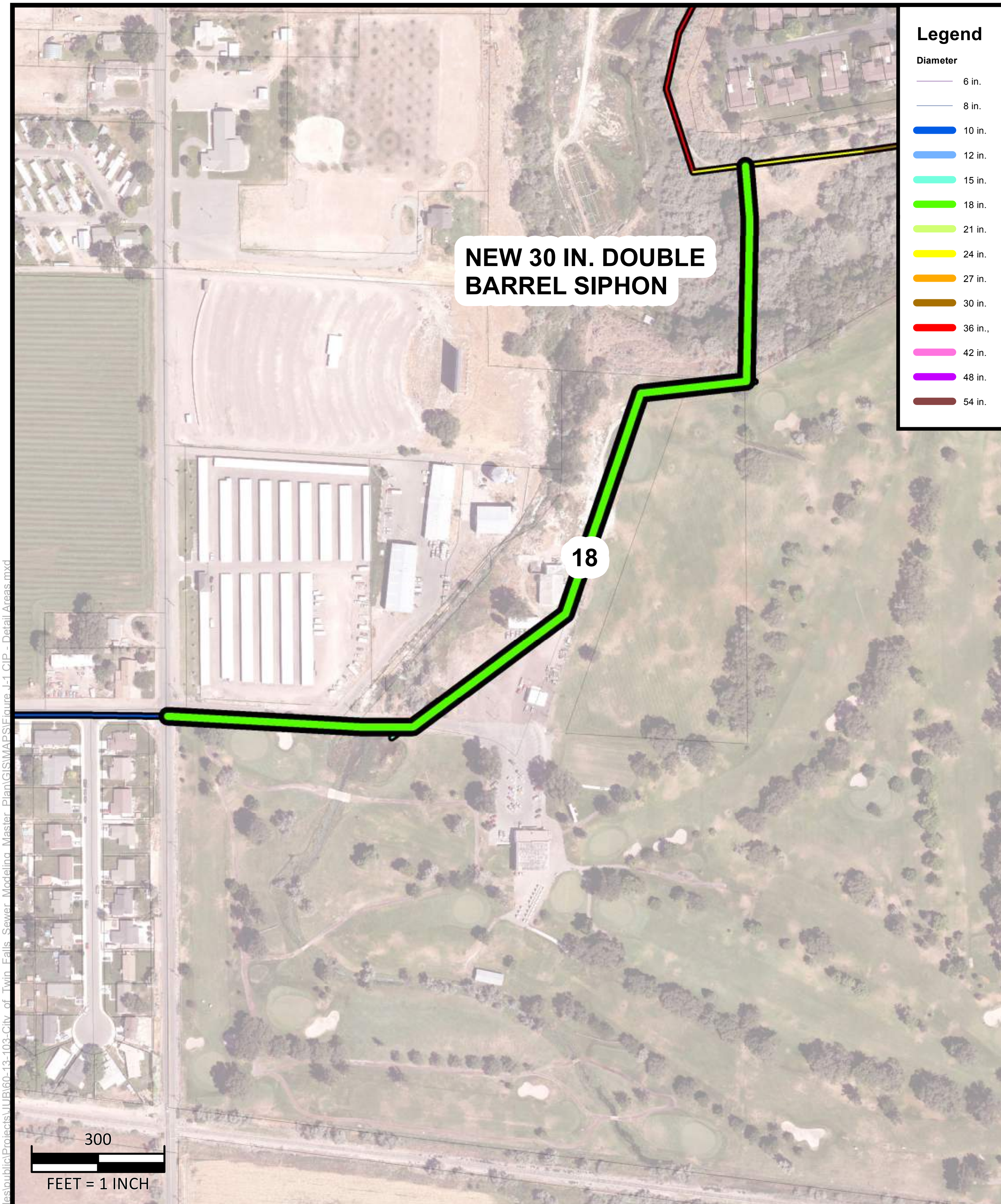
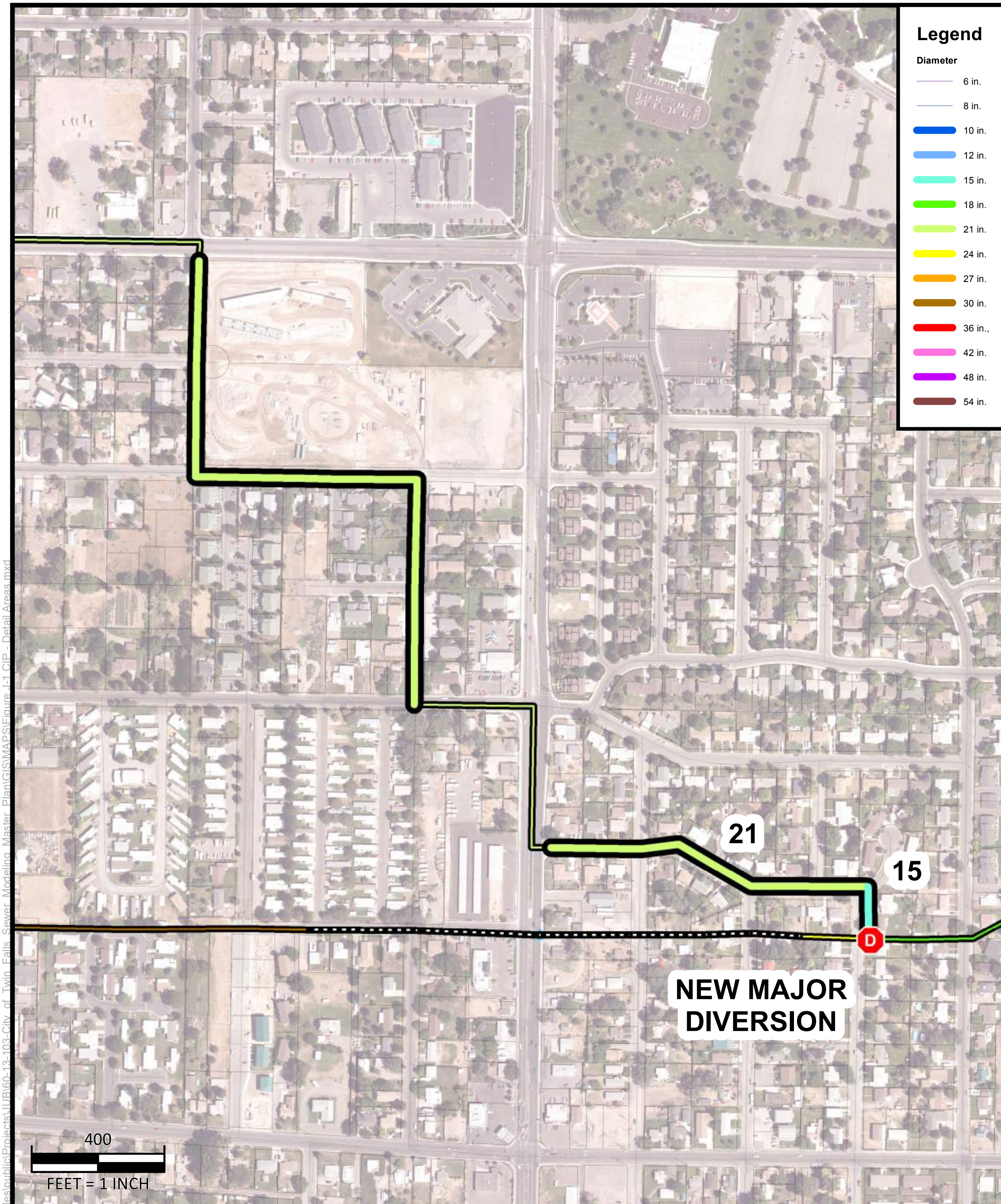


SEWER
COLLECTION
MASTER PLAN

PRIORITY IMPROVEMENT AREA 7
Golf Course Trunkline

J·U·B ENGINEERS, INC.



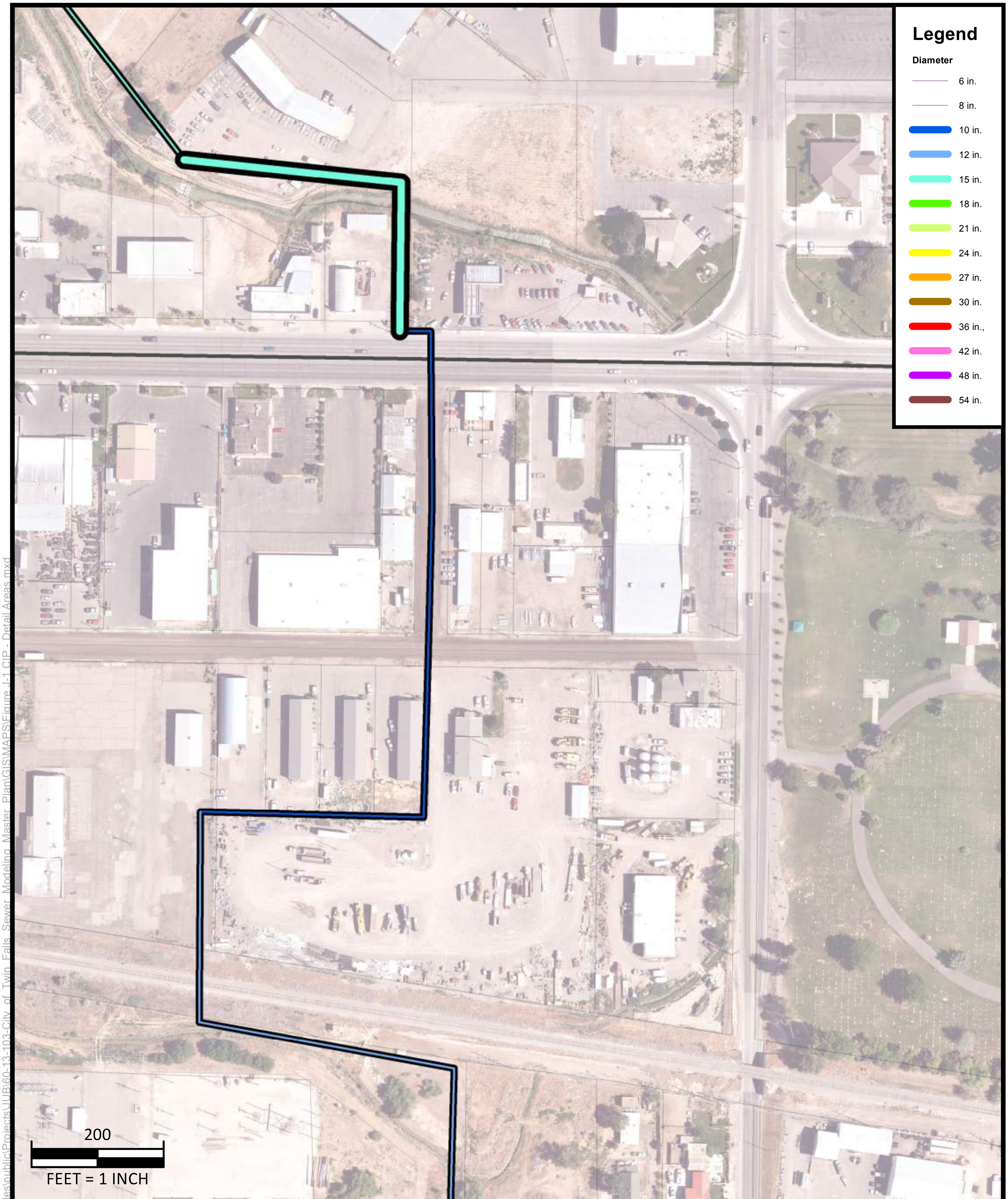
CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 8
Northwest Trunkline

J·U·B ENGINEERS, INC.

03/17/2015 Path: \\twinfiles\public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure J-1 CIP - Detail Areas.mxd



CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 9
Madrona Ext. Trunkline

J-U-B ENGINEERS, INC.

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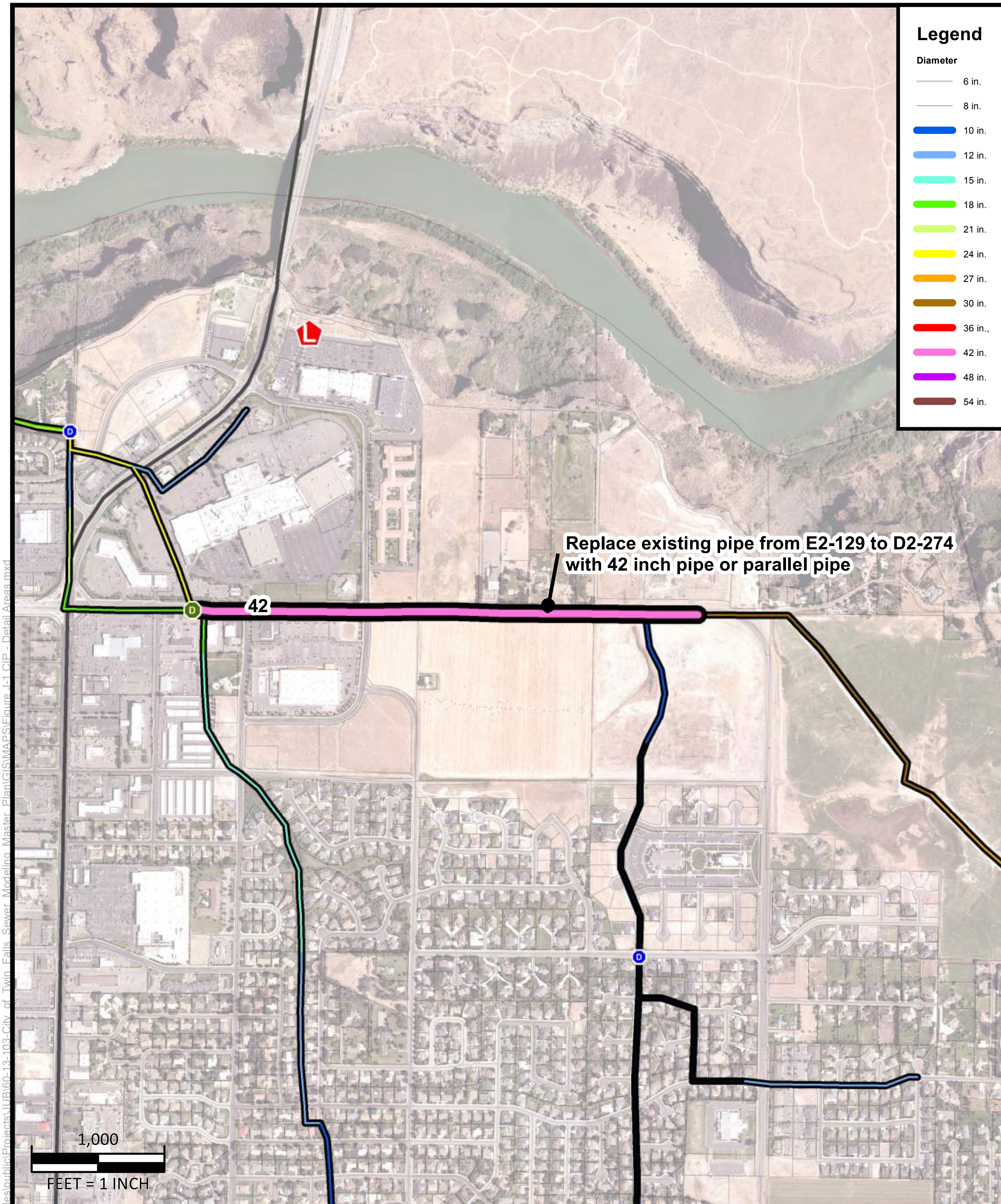

CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 10
Northeast Trunkline

J·U·B
J·U·B ENGINEERS, INC.

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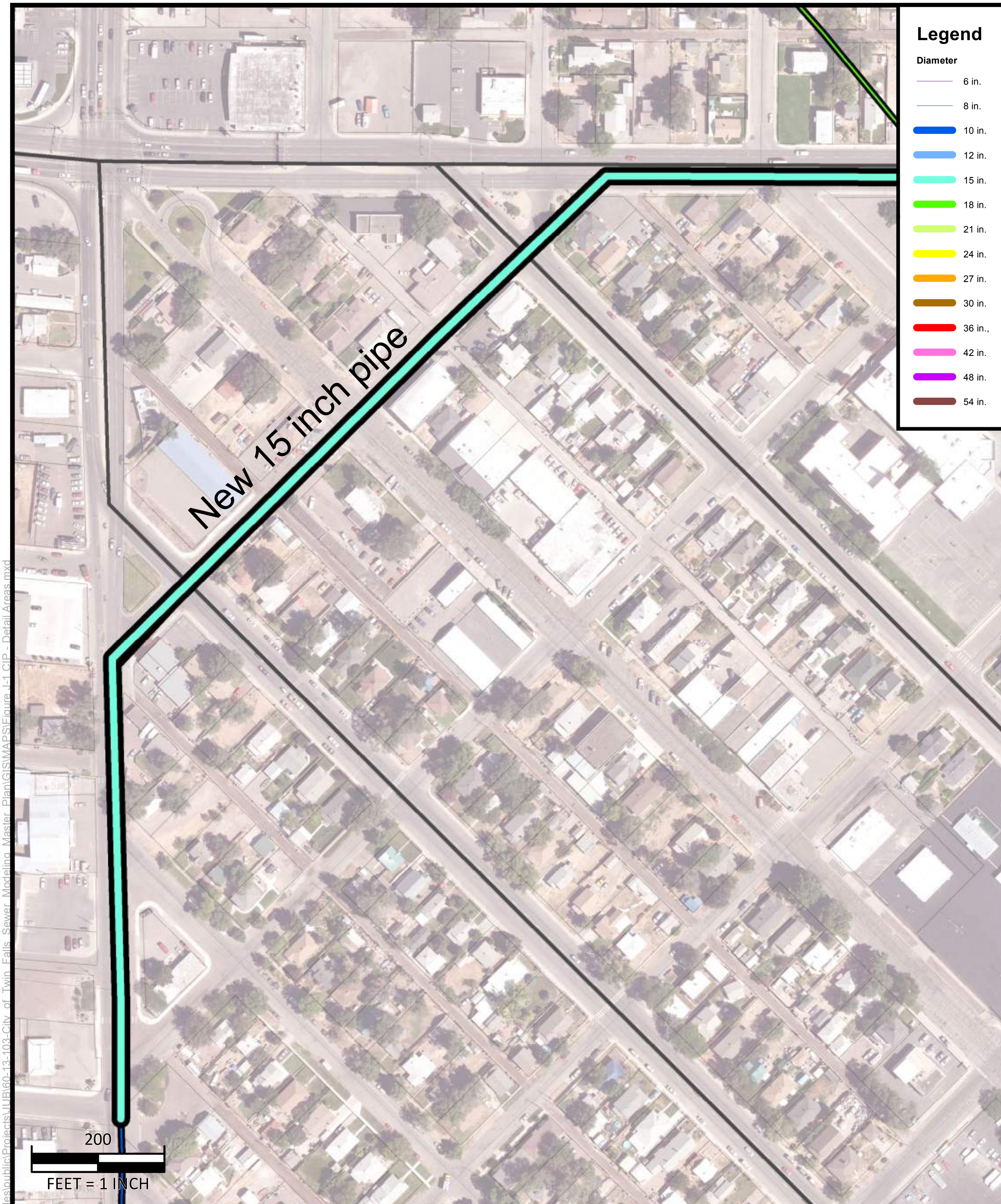

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

PRIORITY IMPROVEMENT AREA 11
Albion Trunkline

J-U-B ENGINEERS, INC.

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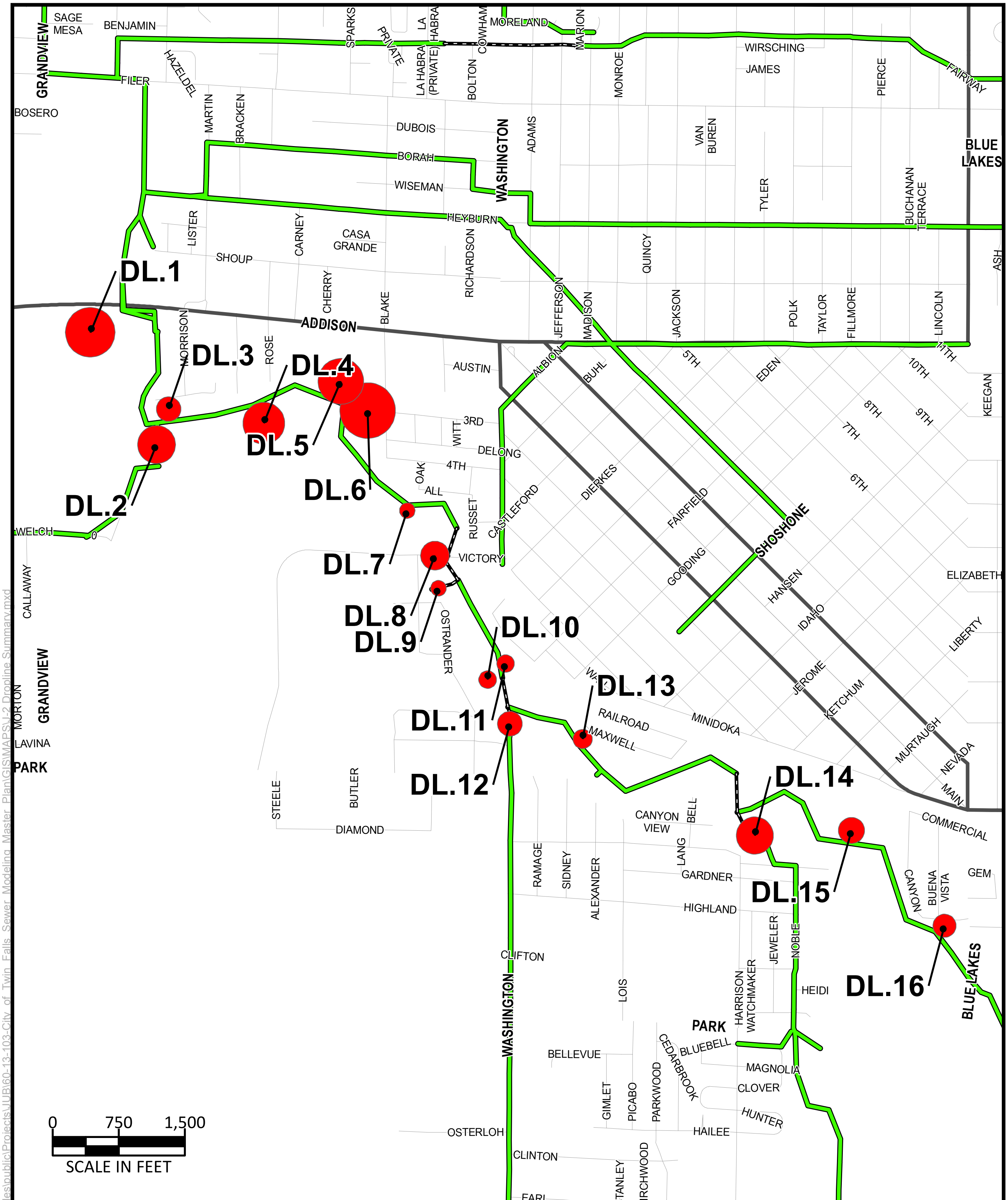

CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREAS

J·U·B ENGINEERS, INC.

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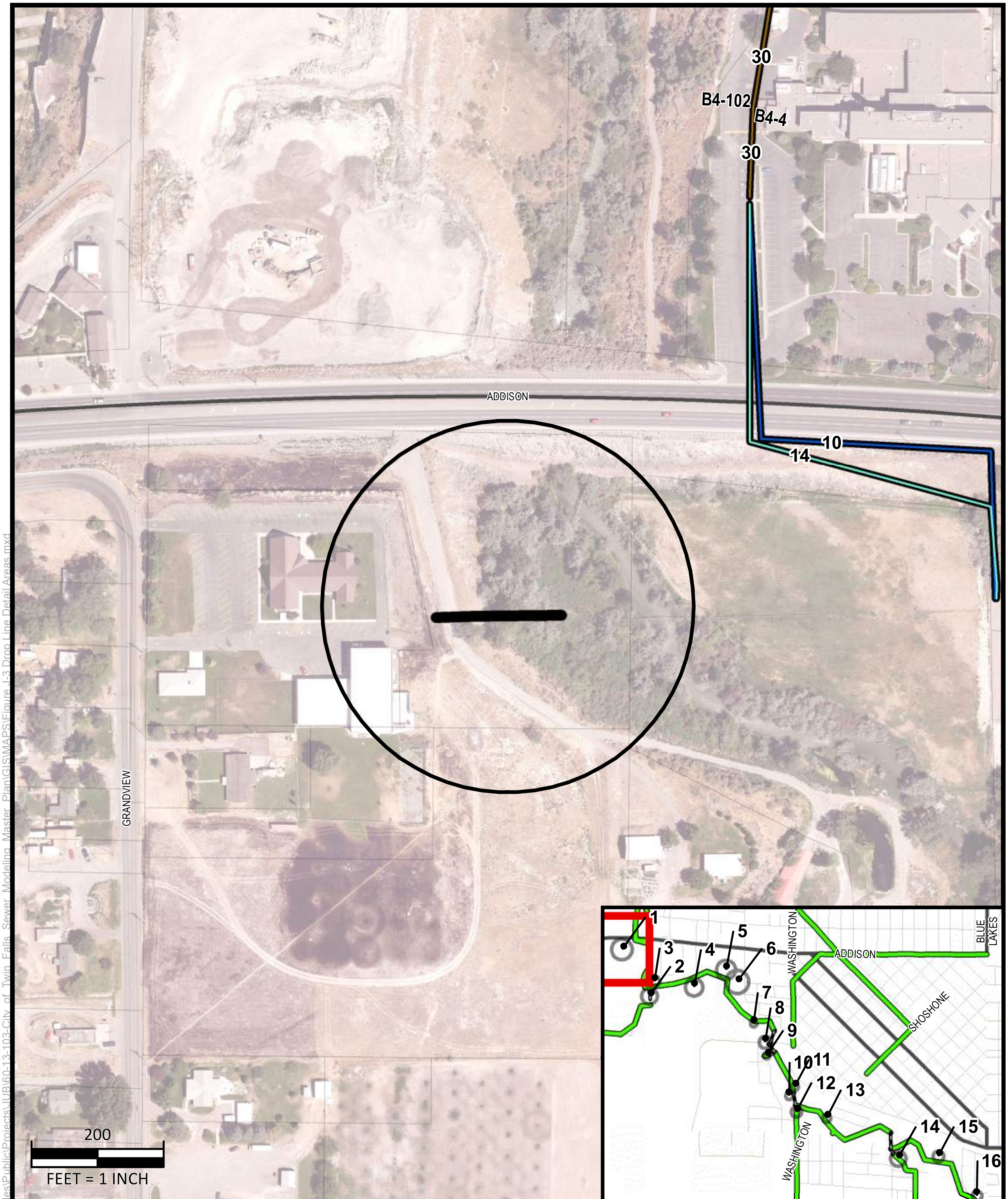
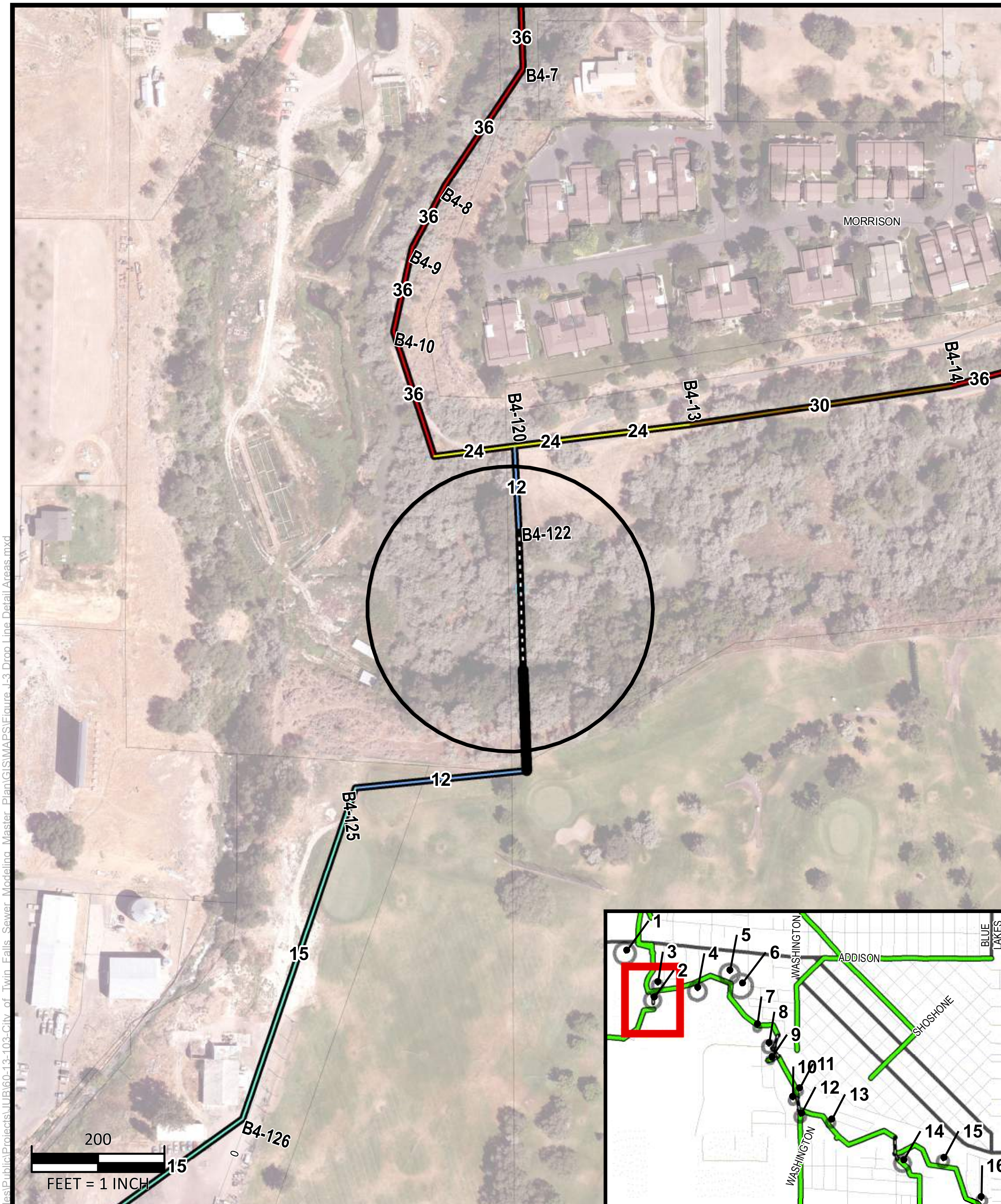


SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.1

J·U·B ENGINEERS, INC.

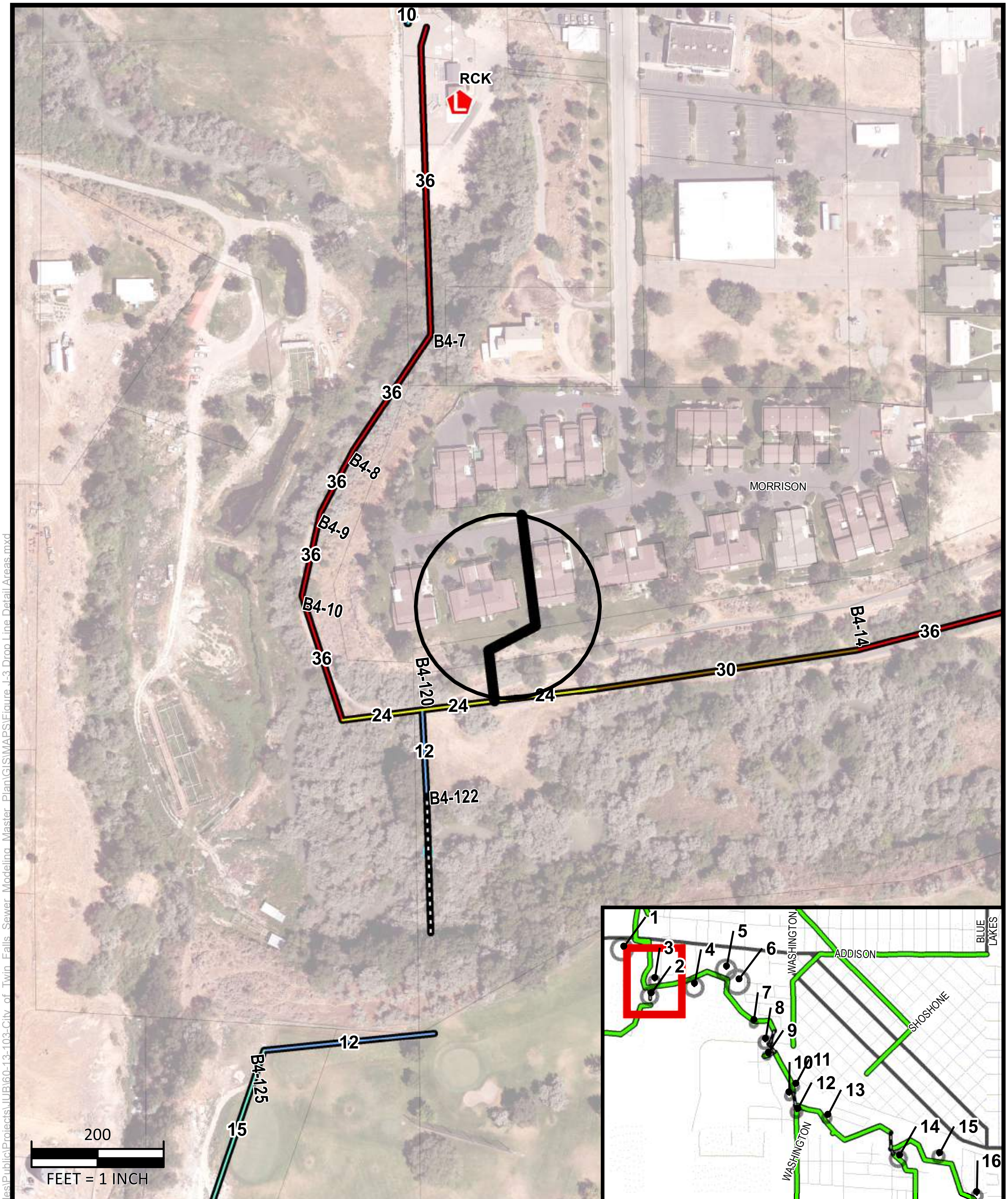


SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.2

J·U·B ENGINEERS, INC.

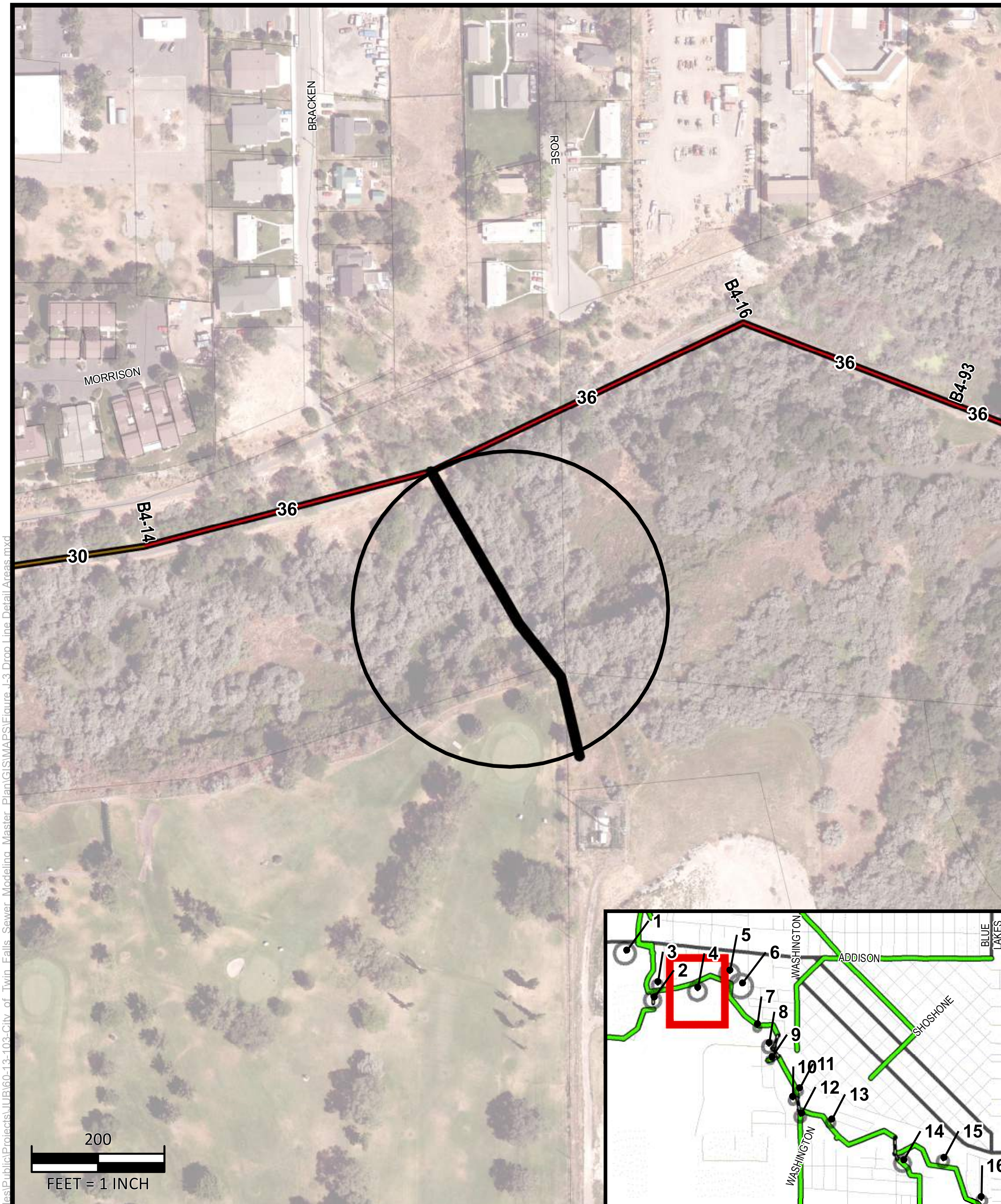
04/21/2015 Path: \\twinfiles\Public\Projects\JUB\60-13-103-City_of_Twin_Falls_Sewer_Modeling_Master_Plan\GIS\MAPS\Figure J-3 Drop Line Detail Areas.mxd



SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.3

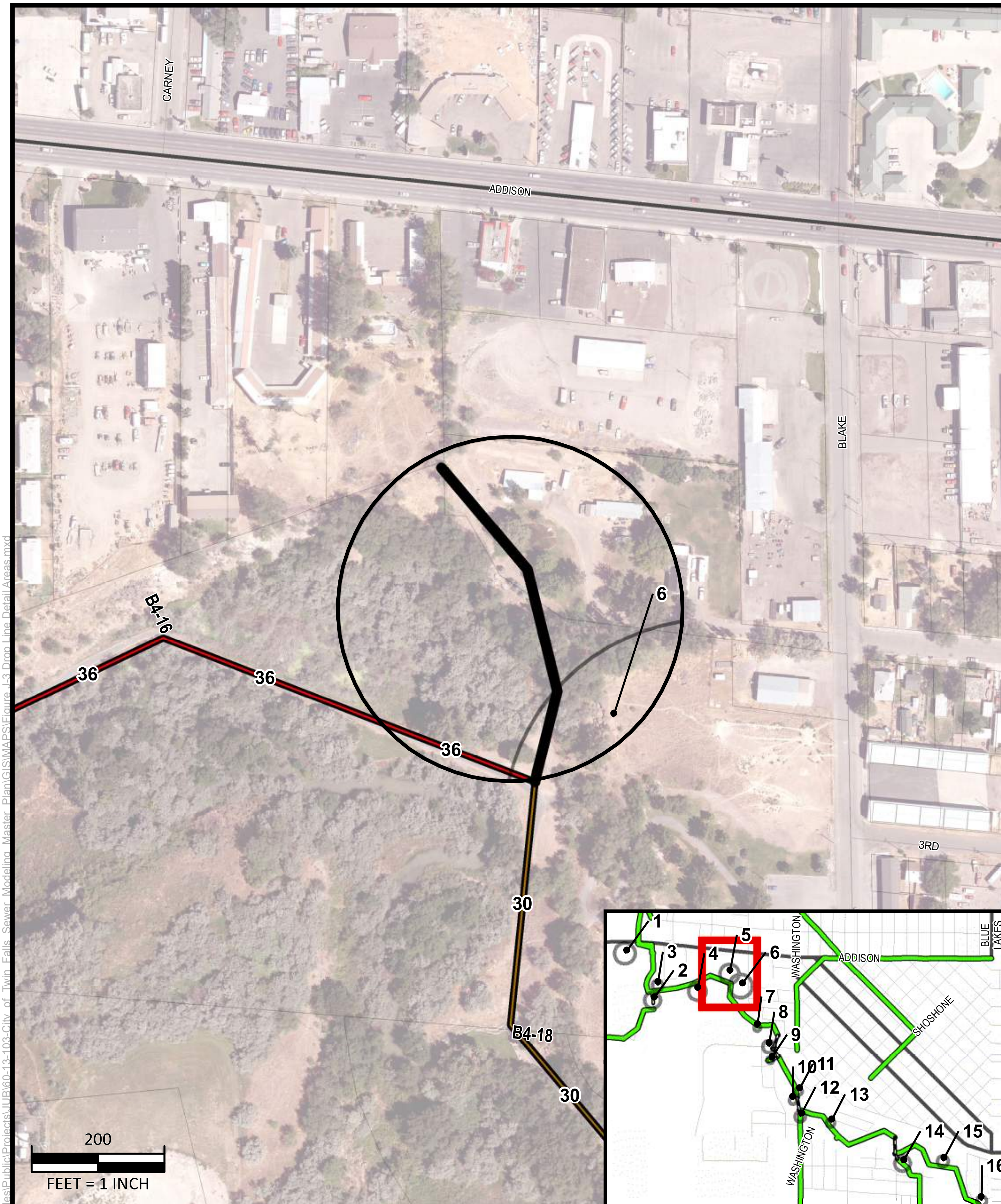
J·U·B ENGINEERS, INC.



SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.4

J·U·B ENGINEERS, INC.



CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.5

J·U·B ENGINEERS, INC.

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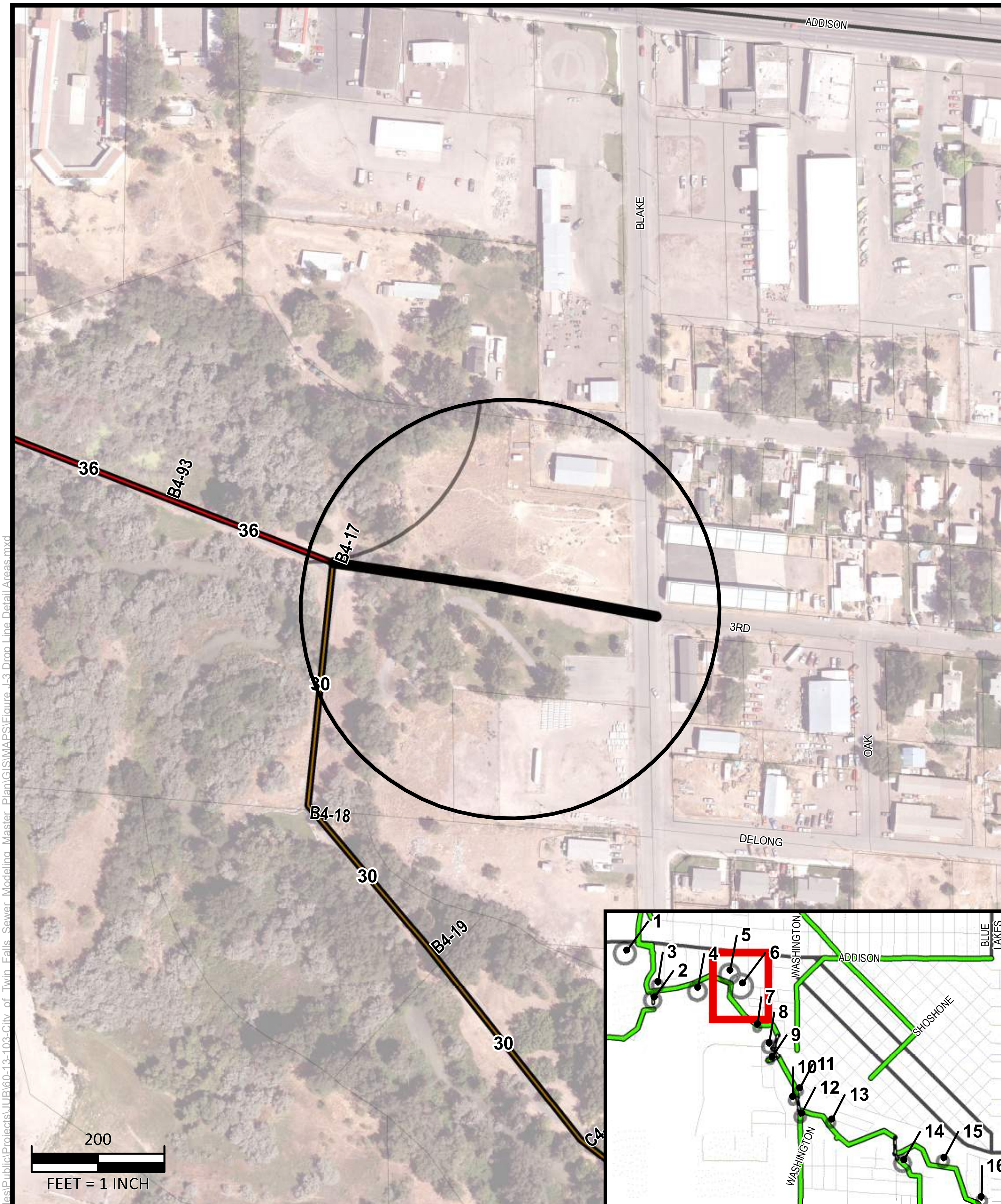

CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.6

J·U·B ENGINEERS, INC.

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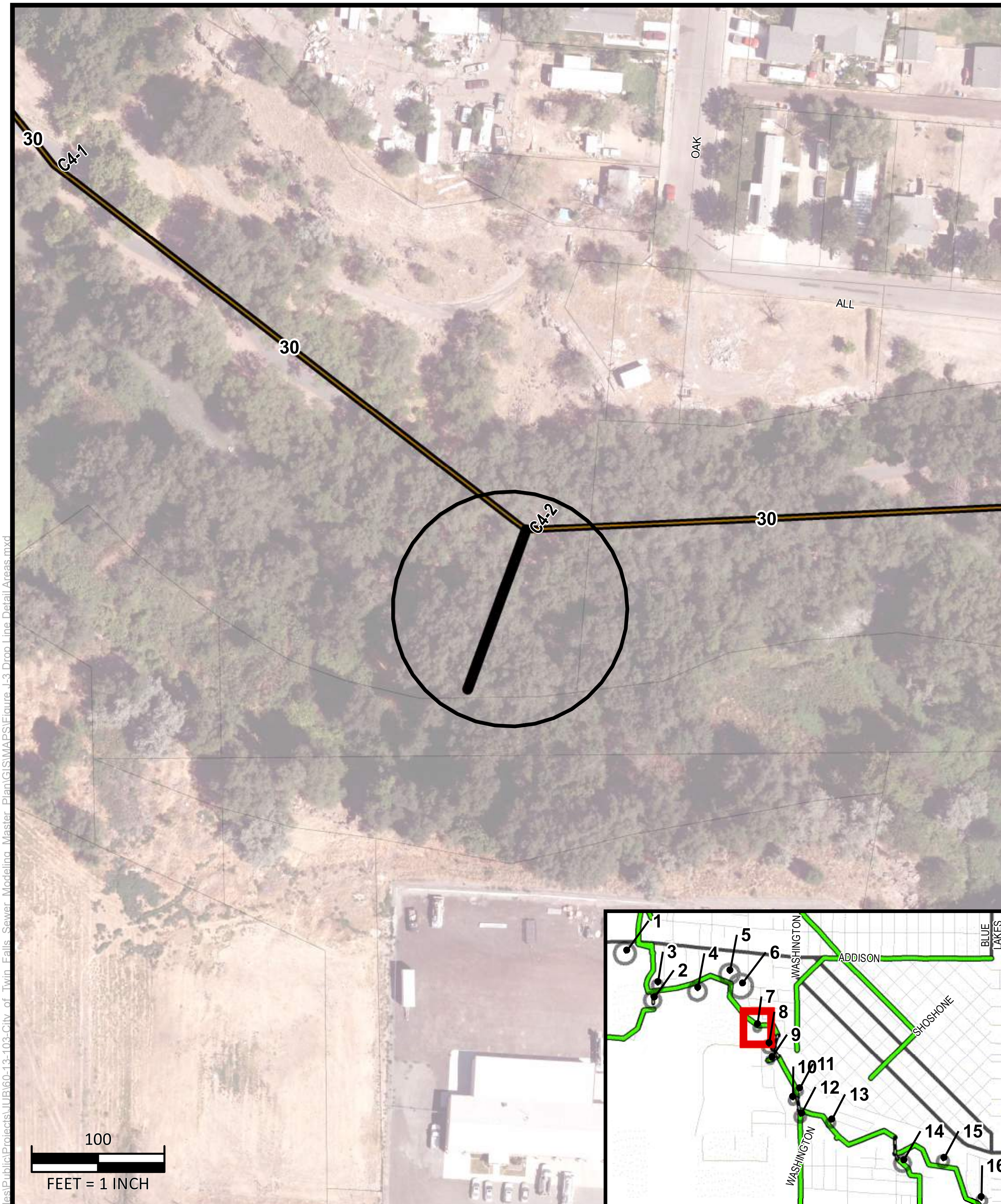
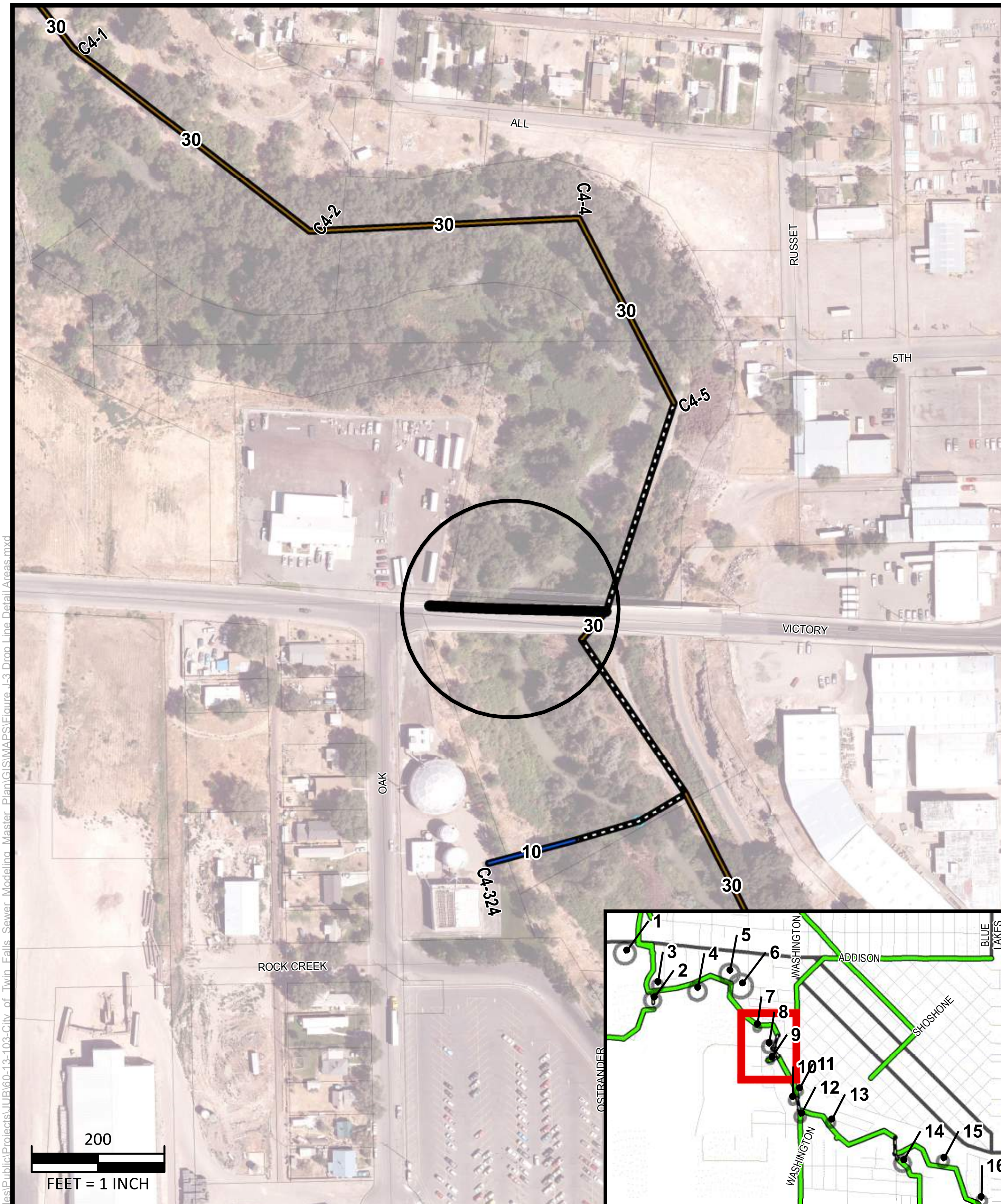


SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.7

J-U-B ENGINEERS, INC.



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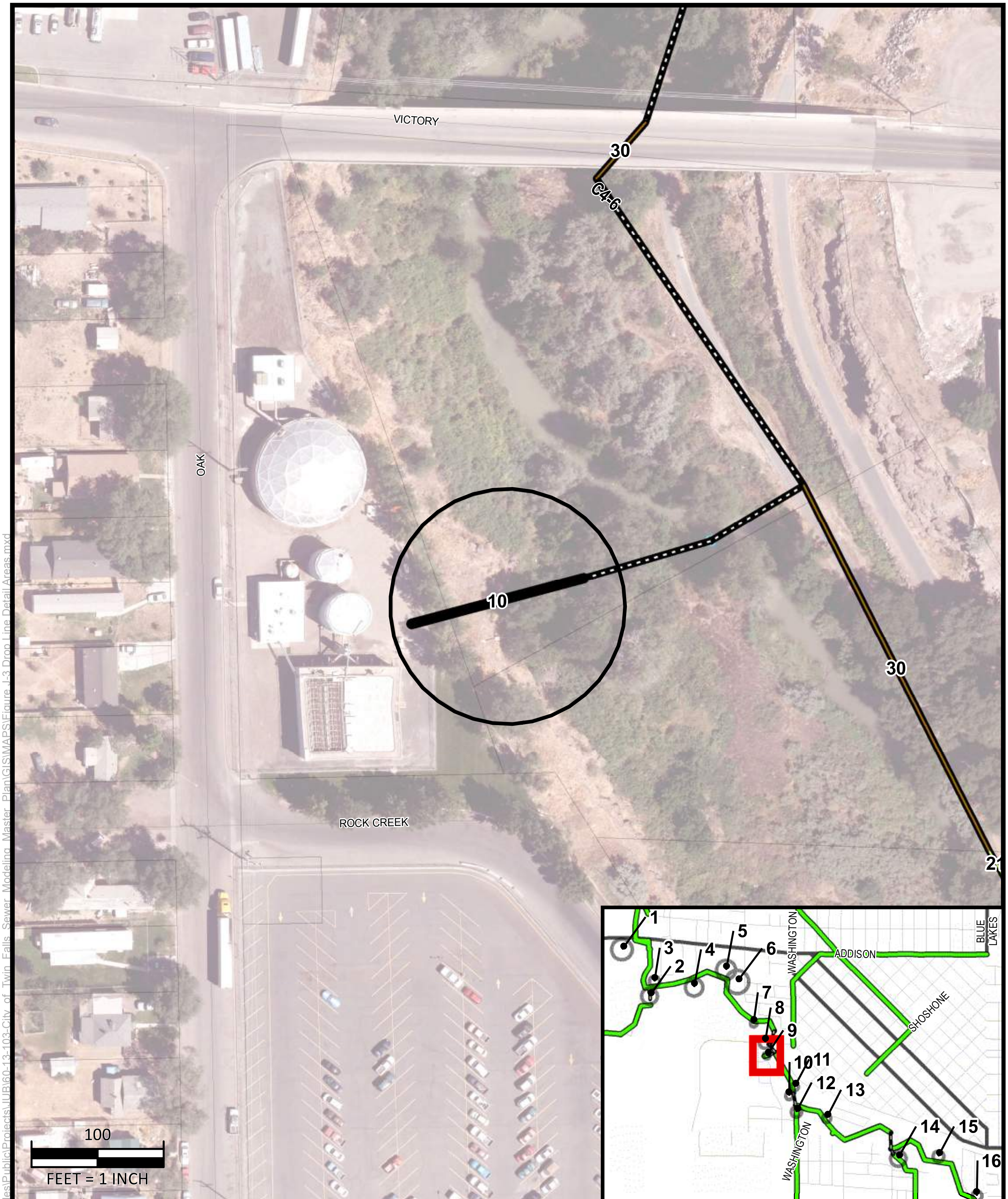
SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.8

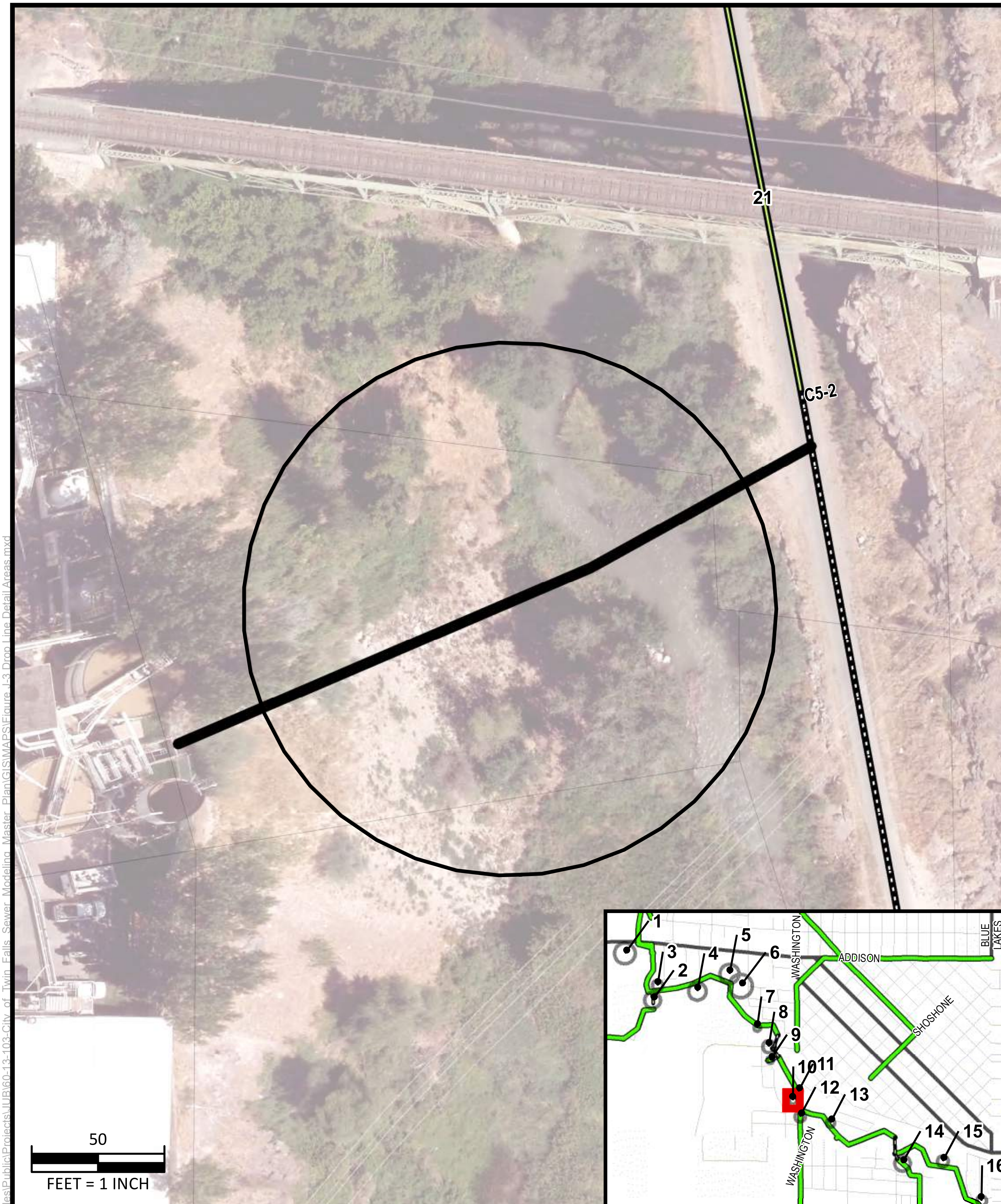
J-U-B ENGINEERS, INC.



SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.9

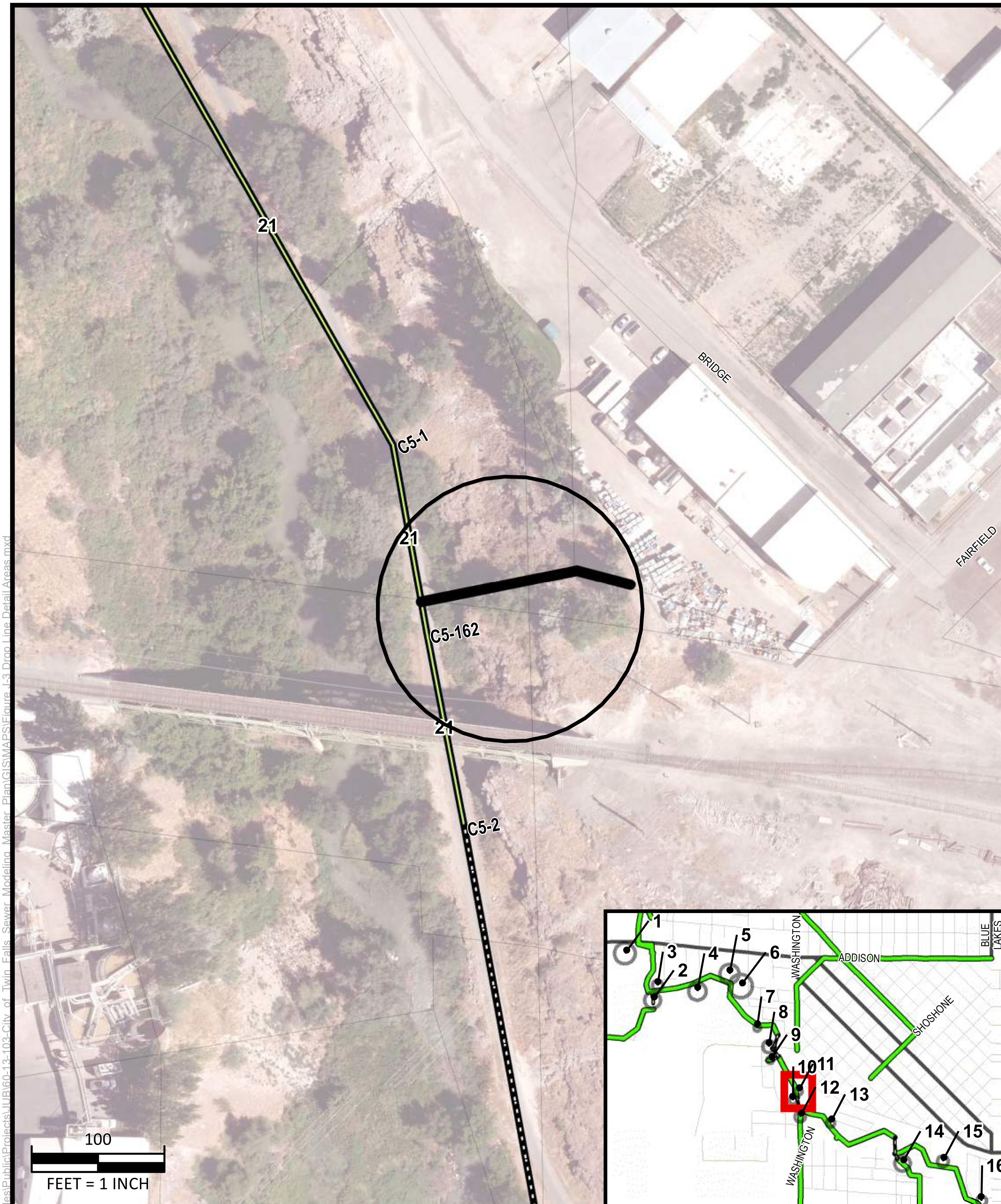
J-U-B ENGINEERS, INC.



SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.10

J-U-B ENGINEERS, INC.



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CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.11

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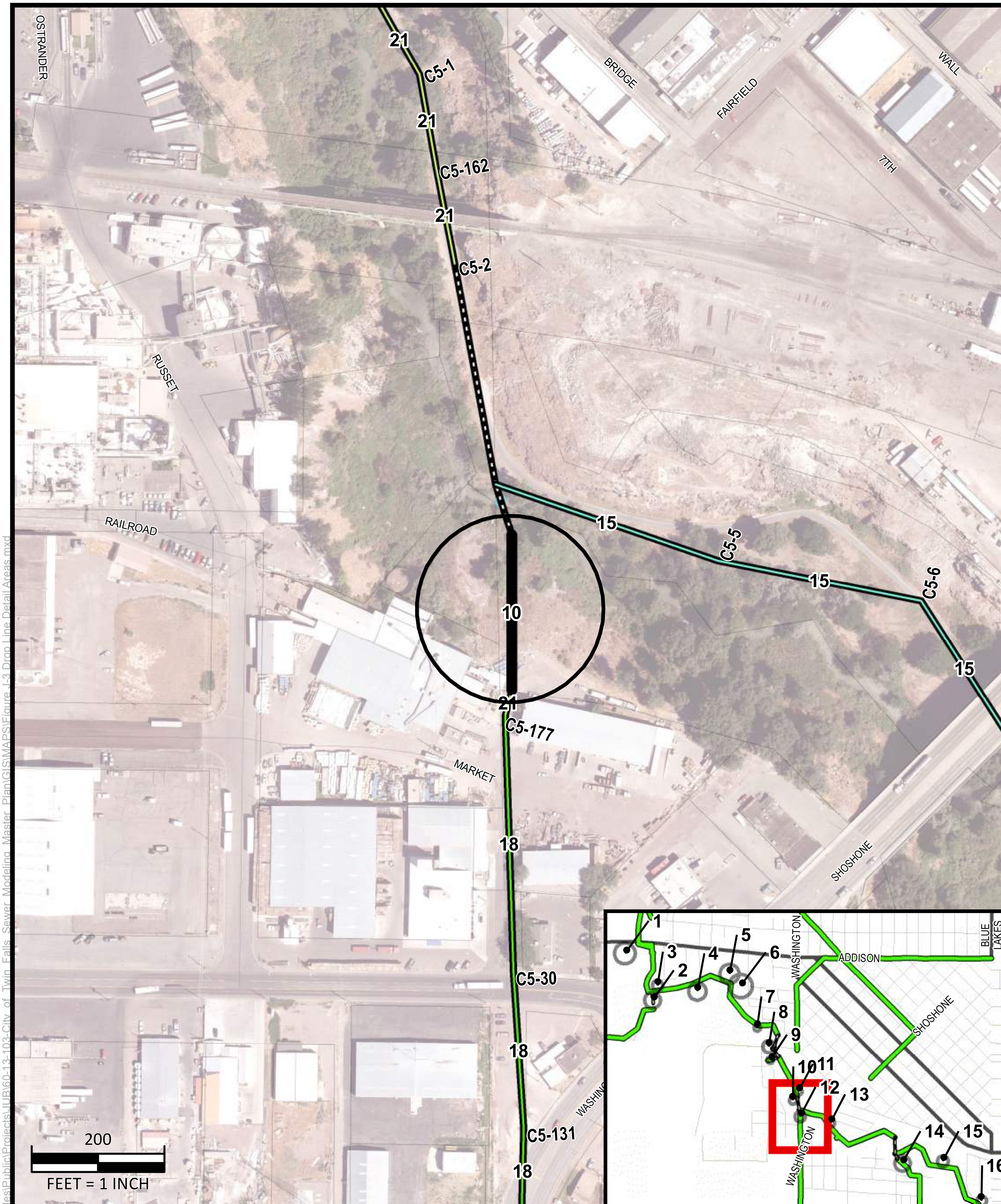

CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.12

J·U·B ENGINEERS, INC.

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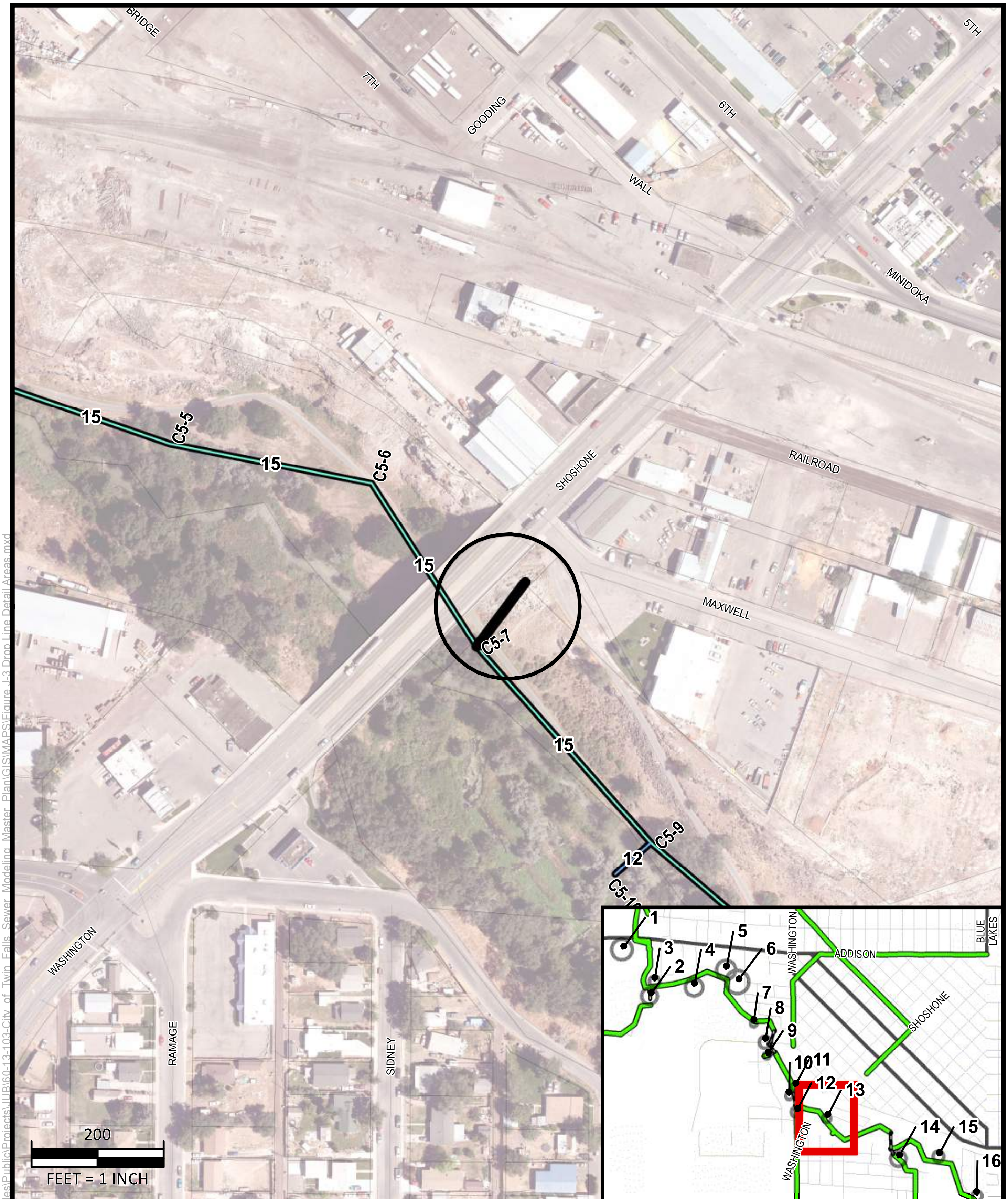
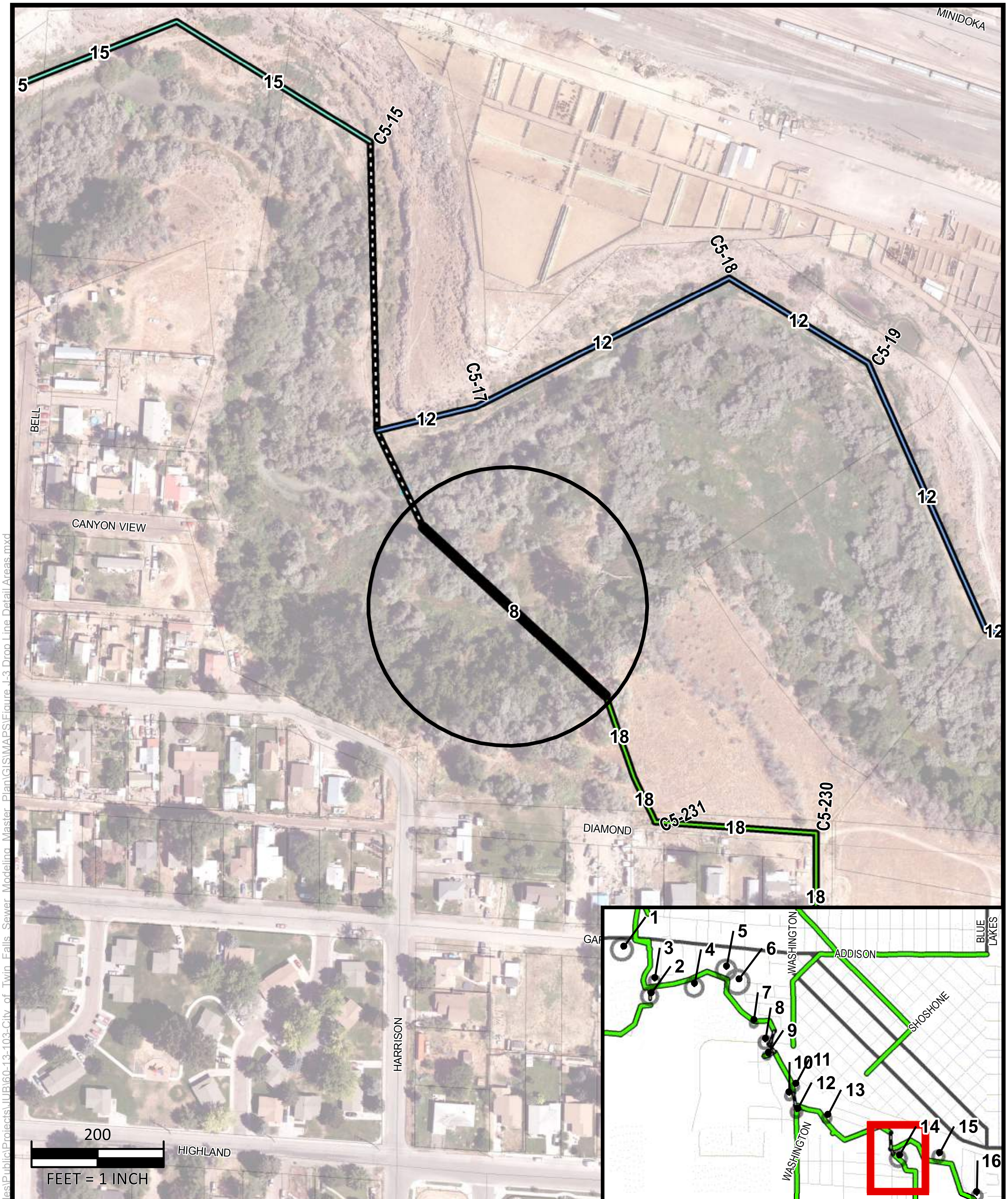


SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.13

J·U·B ENGINEERS, INC.



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CITY OF TWIN FALLS — PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.14

J·U·B ENGINEERS, INC.

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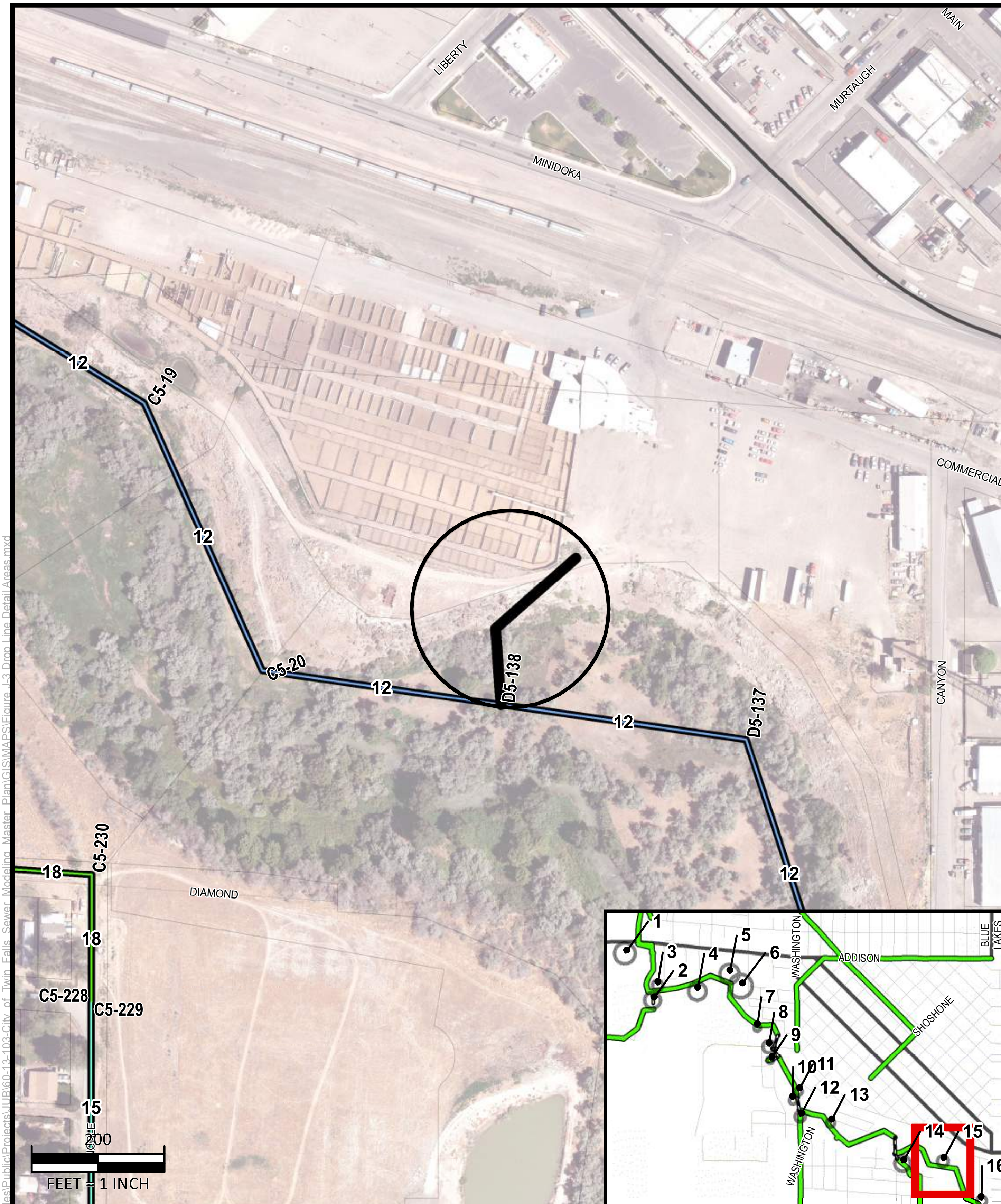

CITY OF TWIN FALLS
PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.15

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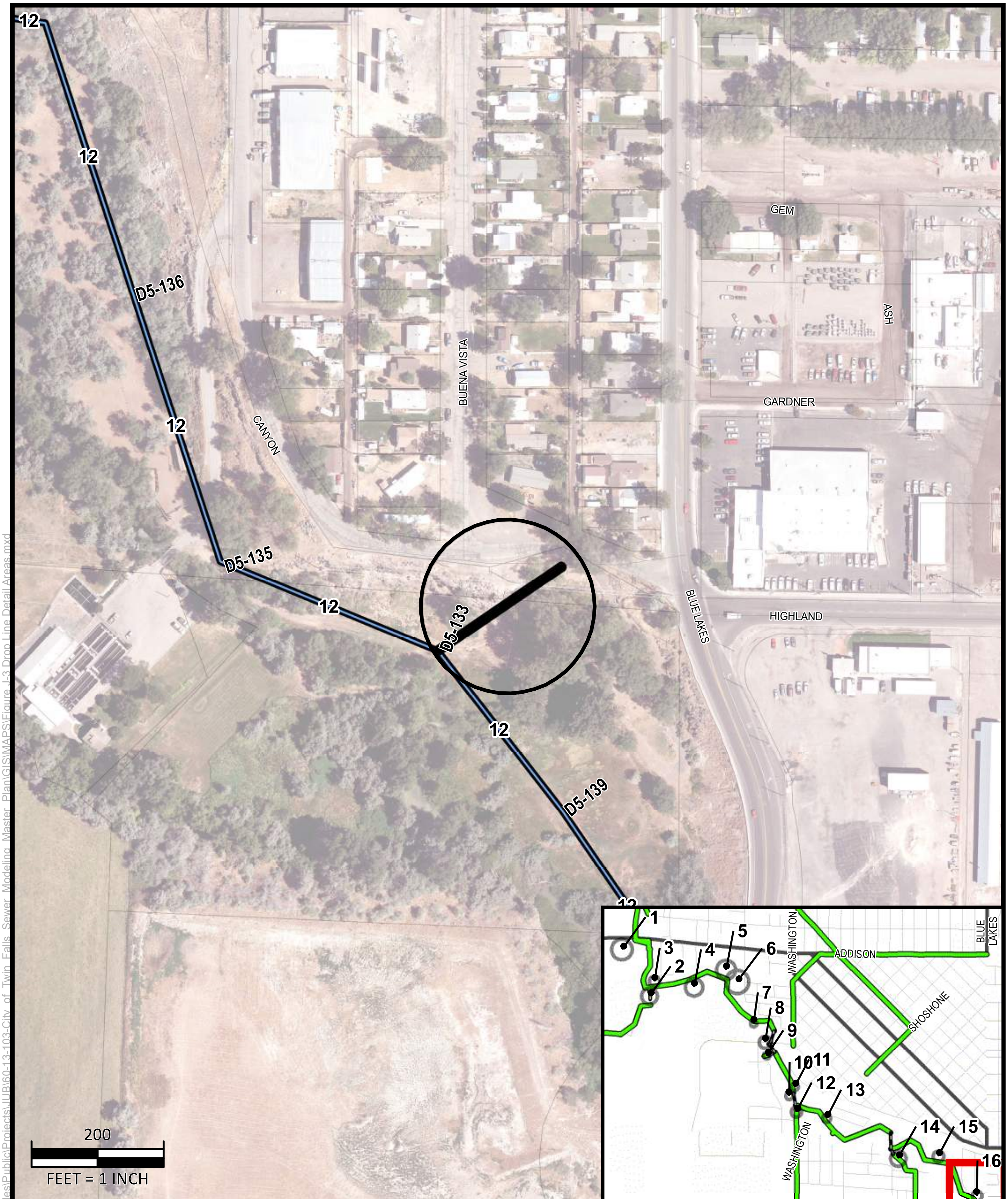

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CITY OF TWIN FALLS PEOPLE SERVING PEOPLE

SEWER COLLECTION MASTER PLAN

DROPLINE AREA DL.16

J-U-B ENGINEERS, INC.

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