



NORTH LOGAN CITY  
SEWER MASTER PLAN

# **North Logan City Sewer Master Plan**

**July 2024**

**Prepared for:**

North Logan City

**Prepared by:**

Lance Anderson, P.E.  
Ashley McAllister  
Cache-Landmark Engineering  
95 Golf Course Rd #101  
Logan, Utah, 84321  
435-713-0099

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## EXECUTIVE SUMMARY

### *Background*

Cache Landmark Engineering has completed a sewer collection system master plan for North Logan City (the City). The purpose of the master plan is to provide a document and tools that help North Logan City meet its existing and future sewer system demands. Cache Landmark developed a detailed sewer model based on data provided by the City. The master plan and model will guide infrastructure design while planning for future improvements to the sewer system.

The main wastewater system in North Logan was installed in 1980 and has expanded as the City has grown. With continual growth, prevention of overloading existing sewer pipes due to new development or redevelopment is important. Development projects have the potential to substantially impact peak flows in collection pipes near the newly developed areas. The model represents the mapped pipes in the sewer system. The model shows areas of the sewer system nearing capacity. It also shows if the system has sufficient capacity for a new development or redevelopments in a proposed area. The master plan goals are outlined in the following list:

### *Master Plan Goals*

- Develop a calibrated model
- Identify existing system capacity and condition deficiencies
- Identify future system deficiencies
- Provide a prioritized list of capital improvement projects needed now until buildout

This master plan combined with the North Logan City 2015 Sewer System Management Plan (SSMP) complies with the requirements of the Utah Division of Water Quality's Utah Sewer Management Program (USMP) including the System Evaluation and Capacity Assurance Plan (SECAP) requirements. The program is authorized under the State of Utah Administrative Code R317-801.

### *Conclusions and Recommendations*

**Existing System Geometry** – The city has not fully updated some system geometry. This includes invert elevations and other geometry. Update the City Gravitational Information System (GIS) data to include new manhole inverts and incorrectly measured inverts. Ensure GIS data accurately reflects the current state of the system. Continue to update the system GIS files, then update the model to match. In the future, the GIS data will be the parent data for the model.

**System Infiltration** – Total approximate winter infiltration recorded at the sewer meter is approximately 500 gallons per minute (GPM) based on the nighttime flows. The spring infiltration is approximately 1,000 GPM. A large portion of the infiltration comes from the area of the city west of the canal where the groundwater is high. Implement more flow monitoring in

the west side of the city and conduct an inflow/infiltration study to identify specific sources of infiltration. This will lead to more effective efforts to reduce the infiltration.

**System Inflow** – Sewer meters recorded some inflow from small rain events while gathering flow data for the master plan. To accurately assess the impact of inflow on the system, collect flow data during significant rain events.

**Existing Pipes Near Capacity** – Figure 4 in Appendix A highlights some pipes nearing capacity in the model. To address this issue, actively monitor these areas using the city-owned meters during the spring months. If the pipes in these locations reach full capacity, implement capacity improvements. If the pipes are not at full capacity, adjust the upstream infiltration inputs in the model to represent actual flow conditions.

**Existing Over Capacity Areas** – Some pipes in the existing system are over capacity at peak flow times. Design and build the improvements listed in Table 4 of the report to add additional capacity.

**Future Areas Near or Over Capacity** – At build out, some areas will approach or exceed capacity based on the assumed growth projections (see Appendix A Figure 7). Monitor the areas approaching capacity with the city owned meters in the future during spring months. Begin plans to build the improvements in Table 4 of the report to prevent the future over capacity areas.

**Future Trunk Lines** – The city is currently building a new trunk line to serve the city. The City completed phases one and two out of seven total phases. Continue to build the planned trunk lines outlined in the trunk line master plan shown in Appendix A, Figure 8.

**Computer Model** - The detailed computer model identifies impacts of new developments. Use the existing model to assess the effects of proposed new developments or redevelopment to higher densities. Update the model regularly with updated system information from the GIS database.

## **1.0 INTRODUCTION**

### ***1.1 Background***

The North Logan City (the City) sanitary sewer system collects wastewater from the City and transports those flows to the Logan City wastewater treatment plant.

There are approximately 305,000 lineal feet of pressure and gravity sewer pipe in the collection system. Pipe diameters range from 8-inch diameter to 24-inch diameter. Most collection pipes are 8-inch diameter making up approximately 230,000 feet in length.

New trunk line construction connecting the North Logan sewer to the Logan City sewer system is in progress. The partially constructed trunk line includes pipes ranging in diameter from 24-inches to 48-inches. The trunk line has seven phases. Phases one and two are complete.

### ***1.2 Population***

North Logan continues to see growth and re-development to higher densities. To determine future sewer system needs, a reasonable growth prediction was determined. The North Logan City population in the year 2000 was 6,163 according to the 2000 Census. In the ten-year period from 1990 to 2000 the City experienced an increase of 54.9% in population (4.6% per year).

The City has been growing at a slower rate during the past twenty years. During the ten-year period from 2000 to 2010 the City experienced an increase of 34.2% in population (3.0% per year). The 2020 Census indicates that the population from 2010 to 2020 increased from 8,269 to 10,986. This is a 32.9% increase in population during the ten-year period with a growth rate of 2.9% per year.

Cache Landmark used a growth rate of 3.0% for this report. Table 1 shows the past population and projected population. There are two time-frames analyzed in this plan: existing flow (2023), and build out flows.

**Table 1: North Logan Population**

<b>North Logan Population</b>	
<b>Year</b>	<b>Population</b>
1980	2,258
1990	3,768
2000	6,163
2010	8,269
2013	9,666
2014	9,864
2015	10,104
2020	10,986
2030	14,758
2035	17,108
2040	19,833
Buildout	22,322

<sup>1</sup> Governor's Office of Planning and Budget

<sup>2</sup> 2010 Census

<sup>3</sup> 2020 Census

<sup>4</sup>  $F = P (1+I)^N$  where F = future population, P = present population (2020),  
I = growth rate (3%), N = Years

### ***1.3 Project Tasks***

Cache Landmark performed the following tasks to complete the plan:

- Gathered system information and flow data from the City
  - Mapped the existing collection system using data provided by the City
  - Added sanitary flows to the collection system based on winter culinary water meter data as recorded by city water meters
  - Added existing sewer flow meter data provided by the City
  - Performed a preliminary model calibration using existing flow data
  - Recommended temporary flow data collection sites
  - Collected data from 9 temporary meter sites to record existing flows and infiltration
  - Calibrated the model to match the metered flows
  - Met with City staff to identify poor condition location in the system
  - Made future flow projections for buildout based on input from city staff.
  - Identified capacity improvement projects needed for the existing system and buildout.
  - Listed conclusions and recommendations drawn from the master plan study
- Computer modeling software used to simulate the current and future sanitary sewer system capacity is a central component of these tasks. Chapter 3 discusses the software and planning parameters used for this study.

#### ***1.4 Master Plan Purpose***

The goals of this master plan are to:

- Create a detailed model that is efficient to operate and update
- Identify existing system limitations
- Identify future system limitations
- Master plan the collection system to serve North Logan City as future development occurs
- Provide a prioritized list of capital improvement projects

The purpose of this master plan is to provide a planning document and tools that help the City meet its future sewer collection system needs and guide future improvements. The City should revisit and update this document periodically. When there are any significant changes to the sewer system conditions, the City should update the hydraulic model to reflect the changes. Before designing any sanitary sewer facilities, the City should review the document and model to ensure that the conclusions made in the master plan are still valid.

## 2.0 DATA COLLECTION

### *2.1 Introduction*

Cache Landmark needed a considerable amount of data to construct a model of the collection system. Existing water use data, sewer flow data, and system mapping information were all needed.

### *2.2 Existing System Mapping*

The map of the existing collection system is based on data from the City GIS maps. See the existing sewer map in Figure 1 of Appendix A.

The mapping includes the following:

- Existing gravity sewer lines
- Existing City owned lift stations
- Existing North Logan City Limits
- Street Labels

Cache Landmark collaborated with North Logan City staff during mapping process to review the current GIS data. During the process, the City made updates to the geometry and data in the existing system GIS. The following section describes the updates. Going forward, the GIS will serve as the primary source of data. The model will align with latest GIS information.

#### *2.2.1 Establishing System Connectivity*

The modeling software requires all mapped pipes to be connected to convey model flows through the system. To achieve this, all manhole invert elevations and locations in the system were necessary. Cache Landmark followed steps outlined in the list to create system connectivity:

- Identified manholes that were missing elevations
- Met with North Logan City staff to review missing elevations
- Developed plan to receive the updated data
- Entered new invert elevations measured by the City into model
- Obtained light detecting and ranging (LiDAR) data for rim elevations of manholes where the City could not collect data
- Interpolated some invert elevations that did not come with the updated GIS data
- Added notes on interpolated manholes

The city gathered many invert elevations, but was not able to identify all elevations. Cache Landmark interpolated unknown invert elevations using the manholes nearby with elevations, then added notes to the model to track manholes with elevations that were calculated rather than measured.

There were also many pipes where the length was unknown. Cache Landmark calculated the lengths of many pipes using the invert elevations of the upstream and downstream manhole, then added notes to the model to identify calculated pipe lengths. Dead-end pipes and cleanouts shown in the GIS were either added as manholes or removed them from the model.

### ***2.2.2 Lift Station Information***

The City uses two lift stations to convey flows. Lift Station One is located at the northwest corner of the city. North Logan City staff provided pump information and wet well geometry for Lift Station One in the form of record drawings. Cache Landmark entered the pump parameters into the model. The second lift station, located near Green Canyon High School, is smaller than Lift Station One. Unfortunately, the City could not provide drawings or specifications for Lift Station Two. Due to the lack of information, the model does not include the smaller lift station. Instead, the model accounts for the flows added by Lift Station Two through calibration.

### ***2.2.3 Reverse Grade Pipes***

The GIS data included some reverse grade pipes. The following steps demonstrated if the pipes were truly sloping the wrong direction or if the manhole elevations were incorrect:

- Identified pipes with adverse slopes
- The City either verified or corrected the Manhole elevations
- Cache Landmark added the updated values to the model
- There are still 13 gravity pipes identified in the model with reverse grade slope. The model cannot calculate flows for gravity pipes with reverse grades. Cache Landmark assumed the downstream invert elevation is to be 0.01 feet lower than the upstream invert elevation so that the model can run.

### ***2.2.4 Drop Manholes***

The existing collection system includes many drop manholes, typically located in steeper areas of the City. Drop manholes typically have two inlet pipes on the upstream side of the manhole, with the upper inlet being mostly dry or completely dry. The dry pipe indicates the elevation of the pipe approaching the manhole. The upstream pipe has a vertical tee and vertical elbows, directing the incoming flow through a lower pipe to an elevation near the bottom of the manhole it enters.

North Logan City staff supplied drop manhole information and made new measurements of additional drop manhole elevations. The City should continue to identify drop manholes over time and update this information in the system GIS files.

This ongoing process ensures the model accurately reflects the presence and characteristics of drop manholes in the collection system.

### ***2.2.5 Pipe Diameter Adjustments***

Cache Landmark identified some pipes in the system data that did not appear correct. For example, some lines had pipes that were smaller than expected based on comparisons with surrounding pipes. In other places, a large pipe flowed into a smaller pipe. North Logan staff verified the actual sizes of these pipes, and Cache Landmark made the corrections in the model.

## ***2.3 Sanitary Sewer Flows***

Sanitary flows in the system come from homes or businesses and exclude any additional flows introduced in the form of infiltration or inflow (I & I). EPA recommends assuming that the daily sanitary sewer volumes from each sewer connection is equal to the culinary water usage recorded by individual water meters during winter months. In winter, most culinary water used enters the sewer collection system since outdoor water use is minimal.

The City provided culinary water meter records for the winter season of 2022-23. Cache Landmark found the average daily volume at each meter location, then added the flow from each water meter to the nearest sewer manhole.

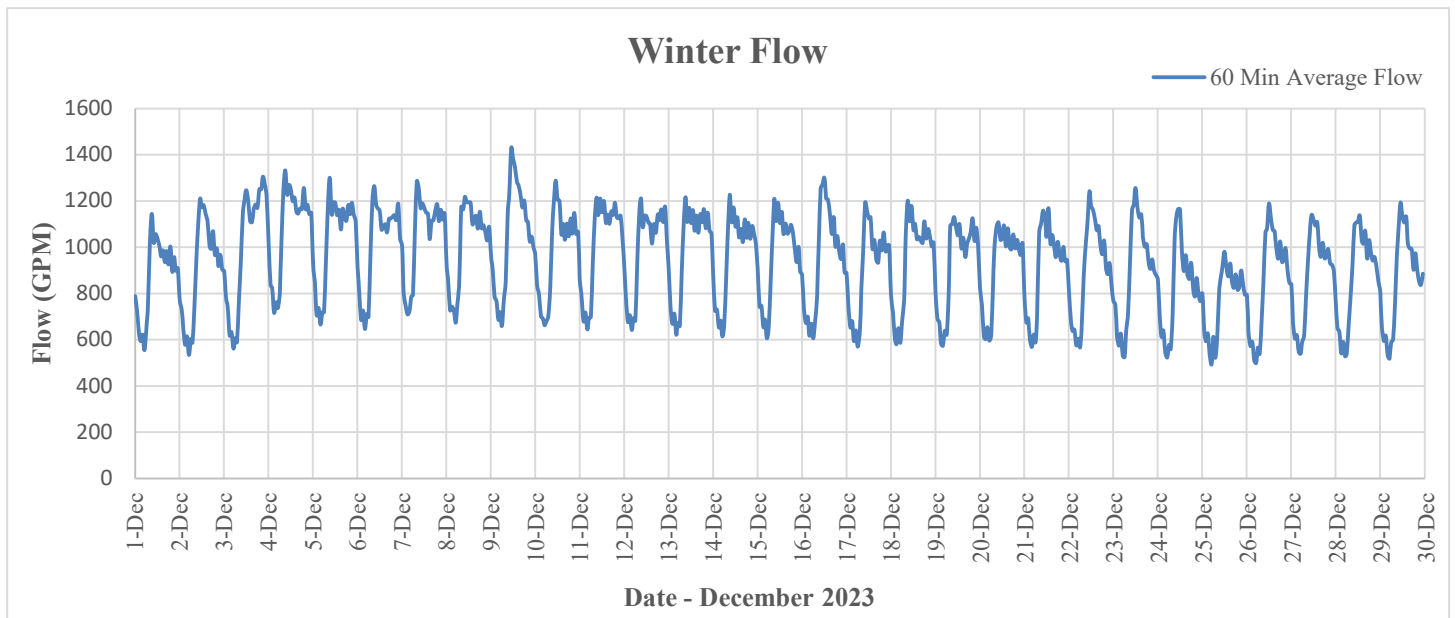
## ***2.4 Total Flows***

Total flows in the collection system consist of sanitary flows along with flows that enter the system in the form of inflow and infiltration. Flow data is critical to quantify the effects of I & I on the system.

Flow data is most useful for collection system master planning when it represents the highest seasonal flows that pass through the system. This allows for future pipe sizing to convey peak seasonal flows. Based on past meter records at the connection point to Logan City's sewer system, the highest flow typically occurs around March to April. Infiltration increases make up a large part of higher flows in the spring.

### ***2.4.1 Infiltration***

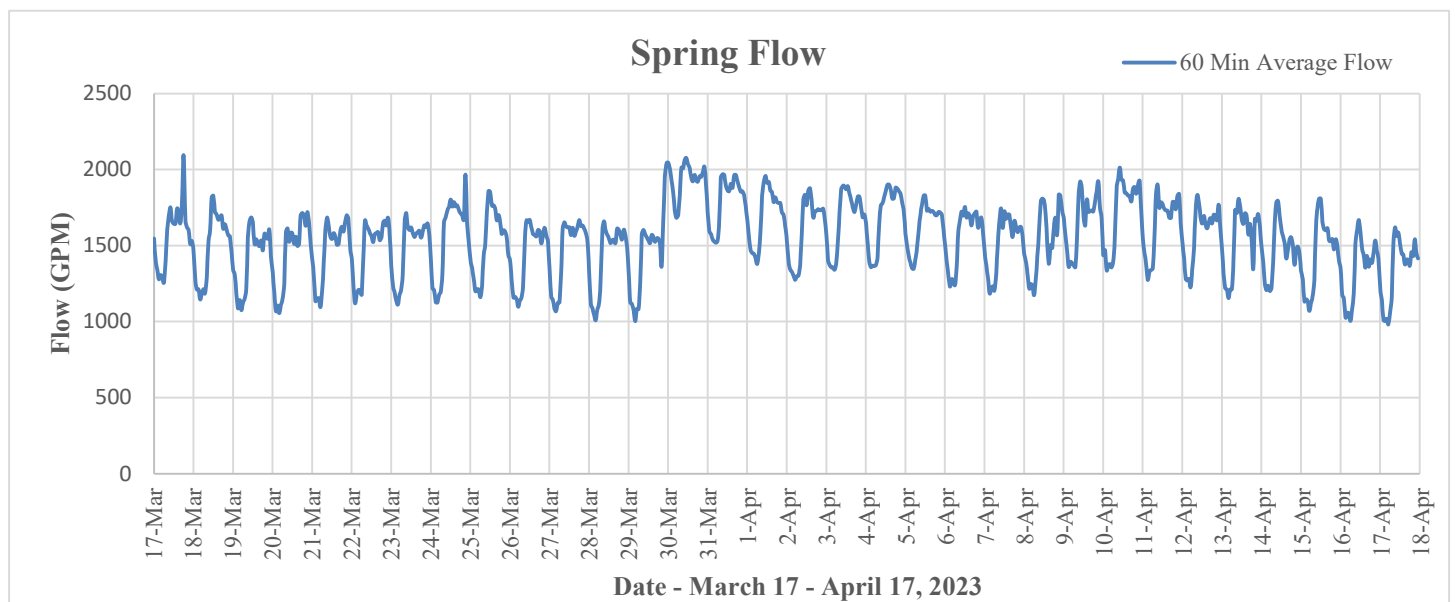
Infiltration is groundwater that enters the system through cracks, flawed joints, or other faulty sections of the pipes and manholes. Infiltration flows are usually slightly less than the total night time flows when most people are asleep. Graph 1 shows the wintertime flows recorded at the metering station where North Logan's system connects to Logan City's sewer system during December 2023.



**Graph 1: Wintertime Sewer Flows**

The base winter nighttime flow (infiltration) recorded by the meter during the winter is approximately 500 GPM.

In North Logan, the groundwater is very high on the west side of the city, west of the canal. The high groundwater leads to increased infiltration, especially in spring months when rainfall is high and groundwater rises. Graph 2 shows the spring time flows recorded at the permanent metering station in March to April 2023.



**Graph 2: Springtime Sewer Flows**

The base spring nighttime flow recorded by the meter is approximately 1,000 GPM. The recorded spring infiltration flows were approximately 500 GPM higher than the winter infiltration flows.

#### ***2.4.2 Inflow***

Inflow is the introduction of stormwater into the sewer system. This can occur during rainfall events or surface water runoff entering the sewer pipes through manhole covers or direct connections like drains or storm sewer connections. Inflow can contribute to overloading the sewer lines during heavy precipitation events. Inflow generally has a much lower impact on sewer flows than infiltration. The City must collect more data during rain events needs to gain an understanding of how inflow affects the North Logan system. Specifically, the City needs to evaluate the impact of rain from large precipitation events.

### ***2.5 Flow Data Collection***

North Logan staff installed temporary flow meters in the winter of 2023-2024 to gather flow data needed to calibrate the sewer model to match daily flows. They installed meters at strategic locations in the system to accurately demonstrate flows in the system. Cache Landmark used the temporary flow data and permanent meter data taken at the same time to calibrate the model.

#### ***2.5.1 Meter Schedule and Location***

The City used four temporary flow meters that they own to collect sewer flow data. The city took four separate sets of measurements. City staff collected data for approximately two-week periods from December 2023 to February 2024. After the first set of measurements, one meter broke, resulting in three usable meters for subsequent measurement sets. The meters collected a total of 9 flow rates. The start and end dates for the data collection vary slightly for some meter sites. Table 2 provides a summary of the meter schedule and the meter location.

**Table 2: Meter Schedule and Location**

Temporary Meter Schedule and Location			
Set 1			
Meter	Dates	Location	Description
1	12/14 - 12/27	2-105	1600 E 2500 N
2	12/13 - 12/27	3-171	600 E 2550 N
3	12/13 - 12/27	1-129	1200 E 3000 N
4	12/13 - 12/27	3-143	800 E 2900 N
Set 2			
Meter	Dates	Location	Description
1	1/3 - 1/23	4-038	860 E 2100 N
2	1/3 - 1/23	6-071	1000 E 1600 N
3	1/3 - 1/23	5-099	1000 E 1900 N
Set 3			
Meter	Dates	Location	Description
1	2/1 - 2/15	9-115	2600 N Wolf Pack Way
2	2/1 - 2/15	7-133	1850 N Main Street

### **2.5.2 Meter Equipment**

North Logan City public works staff measured flow data with four MantaRay optical sewer meters by Pulsar Measurement. The monitors measure flow depth, velocity, and temperature. The meter recorded measurements every five minutes during the metering period using a submerged ultrasonic sensor.

Logan City staff provided outflow data for the permanent meter located at the connection point of North Logan to Logan City's sewer system. The model utilized this data alongside the temporary flow meter data.

### **2.5.3 Flow Data Evaluation**

The City provided graphs of the data collected by the temporary flow meters. Appendix B includes the graphs of the following items for each of the temporary meter sites:

- Flow vs. Time
- Depth and vs. Time
- Velocity vs. Time
- Temperature

Appendix C includes notes and conclusions about the flows recorded at each of the temporary meters.

## **3.0 EXISTING SYSTEM ANALYSIS**

### ***3.1 Introduction***

Cache Landmark created and calibrated a computer model with EPA SWMM 5.2 modeling software. The model simulates and analyzes the existing flows in the collection system.

### ***3.2 Model Development and Assumptions***

The hydraulic model consists of the following inputs:

- Collection system geometry
- Flow input locations
- Sanitary flows
- Pump parameters
- Daily sanitary flow patterns (Diurnal Curves)
- Infiltration flows

Cache Landmark made some assumptions that characterize the area and system components. The following sections outline the key assumptions used in the existing system model.

#### ***3.2.1 System Geometry Assumptions***

The system geometry (Figure 1) consists of the following system components:

- Pipes
- Manholes
- Lift stations
- Force mains

Each of the components has an invert elevation, ground elevation, size, and other necessary information. The City GIS department provided the data for these elements. During the model building process, Cache Landmark found some errors and incomplete areas in the mapping. The City collected more data and increased the accuracy of information in the GIS system. Updating and adding data to the GIS layer will be an ongoing effort by the City, which will improve the accuracy of the model as the model reflects the changes.

#### ***3.2.2 Flow Input Location Assumptions***

Cache Landmark added sanitary flows to the modeled system based on wintertime culinary water meter data. Each water meter flow was assigned to the nearest sewer manhole upstream. Some manholes have multiple water meters' data combined as the flow into the manhole. Once Cache Landmark assigned meter flows to a manhole, they reviewed the sewer map to adjust flow input locations as needed.

### ***3.2.3 Sanitary Flow Assumptions***

The daily sanitary flows in the system are equal to the average daily culinary water use during the winter months. Sanitary flow does not include inflow or infiltration. The City provided culinary water meter as described in section 2.3 of this report.

### ***3.2.4 Diurnal Curve Assumptions***

Sewer flows fluctuate throughout the day. Diurnal curves are flow patterns that represent the changes in flow in a day. For the model, the temporary flow meter data was used to develop diurnal curves for different areas. The diurnal curve assigns a percentage of the total daily volume to each hour of the day for each of the curves.

Cache Landmark assigned one of these curves to each of the sanitary flows added to the model. All sanitary flows upstream of a temporary meter were assigned the diurnal curve developed from the meter. Each meter generally represents a single land use. There are many land uses and patterns that would vary flows slightly. For the model, Cache Landmark accounted for the variation through the meter diurnal curves.

### ***3.2.5 Infiltration Assumptions***

Infiltration is a constant base flow that is approximately equal to the nighttime base flows. The temporary meter data and permanent flow meter data was used to estimate the infiltration values.

Because of the limited number of temporary meters, Cache Landmark made some assumptions about what specific areas between meters have more infiltration than others. North Logan public works staff advised Cache Landmark on what areas they have observed to have significant infiltration. Areas with high groundwater west of the canal tend to have higher infiltration.

Areas of the sewer system were categorized into different rates of infiltration. Cache Landmark adjusted the model infiltration values until the amount of infiltration added per manhole matched the flows recorded by the temporary meters.

Table 3 lists the rates of infiltration added to each zone in the sewer system. Additional infiltration was added to individual manholes that were marked to have significant infiltration in the GIS data.

**Table 3: Infiltration Rates**

<b>Infiltration Rates</b>	
<b>Zone</b>	<b>Flow (GPM/MH)</b>
1	0.1
2	0.1
3	0.2
4	0.2
5	0.3
6	0.0
7	2.5
8	1.5
9	1.5

### ***3.2.6 Inflow Assumptions***

No inflow was added to the model since infiltration is assumed to be a much larger contributor than inflow. The small rain event recorded by the temporary meter did have some effects of the flow, but the City must collect more data during rain events to quantify the effects of inflow on the system.

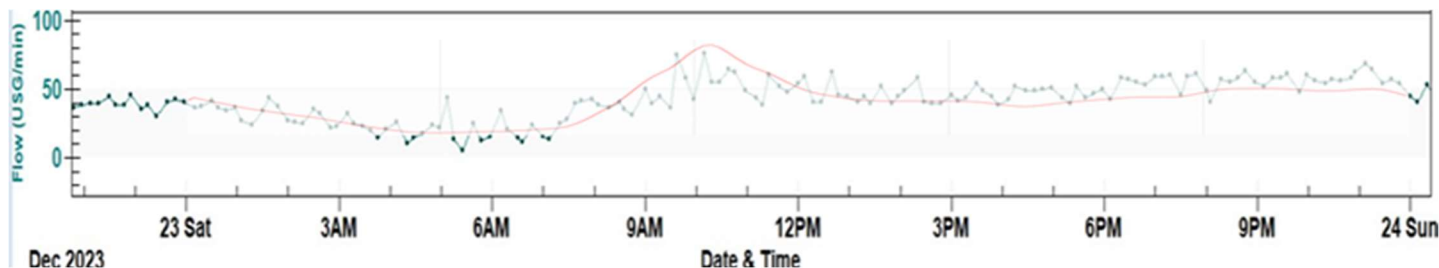
### ***3.3 Model Calibration***

Cache Landmark calibrated the model by adjusting input parameters until the modeled flows and the actual system flows recorded by the meters matched. The first step in this calibration process involved selecting a day to match the real-life data to the model. Cache Landmark deliberately selected a day with high flows to prevent any potential underestimation of current or future flows.

Since the City measured flows over three separate time periods, a day with high flows was used for calibration for each set of measurements. The City chose the following high flow days for the data sets:

- December 23, 2023
- January 16, 2024
- February 7, 2024

Cache Landmark superimposed the flow graphs from the City meters with the model curves. Then, the model flow was adjusted to match the metered flow. The diurnal curves and infiltration amounts were the only aspects adjusted in the model due to the higher uncertainty of the accuracy of values originally entered. Graph 3 shows an example of one of the calibration flow graphs. The graph demonstrates the relationship between the data from the temporary meter vs. the metered values. Appendix D includes all flow calibration graphs and shows the model flows compared to actual metered flows. A summary of how the flows in the calibrated model compare to the flow meter values is found in Appendix E.



Graph 3: Example Calibration Graph

### 3.4 Existing System Evaluation

The existing model simulates the existing flows based on winter culinary water usage along with infiltration to match the flows recorded in the winter of 2023-2024. Cache Landmark evaluated the maximum over full depth and reserve capacity in the following sections.

#### 3.4.1 Maximum over Full Depth (d/D)

Depth of flow divided by the diameter of the pipe is one way that illustrates how full a pipe is and how well the system handles the flows. A full pipe would have a d/D value of 1, while a pipe flowing half full would have a value of 0.5.

The SWWM software reports this value as a “Max/Full Depth” value. Maximum depth is the maximum depth of the flow in the pipe during the simulation (d). Full depth is the maximum diameter of the pipe (D). Larger pipes have more capacity for equivalent d/D values when compared to a smaller pipe.

The d/D values for each pipe are shown in Figure 4: Existing Depth over Diameter. The values in the figure represent the peak time of the day. City staff outlined a full pipe as one flowing over 50% full for 8-inch pipes and 75% full for larger pipes.

#### 3.4.2 Reserve Capacity

Reserve capacity is a measure of how much flow the population can add to a pipe segment before it is full. Cache Landmark calculated reserve capacity of the pipes by using the statistics report in SWWM. The pipe’s maximum depth over diameter measured in the model was subtracted from the value for full depth over diameter. The difference represents the capacity remaining in the pipe.

The calculated reserve volume is an approximation of the actual reserve capacity because there are three depths in each pipe: upstream end, middle, and downstream end. The calculation is an average value for the entire pipe length. The reserve capacity of each of the existing pipes under existing peak flow conditions is shown in Appendix G.

Some pipes have zero or negative reserve capacity. This happens in short, flat, segments of pipe that do not have enough space to convey the flow based on the equation used to calculate capacity. In areas where the downstream pipes are steeper, the hydraulic grade line never actually reaches the top of the pipe. This means that even though the reported reserve capacity is not positive, the pipe is not actually full. Areas with high d/D values were flagged in the model.

### ***3.5 Existing System Improvements***

Cache Landmark identified the highest priority system improvement projects through the existing system evaluation. The improvements are grouped into the following sections outlined in this section.

#### ***3.5.1 Locations to Monitor (Near Capacity)***

The model results show that some areas are approaching or above capacity limits. Due to the broad application of groundwater infiltration rates, it is possible that these are not truly problem areas. The City should monitor these to verify the actual flow conditions match the model. See locations to monitor in Appendix F.

North Logan can install the temporary meters they own to monitor these areas during spring months. The flows in the sewer system are usually the highest between March and April. The City should install the meter for one to two weeks to record a flow that is close to the peak flow.

The City may monitor an area multiple times in the future and determine that it is not a problem area, or may continue monitoring because it is near capacity. If the location appears to be over capacity consistently, the City may plan a project to either add capacity or divert flows through a different path in the collection system. If the temporary meter results are consistently very different from the model outputs, the City may choose to adjust the flow inputs in the model upstream of the monitor location.

#### ***3.5.2 Capacity Improvements***

Certain areas in the collection system do not have enough capacity and require capacity improvements. Figure 5 identifies the existing areas in need of improvement. Necessary improvements to have enough capacity for buildout are outlined in Table 4. The improvements are organized in order of priority, number one being the highest priority. See appendix A for a map of the capacity improvements.

**Table 4: Capacity Improvements**

<b>Capacity Improvements</b>			
<b>Number</b>	<b>Project Description</b>	<b>Pipe Size</b>	<b>Cost Estimate</b>
1	Install new trunk line along 2200 N	21 in.	
2	Move metering station to border of North Logan and Logan city		
3	Install new gravity pipe to turn flow on 1800 N 400 E to the north. Connect to the existing 18 in. pipe	18 in.	
4	Install new gravity pipes along 2500 N to connect 300 E to 400 E	10 in.	
5	Install new gravity pipes along 2500 N to connect gaps from 500 E to 1600 E	8 in.	
6	Connect gravity pipes between 400 E and 600 E along 2200 N	10 in.	
7	Pipe Burst along 2500 N, from Main Street to 300 E	10 in.	

## 4.0 MASTER PLAN AND RELIEF ALTERNATIVES

### 4.1 Introduction

This master plan evaluates both the existing flows and build out flows. The master planning part of the study involves applying the population projections in the model to identify future system improvements and needs.

Build out is the time when all area in the boundaries of the city develop into their planned densities as identified by the current zoning ordinances. Based on a 3% growth rate and the planned densities, the City will reach buildout around 2044. The hydraulic model is a tool used to size the future capacity improvements.

### 4.2 Key Assumptions for Future Models

For the future projections, Cache Landmark assumed the following:

- North Logan City growth rate of 3%
- City growth areas – Cache Landmark used GIS data provided by the Cache County GIS department to identify vacant land in the city that has a possibility of future development. North Logan staff also advised what areas are projected to develop first.
- Build out year of 2044
- Average sanitary flow per future residential unit (0.229 GPM) – The flow is based on Utah Code R317-3-12 which recommends a design flow of 100 gallons per capita per day in residential areas. This flow is assuming 3.3 people per equivalent residential connection.
- Diurnal curves are assigned to the future sanitary flows based on the area of the system the future flow is added to. The diurnal curves used were the same curves developed from the temporary meter data.
- Infiltration rates were assumed to be the same as current infiltration rates in the adjacent areas.
- Table 5 lists future pipe design parameters.

**Table 5: Future Design Parameters**

Future Design Parameters			
Diameter (in.)	d/D Allowed <sup>1</sup>	Allowed Flow Depth (in.)	Minimum Slope <sup>2</sup>
8	0.5	4	0.334%
10	0.5	5	0.248%
12	0.5	6	0.194%
18	0.75	13.5	0.113%
21	0.75	15.75	0.092%
24	0.75	18	0.077%

<sup>1</sup> Standard of practice based on ASCE Manuals of Reports on Engineering Practice #60 – Gravity Sanitary Sewer Design and Construction

<sup>2</sup> Table R317-3-2.3(D)(4) Utah Admin Code

### ***4.3 Creation of Future Models***

Cache Landmark created the build out model based on the future model assumptions listed in section 4.2 and through iteration. Iteration was used to identify the most efficient way to provide capacity for the future demand. The build out model provides the sizes for any new pipes that the City will install to serve the buildout growth.

Future flows were based on the assumptions for average flow per residential unit listed in section 4.2. For commercial areas, flow was added based on a report by Sargent Engineers that indicates that the flow rates for commercial areas are 4,000 gallons per acre per day in North Logan. For each parcel of vacant land, the model future flows were based on the projected number of units multiplied by the average sanitary flow per unit. The flows were added to the nearest manhole to the vacant parcel. Infiltration was added based on current infiltration values for the area.

### ***4.4 Evaluation and Results***

The buildout model scenario assumes that the City has already made the capacity improvements outlined in Table 4. An overview of the d/D values in the system with the projected buildout flow and improvements is shown in Figure 7: Build Out Depth over Diameter.

The capacity improvements needed between now and build out include four upgrades to the existing system. These upgrades include one pipe burst to increase the size of pipe and adding new connecting pipes to the collection system to divert flows.

## 5.0 USER RATE AND IMPACT FEE ANALYSIS

### 5.1 Impact Fee Analysis

The City uses impact fees to pay for improvements to the system that are necessary for new development. This section discusses what the impact fee can cover and the method of implementing an impact fee. The impact fee in this analysis is based on the portion of a project that is available for new ERUs. This section calculates the maximum impact fee, but North Logan may charge an amount equal to or less than the maximum.

#### 5.1.1 Impact Fee Eligibility

An impact fee can only cover the cost of system improvements that are necessary for future growth and new development. Impact fees cannot be used to fix current system deficiencies. Table 6 outlines all future projects along with their impact fees.

**Table 6: Impact Fee Analysis**

<b>Impact Fee Analysis Summary</b>				
<b>Project</b>	<b>Engineers Cost Estimate</b>	<b>Future Development Share</b>	<b>Future ERU</b>	<b>Impact Fee Eligible cost</b>
<b>2500 N Line Connection</b>				
	300-400 E	17%	5520	
	550- 600 E	18%	5520	
	800 E	15%	5520	
	1250 E	16%	5520	
	1250 - 1600 E	22%	5520	
<b>2500 N Pipe Burst</b>				
		15%	5520	
<b>2200 N Improvements</b>				
	400 - 600 E Connection	30%	5520	
	Trunk Line	50%	5520	
<b>1800 N 400 E Pipe Turn</b>				
		53%	5520	
<b>New Metering Station</b>				
		37%	5520	

#### 5.1.2 Impact Fee Assessment Method

The North Logan City impact fee is based on the share of a project that is available for future development and the number of equivalent residential units a connection is equal to. An impact fee also relies on projected ERUs. New ERUs are determined by the difference between the total projected ERUs for a given time and the total current ERUs.

If a project increases the sewer flow rate above the current flow, it becomes eligible for an impact fee. The future development share is represented as a percentage and varies for each project.

### ***5.1.3 Impact Fee Calculation***

To compute the impact fee, Cache Landmark projected the number of future ERUs for the growth period. Based on ERU projections, there will be an additional 5520 ERUs from now until buildout.

The impact fee is calculated by multiplying the future development share percentage described in section 5.1.2 by the estimated cost of the project. The resulting value is the impact fee eligibility cost. The impact fee for residential users is calculated by dividing the impact fee eligibility cost by the new ERUs within the given period.

## 6.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on the sewer system evaluation.

**Existing System Geometry** – The city has not fully updated some system geometry. This includes invert elevations and other geometry.

- Update the City Gravitational Information System (GIS) data to include new manhole inverts and incorrectly measured inverts.
- Ensure GIS data accurately reflects the current state of the system.
- Continue to update the system GIS files, then update the model to match.
- In the future, the GIS data will be the parent data for the model.

**System Infiltration** – Total approximate winter infiltration recorded at the sewer meter is approximately 500 gallons per minute (GPM) based on the nighttime flows. The spring infiltration is approximately 1,000 GPM. A large portion of the infiltration comes from the area of the city west of the canal where the groundwater is high.

- Implement more flow monitoring in the west side of the city
- Conduct an inflow/infiltration study to identify specific sources of infiltration. This will lead to more effective efforts to reduce the infiltration.

**System Inflow** – Sewer meters recorded some inflow from small rain events while gathering flow data for the master plan.

- To accurately assess the impact of inflow on the system, collect flow data during significant rain events.

**Existing Pipes Near Capacity** – Figure 4 highlights some pipes nearing capacity in the model.

- To address this issue, actively monitor these areas using the city-owned meters during the spring months.
- If the pipes in these locations reach full capacity, implement capacity improvements.
- If the pipes are not at full capacity, adjust the upstream infiltration inputs in the model to represent actual flow conditions.

**Existing Over Capacity Areas** – Some pipes in the existing system are over capacity at peak flow times.

- Design and build the improvements listed in Table 4 of the report to add additional capacity.

**Future Areas Near or Over Capacity** – At build out, some areas will approach or exceed capacity based on the assumed growth projections.

- Monitor the areas approaching capacity with the city owned meters in the future during spring months.
- Begin plans to build the improvements in Table 4 of the report to prevent the future over capacity areas.

**Future Trunk Lines** – The city is currently building a new trunk line to serve the city. The City completed phases one and two out of seven total phases.

- Continue to build the planned trunk lines outlined in the trunk line master plan shown in Figure 8.

**Computer Model** - The detailed computer model identifies impacts of new developments.

- Use the existing model to assess the effects of proposed new developments or redevelopment to higher densities.
- Update the model regularly with updated system information from the GIS database.

## References

- ASCE. (2007). Gravity Sanitary Sewer Design and Construction. 60.  
<https://doi.org/10.1061/9780784409008>
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<https://gomb.utah.gov/budget-policy/utahseconomy/>
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<https://www.census.gov/quickfacts/fact/table/northlogancityutah/HSG650222>

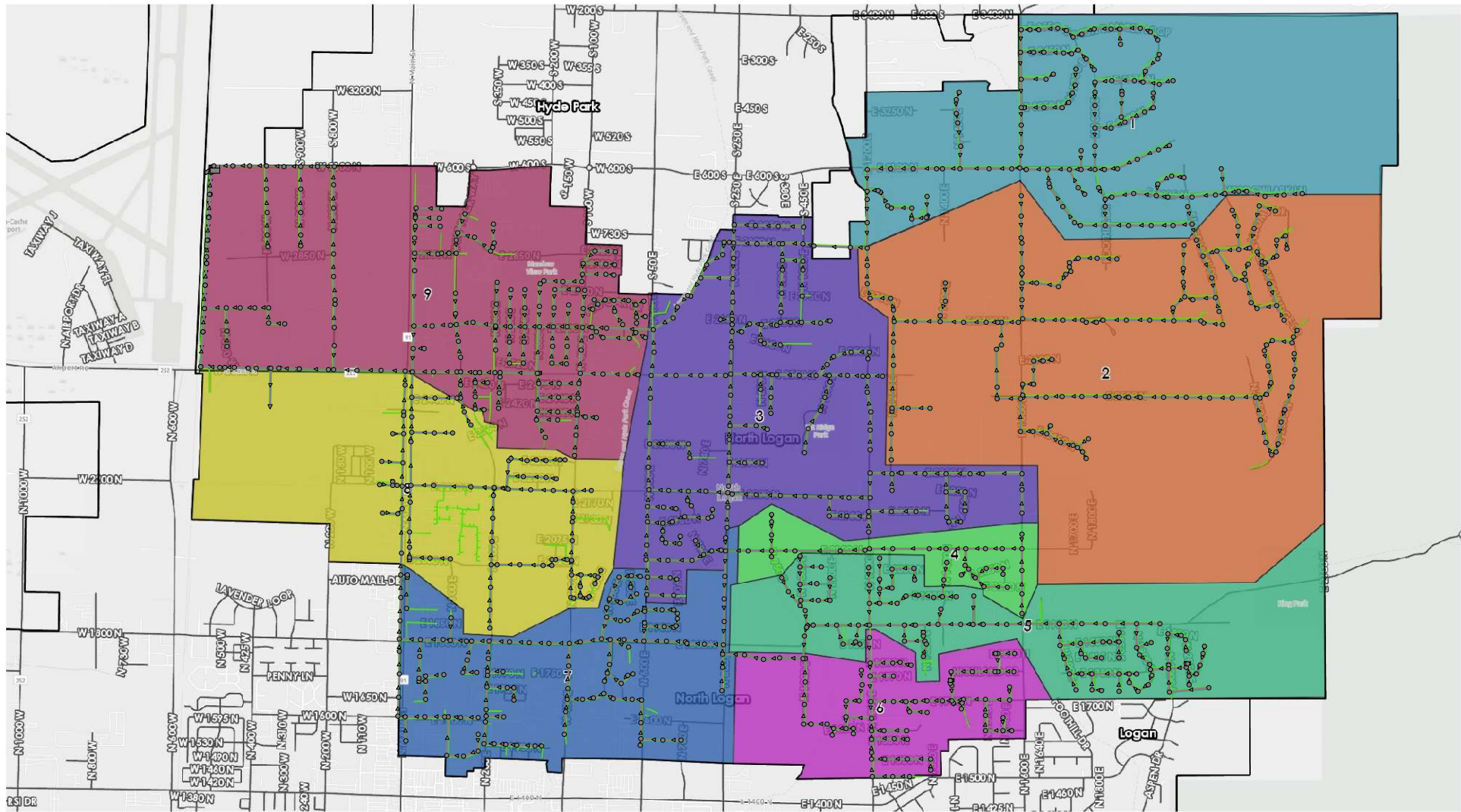
# **Appendix A**

## Distribution System Maps

- Figure 1 Existing Collection System**
- Figure 2 Infiltration Rates**
- Figure 3 Existing Depth over Diameter**
- Figure 4 Buildout System Map With Capital Improvements**
- Figure 5 Vacant Land and Projected Growth**
- Figure 6 Build Out Reserve Capacity**
- Figure 7 Trunk Line Master Plan**



# Infiltration Rates

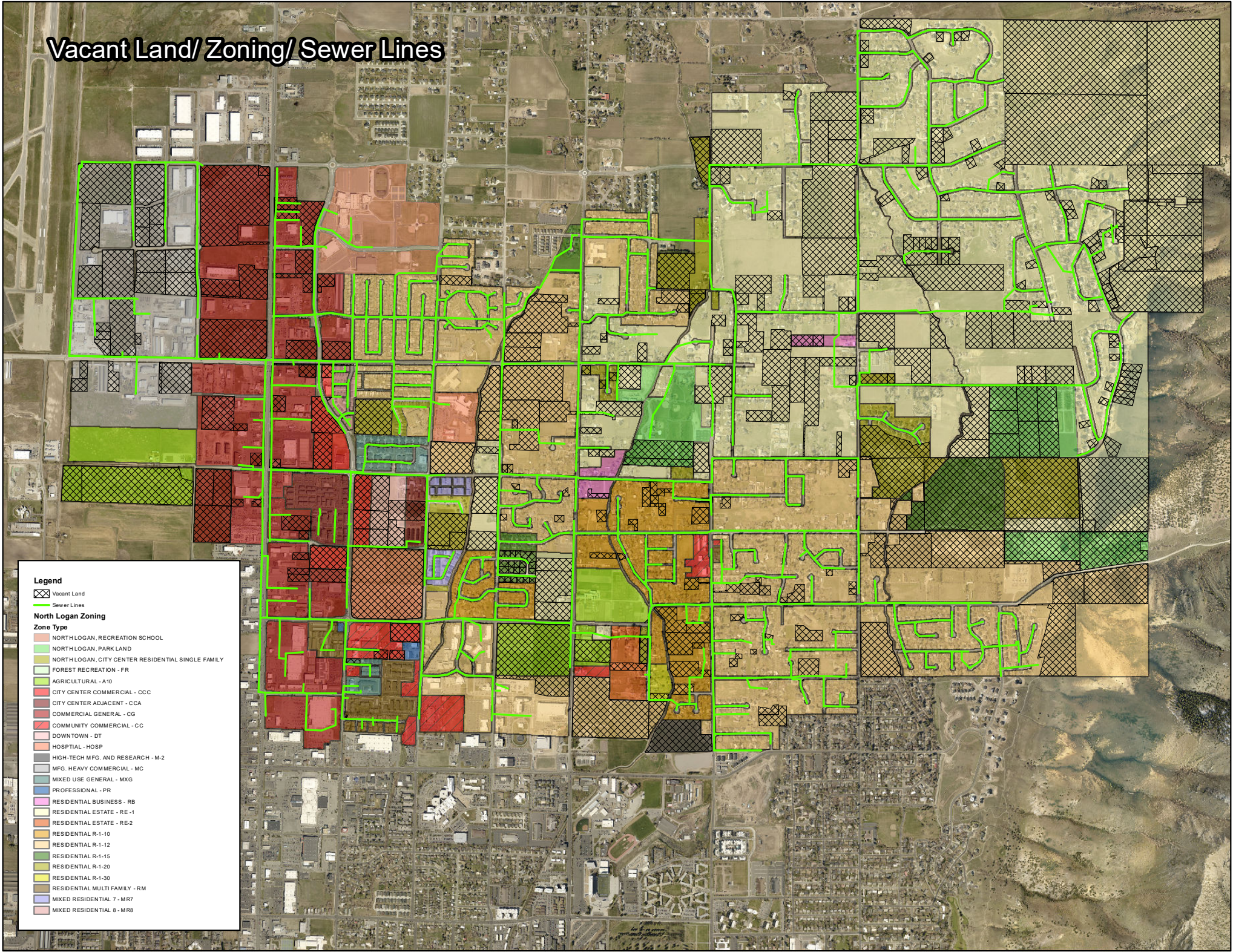


Legend	
Infiltration Rates (GPM)	
1 -	0.1
2 -	0.1
3 -	0.2
4 -	0.2
5 -	0.3
6 -	0
7 -	2.5
8 -	1.5
9 -	1.5





# Vacant Land/ Zoning/ Sewer Lines



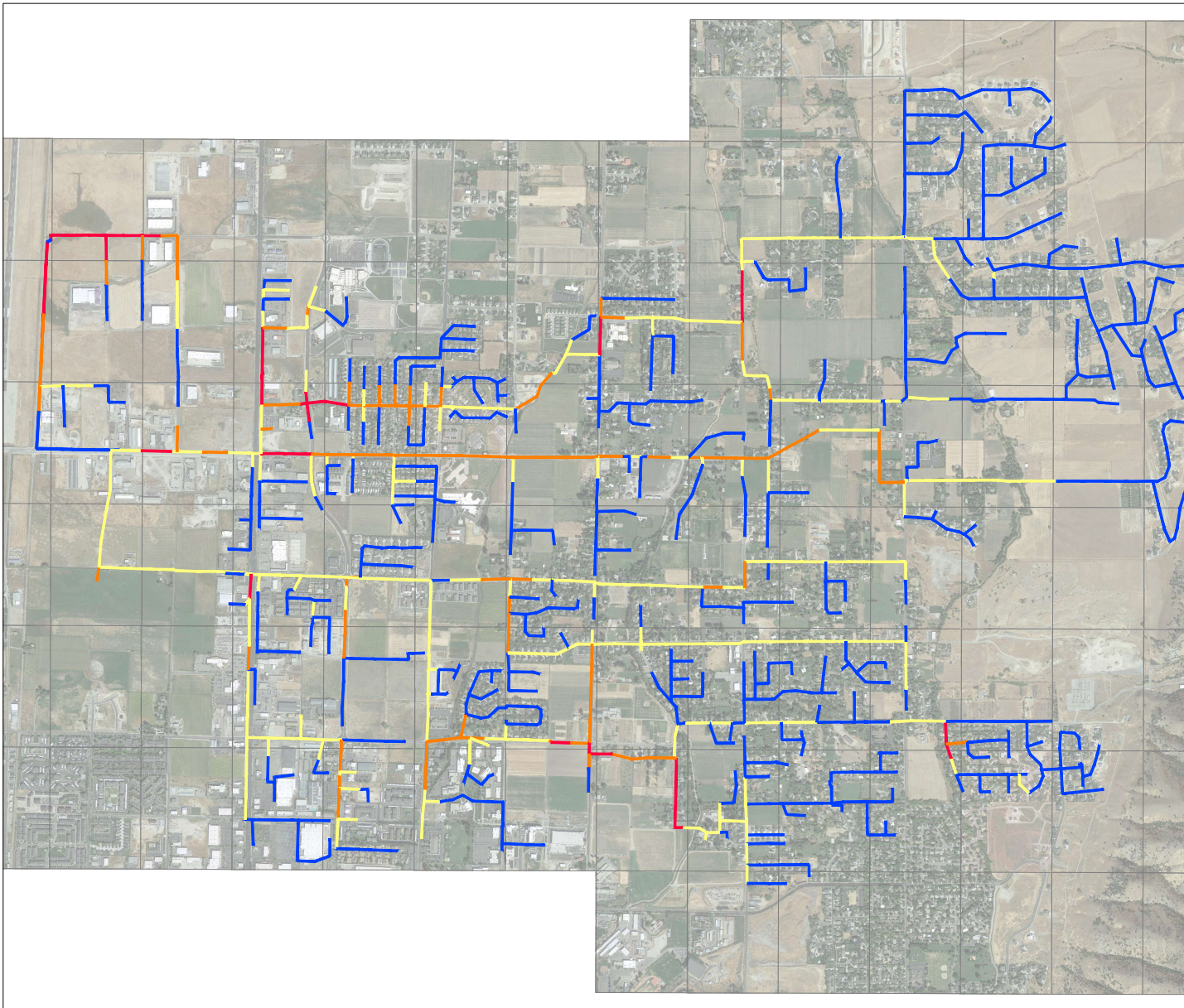
**Legend**

- Vacant Land
- Sewer Lines

**North Logan Zoning**

**Zone Type**

- NORTH LOGAN, RECREATION SCHOOL
- NORTH LOGAN, PARK LAND
- NORTH LOGAN, CITY CENTER RESIDENTIAL SINGLE FAMILY
- FOREST RECREATION - FR
- AGRICULTURAL - A10
- CITY CENTER COMMERCIAL - CCC
- CITY CENTER ADJACENT - CCA
- COMMERCIAL GENERAL - CG
- COMMUNITY COMMERCIAL - CC
- DOWNTOWN - DT
- HOSPITAL - HOSP
- HIGH-TECH MFG. AND RESEARCH - M-2
- MFG. HEAVY COMMERCIAL - MC
- MIXED USE GENERAL - MXG
- PROFESSIONAL - PR
- RESIDENTIAL BUSINESS - RB
- RESIDENTIAL ESTATE - RE-1
- RESIDENTIAL ESTATE - RE-2
- RESIDENTIAL R-1-10
- RESIDENTIAL R-1-12
- RESIDENTIAL R-1-15
- RESIDENTIAL R-1-20
- RESIDENTIAL R-1-30
- RESIDENTIAL MULTI FAMILY - RM
- MIXED RESIDENTIAL 7 - MR7
- MIXED RESIDENTIAL 8 - MR8



**LEGEND**

- ABOVE CAPACITY  
 $Q/D > 50\%$  FOR 8" TO 12"  
 $Q/D > 75\%$  FOR 18" TO 24"
- NEAR CAPACITY  
 $40\% < Q/D < 50\%$  FOR 8" TO 12"  
 $65\% < Q/D < 75\%$  FOR 18" TO 24"
- APPROACHING CAPACITY  
 $Q/D > 25\%$
- BELOW CAPACITY  
 $Q/D < 25\%$

NO.	DATE	DESCRIPTION

**BUILDOUT SYSTEM  
PIPE CAPACITY**

**SEWER MASTER PLAN  
NORTH LOGAN CITY  
NORTH LOGAN, UTAH**



Cache • Landmark  
 Engineers  
 Surveyors  
 Planners

95 Golf Course Rd.  
 Suite 101  
 Logan, UT 84301  
 435.713.0999

DATE:  
 30 JULY 2024

SCALE:  
 1" = 800'

DESIGNED BY:  
 A. MCALLESTER

CHECKED BY:  
 L. ANDERSON

APPROVED BY:  
 L. ANDERSON

PROJECT NUMBER:  
 688-1906

SHEET:  
 1/1



# **Appendix B**

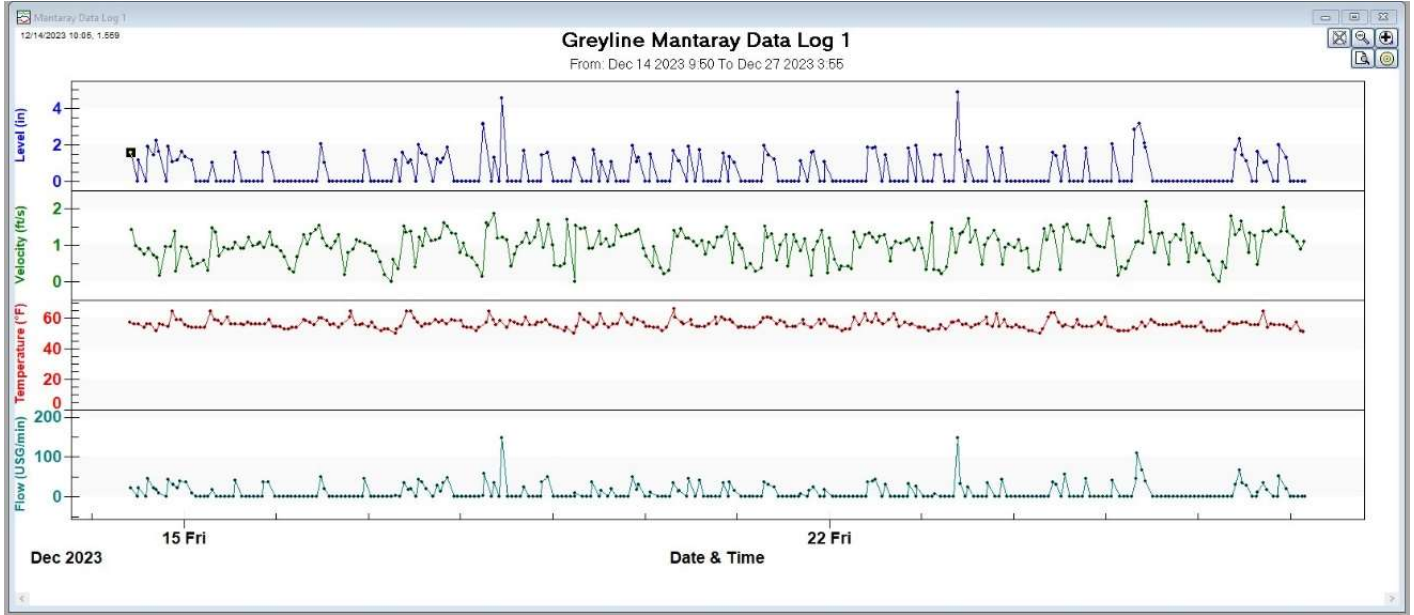
## Temporary Flow Meter Graphs

This appendix includes the following four graphs for each of the 9 temporary meter sites.

- Flow Versus Time
- Depth Versus Time
- Velocity Versus Time
- Temperature

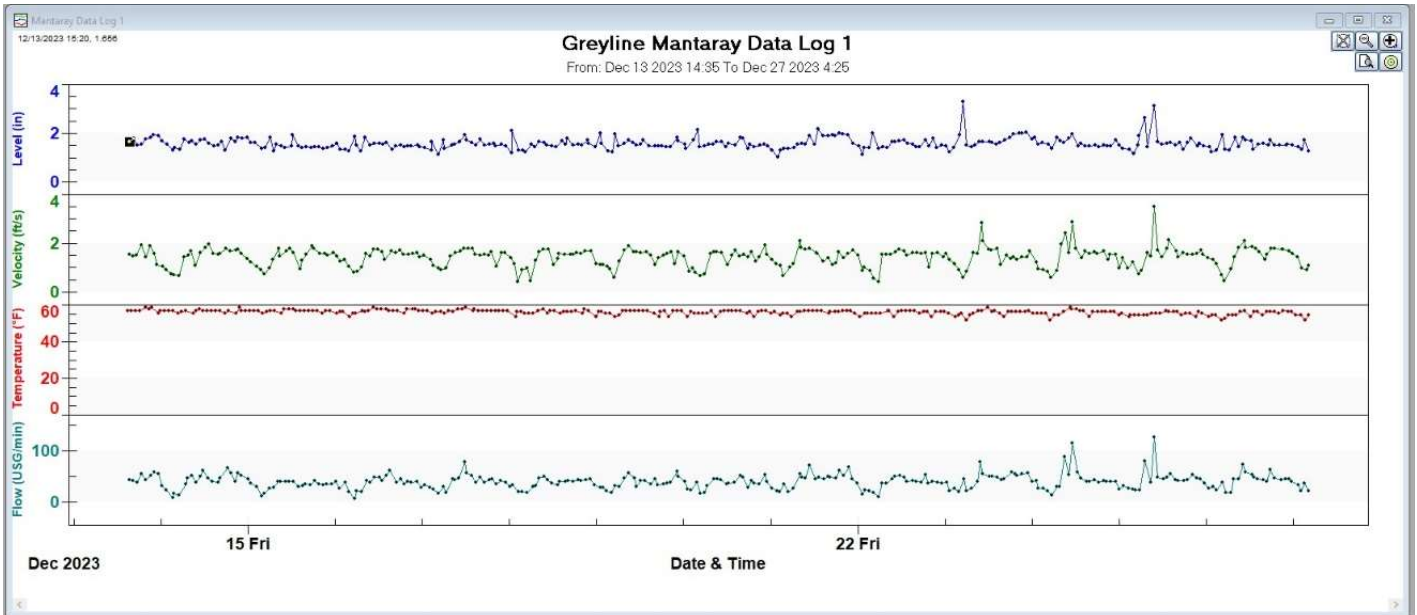
**Set 1 - Meter 1 (2-105)**

Min Flow	0 gpm
Max Flow	163.77 gpm
Average Flow	2.08 gpm

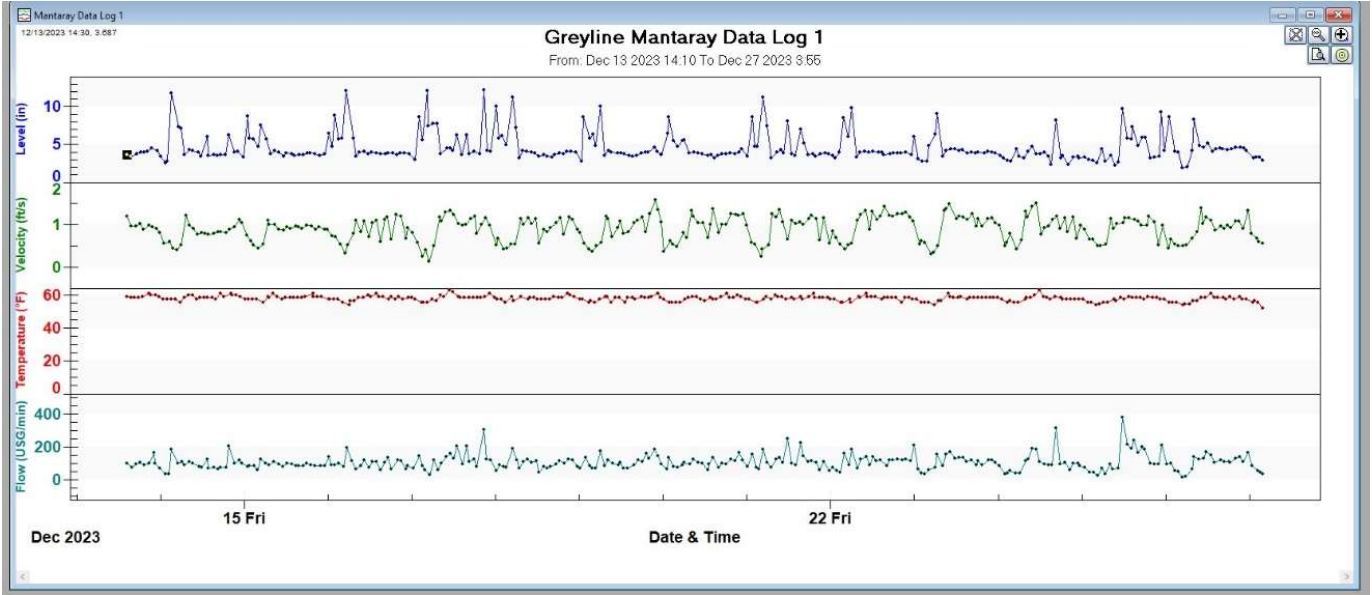


**Set 1 - Meter 2 (3-171)**

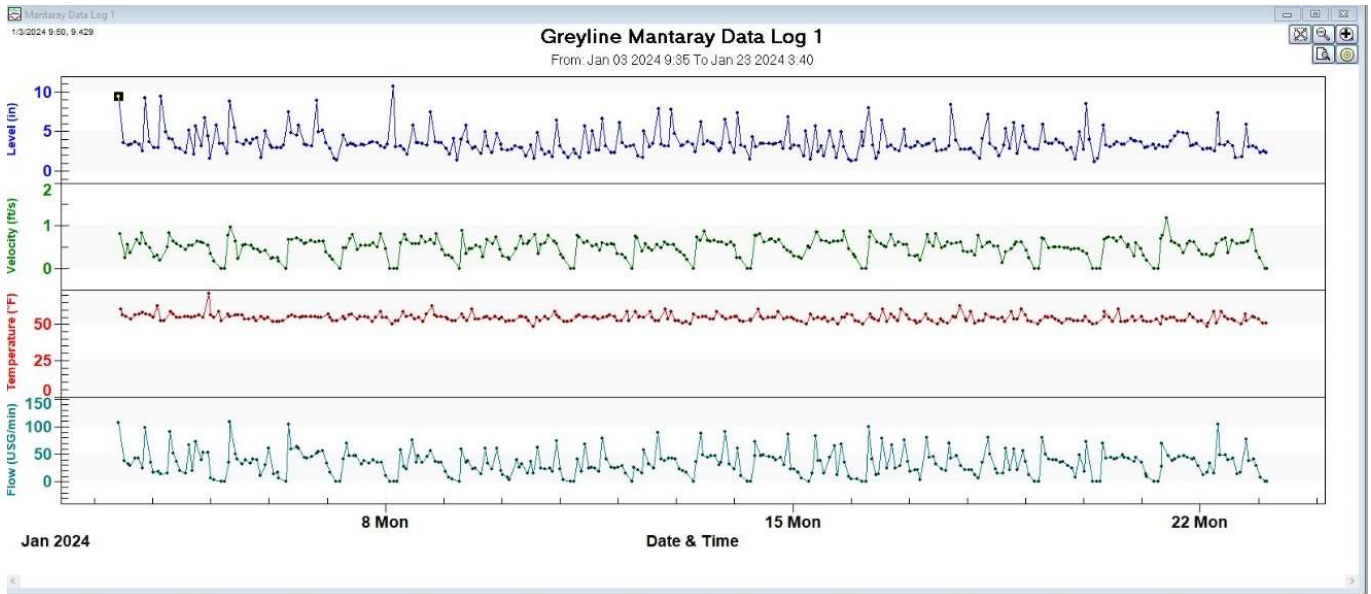
Min Flow	7.01 gpm
Max Flow	99.50 gpm
Average Flow	37.81 gpm



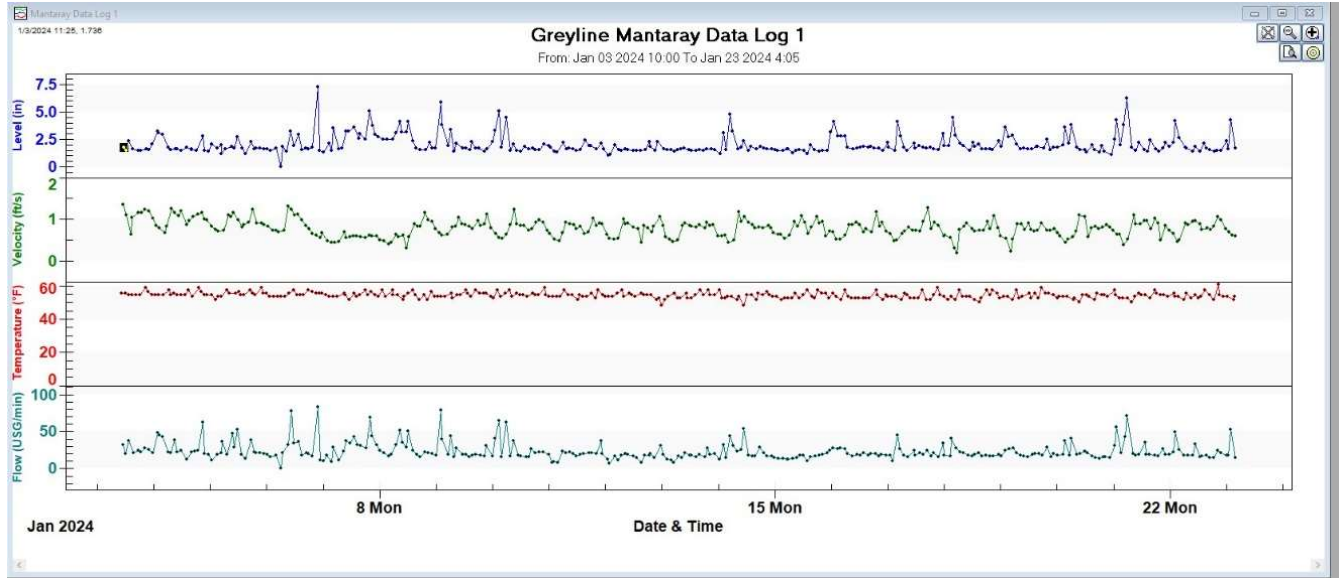
<b>Set 1 - Meter 4 (3-143)</b>	
Min Flow	7.7 gpm
Max Flow	318.24 gpm
Average Flow	91.89 gpm



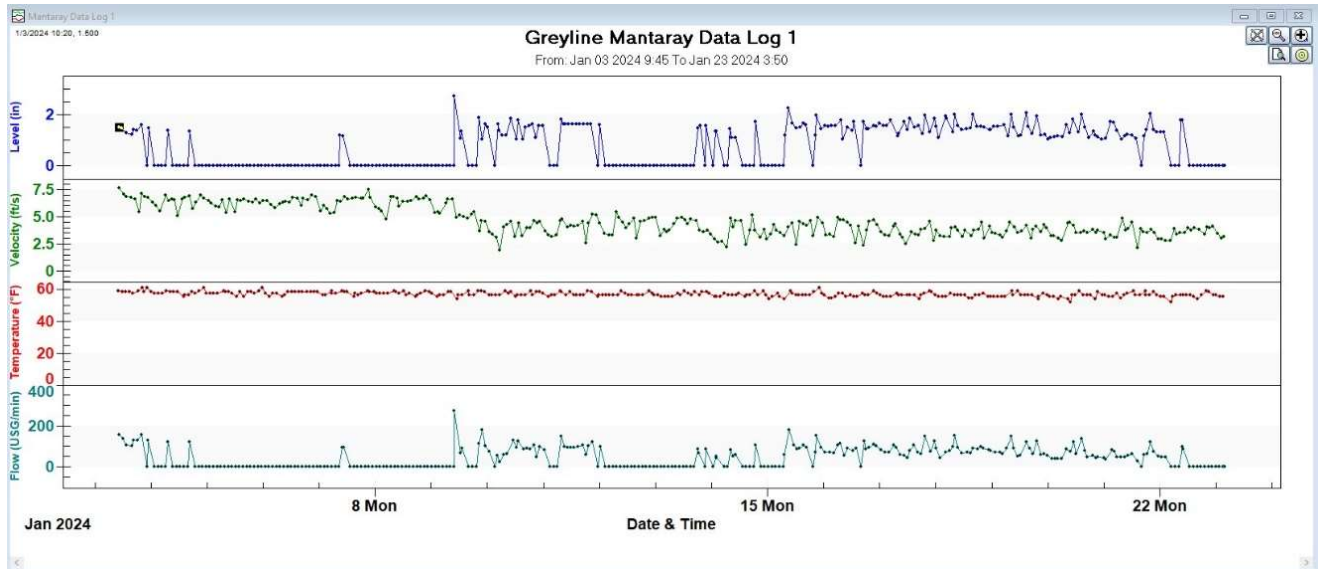
<b>Set 2 - Meter 1 (4-038)</b>	
Min Flow	0 gpm
Max Flow	115.51 gpm
Average Flow	17.65 gpm



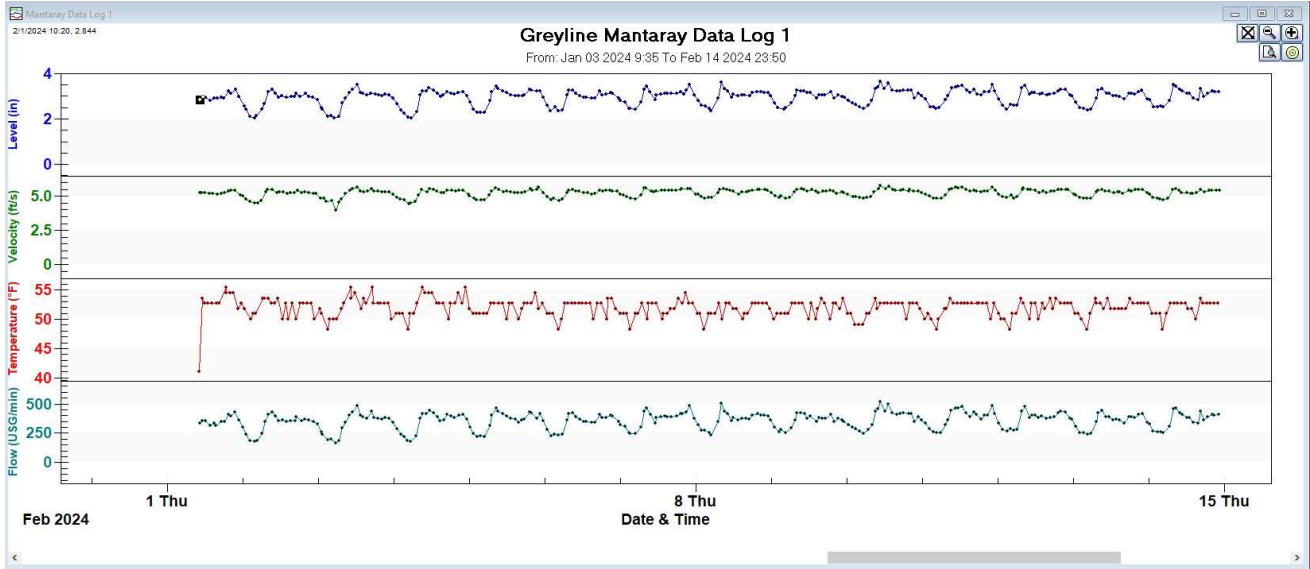
<b>Set 2 - Meter 2 (6-071)</b>	
Min Flow	4.30 gpm
Max Flow	102.52 gpm
Average Flow	18.0 gpm



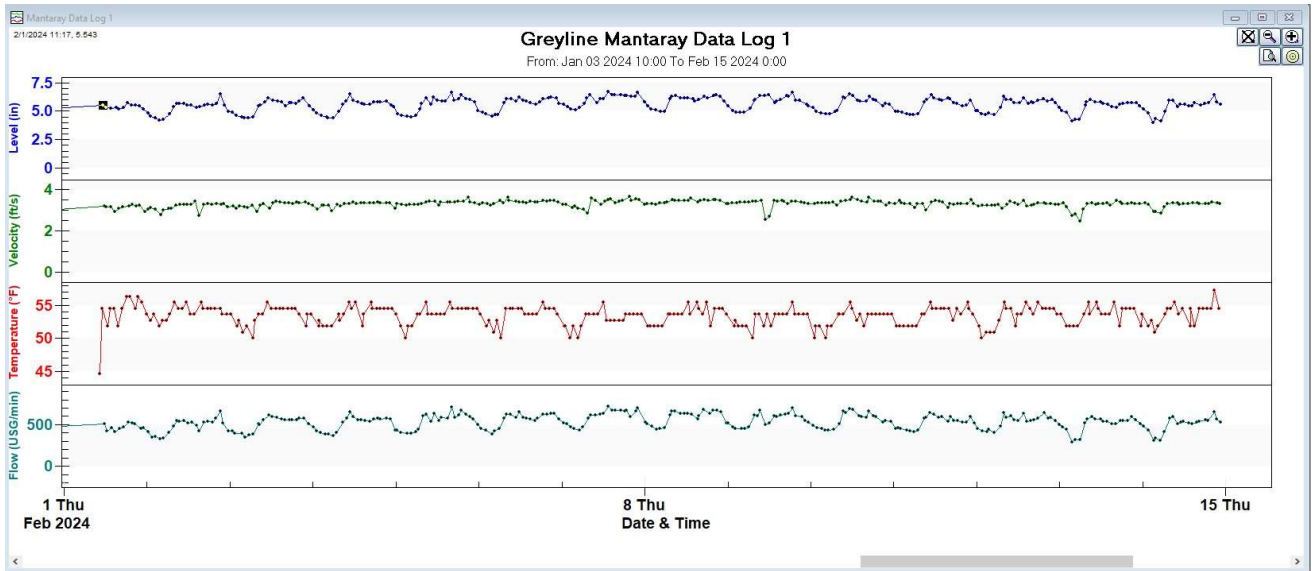
<b>Set 2 - Meter 3 (5-099)</b>	
Min Flow	29.91 gpm
Max Flow	297.67 gpm
Average Flow	44.81 gpm



<b>Set 3 - Meter 1 (9-115)</b>	
Min Flow	147.75 gpm
Max Flow	519.73 gpm
Average Flow	347.93 gpm



<b>Set 3 - Meter 2 (7-133)</b>	
Min Flow	278.97 gpm
Max Flow	744.09 gpm
Average Flow	520.74 gpm



# **Appendix C**

Temporary Flow Meter Notes

## Temporary Flow Meter Data Notes and Conclusions

Some notes and conclusions about flows recorded during the winter of 2023-2024 at each of the following temporary meter sites:

### *1 Set 1 - Meter Site 1*

**Description:** Placed in manhole 2-105 located on the west side of the street at 1600 E 2500 N. The pipe measured was 10 inches in diameter.

**Peaks:** The peak flow was approximately 160 GPM.

**Infiltration:** There was very little base infiltration in this area. We assumed 5 GPM of infiltration comes from this area based on the temporary meter data.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure. There are some steep slopes leading to higher max velocities in this area. The depth and velocity correlations indicate that there were no flow backups during the meter period.

**Other:** Zero read indicates no flow or loss of signal. Time of day for minimum flow registered relatively regularly.

### *2 Set 1 - Meter Site 2*

**Description:** Placed in manhole 3-171 located east of the canal, approximately 400 feet north of 600 E 2550 N. The pipe measured was 12 inches in diameter.

**Peaks:** The peak flow was approximately 100 GPM.

**Infiltration:** There was a moderate amount of base infiltration measured in this area. We assumed that 40 GPM of infiltration comes from this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:** There were instances of zero flow and zero velocity reads that were assumed to be data collector error.

### 3 *Set 1 - Meter Site 3*

**Description:** Placed in manhole 1-129 located at 1200 E 3000 N, west of the entrance to Bentwood Drive. The pipe measured was 8 inches in diameter.

**Peaks:** The peak flow was approximately 180 GPM.

**Infiltration:** There was very little base infiltration in this area. We assumed 10 GPM of infiltration comes from this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure. There are areas with high velocity, likely caused by steeper slopes and a high peak flow in the area.

**Other:** The meter died twice and had to be removed, recharged, and replaced. The city could not provide a flow, velocity, or depth graph due to the issues with the meter. Daily maximum values, minimum values and average values along with the time of occurrence were recorded and used for calibration. The City did not use this meter for any other data collection.

### 4 *Set 1 - Meter Site 4*

**Description:** Placed in manhole 3-143 located on the south west side of the 800 E 2900 N intersection. The pipe measured was 12 inches in diameter.

**Peaks:** The peak flow was approximately 320 GPM.

**Infiltration:** There was very little base infiltration in this area. We assumed an additional 5 GPM of infiltration enters the system in this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:**

5      *Set 2 - Meter Site 1*

**Description:** Placed in manhole 4-038 located at 860 E 2100 N.

**Peaks:** The peak flow was approximately 115 GPM.

**Infiltration:** There was very little base infiltration in this area. We assumed 5 GPM of infiltration comes from this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:**

6      *Set 2 - Meter Site 2*

**Description:** Placed in manhole 6-071 located at 1000 E 1600 N.

**Peaks:** The peak flow was approximately 100 GPM.

**Infiltration:** There was no base infiltration recorded in this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:**

7      *Set 3 - Meter Site 3*

**Description:** Placed in manhole 5-099 located at 1000 E 1900 N.

**Peaks:** The peak flow was approximately 180 GPM.

**Infiltration:** There was a moderate amount base infiltration in this area. We assumed 50 GPM of infiltration comes from this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:** The meter died during measurement from 1/5 to 1/8. The meter was removed, recharged, and replaced.

8      *Set 4 - Meter Site 1*

**Description:** Placed in manhole 9-115 located at 2600 N Wolfpack Way.

**Peaks:** The peak flow was approximately 520 GPM.

**Infiltration:** There was high base infiltration measured in this area. We assumed 150 GPM of infiltration comes from this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:**

9      *Set 4 - Meter Site 2*

**Description:** Placed in manhole 7-133 located at 1850 N Main Street in a parking lot.

**Peaks:** The peak flow was approximately 740 GPM.

**Infiltration:** Very high base infiltration values were measured in this area. We assumed 370 GPM of infiltration comes from this area.

**Depths and Velocities:** The depth and velocity values are within a range that the meter can accurately measure.

**Other:** This area is west of the canal which has very high groundwater. This likely plays a role in the high infiltration values measured.

# Appendix D

## Model Calibration Graphs

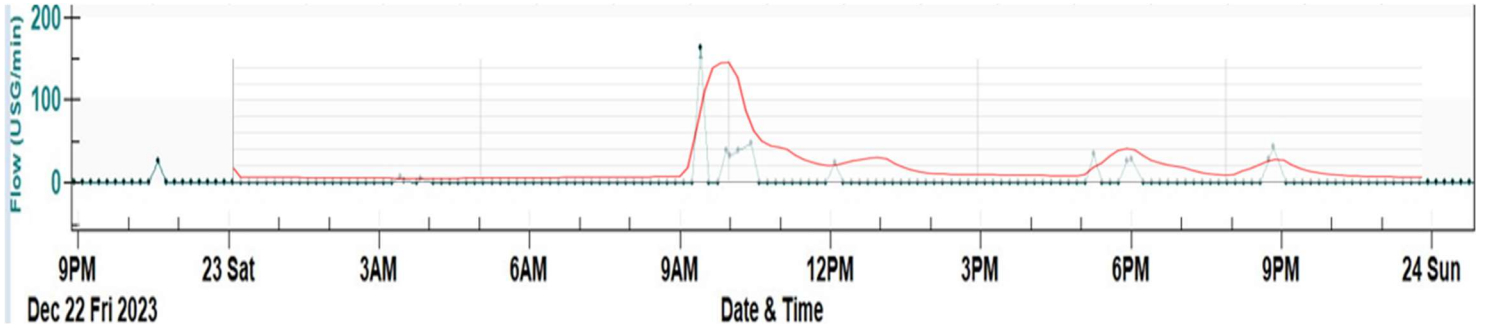


Model Data

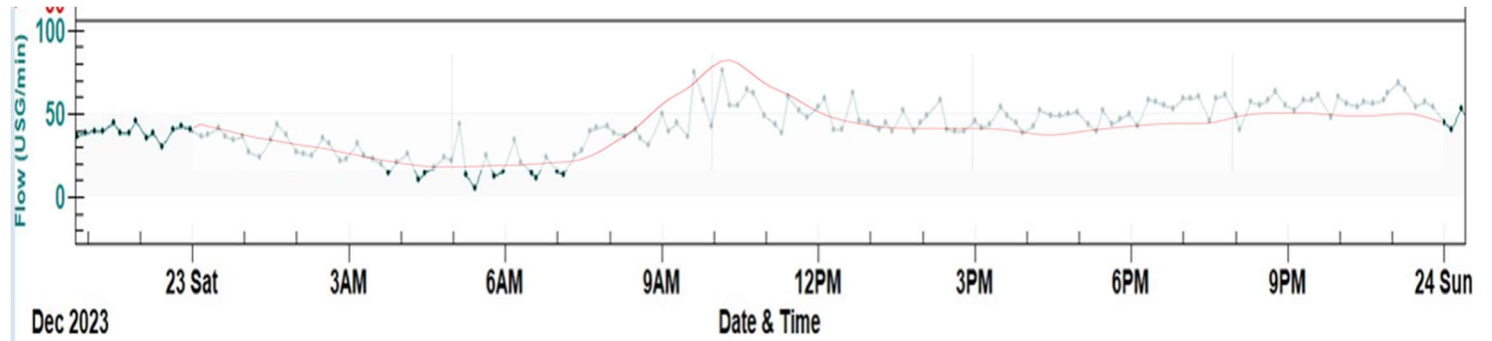


Temporary Meter Data

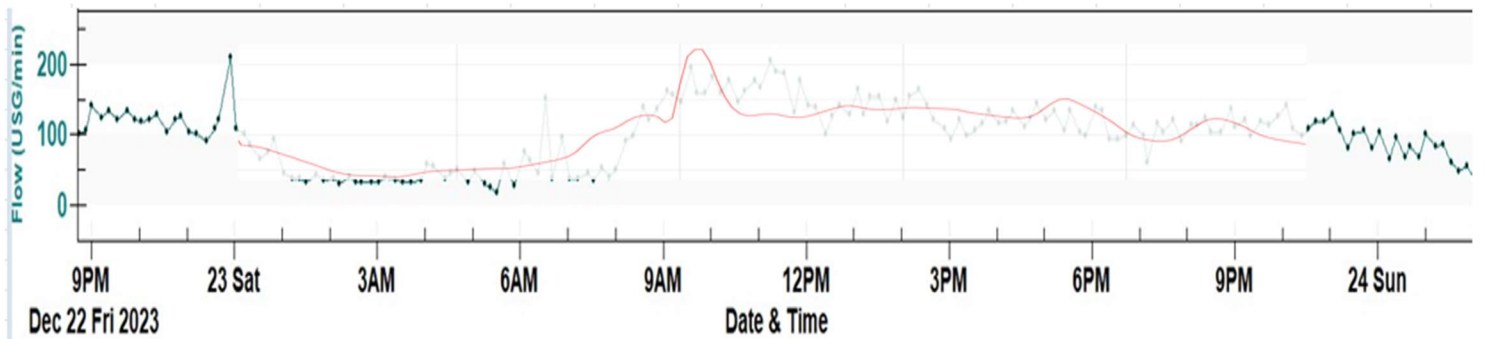
### Meter 2-105



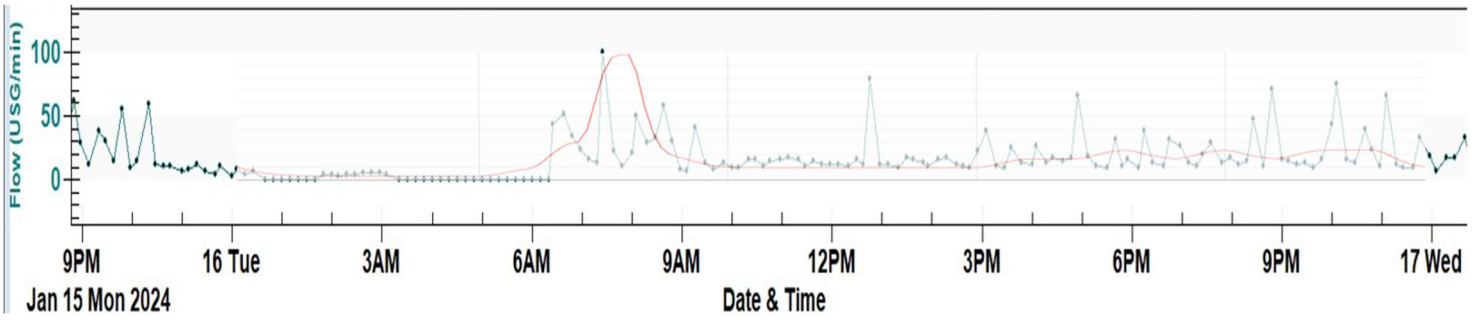
### Meter 3-171



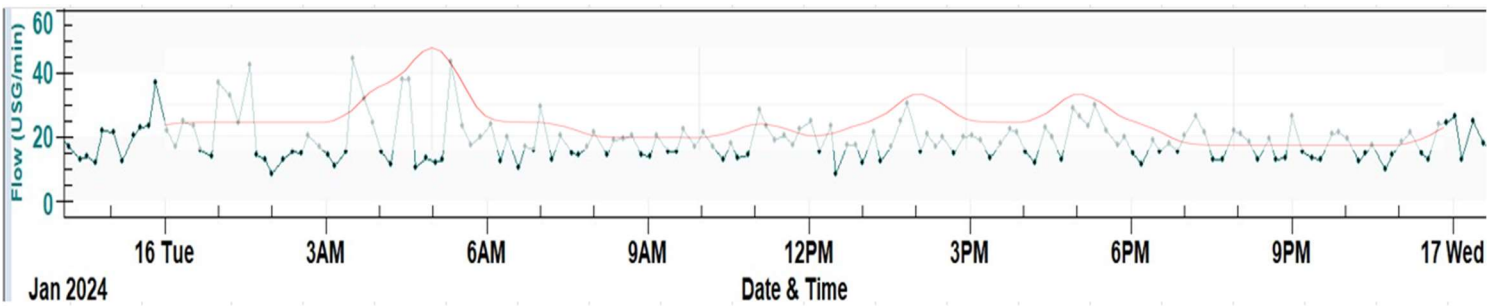
### Meter 3-143



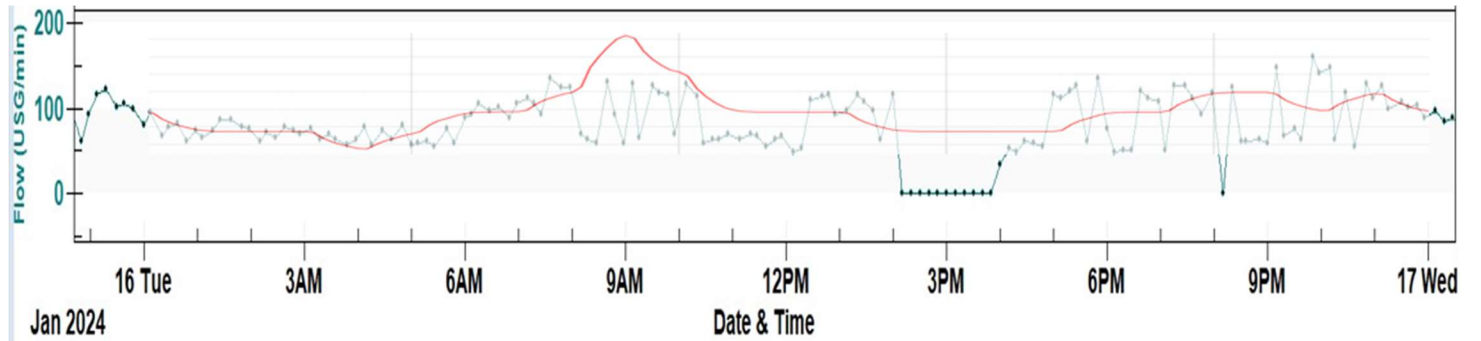
### Meter 4-038



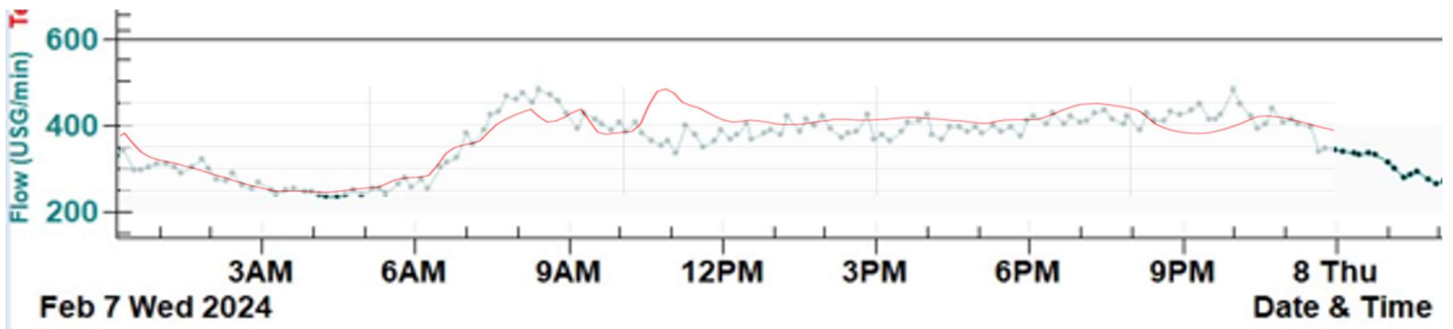
### Meter 6-071



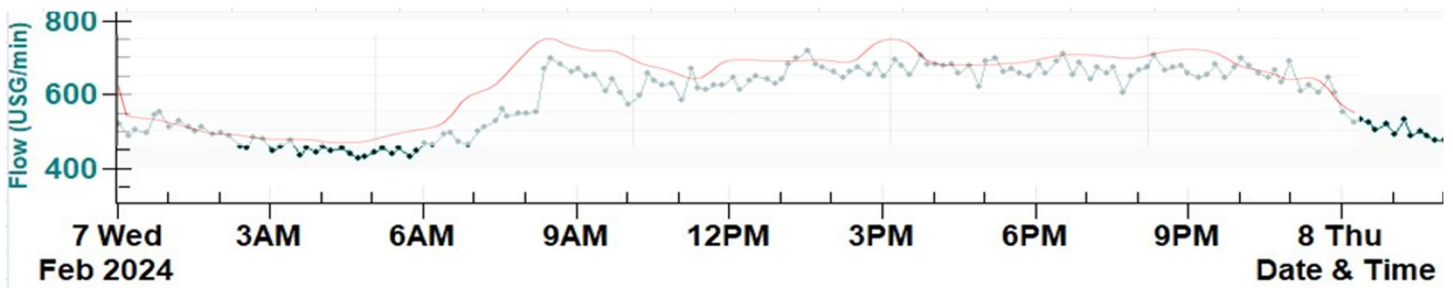
### Meter 5-099



Meter 9-115



Meter 7-133



# **Appendix E**

Calibration Notes

Calibration Notes by Meter Site

Meter	Location	Notes
Set 1		
1	2-105 1600 E 2500 N	The model flows match the general trend of metered flows. The meter has zero flows recorded often. Model peak flow is approximately 10% lower than the maximum metered flow.
2	3-171 600 E 2550 N	Diurnal pattern matches well. Model peak flow is approximately 7% higher than the daily maximum metered flow.
3	1-129 1200 E 3000 N	Model peak flow is approximately 5% lower than the daily maximum metered flow. There are no graphs to compare the model to the meter at this point.
4	3-143 800 E 2900 N	Diurnal pattern matches the general trend of metered flow. Model peak flow is approximately 8% higher than the metered flow.
Set 2		
1	4-038 860 E 2100 N	The model flows match closely to the average flows metered at the site; however, the meter has much more variation than the model. Model peak flow is approximately 6% lower than the metered flow.
2	6-071 1000 E 1600 N	Diurnal pattern matches well. The meter has more variation in flow than the model. Model peak flow is approximately equal to the maximum metered flow.
3	5-099 1000 E 1900 N	Diurnal pattern matches well. Model peak flow is approximately 15% higher than the maximum metered flow.
Set 3		
1	9-115 2600 N Wolf Pack Way	The model flows match the general trend of metered flows. Peak times do not line up exactly. Model peak flow is approximately 1% lower than daily maximum metered flow
2	7-133 1850 N Main Street	Diurnal pattern matches well. Model peak flow is approximately 4% higher than the daily maximum metered flow

# **Appendix F**

## Buildout Flows and Reserve Capacity

**Buildout Flows Added to System**

**Existing System Reserve Capacity**

**Buildout System Reserve Capacity**

**BUILDOUT FLOWS ADDED**

Parcel #	Zoning	New Flow Added (GPM)	Combined Flow	MH
04-050-0049	RE-1	1.254	22.383	1-001
18-003-0017	RE-1	19		1-001
18-006-0003	RE-1	2.129		1-001
04-263-0005	RE-1	0.344		1-023D
04-263-0006	RE-1	0.688		1-023F
04-263-0009	RE-1	0.245		1-023G
04-263-0008	RE-1	0.243		1-023I
04-049-0008	RE-1	17.194		1-029
04-169-0022	RE-1	0.222		1-034
04-112-0004	RE-1	0.245		1-040
04-134-0007	RE-1	0.229		1-043
04-134-0022	RE-1	0.289		1-050
04-049-0007	RE-1	18.068		1-058
04-048-0028	RE-1	2.292		1-103
04-048-0027	RE-1	0.917		1-104
04-048-0026	RE-1	1.102		1-107
04-048-0016	RE-1	1.348	7.781	1-108
04-052-0007	RE-1	6.433		1-108
04-194-0016	RE-1	0.229		1-120
04-048-0014	RE-1	3.208	3.488	1-127
04-052-0047	RE-1	0.28		1-127
04-045-0022	R-1-20	2.745	3.034	1-128
04-052-0052	RE-1	0.289		1-128
04-199-0054	RE-1	0.399		2-006
04-199-0060	RE-1	0.231	0.476	2-008
04-199-0061	RE-1	0.245		2-008
04-199-0041	RE-1	0.241	0.931	2-009
04-199-0042	RE-1	0.245		2-009
04-199-0062	RE-1	0.227		2-009
04-199-0063	RE-1	0.218		2-009
05-004-0001	RE-1	8.956		2-028
18-006-0004	RE-5	1.375		2-029
04-140-0031	RE-1	0.248		2-031
04-140-0035	RE-1	0.259		2-038
04-140-0047	RE-1	0.209		2-042
04-050-0098	RE-5	0.229	1.135	2-042
18-006-0005	RE-5	0.688		2-042
04-140-0042	RE-1	0.218		2-043
04-140-0048	RE-1	0.206		2-044
04-050-0064	RE-5	0.229	0.917	2-045
18-006-0001	RE-5	0.688		2-045
04-050-0009	RE-1	3.921		2-057
04-135-0052	RE-1	0.213		2-063

FLOW RATES ADDED	
Res	100
	0.0695
	0.2341
Com	4000
ERU	3.3

GPCD  
GPM/P  
GPM/ERU  
G/Ac/D  
People

**Total Flow Added:**  
1292.4 GPM

**Total ERU Added:**  
5521

04-050-0054	RE-1	3.488		2-065
04-050-0014	RE-1	1.648	3.023	2-066
04-050-0060	RE-1	1.375		2-066
04-050-0065	RE-1	0.724		2-069
04-050-0011	RE-1	1.893		2-073
04-050-0071	PARK LAND	0.229	1.118	2-077
04-050-0085	RE-1	0.889		2-077
04-050-0070	PARK LAND	0.229	0.653	2-078
04-050-0087	RE-1	0.424		2-078
04-050-0074	PARK LAND	0.229	0.916	2-079
04-050-0075	PARK LAND	0.229		2-079
04-050-0084	RE-1	0.229		2-079
04-050-0086	RE-1	0.229		2-079
04-050-0078	PARK LAND	0.229	0.687	2-080
04-050-0079	PARK LAND	0.229		2-080
04-050-0081	PARK LAND	0.229		2-080
04-050-0076	RE-1	2.292		2-081
04-050-0017	RE-1	1.606		2-086
04-050-0090	R-1-20	0.245		2-087
04-050-0030	R-1-20	1.003		2-090
04-050-0025	RE-1	1.293		2-103
04-055-0008	RE-1	0.573		2-107
04-050-0007	RE-1	1.57		2-112
04-239-0004	RE-1	0.222		2-118
04-055-0018	RB	2.417	3.256	2-120
04-167-0016	RE-1	0.839		2-120
04-055-0017	RB	5.111		2-121
04-054-0007	RE-1	0.688		2-122
04-214-0004	RE-1	0.215		2-126
04-054-0013	RE-1	0.261		2-127
04-052-0010	RE-1	1.146		2-129
04-051-0030	R-1-20	0.125		2-130
04-054-0010	RE-1	1.719		2-134
04-056-0010	RE-1	1.146	2.292	2-139
04-057-0004	RE-1	1.146		2-139
05-003-0003	R-1-20	6.474		3-002
04-093-0030	R-1-12	1.564		3-003
05-003-0013	R-1-12	0.258		3-003
04-057-0011	R-1-15	0.229		3-003
04-050-0020	R-1-20	5.61	63.416	3-003
05-002-0007	RE-1	55.23		3-003
04-088-0024	R-1-10	2.126		3-018
04-088-0054	R-1-10	0.23	0.63	3-019
04-088-0057	R-1-10	0.22		3-019
04-088-0058	R-1-10	0.18		3-019
04-088-0059	R-1-10	0.459		3-019
04-088-0051	R-1-10	0.779	1.647	3-027

04-088-0053	R-1-10	0.379		3-027
04-088-0056	R-1-10	0.489		3-027
04-087-0028	RB	2.056		3-034
07-131-0004	R-1-12	0.299	0.607	3-040
07-131-0005	R-1-12	0.308		3-040
04-084-0004	RE-1	1.49		3-042
07-094-0038	R-1-12	0.25		3-047
07-094-0014	R-1-12	0.241		3-052
07-094-0049	R-1-12	0.233		3-059
04-084-0006	RE-1	0.917	1.103	3-059
04-261-0001	R-1-15	0.186		3-060B
04-261-0010	R-1-15	0.186	1.03	3-060D
04-261-0012	R-1-15	0.186		3-060D
04-261-0014	R-1-15	0.186		3-060D
04-261-0015	R-1-15	0.286		3-060D
04-261-0016	R-1-15	0.186		3-060D
04-261-0005	R-1-15	0.313	0.939	3-060G
04-261-0006	R-1-15	0.413		3-060G
04-261-0007	R-1-15	0.213		3-060G
04-261-0019	R-1-15	0.186		3-060G
04-261-0022	R-1-12	0.286		3-060H
04-261-0002	R-1-15	0.186	1.346	3-060H
04-261-0003	R-1-15	0.186		3-060H
04-261-0004	R-1-15	0.186		3-060H
04-261-0020	R-1-15	0.186		3-060H
04-261-0021	R-1-15	0.186		3-060H
04-084-0049	RE-1	0.416		3-065
04-053-0029	RE-1	0.788		3-071
04-054-0005	PARK LAND	1.872		3-074
04-053-0028	RE-1	0.229		3-085
04-053-0053	RE-1	0.293		3-087
04-053-0014	R-1-20	0.985		3-088
04-207-0005	R-1-20	0.21	0.42	3-091
04-207-0010	RE-1	0.21		3-091
04-053-0017	RE-1	1.233		3-094
04-053-0022	R-1-12	0.209		3-102
04-061-0044	RE-1	2.895		3-104
04-061-0068	R-1-12	0.264		3-107
04-061-0009	R-1-12	4.617	10.607	3-108
04-061-0014	R-1-12	5.99		3-108
04-061-0008	R-1-12	4.168	17.228	3-109
04-061-0011	R-1-12	13.06		3-109
04-061-0006	R-1-20	3.328		3-111
07-118-0004	R-1-12	0.229		3-114
04-207-0001	RE-1	0.319	4.254	3-114
04-061-0015	RE-1	3.935		3-115
04-053-0044	R-1-12	0.211		3-117

04-061-0073	R-1-20	0.25		3-119
04-051-0032	R-1-12	0.779	3.932	3-131
07-183-0340	R-1-12	0.591		3-131
07-183-0365	R-1-20	2.562		3-131
04-051-0023	R-1-12	4.916		3-133
04-059-0026	R-1-12	1.747		3-165
04-061-0003	R-1-12	8.968		3-166
04-061-0072	R-1-15	3.194		3-171
04-095-0022	R-1-12	0.316	0.566	4-001
04-095-0023	R-1-12	0.25		4-001
05-002-0008	R-1-12	9.899	29.276	4-005
05-002-0009	R-1-12	15.564		4-005
05-002-0013	R-1-12	3.602		4-005
05-004-0009	RE-1	0.211		4-005
05-003-0008	R-1-12	1.497		4-006
07-090-0036	R-1-12	0.241		4-020
04-087-0033	R-1-10	0.789		4-038
05-004-0003	PARK LAND	0.229		5-002
05-007-0001	R-1-12	14.483		5-004
05-004-0002	R-1-12	0.229		5-021
05-005-0020	R-1-12	17.053		5-041
07-137-0001	R-1-12	0.266		5-062
04-094-0036	R-1-12	0.666	0.899	5-067
07-137-0021	R-1-12	0.233		5-067
04-251-0003	R-1-12	0.832		5-069
04-173-0007	R-1-12	0.466		5-075
04-173-0026	R-1-10	0.233		5-078
04-103-0007	R-1-12	0.15	1.887	5-078
04-097-0013	R-1-10	1.737		5-092
04-097-0007	R-1-10	4.123		5-097
07-025-0047	R-1-12	0.28		5-105
04-107-0006	R-1-12	2.096		6-006
04-102-0001	R-1-12	2.163		6-016
04-104-0013	R-1-10	0.391		6-032
04-097-0014	R-1-10	5.86		6-033
04-097-0015	R-1-10	0.459		6-038
04-097-0018	R-1-12	3.903		6-040
04-100-0023	R-1-12	0.94		6-047
04-100-0026	M-2	2.446		6-050
04-099-0006	RE-2	35.583		6-059
07-080-0005	R-1-20	0.229		6-073
04-097-0025	RE-1	0.779		6-075
04-084-0045	R-1-10	0.82	1.758	7-004
04-089-0005	RE-1	0.938		7-004
04-084-0047	A-10	1.783		7-005
04-086-0009	CC	0.688		7-010
04-085-0080	CCC	2.833		7-065

04-085-0036	CC	11.111		7-071
04-143-0006	MXG	2.528		7-078
04-153-0001	CG	1.444		7-079
04-083-0010	CG	3.194	5.972	7-134
04-083-0068	CG	2.778		7-134
04-083-0070	R-1-12	2.278		7-137
04-061-0037	CCA	8.236		8-002
04-083-0022	SF6	14.944		8-005
04-084-0021	SF6	12.761		8-006
04-084-0046	DT	4.243		8-009
04-083-0017	CG	7.222		8-017
04-062-0066	CCC	2.167		8-018
04-083-0066	CG	13.194		8-019
04-083-0067	CCC	9.667		8-022
04-083-0016	CCC	13.194		8-024
04-083-0023	SF6	25.778		8-025
04-060-0065	CG	5		8-063
04-062-0032	CCC	22.222		8-064
04-060-0007	CG	17.194		8-069
04-163-0003	CCC	1.889		8-070
04-080-0053	CG	1.694		8-081
04-080-0009	CG	13.889	29.584	8-083
04-080-0010	CG	13.889		8-083
04-080-0011	CG	1.806		8-083
04-083-0116	CG	8.889		8-084
04-080-0015	CG	27.778		8-086
04-139-0004	CCC	1.722		8-090
04-083-0009	CG	18.111	124.5	8-090
04-083-0018	CG	106.389		8-101
04-060-0027	CG	16.638		9-022
04-060-0056	HOSP	4.5	7.194	9-042
04-235-0003	MC	2.694		9-042
04-060-0067	CG	22.778		9-045
04-062-0402	CCC	16.556		9-089
04-265-0001	CG	4.944		9-117
04-058-0021	MC	5.556		9-134
04-058-0002	CG	4.778		9-136
04-058-0048	CG	8.639	25.806	9-140
04-058-0049	CG	17.167		9-140
04-058-0010	CG	6.5		9-142
04-062-0078	CG	20.194		9-143
04-062-0025	CG	52.917		9-148
04-062-0077	CG	13.222		9-155
				9-159/ 9-
04-062-0007	CG	102.417		136
04-210-0009	CG	6.139		9-166
04-210-0008	CG	6.75		9-168

04-210-0015	MC	5.556		9-170
04-210-0014	MC	5.75		9-171
04-210-0010	MC	23.694		9-173
				9-176/ 9-
04-062-0001	MC	35.25		180
04-062-0401	MC	18.028		9-183
04-062-0004	MC	32.639		9-195
04-062-0312	MC	2.778		9-200
04-062-0313	MC	2.778		9-202
04-062-0096	MC	2.889	7.25	9-206
04-062-0098	MC	4.361		9-206
04-062-0314	MC	3.917		9-208
04-062-0026	MC	6.111		9-210
04-062-0095	MC	1.472		9-213
04-062-0027	MC	21		9-216
04-060-0042	MC	14.056		SMH-A1
04-136-0001	CG	2.889		SMH-A6

**Existing System Reserve Capacity**

<b>Pipe</b>	<b>Reserve d/D</b>								
C-1-000	0.44	C-1-037	0.49	C-1-086	0.47	C-1-131	0.23	C-2-050	0.45
C-1-001	0.48	C-1-038	0.4	C-1-087	0.48	C-1-132	0.31	C-2-051	0.47
C-1-002	0.48	C-1-039	0.39	C-1-088	0.47	C-2-001	0.43	C-2-052	0.49
C-1-003	0.48	C-1-040	0.36	C-1-089	0.45	C-2-005	0.4	C-2-053	0.41
C-1-005	0.47	C-1-041	0.34	C-1-090	0.46	C-2-006	0.44	C-2-054	0.45
C-1-007	0.46	C-1-042	0.35	C-1-091	0.47	C-2-006A	0.41	C-2-055	0.47
C-1-008	0.46	C-1-043	0.41	C-1-092	0.48	C-2-007	0.33	C-2-056	0.46
C-1-009	0.46	C-1-046	0.36	C-1-093	0.44	C-2-008	0.32	C-2-057	0.44
C-1-010	0.46	C-1-047	0.36	C-1-094	0.45	C-2-009	0.43	C-2-058	0.42
C-1-011	0.45	C-1-048	0.45	C-1-095	0.46	C-2-011	0.44	C-2-059	0.42
C-1-012	0.48	C-1-049	0.41	C-1-096	0.46	C-2-012	0.46	C-2-060	0.42
C-1-013	0.48	C-1-050	0.41	C-1-097	0.45	C-2-013	0.47	C-2-061	0.42
C-1-014	0.46	C-1-051	0.43	C-1-098	0.44	C-2-014	0.48	C-2-062	0.46
C-1-015	0.44	C-1-052	0.46	C-1-099	0.43	C-2-017	0.44	C-2-063	0.49
C-1-016	0.45	C-1-053	0.46	C-1-100	0.42	C-2-018	0.45	C-2-063A	0.49
C-1-018	0.49	C-1-054	0.47	C-1-101	0.41	C-2-019	0.43	C-2-064	0.41
C-1-019	0.48	C-1-055	0.48	C-1-102	0.42	C-2-020	0.42	C-2-065	0.42
C-1-019A	0.48	C-1-056	0.48	C-1-103	0.41	C-2-021	0.43	C-2-065A	0.45
C-1-020	0.46	C-1-057	0.48	C-1-104	0.41	C-2-022	0.4	C-2-066	0.41
C-1-021	0.46	C-1-058	0.48	C-1-105	0.38	C-2-023	0.37	C-2-067	0.43
C-1-022	0.44	C-1-059	0.49	C-1-106	0.36	C-2-024	0.35	C-2-068	0.44
C-1-023	0.41	C-1-060	0.49	C-1-107	0.35	C-2-025	0.32	C-2-069	0.42
C-1-023B	0.5	C-1-061	0.46	C-1-108	0.35	C-2-026	0.31	C-2-070	0.42
C-1-023C	0.5	C-1-063	0.46	C-1-109	0.35	C-2-028	0.37	C-2-071	0.42
C-1-023D	0.5	C-1-063A	0.46	C-1-110	0.4	C-2-029	0.48	C-2-072	0.4
C-1-023E	0.5	C-1-064	0.48	C-1-111	0.45	C-2-030	0.45	C-2-073	0.41
C-1-023F	0.5	C-1-065	0.46	C-1-112	0.44	C-2-031	0.42	C-2-074	0.4
C-1-023G	0.5	C-1-066	0.45	C-1-113	0.43	C-2-032	0.43	C-2-075	0.43
C-1-023H	0.5	C-1-067	0.48	C-1-114	0.45	C-2-033	0.43	C-2-076	0.45
C-1-023I	0.5	C-1-068	0.46	C-1-115	0.34	C-2-034	0.45	C-2-077	0.35
C-1-023J	0.48	C-1-070	0.43	C-1-116	0.33	C-2-034-B	0.43	C-2-078	0.35
C-1-023K	0.46	C-1-071	0.43	C-1-117	0.45	C-2-035	0.46	C-2-079	0.34
C-1-024	0.42	C-1-072	0.45	C-1-118	0.45	C-2-036	0.48	C-2-080	0.32
C-1-025	0.38	C-1-073	0.46	C-1-119	0.33	C-2-037	0.49	C-2-081	0.33
C-1-026	0.39	C-1-074	0.46	C-1-120	0.45	C-2-038	0.46	C-2-082	0.33
C-1-027	0.44	C-1-075	0.46	C-1-121	0.46	C-2-039	0.45	C-2-083	0.33
C-1-028	0.41	C-1-076	0.48	C-1-122	0.45	C-2-040	0.47	C-2-084	0.32
C-1-029	0.48	C-1-078	0.49	C-1-123	0.43	C-2-041	0.48	C-2-085	0.32
C-1-030	0.47	C-1-079	0.49	C-1-124	0.43	C-2-042	0.48	C-2-086	0.3
C-1-031	0.47	C-1-080	0.43	C-1-125	0.44	C-2-043	0.47	C-2-087	0.29
C-1-032	0.47	C-1-081	0.43	C-1-126	0.35	C-2-044	0.47	C-2-088	0.29
C-1-033	0.43	C-1-082	0.42	C-1-127	0.32	C-2-045	0.48	C-2-089	0.26
C-1-034	0.41	C-1-083	0.46	C-1-128	0.28	C-2-047	0.48	C-2-090	0.29
C-1-035	0.41	C-1-084	0.47	C-1-129	0.26	C-2-048	0.48	C-2-091	0.35
C-1-036	0.45	C-1-085	0.47	C-1-130	0.22	C-2-049	0.47	C-2-092	0.37

**Existing System Reserve Capacity**

<b>Pipe</b>	<b>Reserve d/D</b>								
C-2-095	0.3	C-2-140	0.45	C-3-050	0.46	C-3-085	0.48	C-3-133	0.44
C-2-096	0.35	C-2-141	0.46	C-3-051	0.46	C-3-086	0.43	C-3-134	0.42
C-2-097	0.36	C-3-001	0.47	C-3-052	0.47	C-3-087	0.42	C-3-136	0.31
C-2-098	0.44	C-3-002	0.47	C-3-053	0.43	C-3-088	0.42	C-3-137	0.32
C-2-099	0.41	C-3-003	0.46	C-3-054	0.44	C-3-089	0.41	C-3-138	0.31
C-2-100	0.44	C-3-004	0.46	C-3-055	0.44	C-3-090	0.41	C-3-139	0.46
C-2-101	0.44	C-3-005	0.44	C-3-056	0.44	C-3-091	0.44	C-3-140	0.44
C-2-102	0.44	C-3-006	0.42	C-3-057	0.45	C-3-092	0.44	C-3-141	0.42
C-2-103	0.46	C-3-008	0.42	C-3-058	0.47	C-3-093	0.48	C-3-142	0.16
C-2-104	0.44	C-3-009	0.45	C-3-059	0.35	C-3-094	0.49	<b>C-3-143</b>	<b>0.09</b>
C-2-105	0.2	C-3-010	0.47	C-3-060	0.33	C-3-095	0.42	C-3-144	0.18
C-2-106	0.17	C-3-011	0.47	C-3-060B	0.43	C-3-096	0.4	C-3-145	0.29
C-2-107	0.11	C-3-012	0.47	C-3-060C	0.48	C-3-100	0.41	C-3-146	0.31
<b>C-2-108</b>	<b>-0.06</b>	C-3-012A	0.44	C-3-060D	0.49	C-3-101	0.48	C-3-147	0.32
<b>C-2-109</b>	<b>-0.03</b>	C-3-014	0.46	C-3-060G	0.49	C-3-102	0.48	C-3-148	0.43
C-2-110	0.27	C-3-015	0.45	C-3-060H	0.48	C-3-104	0.46	C-3-149	0.47
C-2-110B	0.42	C-3-016	0.42	C-3-061	0.39	C-3-105	0.46	C-3-150	0.47
C-2-111	0.44	C-3-017	0.32	C-3-062	0.42	C-3-106	0.32	C-3-151	0.39
C-2-112	0.46	C-3-018	0.43	C-3-063	0.44	C-3-107	0.27	C-3-152	0.4
C-2-113	0.46	C-3-019	0.4	C-3-064	0.44	C-3-108	0.24	C-3-153	0.39
C-2-114	0.47	C-3-020	0.34	C-3-065	0.45	C-3-109	0.26	C-3-154	0.33
C-2-115	0.47	C-3-021	0.37	C-3-066	0.48	C-3-110	0.26	C-3-155	0.2
C-2-116	0.47	C-3-022	0.35	C-3-067	0.42	C-3-111	0.35	C-3-156	0.17
C-2-117	0.48	C-3-024	0.36	C-3-068	0.41	C-3-112	0.47	C-3-157	0.45
C-2-118	0.11	C-3-027	0.36	C-3-069	0.41	C-3-113	0.48	C-3-158	0.43
C-2-119	0.19	C-3-028	0.34	C-3-070	0.36	C-3-114	0.36	C-3-159	0.43
C-2-120	0.26	C-3-029	0.36	C-3-071	0.36	C-3-114A	0.41	C-3-160	0.21
C-2-121	0.22	C-3-032	0.33	C-3-072	0.46	C-3-115	0.42	C-3-161	0.17
C-2-122	0.21	C-3-034	0.41	C-3-073	0.45	C-3-116	0.38	C-3-162	0.19
C-2-123	0.33	C-3-034A	0.48	C-3-074	0.45	C-3-117	0.38	C-3-163	0.15
C-2-124	0.44	C-3-035	0.35	C-3-075	0.44	C-3-118	0.35	C-3-165	0.23
C-2-125	0.45	C-3-036	0.43	C-3-076	0.45	C-3-119	0.39	C-3-166	0.14
C-2-126	0.17	C-3-037	0.35	C-3-077	0.44	C-3-120	0.38	C-3-170	0.24
C-2-127	0.13	C-3-038	0.35	C-3-078	0.44	C-3-121	0.42	C-3-171	0.37
C-2-128	0.16	C-3-039	0.22	C-3-079	0.42	C-3-122	0.43	C-4-001	0.41
C-2-129	0.19	C-3-040	0.24	C-3-080	0.42	C-3-123	0.44	C-4-003	0.37
C-2-130	0.16	C-3-041	0.27	C-3-080B	0.45	C-3-124	0.45	C-4-005	0.38
<b>C-2-131</b>	<b>0.08</b>	C-3-042	0.37	C-3-080C	0.46	C-3-125	0.47	C-4-006	0.4
C-2-132	0.12	C-3-043	0.38	C-3-080D	0.46	C-3-126	0.44	C-4-007	0.43
C-2-133	0.28	C-3-044	0.44	C-3-080E	0.49	C-3-127	0.44	C-4-008	0.4
C-2-134	0.44	C-3-045	0.46	C-3-080F	0.5	C-3-128	0.44	C-4-010	0.38
C-2-136	0.44	C-3-046	0.39	C-3-081	0.43	C-3-129B	0.44	C-4-011	0.35
C-2-137	0.44	C-3-047	0.47	C-3-082	0.45	C-3-130	0.45	C-4-012	0.36
C-2-138	0.45	C-3-048	0.41	C-3-083	0.45	C-3-131	0.46	C-4-013	0.38
C-2-139	0.47	C-3-049	0.47	C-3-084	0.47	C-3-132	0.45	C-4-014	0.45

**Existing System Reserve Capacity**

<b>Pipe</b>	<b>Reserve d/D</b>								
C-4-015	0.42	C-5-024	0.42	C-5-070	0.38	C-6-004	0.43	C-6-049	0.46
C-4-016	0.42	C-5-025	0.4	C-5-071	0.28	C-6-005	0.42	C-6-050	0.49
C-4-017	0.44	C-5-026	0.37	C-5-072	0.28	C-6-006	0.39	C-6-051	0.41
C-4-018	0.45	C-5-027	0.35	C-5-073	0.47	C-6-007	0.36	C-6-052	0.44
C-4-019	0.45	C-5-028	0.3	C-5-074	0.44	C-6-008	0.47	C-6-053	0.45
C-4-020	0.43	C-5-029	0.26	C-5-075	0.34	C-6-009	0.43	C-6-055	0.46
C-4-021	0.34	C-5-030	0.38	C-5-076	0.41	C-6-010	0.42	C-6-056	0.46
C-4-022	0.46	C-5-031	0.31	C-5-077	0.43	C-6-011	0.4	C-6-058	0.47
C-4-023	0.46	C-5-032	0.31	C-5-078	0.44	C-6-012	0.41	C-6-059	0.45
C-4-024	0.34	C-5-033	0.41	C-5-080	0.28	C-6-013	0.44	C-6-060	0.47
C-4-025	0.34	C-5-034	0.27	C-5-081	0.31	C-6-014	0.46	C-6-061	0.48
C-4-026	0.33	C-5-035	0.42	C-5-082	0.4	C-6-015	0.46	C-6-062	0.3
C-4-027	0.32	C-5-036	0.33	C-5-083	0.44	C-6-016	0.41	C-6-063	0.38
C-4-028	0.33	C-5-037	0.3	C-5-084	0.46	C-6-017	0.46	C-6-064	0.47
C-4-029	0.31	C-5-038	0.33	C-5-085	0.42	C-6-018	0.45	C-6-066	0.33
C-4-031	0.34	C-5-039	0.28	C-5-086	0.4	C-6-019	0.43	C-6-067	0.34
C-4-032	0.29	C-5-040	0.39	C-5-087	0.43	C-6-020	0.4	C-6-068	0.42
C-4-033	0.33	C-5-041	0.01	C-5-088	0.44	C-6-021	0.38	C-6-069	0.34
C-4-034	0.38	C-5-042	0.05	C-5-089	0.44	C-6-022	0.33	C-6-070	0.2
C-4-035	0.41	C-5-043	0.11	C-5-090	0.46	C-6-023	0.37	C-6-071	0.13
C-4-038	0.24	C-5-044	0.43	C-5-091	0.25	C-6-024	0.34	C-6-072	0.25
C-5-001	0.46	C-5-045	0.44	C-5-092	0.47	C-6-025	0.42	C-6-073	0.26
C-5-002	0.45	C-5-046	0.46	C-5-093	0.39	C-6-026	0.42	C-6-074	0.24
C-5-003	0.46	C-5-047	0.43	C-5-094	0.34	C-6-027	0.4	C-6-075	0.15
C-5-004	0.48	C-5-048	0.44	C-5-096	0.17	C-6-028	0.41	C-6-076	0.13
C-5-005	0.44	C-5-049	0.42	C-5-097	0.22	C-6-029	0.34	C-6-077	0.12
C-5-006	0.44	C-5-050	0.44	C-5-098	0.26	C-6-030	0.33	C-6-078	0.03
C-5-007	0.44	C-5-051	0.46	C-5-099	0.18	C-6-031	0.35	C-7-000	0.39
C-5-008	0.43	C-5-052	0.46	C-5-101	0.26	C-6-032	0.46	C-7-002	0.31
C-5-009	0.44	C-5-053	0.46	C-5-102	0.33	C-6-033	0.42	C-7-003	0.17
C-5-0100	0.16	C-5-054	0.27	C-5-103	0.38	C-6-034	0.45	C-7-004	0.14
C-5-010-9	0.44	C-5-056B	0.26	C-5-104	0.39	C-6-035	0.48	C-7-005	0.12
C-5-011	0.38	C-5-057	0.3	C-5-105	0.45	C-6-036	0.5	C-7-006	0.14
C-5-012	0.45	C-5-058	0.32	C-5-106	0.43	C-6-037	0.44	C-7-007	0.18
C-5-013	0.44	C-5-059	0.33	C-5-107	0.45	C-6-038	0.5	C-7-008	0.03
C-5-014	0.44	C-5-060	0.38	C-5-108	0.45	C-6-039	0.5	C-7-009	0.17
C-5-015	0.43	C-5-061	0.32	C-5-109	0.46	C-6-040	0.5	C-7-010	0.41
C-5-016	0.42	C-5-062	0.29	C-5-110	0.42	C-6-041	0.41	C-7-011	0.38
C-5-017	0.39	C-5-063	0.37	C-5-111	0.44	C-6-042	0.35	C-7-012	0.33
C-5-018	0.44	C-5-064	0.46	C-5-112	0.48	C-6-043	0.43	C-7-013	0.37
C-5-020	0.48	C-5-065-B	0.45	C-5-113	0.46	C-6-044	0.4	C-7-014	0.3
C-5-021A	0.47	C-5-066	0.44	C-6-001	0.45	C-6-045	0.43	C-7-015	0.32
C-5-021B	0.46	C-5-067	0.43	C-6-002	0.43	C-6-046	0.39	C-7-016	0.34
C-5-022	0.43	C-5-068	0.44	C-6-003-A	0.46	C-6-047	0.47	C-7-017	0.29
C-5-023	0.45	C-5-069	0.42	C-6-003B	0.47	C-6-048	0.41	C-7-018	0.29

**Existing System Reserve Capacity**

Pipe	Reserve d/D								
C-7-019	0.29	C-7-067	0.11	C-7-117	0.37	C-8-028	0.27	C-8-082	0.05
C-7-020	0.2	C-7-068	0.13	C-7-119	0.08	C-8-030	0.34	C-8-083	0.45
C-7-021	0.34	C-7-069	0.24	C-7-120	-0.21	C-8-030A	0.7	C-8-084	0.4
C-7-022	0.3	C-7-071	0.04	C-7-121	-0.22	C-8-031	0.69	C-8-085	0.43
C-7-023	0.37	C-7-072	0.03	C-7-122	-0.05	C-8-033	0.68	C-8-086	-0.1
C-7-024	0.45	C-7-073	-0.2	C-7-123	-0.03	C-8-035	0.43	C-8-087	0.44
C-7-025	0.46	C-7-074	-0.22	C-7-127	-0.05	C-8-035A	0.45	C-8-088	0.44
C-7-026	0.22	C-7-075	-0.21	C-7-128	-0.03	C-8-036	0.34	C-8-089	0.42
C-7-027	0.12	C-7-076	0.1	C-7-129	0.1	C-8-037	0.3	C-8-090	0.45
C-7-028	0.2	C-7-077	0.16	C-7-130	-0.06	C-8-038	0.34	C-8-101	0.71
C-7-029	0.29	C-7-078	0.27	C-7-131	-0.07	C-8-039	0.38	C-8-102	0.43
C-7-030	0.18	C-7-079	0.09	C-7-133	0.01	C-8-040	0.42	C-8-103	0.44
C-7-031	0.29	C-7-080	0.19	C-7-134	0.35	C-8-041	0.43	C-8-103A	0.45
C-7-032	0.18	C-7-081	0.4	C-7-135	-0.03	C-8-042	0.44	C-8-104	0.42
C-7-033	0.21	C-7-083	0.42	C-7-136	0.35	C-8-043	0.46	C-8-105	0.44
C-7-034	0.07	C-7-085	0.06	C-7-137	0.33	C-8-050	0.38	C-8-106	0.45
C-7-035	0.05	C-7-086	0.02	C-7-138	-0.12	C-8-054	0.41	C-9-000	0.31
C-7-036	0.21	C-7-087	0.2	C-8-000A	0.7	C-8-055	0.33	C-9-001	0.46
C-7-037	0.39	C-7-088	0.04	C-8-002	0.72	C-8-056	0.35	C-9-003	0.44
C-7-038	0.38	C-7-089	0.42	C-8-003	0.68	C-8-057	0.44	C-9-005	0.42
C-7-039	0.42	C-7-090	0.23	C-8-004	0.69	C-8-058	0.43	C-9-006	0.39
C-7-040	0.44	C-7-091	0.36	C-8-005	0.7	C-8-059	0.07	C-9-007	0.42
C-7-041A	0.45	C-7-092	0.38	C-8-005A	0.69	C-8-060	-0.17	C-9-007A	0.42
C-7-041B	0.44	C-7-093	0.4	C-8-006	0.67	C-8-061	-0.17	C-9-008	0.43
C-7-042	0.43	C-7-094	0.31	C-8-008	0.66	C-8-062	-0.5	C-9-008A	0.41
C-7-043	0.42	C-7-095	0.36	C-8-009	0.71	C-8-063	0.08	C-9-009	0.37
C-7-044	0.41	C-7-097	0.38	C-8-010	0.41	C-8-064	-0.11	C-9-009A	0.4
C-7-045	0.4	C-7-098	0.4	C-8-010A	0.43	C-8-065	-0.5	C-9-010	0.34
C-7-046	0.37	C-7-099	0.44	C-8-011	0.43	C-8-066	0.04	C-9-011	0.37
C-7-047	0.35	C-7-100	0.45	C-8-011A	0.45	C-8-067	0.12	C-9-012	0.46
C-7-048	0.36	C-7-101	0.41	C-8-012	0.44	C-8-068	0.29	C-9-013	0.29
C-7-049	0.35	C-7-102	0.38	C-8-014	0.39	C-8-069	0.46	C-9-014	0.29
C-7-050	0.08	C-7-103	0.39	C-8-015	0.37	C-8-070	-0.5	C-9-016	0.4
C-7-051	0.3	C-7-105	0.41	C-8-016	0.38	C-8-071	-0.5	C-9-017	0.31
C-7-052	0.3	C-7-106	0.22	C-8-017	0.37	C-8-072	0.18	C-9-018	0.28
C-7-053	0.36	C-7-107	0.32	C-8-018	0.36	C-8-072A	0.22	C-9-019	0.28
C-7-054	0.42	C-7-108	0.37	C-8-019	0.37	C-8-073	0.14	C-9-020	0.24
C-7-055	0.34	C-7-109	0.22	C-8-020	0.45	C-8-074	0.11	C-9-021	0.21
C-7-056	0.38	C-7-110	0.25	C-8-021	0.44	C-8-075	-0.5	C-9-022	0.32
C-7-057	0.43	C-7-111	0.37	C-8-022	0.39	C-8-076	-0.04	C-9-023	0.46
C-7-062	0.03	C-7-112	0.36	C-8-023	0.23	C-8-077	0.45	C-9-024	0.29
C-7-063	0.06	C-7-113	0.4	C-8-024	0.22	C-8-078	0.41	C-9-025	0.32
C-7-064	0.07	C-7-114	0.38	C-8-025	0.19	C-8-079	0.41	C-9-026	0.25
C-7-065	-0.02	C-7-115	0.42	C-8-026	0.21	C-8-080	0.28	C-9-027	0.26
C-7-066	0.06	C-7-116	0.33	C-8-027	0.65	C-8-081	-0.29	C-9-028	0.42

## Existing System Reserve Capacity

Pipe	Reserve d/D						
C-9-029	0.42	C-9-079	0.44	C-9-123	0.35	C-9-173	0.2
C-9-031	0.44	C-9-080	0.46	C-9-126	0.38	C-9-174	0.21
C-9-035	0.3	C-9-081	0.45	C-9-127	0.42	C-9-175	0.22
C-9-036	0.31	C-9-082	0.43	C-9-128	0.44	C-9-176	0.22
C-9-036A	0.43	C-9-083	0.42	C-9-129	0.21	C-9-177	0.25
C-9-040	0.24	C-9-084	0.4	C-9-134	0.43	C-9-178	0.15
C-9-040A	0.15	C-9-085	0.43	C-9-134A	0.45	C-9-179	-0.5
C-9-041	0.4	C-9-086	0.46	C-9-135	0.39	C-9-180	0.12
C-9-042	0.32	C-9-087	0.25	C-9-136	0.37	C-9-181	-0.5
C-9-043	-0.01	C-9-088	0.37	C-9-136A	0.41	C-9-182	-0.5
C-9-044	0.22	C-9-089	0.36	C-9-137	0.42	C-9-183	0.28
C-9-045	0.2	C-9-090	0.41	C-9-137A	0.43	C-9-184	0.16
C-9-046	0.23	C-9-091	0.25	C-9-138	0.31	C-9-185	-0.5
C-9-047	0.22	C-9-092	0.15	C-9-139	0.19	C-9-186	0.29
C-9-048	0.44	C-9-093	0.29	C-9-139A	0.24	C-9-186A	0.15
C-9-049	-0.04	C-9-094	0.4	C-9-140A	0.17	C-9-187	-0.5
C-9-050	-0.04	C-9-095	0.38	C-9-141	0.15	C-9-188	0.26
C-9-051	0.43	C-9-096	0.4	C-9-142	-0.01	C-9-190	-0.5
C-9-052	0.48	C-9-097	0.44	C-9-143	0.47	C-9-191	-0.5
C-9-053	0.1	C-9-098	0.42	C-9-144	0.45	C-9-192	0.28
C-9-054	0.13	C-9-099	0.4	C-9-146	0.11	C-9-192A	-0.5
C-9-055	0.22	C-9-100	0.37	C-9-147	0.19	C-9-193	0.38
C-9-056	0.44	C-9-101	0.34	C-9-148	0.16	C-9-194	0.41
C-9-057	0.44	C-9-102	0.39	C-9-149	0.3	C-9-195	0.4
C-9-058	0.45	C-9-103	0.33	C-9-150	0.26	C-9-196	0.42
C-9-059	0.14	C-9-104	0.36	C-9-152	-0.01	C-9-197	0.41
C-9-061	0.14	C-9-105	0.25	C-9-153	0.45	C-9-199	0.39
C-9-062	0.19	C-9-106	0.18	C-9-154	0.4	C-9-200	0.43
C-9-063	0.43	C-9-107	0.33	C-9-155	0.36	C-9-201	0.31
C-9-064	0.46	C-9-108	0.3	C-9-156	0.35	C-9-202	0.44
C-9-064A	0.46	C-9-109	0.41	C-9-157	0.25	C-9-203	0.4
C-9-065	0.42	C-9-110	0.18	C-9-158	0.26	C-9-204	-0.5
C-9-066	0.14	C-9-111	0.21	C-9-159	0.33	C-9-206	0.41
C-9-067	0.16	C-9-112	0.43	C-9-160	0.32	C-9-207	-0.5
C-9-068	0.2	C-9-113	0.44	C-9-162	0.32	C-9-208	0.4
C-9-069	0.22	C-9-114	0.17	C-9-163	0.29	C-9-210	-0.5
C-9-070	0.28	C-9-115	0.14	C-9-164	0.24	C-9-211	0.41
C-9-071	0.45	C-9-115A	-0.03	C-9-165	0.32	C-9-212	-0.09
C-9-072	0.23	C-9-115B	0.18	C-9-166	0.4	C-9-213	0.39
C-9-073	0.16	C-9-116	-0.09	C-9-167	0.44	C-9-214	0.44
C-9-074	0.44	C-9-117	0.38	C-9-168	0.46	C-9-215	0.29
C-9-075	0.44	C-9-118	0.14	C-9-169	0.44	C-9-215A	0.24
C-9-076	0.45	C-9-118A	-0.02	C-9-170	0.42	C-9-216	0.09
C-9-077	0.46	C-9-120	-0.04	C-9-171	0.41		
C-9-078	0.46	C-9-121	0.16	C-9-172	0.29		

**Buildout System Reserve Capacity**

Pipe	Reserve d/D								
1	0.48	C-1-021	0.46	C-1-058	0.37	C-1-105	0.31	C-2-023	0.35
2	0.44	C-1-022	0.41	C-1-059	0.49	C-1-106	0.24	C-2-024	0.32
3	0.5	C-1-023	0.33	C-1-060	0.49	C-1-107	0.23	C-2-025	0.28
4	0.38	C-1-023B	0.5	C-1-061	0.46	C-1-108	0.22	C-2-026	0.26
5	0.27	C-1-023C	0.49	C-1-063	0.46	C-1-109	0.22	C-2-028	0.34
6	0.29	C-1-023D	0.48	C-1-063A	0.46	C-1-110	0.33	C-2-029	0.41
7	0.31	C-1-023E	0.47	C-1-064	0.44	C-1-111	0.44	C-2-030	0.39
8	0.32	C-1-023F	0.46	C-1-065	0.38	C-1-112	0.43	C-2-031	0.33
9	0.46	C-1-023G	0.46	C-1-066	0.37	C-1-113	0.42	C-2-032	0.35
10	0.36	C-1-023H	0.46	C-1-067	0.48	C-1-114	0.44	C-2-033	0.37
11	0.31	C-1-023I	0.46	C-1-068	0.46	C-1-115	0.2	C-2-034	0.42
12	0.39	C-1-023J	0.45	C-1-070	0.34	C-1-116	0.19	C-2-034-B	0.37
13	0.4	C-1-023K	0.42	C-1-071	0.42	C-1-117	0.44	C-2-035	0.44
C-ADD-1	0.09	C-1-024	0.32	C-1-072	0.44	C-1-118	0.44	C-2-036	0.48
C-ADD-1A	0.11	C-1-025	0.23	C-1-073	0.46	C-1-119	0.19	C-2-037	0.48
C-ADD-2	0.06	C-1-026	0.26	C-1-074	0.46	C-1-120	0.44	C-2-038	0.44
C-ADD-4	0.01	C-1-027	0.35	C-1-075	0.45	C-1-121	0.45	C-2-039	0.42
C-ADD-3	0.01	C-1-028	0.32	C-1-076	0.48	C-1-122	0.44	C-2-040	0.44
C-ADD-5	0	C-1-029	0.39	C-1-078	0.49	C-1-123	0.42	C-2-041	0.46
C-ADD-6	-0.06	C-1-030	0.39	C-1-079	0.49	C-1-124	0.42	C-2-042	0.45
C-ADD-6A	0.05	C-1-031	0.39	C-1-080	0.34	C-1-125	0.44	C-2-043	0.43
C-ADD-7	-0.13	C-1-032	0.38	C-1-081	0.35	C-1-126	0.23	C-2-044	0.43
C-ADD-8	0.31	C-1-033	0.34	C-1-082	0.34	C-1-127	0.15	C-2-045	0.47
C-MH-1	0.2	C-1-034	0.3	C-1-083	0.46	C-1-128	0.07	C-2-047	0.47
C-MH-2	0.15	C-1-035	0.31	C-1-084	0.47	C-1-129	0.04	C-2-048	0.47
C-A14	0.1	C-1-036	0.39	C-1-085	0.47	C-1-130	-0.06	C-2-049	0.47
C-1-000	0.44	C-1-037	0.49	C-1-086	0.47	C-1-131	-0.04	C-2-050	0.43
C-1-001	0.39	C-1-038	0.3	C-1-087	0.47	C-1-132	0.2	C-2-051	0.47
C-1-002	0.39	C-1-039	0.28	C-1-088	0.47	C-2-001	0.38	C-2-052	0.49
C-1-003	0.39	C-1-040	0.23	C-1-089	0.45	C-2-005	0.37	C-2-053	0.36
C-1-005	0.38	C-1-041	0.2	C-1-090	0.45	C-2-006	0.43	C-2-054	0.42
C-1-007	0.36	C-1-042	0.22	C-1-091	0.47	C-2-006A	0.38	C-2-055	0.47
C-1-008	0.36	C-1-043	0.31	C-1-092	0.48	C-2-007	0.27	C-2-056	0.44
C-1-009	0.4	C-1-046	0.22	C-1-093	0.44	C-2-008	0.27	C-2-057	0.4
C-1-010	0.37	C-1-047	0.23	C-1-094	0.44	C-2-009	0.4	C-2-058	0.37
C-1-011	0.36	C-1-048	0.4	C-1-095	0.46	C-2-011	0.42	C-2-059	0.37
C-1-012	0.48	C-1-049	0.32	C-1-096	0.45	C-2-012	0.46	C-2-060	0.37
C-1-013	0.48	C-1-050	0.34	C-1-097	0.45	C-2-013	0.46	C-2-061	0.38
C-1-014	0.42	C-1-051	0.39	C-1-098	0.44	C-2-014	0.48	C-2-062	0.44
C-1-015	0.37	C-1-052	0.46	C-1-099	0.43	C-2-017	0.42	C-2-063	0.46
C-1-016	0.37	C-1-053	0.45	C-1-100	0.41	C-2-018	0.44	C-2-063A	0.46
C-1-018	0.49	C-1-054	0.47	C-1-101	0.39	C-2-019	0.41	C-2-064	0.34
C-1-019	0.47	C-1-055	0.47	C-1-102	0.41	C-2-020	0.41	C-2-065	0.31
C-1-019A	0.48	C-1-056	0.48	C-1-103	0.39	C-2-021	0.42	C-2-065A	0.39
C-1-020	0.46	C-1-057	0.39	C-1-104	0.39	C-2-022	0.39	C-2-066	0.27

**Buildout System Reserve Capacity**

Pipe	Reserve d/D								
C-2-067	0.33	C-2-114	0.47	C-3-020	0.3	C-3-066	0.47	C-3-111	0
C-2-068	0.35	C-2-115	0.47	C-3-021	0.05	C-3-067	0.3	C-3-112	0.04
C-2-069	0.29	C-2-116	0.47	C-3-022	-0.01	C-3-068	0.18	C-3-113	0.03
C-2-070	0.28	C-2-117	0.48	C-3-024	0.14	C-3-069	0.18	C-3-114A	0.2
C-2-071	0.28	C-2-118	0.09	C-3-027	0.14	C-3-070	0.02	C-3-115	0.38
C-2-072	0.22	C-2-119	0.16	C-3-028	0.09	C-3-071	0	C-3-116	0.36
C-2-073	0.24	C-2-120	0.23	C-3-029	0.14	C-3-072	0.46	C-3-117	0.38
C-2-074	0.39	C-2-121	0.19	C-3-032	0.07	C-3-073	0.45	C-3-118	0.46
C-2-075	0.43	C-2-122	0.18	C-3-034	0.25	C-3-074	0.44	C-3-119	0.42
C-2-076	0.45	C-2-123	0.3	C-3-034A	0.45	C-3-075	0.21	C-3-120	0.39
C-2-077	0.31	C-2-124	0.44	C-3-035	0.11	C-3-076	0.01	C-3-121	0.4
C-2-078	0.3	C-2-125	0.45	C-3-036	0.43	C-3-077	0.05	C-3-122	0.41
C-2-079	0.28	C-2-126	0.13	C-3-037	0.13	C-3-078	0.12	C-3-123	0.43
C-2-080	0.25	C-2-127	0.08	C-3-038	0.13	C-3-079	-0.01	C-3-124	0.46
C-2-081	0.24	C-2-128	0.12	C-3-039	0.07	C-3-080	0	C-3-125	0.47
C-2-082	0.25	C-2-129	0.15	C-3-041	0.21	C-3-080B	0.3	C-3-126	0.42
C-2-083	0.25	C-2-130	0.11	C-3-042	0.32	C-3-080C	0.46	C-3-127	0.41
C-2-084	0.24	C-2-131	0.03	C-3-043	0.35	C-3-080D	0.46	C-3-128	0.41
C-2-085	0.23	C-2-132	0.03	C-3-044	0.44	C-3-080E	0.49	C-3-129B	0.41
C-2-086	0.19	C-2-133	0.26	C-3-045	0.46	C-3-080F	0.5	C-3-130	0.42
C-2-087	0.17	C-2-134	0.45	C-3-046	0.36	C-3-081	0.16	C-3-131	0.43
C-2-088	0.18	C-2-136	0.43	C-3-047	0.46	C-3-082	0.45	C-3-132	0.43
C-2-089	0.14	C-2-137	0.25	C-3-048	0.3	C-3-083	0.45	C-3-133	0.4
C-2-090	0.2	C-2-138	0.43	C-3-049	0.47	C-3-084	0.46	C-3-134	0.38
C-2-091	0.32	C-2-139	0.45	C-3-050	0.46	C-3-085	0.47	C-3-136	0.21
C-2-092	0.36	C-2-140	0.45	C-3-051	0.46	C-3-086	0.11	C-3-137	0.22
C-2-095	0.23	C-2-141	0.46	C-3-052	0.46	C-3-087	0.1	C-3-138	0.21
C-2-096	0.34	C-3-001	0.35	C-3-053	0.42	C-3-088	0.09	C-3-139	0.46
C-2-097	0.34	C-3-002	0.25	C-3-054	0.44	C-3-089	0.1	C-3-140	0.44
C-2-098	0.43	C-3-003	0.2	C-3-055	0.44	C-3-090	0.11	C-3-141	0.42
C-2-099	0.4	C-3-004	0.21	C-3-056	0.44	C-3-091	0.28	C-3-142	-0.04
C-2-100	0.42	C-3-005	0.18	C-3-057	0.45	C-3-092	0.28	C-3-143	-0.18
C-2-101	0.42	C-3-006	0.17	C-3-058	0.47	C-3-093	0.48	C-3-144	-0.03
C-2-102	0.43	C-3-008	0.3	C-3-059	0.29	C-3-094	0.46	C-3-145	0.17
C-2-103	0.44	C-3-009	0.45	C-3-060	0.26	C-3-095	0.41	C-3-146	0.21
C-2-104	0.43	C-3-010	0.47	C-3-060B	0.39	C-3-096	0.05	C-3-147	0.22
C-2-105	0.07	C-3-011	0.47	C-3-060C	0.43	C-3-100	0.41	C-3-148	0.41
C-2-106	0	C-3-012	0.47	C-3-060D	0.44	C-3-101	0.48	C-3-149	0.47
C-2-107	0.04	C-3-012A	0.44	C-3-060G	0.45	C-3-102	0.48	C-3-150	0.47
C-2-109	0.27	C-3-014	0.46	C-3-060H	0.43	C-3-104	0.43	C-3-151	0.42
C-2-110	0.18	C-3-015	0.45	C-3-061	0.37	C-3-105	0.44	C-3-152	0.43
C-2-110B	0.28	C-3-016	0.4	C-3-062	0.42	C-3-106	0.37	C-3-153	0.42
C-2-111	0.36	C-3-017	0.27	C-3-063	0.43	C-3-107	0.41	C-3-154	0.29
C-2-112	0.44	C-3-018	0.4	C-3-064	0.43	C-3-108	0.31	C-3-155	0.11
C-2-113	0.46	C-3-019	0.28	C-3-065	0.45	C-3-109	0.18	C-3-156	-0.02

**Buildout System Reserve Capacity**

<b>Pipe</b>	<b>Reserve d/D</b>								
C-3-157	0.45	C-5-003	0.46	C-5-047	0.44	C-5-094	0.31	C-6-027	0.37
C-3-158	0.44	C-5-004	0.4	C-5-048	0.45	C-5-096	0.13	C-6-028	0.38
C-3-159	0.44	C-5-005	0.45	C-5-049	0.43	C-5-097	0.18	C-6-029	0.27
C-3-160	0.16	C-5-006	0.44	C-5-050	0.45	C-5-098	0.23	C-6-030	0.2
C-3-161	0.11	C-5-007	0.44	C-5-051	0.46	C-5-099	0.15	C-6-031	0.25
C-3-162	0.08	C-5-008	0.41	C-5-052	0.47	C-5-101	0.26	C-6-032	0.4
C-3-163	0.09	C-5-009	0.44	C-5-053	0.46	C-5-102	0.36	C-6-033	0.32
C-3-165	0.05	C-5-0100	0.1	C-5-054	0.22	C-5-103	0.4	C-6-034	0.39
C-3-166	0.04	C-5-010-9	0.44	C-5-056B	0.21	C-5-104	0.4	C-6-035	0.48
C-3-170	0.16	C-5-011	0.4	C-5-057	0.26	C-5-105	0.44	C-6-036	0.5
C-3-171	0.46	C-5-012	0.46	C-5-058	0.29	C-5-106	0.44	C-6-037	0.38
C-4-001	0.38	C-5-013	0.45	C-5-059	0.29	C-5-107	0.45	C-6-038	0.46
C-4-003	0.13	C-5-014	0.44	C-5-060	0.36	C-5-108	0.46	C-6-039	0.45
C-4-005	0.03	C-5-015	0.44	C-5-061	0.29	C-5-109	0.47	C-6-040	0.41
C-4-006	0.17	C-5-016	0.41	C-5-062	0.25	C-5-110	0.44	C-6-041	0.23
C-4-007	0.32	C-5-017	0.35	C-5-063	0.36	C-5-111	0.45	C-6-042	0.14
C-4-008	0.19	C-5-018	0.38	C-5-064	0.47	C-5-112	0.48	C-6-043	0.26
C-4-010	0.18	C-5-020	0.48	C-5-065-B	0.45	C-5-113	0.47	C-6-044	0.37
C-4-011	0.14	C-5-021A	0.47	C-5-066	0.44	C-6-001	0.44	C-6-045	0.42
C-4-012	0.26	C-5-021B	0.46	C-5-067	0.43	C-6-002	0.41	C-6-046	0.15
C-4-013	0.38	C-5-022	0.44	C-5-068	0.43	C-6-003-A	0.46	C-6-047	0.45
C-4-014	0.45	C-5-023	0.46	C-5-069	0.42	C-6-003B	0.47	C-6-048	0.11
C-4-015	0.41	C-5-024	0.43	C-5-070	0.38	C-6-004	0.41	C-6-049	0.29
C-4-016	0.42	C-5-025	0.39	C-5-071	0.25	C-6-005	0.39	C-6-050	0.45
C-4-017	0.44	C-5-026	0.33	C-5-072	0.25	C-6-006	0.35	C-6-051	0.09
C-4-018	0.44	C-5-027	0.32	C-5-073	0.47	C-6-007	0.31	C-6-052	0.18
C-4-019	0.44	C-5-028	0.26	C-5-074	0.45	C-6-008	0.46	C-6-053	0.32
C-4-020	0.42	C-5-029	0.2	C-5-075	0.33	C-6-009	0.42	C-6-055	0.45
C-4-021	0.13	C-5-030	0.36	C-5-076	0.41	C-6-010	0.39	C-6-056	0.45
C-4-022	0.46	C-5-031	0.27	C-5-077	0.44	C-6-011	0.38	C-6-058	0.47
C-4-023	0.46	C-5-032	0.28	C-5-078	0.44	C-6-012	0.39	C-6-059	0.11
C-4-024	0.14	C-5-033	0.39	C-5-080	0.26	C-6-013	0.43	C-6-060	0.26
C-4-025	0.15	C-5-034	0.23	C-5-081	0.3	C-6-014	0.46	C-6-061	0.48
C-4-026	0.12	C-5-035	0.43	C-5-082	0.41	C-6-015	0.46	C-6-062	0.04
C-4-027	0.11	C-5-036	0.33	C-5-083	0.45	C-6-016	0.37	C-6-063	0.23
C-4-028	0.14	C-5-037	0.28	C-5-084	0.46	C-6-017	0.45	C-6-064	0.47
C-4-029	0.12	C-5-038	0.31	C-5-085	0.43	C-6-018	0.44	C-6-066	0.1
C-4-031	0.24	C-5-039	0.23	C-5-086	0.41	C-6-019	0.4	C-6-067	0.13
C-4-032	0.1	C-5-040	0.38	C-5-087	0.44	C-6-020	0.36	C-6-068	0.33
C-4-033	0.23	C-5-041	<b>-0.12</b>	C-5-088	0.44	C-6-021	0.33	C-6-069	0.14
C-4-034	0.37	C-5-042	<b>-0.06</b>	C-5-089	0.45	C-6-022	0.27	C-6-070	<b>-0.13</b>
C-4-035	0.4	C-5-043	0.03	C-5-090	0.47	C-6-023	0.32	C-6-071	<b>-0.32</b>
C-4-038	<b>-0.01</b>	C-5-044	0.43	C-5-091	0.23	C-6-024	0.28	C-6-072	<b>-0.1</b>
C-5-001	0.46	C-5-045	0.45	C-5-092	0.44	C-6-025	0.39	C-6-073	<b>-0.08</b>
C-5-002	0.45	C-5-046	0.47	C-5-093	0.38	C-6-026	0.39	C-6-074	<b>-0.03</b>

**Buildout System Reserve Capacity**

Pipe	Reserve d/D								
C-6-075	0.04	C-7-041B	0.44	C-7-093	0.4	C-8-006	0.33	C-8-062	0.31
C-6-076	0.02	C-7-042	0.43	C-7-094	0.31	C-8-008	0.26	C-8-063	0.27
C-6-077	0	C-7-043	0.42	C-7-095	0.36	C-8-009	0.48	C-8-064	0.29
<b>C-6-078</b>	<b>-0.14</b>	C-7-044	0.41	C-7-097	0.38	C-8-010	0.09	C-8-065	0.34
C-7-000	0.39	C-7-045	0.4	C-7-098	0.4	C-8-010A	0.43	C-8-066	0.26
C-7-002	0.15	C-7-046	0.37	C-7-099	0.44	C-8-011	0.43	C-8-067	0.4
<b>C-7-003</b>	<b>-0.16</b>	C-7-047	0.35	C-7-100	0.45	C-8-011A	0.45	C-8-068	0.34
<b>C-7-004</b>	<b>-0.25</b>	C-7-048	0.36	C-7-101	0.41	C-8-012	0.44	C-8-069	0.37
<b>C-7-005</b>	<b>-0.34</b>	C-7-049	0.35	C-7-102	0.38	C-8-014	0.4	C-8-070	0.38
<b>C-7-006</b>	<b>-0.26</b>	<b>C-7-050</b>	<b>-0.07</b>	C-7-103	0.39	C-8-015	0.38	C-8-071	0.39
C-7-007	0	C-7-051	0.3	C-7-105	0.41	C-8-016	0.38	<b>C-8-076</b>	<b>-0.03</b>
<b>C-7-008</b>	<b>-0.13</b>	C-7-052	0.3	C-7-106	0.22	C-8-017	0.34	C-8-078	0.42
C-7-009	0.06	C-7-053	0.36	C-7-107	0.32	C-8-018	0.3	C-8-079	0.41
C-7-010	0.4	C-7-054	0.42	C-7-108	0.37	C-8-019	0.28	C-8-080	0.14
C-7-011	0.38	C-7-055	0.34	C-7-109	0.22	C-8-020	0.45	<b>C-8-081</b>	<b>-0.1</b>
C-7-012	0.33	C-7-056	0.38	C-7-110	0.25	C-8-021	0.41	C-8-082	0.19
C-7-013	0.37	C-7-057	0.43	C-7-111	0.37	C-8-022	0.31	C-8-083	0.29
C-7-014	0.3	<b>C-7-062</b>	<b>-0.12</b>	C-7-112	0.36	C-8-023	0.03	C-8-084	0.35
C-7-015	0.32	<b>C-7-063</b>	<b>-0.12</b>	C-7-113	0.4	<b>C-8-024</b>	<b>-0.02</b>	C-8-085	0.36
C-7-016	0.34	<b>C-7-064</b>	<b>-0.14</b>	C-7-114	0.38	C-8-025	0.21	C-8-086	0.13
C-7-017	0.29	<b>C-7-065</b>	<b>-0.16</b>	C-7-115	0.42	<b>C-8-026</b>	<b>-0.02</b>	C-8-087	0.39
C-7-018	0.29	C-7-066	0.06	C-7-116	0.33	C-8-027	0.41	C-8-088	0.37
C-7-019	0.29	C-7-067	0.11	C-7-117	0.37	C-8-028	0.02	C-8-089	0.31
C-7-020	0.2	C-7-068	0.13	C-7-119	0.23	C-8-030A	0.43	C-8-090	0.33
C-7-021	0.34	C-7-069	0.24	C-7-120	0.16	C-8-031	0.46	C-8-099	0.22
C-7-022	0.3	C-7-071	0.4	C-7-121	0.15	C-8-033	0.42	C-8-101	0.39
C-7-023	0.37	C-7-072	0.39	C-7-122	0.2	C-8-035	0.43	C-8-102	0.04
C-7-024	0.45	C-7-073	0.26	C-7-123	0.21	C-8-035A	0.46	C-8-103	0.44
C-7-025	0.46	C-7-074	0.18	C-7-127	0.19	C-8-036	0.34	C-8-103A	0.45
C-7-026	0.12	C-7-075	0.06	C-7-128	0.18	C-8-037	0.3	C-8-104	0.42
<b>C-7-027</b>	<b>-0.07</b>	C-7-076	0.09	C-7-129	0.23	C-8-038	0.35	C-8-105	0.44
C-7-028	0.07	C-7-077	0.15	C-7-130	0.12	C-8-039	0.39	C-8-106	0.45
C-7-029	0.21	C-7-078	0.25	C-7-131	0.15	C-8-040	0.42	C-9-000	0.32
C-7-030	0.02	C-7-079	0.08	C-7-133	0.19	C-8-041	0.43	C-9-001	0.02
C-7-031	0.29	C-7-080	0.18	C-7-134	0.33	C-8-042	0.44	C-9-003	0
C-7-032	0.01	C-7-081	0.4	C-7-135	0.16	C-8-043	0.46	<b>C-9-005</b>	<b>-0.07</b>
C-7-033	0.05	C-7-083	0.42	C-7-136	0.31	C-8-050	0.31	C-9-007A	0.42
<b>C-7-034</b>	<b>-0.16</b>	C-7-085	0.06	C-7-137	0.29	C-8-054	0.41	C-9-008	0.43
<b>C-7-035</b>	<b>-0.2</b>	C-7-086	0.02	C-7-138	0.09	C-8-055	0.18	C-9-008A	0.42
C-7-036	0.1	C-7-087	0.2	C-8-000A	0.45	C-8-056	0.17	C-9-009	0.38
C-7-037	0.39	C-7-088	0.04	C-8-002	0.55	C-8-057	0.44	C-9-009A	0.41
C-7-038	0.38	C-7-089	0.42	C-8-003	0.43	C-8-058	0.43	C-9-010	0.35
C-7-039	0.42	C-7-090	0.23	C-8-004	0.44	<b>C-8-059</b>	<b>-0.02</b>	C-9-011	0.38
C-7-040	0.44	C-7-091	0.36	C-8-005	0.44	<b>C-8-060</b>	<b>-0.04</b>	C-9-012	0.46
C-7-041A	0.45	C-7-092	0.38	C-8-005A	0.41	C-8-061	0.34	C-9-013	0.31

**Buildout System Reserve Capacity**

Pipe	Reserve d/D								
C-9-014	0.32	C-9-066	0.03	C-9-111	0.12	C-9-158	0.12	C-9-204	-0.5
C-9-016	0.37	C-9-067	0.05	C-9-112	0.43	C-9-159	0.06	C-9-206	0.31
C-9-017	0.29	C-9-068	0.1	C-9-113	0.44	C-9-160	0.05	C-9-207	-0.5
C-9-018	0.27	C-9-069	0.14	C-9-114	0.06	C-9-162	0.07	C-9-208	0.32
C-9-019	0.26	C-9-070	0.22	C-9-115	0.02	C-9-163	-0.1	C-9-210	-0.5
C-9-020	0.14	C-9-071	0.45	C-9-115A	-0.21	C-9-164	-0.38	C-9-211	0.39
C-9-021	0.17	C-9-072	0.17	C-9-115B	0.08	C-9-165	0.02	C-9-212	-0.1
C-9-022	0.25	C-9-073	0.06	C-9-116	-0.26	C-9-166	0.28	C-9-213	0.34
C-9-023	0.46	C-9-074	0.44	C-9-117	0.19	C-9-167	0.35	C-9-214	0.44
C-9-024	0.1	C-9-075	0.44	C-9-118	0.16	C-9-168	0.4	C-9-215	0.23
C-9-025	0.02	C-9-076	0.45	C-9-118A	0.01	C-9-169	0.4	C-9-215A	0.18
C-9-026	-0.04	C-9-077	0.46	C-9-120	0	C-9-170	0.33	C-9-216	-0.04
C-9-027	0	C-9-078	0.46	C-9-121	0.19	C-9-171	0.05		
C-9-028	0.37	C-9-079	0.44	C-9-123	0.37	C-9-172	-0.37		
C-9-029	0.42	C-9-080	0.46	C-9-126	0.39	C-9-173	-0.5		
C-9-031	0.44	C-9-081	0.45	C-9-127	0.43	C-9-174	-0.5		
C-9-035	0.07	C-9-082	0.43	C-9-128	0.45	C-9-175	-0.5		
C-9-036	0.21	C-9-083	0.42	C-9-129	0.23	C-9-176	-0.5		
C-9-036A	0.43	C-9-084	0.4	C-9-134	0.27	C-9-177	-0.5		
C-9-040	-0.06	C-9-085	0.43	C-9-134A	0.42	C-9-178	-0.5		
C-9-041	0.4	C-9-086	0.46	C-9-135	0.08	C-9-179	-0.5		
C-9-042	0.04	C-9-087	0.17	C-9-136	0.07	C-9-180	-0.5		
C-9-043	-0.16	C-9-088	0.32	C-9-136A	0.22	C-9-181	-0.5		
C-9-044	-0.07	C-9-089	0.26	C-9-137	0.27	C-9-182	-0.5		
C-9-045	-0.1	C-9-090	0.35	C-9-137A	0.31	C-9-183	-0.5		
C-9-046	-0.03	C-9-091	0.18	C-9-138	0.05	C-9-184	-0.5		
C-9-047	-0.07	C-9-092	-0.01	C-9-139	-0.18	C-9-185	-0.5		
C-9-048	0.34	C-9-093	0.26	C-9-139A	-0.02	C-9-186	0.01		
C-9-049	-0.14	C-9-094	0.4	C-9-140A	0.02	C-9-186A	-0.26		
C-9-050	-0.22	C-9-095	0.39	C-9-141	0.06	C-9-187	-0.5		
C-9-051	0.44	C-9-096	0.41	C-9-142	-0.14	C-9-188	-0.04		
C-9-052	0.48	C-9-097	0.44	C-9-142A	-0.34	C-9-190	-0.5		
C-9-053	-0.04	C-9-098	0.43	C-9-143	0.34	C-9-191	-0.5		
C-9-054	0.01	C-9-099	0.4	C-9-144	0.33	C-9-192	0		
C-9-055	0.13	C-9-100	0.37	C-9-146	-0.01	C-9-192A	-0.5		
C-9-056	0.44	C-9-101	0.35	C-9-147	0.13	C-9-193	0.21		
C-9-057	0.44	C-9-102	0.4	C-9-148	0.1	C-9-194	0.25		
C-9-058	0.45	C-9-103	0.34	C-9-149	0.19	C-9-195	0.2		
C-9-059	0.03	C-9-104	0.37	C-9-150	0.13	C-9-196	0.32		
C-9-061	0.02	C-9-105	0.15	C-9-152	-0.02	C-9-197	0.41		
C-9-062	0.08	C-9-106	0.05	C-9-153	0.45	C-9-199	0.4		
C-9-063	0.44	C-9-107	0.34	C-9-154	0.36	C-9-200	0.33		
C-9-064	0.46	C-9-108	0.31	C-9-155	0.28	C-9-201	0.1		
C-9-064A	0.46	C-9-109	0.42	C-9-156	0.28	C-9-202	0.37		
C-9-065	0.42	C-9-110	0.08	C-9-157	0.19	C-9-203	0.3		